OREGON NATURAL HAZARDS MITIGATION PLAN

2015

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Approved by FEMA September 24, 2015

Effective through September 23, 2020

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was provided in part by a grant from the Federal Emergency Management Agency.

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State of Oregon Promulgation

KATE BROWN
Governor

July 1, 2015

Mr. Kenneth Murphy, Region X Administrator
Federal Emergency Management Agency
US Department of Homeland Security
Federal Regional Center
130 228th Street, SW
Bothell, WA 98021-8627

Dear Mr. Murphy,

The State of Oregon is pleased to submit the updated *Oregon Natural Hazards Mitigation Plan*.

The Plan's stated mission, *Create a disaster-resilient State of Oregon*, is supported by its vision that ultimately *Natural hazard events result in no loss of life, minimal property damage, and limited long-term impacts to the economy*. The Plan contains the most complete and up-to-date description of Oregon's natural hazards and their probability, the State's vulnerabilities, its mitigation strategies and implementation capability. It is the result of a coordinated effort overseen by the State Interagency Hazard Mitigation Team, a collaborative body providing expertise and support for natural hazard mitigation planning and implementation statewide.

The *Oregon Natural Hazards Mitigation Plan* meets the requirements of Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended, as well as those of 44 CFR 201 and 206, maintaining the State of Oregon's eligibility for Stafford Act assistance and non-disaster hazard mitigation programs. The Plan includes a Repetitive Loss Strategy meeting the requirements of 44 CFR §201.4(c)(3)(v) which qualifies the state to request increased funding for mitigating repetitive loss properties under the Flood Mitigation Assistance Program. The Plan also meets the Enhanced Plan requirements of 44 CFR 201.5 which qualifies the state to receive additional funding under the Hazard Mitigation Grant Program. The Enhanced Plan designation recognizes the State of Oregon's commitment to maintaining and supporting a comprehensive natural hazard mitigation program.

I hereby adopt the Oregon Natural Hazards Mitigation Plan and assure that the State of Oregon will continue to comply with all applicable federal statutes and regulations in effect with respect to the periods for which it receives grant funding in compliance with 44 CFR 13.11(c), and will amend this plan as necessary to reflect changes in state or federal statutes and regulations as required in 44 CFR 13.11(d).

Sincerely,

Kate Brown

Governor Kate Brown

KB/HM/ad

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Federal Emergency Management Agency Approval

Governor Brown
September 24, 2015
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We look forward to continuing a productive relationship between FEMA Region X and the State of Oregon. Please contact our Regional Mitigation Planning Manager, Kristen Meyers, at 425-487-4543, or our Mitigation Division Director, Mark Carey, at 425-487-4687 with any questions or for further assistance.

Sincerely,

Kenneth D. Murphy
Regional Administrator

Enclosure

KM

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

FEMA

September 24, 2015

Honorable Kate Brown
Governor, State of Oregon
160 State Capitol
900 Court Street
Salem, Oregon 97301-4047

Dear Governor Brown:

Congratulations, the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) has approved the 2015 update to the ***Oregon Natural Hazards Mitigation Plan*** as an Enhanced State Plan, in accordance with 44 CFR Part 201.5. The State of Oregon continues to be eligible for Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) non-emergency programs through September 23, 2020. To continue eligibility, the plan must be reviewed, revised as appropriate and re-submitted for approval within five years from the date of this letter.

As a result of the Disaster Mitigation Act of 2000, states and tribes are required to develop and maintain hazard mitigation plans compliant with FEMA standards as a condition for receiving non-emergency Stafford Act assistance. Applicable Stafford Act assistance includes Public Assistance (Categories C-G), Fire Management Assistance, Hazard Mitigation Grant Program, and Pre-Disaster Mitigation grants. For local entities and tribes who conduct their emergency management activities and programs through the state, a FEMA approved local plan is required for hazard mitigation project grant eligibility.

FEMA's approval of your updated plan as an Enhanced State Plan provides the State of Oregon continued availability of various Stafford Act programs. All requests for assistance, however, will be evaluated individually according to the specific eligibility and other requirements of the particular programs. For example, a mitigation action identified in the approved plan may or may not meet the eligibility requirements for HMGP funding. FEMA's program specialists are available to answer any questions regarding specific program requirements and eligibility.

FEMA approval of your Enhanced State mitigation plan is based partially on a review of your mitigation program management performance [44 CFR 201.5 (b)(2)(iii A-D)] since the State of Oregon's previous Enhanced State mitigation plan approval. It is important to be aware that when you submit your next plan update for FEMA approval, in accordance with our regulatory requirement, the review of your mitigation program management performance will cover the full period of time between this approval and the next submission of your plan.

www.fema.gov

Executive Summary

Introduction

The Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) was signed into law on November 23, 1988 and provides the legal authority for most federal disaster response activities, particularly Federal Emergency Management Agency (FEMA) activities and programs. The Disaster Mitigation Act of 2000 (DMA 2000) amended the Stafford Act, emphasizing the need for state, local, and Indian Tribal entities to coordinate hazard mitigation efforts. It made the existing requirement for states to have natural hazard mitigation plans a prerequisite for disaster assistance, and provided an incentive in the form of additional funding for states that enhance coordination and integration of mitigation planning and activities. The State of Oregon's Natural Hazard Mitigation Plan (NHMP) is such an "enhanced plan." Oregon has received and made good use of the additional incentive funding following past disasters. Oregon also continues to advance coordination and integration of natural hazard mitigation planning with other state plans and programs.

The Code of Federal Regulations Title 44, Part 201 (44 CFR Part 201) implements DMA2K by establishing requirements for developing and updating state, local, and Indian Tribal natural hazard mitigation plans (NHMPs). An amendment to 44 CFR Part 201 effective May 27, 2014, extended the state and Indian Tribal NHMP planning cycle from 3 to 5 years. The first Oregon NHMP was completed in 1992; it was updated in 2000, 2004, 2006, 2009, 2012, and now 2015.

The stated mission of this Plan is to *Create a disaster-resilient state of Oregon*, which is elucidated by its vision that ultimately *Natural hazard events result in no loss of life, minimal property damage, and limited long-term impacts to the economy.* From this guidance and the Plan's risk assessment flow 11 goals and well over one hundred specific actions calibrated to advance disaster resilience through natural hazard mitigation in the State of Oregon.

Disasters occur as a predictable interaction among three broad systems: natural systems, the built environment, and social systems. What is not predictable is exactly when natural hazards will occur or the extent to which they will affect communities within the state.

Hazard mitigation is defined at 44 CFR 201.2 as *any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards.* Benefits of hazard mitigation activities include fewer injuries and deaths; less damage to buildings, critical facilities, and infrastructure; diminished interruption in essential services; reduced economic hardship; minimized environmental harm; and quicker, lower-cost recovery.

The Oregon NHMP contains the most complete and up-to-date description of Oregon's natural hazards and their probability, the state's vulnerabilities, its mitigation strategies and implementation capability. Oregon's counties and cities can rely upon this information when preparing local natural hazard mitigation plans.

The Oregon NHMP is one component of the first volume of the Oregon Emergency Management Plan, administered by the Oregon Military Department's Office of Emergency Management.

Risk Assessment

Introduction

The purpose of the Oregon NHMP Risk Assessment is to identify and characterize Oregon's natural hazards, determine which jurisdictions are most vulnerable to each hazard and estimate potential losses to vulnerable structures and infrastructure and to state facilities from those hazards.

Assessing the state's level of risk involves three components: characterizing natural hazards, assessing vulnerabilities, and analyzing risk. Characterization involves determining cause and characteristics, documenting historic events, and evaluating future probability of occurrence.

A vulnerability assessment combines information from the hazard characterization 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 each hazard.

A risk analysis involves estimating the damages, injuries, and costs likely to be incurred in a geographic area over a period of time. Risk has two measurable components: (a) the magnitude of the harm that may result, defined through vulnerability assessments; and (b) the likelihood or probability of the harm occurring. Together, the Oregon Hazards and Oregon Vulnerabilities sections form the risk analysis at the state level.

Regional risk assessments begin with a description of the region's natural environment, demographics, economy, infrastructure, and built environment followed by a region-specific hazard characterization, vulnerability assessment, and risk analysis.

Oregon Hazards Overview

Oregon is subject to 11 natural hazards:

- Coastal Hazards
- Droughts
- Dust Storms
- Earthquakes
- Floods
- Landslides
- Tsunamis
- Volcanoes
- Wildfires
- Windstorms
- Winter Storms

Each hazard is analyzed statewide and at a regional level. The regions used for this analysis are shown in **Figure ES-1** and are physiographic regions delineated specifically for the purposes of the Oregon NHMP risk assessment. The hazards impacting each region are identified in **Table ES-1**.

Figure ES-1. Oregon NHMP Natural Hazard Regions

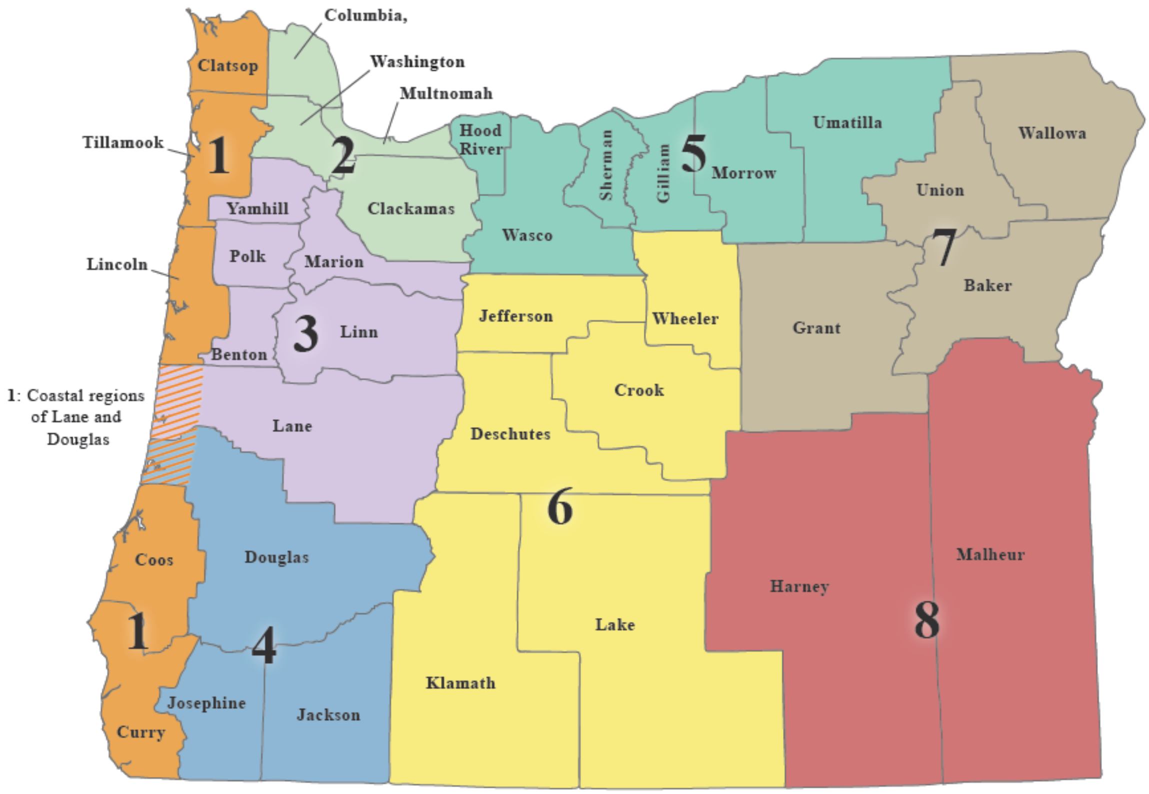

Table ES-1. Hazards Impacting Natural Hazard Mitigation Regions

Hazard	Region							
	1	2	3	4	5	6	7	8
Coastal Hazards	✓							
Droughts	✓	✓	✓	✓	✓	✓	✓	✓
Dust Storms					✓	✓	✓	✓
Earthquakes	✓	✓	✓	✓	✓	✓	✓	✓
Floods	✓	✓	✓	✓	✓	✓	✓	✓
Landslides	✓	✓	✓	✓	✓	✓	✓	✓
Tsunamis	✓							
Volcanoes	✓	✓	✓	✓	✓	✓	✓	✓
Wildfires	✓	✓	✓	✓	✓	✓	✓	✓
Windstorms	✓	✓	✓	✓	✓	✓	✓	✓
Winter Storms	✓	✓	✓	✓	✓	✓	✓	✓

Introduction to Climate Change in Oregon

Climate is an important element in certain natural hazards, even though in itself, climate is not a distinct natural hazard.

Climate change is an important stressor that significantly influences the incidence — and in some cases the location — of natural hazards and hazard events. Climate change is anticipated to affect the frequency, magnitude, or both of some natural hazards in Oregon. Over the period 1895-2011 (the observed record), temperatures across the Pacific Northwest have increased by 1.3°F while annual precipitation amounts have remained within the normal range of annual variability. During the same period, Cascade Mountain snowpacks have declined, and higher temperatures are causing earlier spring snowmelt and spring peak streamflows. On the coast, increasing deep-water wave heights in recent decades are likely to have increased the frequency of coastal flooding and erosion. In Oregon's forested areas, large areas have been impacted by disturbances that include wildfire in recent years, and climate change is probably one major factor. A three-fold increase in heat-related illness has been documented in Oregon with each 10 ˚F rise in daily maximum temperature.

Every climate model shows an increase in temperature for the Pacific Northwest, with the magnitude of the increase depending on rate or magnitude of global greenhouse gas emissions. Each season will be warmer in the future, and the largest amount of warming will occur in the summer.

Sea levels and wave heights are the primary climate-related drivers that influence rates of coastal erosion. Recent research indicates that sea levels along Oregon's coast are rising and that significant wave heights off the Oregon coast are increasing. Rising sea levels and increasing wave heights are both expected to increase coastal erosion and coastal flooding. Increased coastal erosion can lead to loss of natural buffering functions of beaches, tidal wetlands, and dunes, and will likely increase damage to private property and infrastructure situated on coastal shorelands.

Warmer, drier conditions are projected to increase the incidence of drought, wildfire, and dust storms in all eight regions in the state, and particularly in southwest, central, and eastern Oregon. More frequent droughts are likely to cause significant economic damage to the agriculture industry through reduced yields and quality of some crops. Droughts can also significantly increase demand for groundwater and surface water, impacting drinking water supply and aquatic systems. Drought-dried soils increase the potential for wildfire and dust storms. More frequent and intense wildfires are likely to damage larger areas, posing greater risk to human health through exposure to smoke and greater ecosystem and habitat damage. Increased risk of wildfire also leads to increased potential for economic damage (e.g., property infrastructure, commercial timber, recreational opportunities) at the urban-wildland interface.

The projected increase in extreme precipitation is expected to result in a greater risk of flooding in certain basins. Generally, western Oregon basins (Oregon NHMP Natural Hazard Regions 1–4) are projected to experience increased flood risk in future decades. In other areas of the state, flood risk may decrease in some basins and increase in others. Areas thought to be outside the floodplain may begin to experience flooding, increasing vulnerability of structures not built to floodplain management standards. Increased rainfall and extreme precipitation events are also likely to trigger more landslides. More floods and landslides will increase damage to property and infrastructure. Transportation systems may also be affected, potentially impacting distribution of water, food, and essential services.

Table ES-2 shows which hazards in each Oregon NHMP Natural Hazard Region are expected to be impacted by climate change.

Table ES-2. Climate Change Impacts Projected for Each Oregon NHMP Natural Hazard Region

	Region							
Hazard	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Coastal Erosion / Sea Level Rise	X							
Droughts	X	X	X	X	X	X	X	X
Dust Storms	X	X	X	X	X	X	X	X
Wildfires	X	X	X	X	X	X	X	
Winter Storms	unknown							
Floods	X	X	X	X				
Landslides	X	X	X	X				
Windstorms	unknown							

Three important Oregon initiatives address climate change across the state. The **Oregon Climate Assessment Report** (Dello & Mote, 2010) was the first ever comprehensive scientific assessment of climate change in Oregon. This report was updated by the **2013 Northwest Climate Assessment Report** (Dalton et al., 2013). In addition, the **Oregon Climate Change Adaptation Framework** (2010) was a collaborative effort among state agencies and institutes to begin to establish a rigorous framework for addressing the effects of climate change in Oregon. Oregon's framework is the first state-level adaptation strategy based on *climate risks* as opposed to *affected sectors*. It identifies 11 climate-related risks for which the state must plan. Five of those 11 — droughts, coastal erosion, wildfires, floods, and landslides — are directly identified in the Oregon NHMP. Three other hazards in the Oregon NHMP — windstorms, winter storms, and dust storms — have an underlying climate component. Together, these bodies of work inform the state about changing climate conditions in Oregon and their principal effects on the natural hazards addressed in the Oregon NHMP.

Climate change is intentionally treated separately from hazards in this Plan, except for describing how climate change is predicted to impact the probability of a hazard occurring in the future. This is because the most localized scale of the best available climate change data is the Pacific Northwest region. Since the Pacific Northwest region is relatively homogenous in its climate, projections for the Pacific Northwest are relevant for planning in Oregon. Data for individual hazards are available at state and some local scales. As climate change data become available at more local scales they will be included in future Oregon NHMP updates.

State and Regional Risk Assessments

Methodology

Currently, to identify the probability of each hazard and the communities most vulnerable to each hazard, each is assessed at the county level and statewide. Local emergency program managers, usually with the assistance of a team of local public safety officials, perform county-level assessments. At the state level, state agencies' subject matter experts perform the assessments. The local and state assessments are presented together in the Regional Risk Assessments.

Local risk assessments employ the same methodology statewide. FEMA developed the methodology and together with the state adjusted it for Oregon. The local risk assessment team first identifies the community's relevant hazards, then scores each one in four categories: history, probability, vulnerability, and maximum threat. Total scores range from 24 (low) to 240 (high). This method provides local jurisdictions with a sense of hazard priorities, or relative risk. It is also intended to provide comparison of the same hazard between local jurisdictions statewide.

Although this methodology is consistent statewide, the reported raw scores for each county are based on partially subjective rankings for each hazard. Because the rankings are used to describe the relative risk of a hazard within a county, and because each county conducted the analysis with a different team of people using slightly different assumptions, comparisons between local risk assessments must be treated with caution.

The state relies on subject matter experts in one or more agencies to determine the best method or combination of methods to establish probability of and vulnerability to each hazard. Due to the wide range of data available for each hazard, the method used to assess risk varies from hazard to hazard. In general, each hazard is assessed using a combination of exposure, historical, and scenario analyses. Hazards for which more data exist have undergone a more robust analysis.

State and Local Vulnerability Comparison

Some state and local vulnerability assessments are quite consistent, while others are starkly inconsistent. Similarities and differences between state and local level vulnerability assessments have not been analyzed. The state has prioritized communication and education among state and local staff responsible for assessing vulnerability to improve understanding and consistency for future local and state plan updates.

New Risk Assessment Methodology

During this update, the Risk Assessment Subcommittee of the State Interagency Hazard Mitigation Team conceptualized a new risk assessment methodology that would be standardized statewide and across all hazards. When this new concept becomes a fully developed model, it is expected to identify the drivers of vulnerability and provide a comparison of vulnerability at the local level, improving the ability of the state to weigh various mitigation actions and direct resources to the most vulnerable areas.

Profiles

The descriptions of the natural environment, demographics, economy, infrastructure, and built environment in each Regional Risk Assessment's "Profile" section shows that region's existing strengths and weaknesses, highlighting potential vulnerabilities to natural hazard events. Together with information about the natural hazards that may impact each region, this understanding better enables policy makers to develop and implement effective mitigation actions. Following is a brief, general summary of the eight Oregon NHMP Natural Hazard Regions' social, economic, infrastructure, and built environment profiles.

Demographic Profile

The demographic profile of Oregon's population varies widely from region to region. The Coast and Willamette valley have high numbers of tourists who may not be aware of the type and degree of hazard risk or preparedness needs in the area. Homelessness is on the rise in portions of the Willamette Valley and Southwest Oregon. In all regions except the Northern Willamette Valley and Southeast Oregon, there are high percentages of seniors. Conversely, in the Northern Willamette Valley and Southeast Oregon, there are high percentages of children. Educational attainment among the populations of some coastal communities and in Southwest Oregon, the Mid-Columbia Region, and Northeast Oregon tends to be lower. The share of persons who do not speak English very well is greater for some communities in Willamette Valley, Mid-Columbia, and Southeast Oregon.

Economic Profile

Communities along the Oregon Coast and in Central, Southeast, and Southwest Oregon were hit particularly hard by the financial crisis that began in 2007 and are still experiencing low job recovery rates. Because these regions have few key industries, rebounding is especially difficult. In general, wages are higher in the Northern Willamette Valley. Unemployment rates are higher in the regions outside the Coast and Willamette Valley.

Infrastructure Profile

Counties in all eight regions have transportation, energy, and water facilities or conveyance systems that are vulnerable to natural hazard events. The state's energy hub in the Portland Harbor area of the lower Willamette River is highly vulnerable to a seismic event due to liquefiable soils and to the age and poor condition of many facilities.

Built Environment Profile

Populations tend to cluster around transportation corridors. The majority of growth is occurring in the Willamette Valley. Each region outside the Willamette Valley has at least one county with a high proportion of mobile homes, which are inherently vulnerable to natural hazards. Also, in at least one county, half or more of the structures were built prior to current floodplain management or seismic standards.

Hazards and Vulnerability

Coastal Hazards

Wave-induced coastal erosion (both short- and long-term), wave runup and wave-induced flood hazards, wind-blown sand, coastal landslides, earthquakes, and potentially catastrophic tsunamis generated by the Cascadia Subduction Zone (CSZ) all affect Oregon's coastal strip. The region's natural landforms have restricted development to low-lying areas, chiefly along dunes, barrier spits, or along coastal bluffs subject to varying rates of erosion, and to low-lying areas adjacent to the numerous estuaries. Intense chronic storms at the coast gradually cause damage over time, impacting property, infrastructure, and ecosystem services.

Counties most vulnerable to coastal hazards: Tillamook, Lincoln, Clatsop, and Curry

Other communities considered vulnerable to coastal hazards: A few communities scattered through Coos County and the coastal area of Lane County, for example, adjacent to the south Coquille jetty in Bandon, along Lighthouse Beach near Cape Arago, Heceta Beach, and adjacent to the mouth of the Siuslaw River.

State-owned/leased facilities in the coastal erosion zone: There are 28 state-owned/leased facilities representing approximately $7 million in the coastal erosion zone. One of these is a state-owned/leased critical or essential facility.

Droughts

Oregon is continuously confronted with drought and water scarcity issues, despite its rainy reputation. Droughts can occur in Oregon in both summer and winter months. These events generally affect areas east of the Cascades and some specific locales across the state. Severe or prolonged drought can impact Oregon's public health, infrastructure, facilities, economy, and environment.

Counties most vulnerable to droughts: Klamath and Baker

Other counties considered vulnerable to droughts: Lake, Malheur, Sherman, Gilliam, and Morrow

Dust Storms

Dust storms occur most frequently in arid regions of Central and Eastern Oregon. With wind speeds of at least 25 miles per hour, dust storms can spread over hundreds of miles and rise over 10,000 feet. Airborne dust particles, or dust aerosols, alter the climate by intercepting sunlight traveling toward the earth's surface. Dust storms impact air quality, erode topsoil, and increase fine sediment loading in creeks and rivers. Dust storms can also damage equipment and engines and can cause vehicle collisions.

Counties most vulnerable to dust storms: Morrow and Umatilla

Other counties considered vulnerable to dust storms: Baker, Deschutes, Harney, Jefferson, Klamath, Lake, Malheur, Union, and Wasco

Earthquakes

Oregon is susceptible to four types of earthquakes: subduction zone, crustal, intraplate and volcano-induced earthquakes. The greatest threat to Oregon is a Cascadia Subduction Zone (CSZ) event. A CSZ event will primarily impact western Oregon. The heavily populated metropolitan areas of Portland, Salem, and Eugene will experience major damage and loss of life.

Since the publication of the 2012 Oregon NHMP, five major initiatives have taken place that boost the state's understanding of its earthquake risk.

First, the Oregon Department of Transportation (ODOT) conducted the **Statewide Loss Estimates: Oregon Highways Seismic Options Report** project that identified priority state-owned lifelines in a CSZ event. A three-tier roadway system was devised:

- Tier 1 provides access from Central Oregon, Washington, and California, and provides access to each region within the study area
- Tier 2 extends the reach of the Tier 1 system throughout seismically vulnerable areas of the state and provides lifeline route redundancy in the Portland Metro Area and Willamette Valley
- Tier 3, together with Tiers 1 and 2, provides an interconnected network with redundant paths to serve all of the study area

Second, DOGAMI published Open File Report O-13-09, Earthquake Risk Study for Oregon's Critical Energy Infrastructure Hub (Wang et al., 2013; http://www.oregongeology.org/sub/earthquakes/cei-hub-report.pdf). This report highlights the concentration of critical energy facilities in the Portland area and the potential statewide impacts of a seismic event affecting this hub.

Third, in 2013 the Cascadia Region Earthquake Workgroup (CREW) issued an updated scenario for a CSZ magnitude 9.0 event (**Appendix 9.1.20**). It explains the latest science and expected impacts, and suggests mitigation strategies.

Fourth, the Oregon Seismic Safety Policy Advisory Commission (OSSPAC) developed the **Oregon Resilience Plan** that was commissioned by a legislative resolution. The ORP estimated the impacts of a magnitude 9.0 CSZ earthquake on the state's population, buildings, and infrastructure. According to the ORP, recovery time estimates for coastal infrastructure in a Medium CSZ event will be:

- Electricity and natural gas, 3–6 months
- Drinking water and sewer systems, 1–3 years
- Healthcare facilities, 3 years

The ORP does not estimate recovery times for police and fire stations or the coastal transportation system. Recovery of the transportation system will no doubt be measured in years. Because the coast's economy is dependent on the transportation system, economic recovery would also be many years.

The ORP recommends actions for improving resilience to the CSZ event and that they be implemented over a 50-year period. Some examples:

- Comprehensively assessing key structures and systems
- Retrofitting Oregon's public buildings
- Helping Oregon's private sector improve resilience
- Revising public policies to streamline recovery and increase public preparedness

Finally, SB 33 (2013) established the Oregon Resilience Task Force to develop a plan to implement the ORP. The Task Force reported to the Oregon Legislature in October 2014 (**Appendix 9.2.6**).

The 10 counties projected to incur the most loss and damage due to a CSZ earthquake (most to least): Multnomah, Lane, Coos, Washington, Marion, Benton, Lincoln, Josephine, Clatsop, and Jackson

The 10 counties projected to incur the most loss and damage due to combined crustal earthquakes (most to least): Multnomah, Washington, Lane, Marion, Clackamas, Coos, Jackson, Benton, Linn, and Klamath

Other communities vulnerable to earthquakes: Seaside is the most vulnerable coastal town.

State-owned/leased facilities in an earthquake hazard zone: Almost all state facilities representing over $7 billion are in an earthquake hazard zone. 1,141 state-owned/leased critical or essential facilities are located in an earthquake zone.

Floods

Oregon has an extensive history of flooding, and there are localized risks of flooding across the state. Types of flooding in Oregon include riverine flooding, flash floods, coastal floods, shallow area flooding, urban flooding, playa flooding, and floods caused by ice jams and dam failure. In La Niña years, floods can be severe. In addition, channel migration has created hazardous conditions along developed river banks. The National Flood Insurance Program (NFIP) identifies 251 communities in Oregon as flood-prone including locations in all 36 counties, 212 cities, and three Indian Tribal Nations. Damage and loss of life occur when flood waters come into contact with the built environment or other areas where people congregate. In addition to taking lives and damaging property, floods can cause stream channels to migrate and erode and can precipitate landslides.

FEMA has identified 302 buildings in Oregon as repetitive loss properties, the majority of which are residential structures. There are only 11 severe repetitive loss properties in Oregon.

Counties most vulnerable to floods based on number of and dollar amount of National Flood Insurance Program (NFIP) claims: Clackamas, Columbia, and Tillamook

The 10 cities with the greatest percentage of land area in a 1% annual flood zone are (most to least): Helix, Scio, Burns, Warrenton, Seaside, Vernonia, Sheridan, Ione, Adams, and Athena

State-owned/leased facilities in a flood hazard zone: There are 788 state-owned/leased facilities representing nearly $900 million in flood hazard areas. 41 are state-owned/leased critical or essential facilities.

Landslides

Landslides occur across the state. In general, counties in Oregon have hundreds to thousands of existing landslides. Typically, areas with more relief and steeper slopes, such as the Coast Range and Cascade Mountains, tend to have more landslides. Three main factors influence an area's susceptibility to landslides: geometry of the slope, geologic material, and water. Landslides in Oregon are typically triggered by periods of heavy rainfall alone or with rapid snowmelt. Earthquakes, volcanoes, and human activities also trigger landslides. Average annual repair costs for landslides in Oregon exceed $10 million. As population increases in Oregon and development encroaches upon landslide-susceptible terrain, greater losses are likely to result. Major landslides have severed key transportation routes such as highways and rail lines causing temporary but significant statewide economic damage. Landslides that close US-101 or any of the highways connecting the I-5 corridor to the coast have a significant effect on commerce in the Oregon Coast Region.

Counties most vulnerable to landslides: Clackamas, Linn, Douglas, Coos, Lane, Tillamook, Multnomah, Benton, Jackson, Clatsop, Lincoln, Marion, Washington, Curry, Columbia, Hood River, and Yamhill

Other counties vulnerable to landslides: Multnomah, Clackamas, and Washington

State-owned/leased facilities in a landslide hazard area: There are 5,146 facilities representing nearly $7 billion in “High” and “Moderate” landslide hazard zones. 1,038 are state-owned/leased critical or essential facilities.

Tsunamis

The entire Oregon coast is at risk from distant and local tsunamis. Distant tsunamis caused by earthquakes on the Pacific Rim strike the Oregon coast frequently but few have caused significant damage or loss of life. Local tsunamis caused by a Cascadia Subduction Zone (CSZ) event happen much less frequently but will cause catastrophic damage and, without effective mitigation actions, great loss of life. Most locally-generated tsunamis will be higher and travel farther inland (overland and up river) than distant tsunamis. By the time a tsunami wave hits the coastline, it may be traveling at 30 mph and have heights of 20 to approximately 100 feet. The tsunami wave will break up into a series of waves that will continue to strike the coast for a day or more, with the most destructive waves arriving in the first 4-5 hours after the local earthquake. Significant loss of life and profound damage due to a local tsunami caused by a CSZ event is likely.

Counties most vulnerable to tsunami: All coastal counties. Clatsop and Tillamook counties have the greatest vulnerability. Gearhart, Cannon Beach, Rockaway Beach, Pacific City, Neskowin, Salishan Spit, Cutler City in Lincoln City, South Beach in Newport, and downtown Waldport are all extremely difficult to evacuate.

State-owned/leased facilities in a tsunami hazard zone: There are 676 state-owned/leased facilities representing approximately $134 million located in a tsunami zone. Of those, 105 are state-owned/leased critical or essential facilities.

Volcanoes

Volcanic activity can impact central Oregon, the Cascade Range, Southeast Oregon, and the Northern Basin and Range ecoregion (**Figure 2-218, Region 8 Ecoregions**). Potentially hazardous volcanoes in Oregon exist along the crest of the Cascade Range and to a lesser extent in the Northern Basin and Range ecoregion. Volcanic hazards that can impact the state include ashfall that can travel long distances, lahars (volcanic debris flows), lava flows (streams of molten rock), pyroclastic flows and surges (avalanches of rock and gas at temperatures of 600–1500 °F), landslides, earthquakes, flooding, and channel migration.

Counties most vulnerable to volcanic hazards: Clackamas, Douglas, Deschutes, Hood River, Jackson, Jefferson, Klamath, Lane, Linn, Marion, Multnomah, and Wasco

State-owned/leased facilities in a volcanic hazard zone: There are 601 state-owned/leased facilities representing approximately $355 million located in a volcanic hazard zone. Of those, 55 are located in “Moderate” or “High” volcanic hazard zones. Of the 77 state-owned/leased critical or essential facilities located in a volcanic hazard zone, one is in a “High” volcanic hazard zone and the rest are in a “Low” volcanic hazard zone.

Wildfires

Wildfires occur throughout the state and may start at any time of the year when weather and fuel conditions combine to allow ignition and spread. Wildfires impact primarily southwest, central, and northeast Oregon, with localized risks statewide. The majority of wildfires take place between June and October. Wildfires may be broadly categorized as agricultural, forest, range, or wildland-urban interface (WUI) fires. Common sources of wildfire in Oregon include lightning, equipment use, railroad activity, recreational activity, debris burning, arson, and smoking.

The West Wide Wildfire Risk Assessment (WWRA) was published in 2013. The WWRA identified that six Oregon counties each have over 1 million wildland acres at moderate risk of wildfire. 751,672 Oregonians live in wildland development areas that are at risk of wildfire. Over 12 million acres of forest are at moderate to high risk of wildfire in Oregon.

Counties most vulnerable to wildfire: Deschutes, Douglas, Grant, Jackson, Jefferson, Josephine, Klamath, Umatilla, Union, Wallowa, and Wasco

Other counties vulnerable to wildfire: All other counties in Oregon

State-owned/leased facilities in a wildfire hazard zone: Roughly half of all state facilities representing approximately $1.05 billion are located in a wildfire hazard zone. Of these, 330 are state-owned/leased critical or essential facilities.

Windstorms

The risk of windstorms is localized across the state. Windstorms are especially common in exposed coastal areas and in the mountains of the Coast Range, occur most frequently from October through March. Communities in the Willamette Valley and Columbia River Gorge also experience strong winds. The wind itself, the debris it carries, and the trees it may blow down cause injury and damage property and infrastructure. The harmful effects of windstorms may extend for distances of 100 to 300 miles from the storm’s center of activity.

Counties most vulnerable to wind storms: Benton, Clatsop, Coos, Columbia, Curry, Douglas, Gilliam, Hood River, Lane, Lincoln, Linn, Marion, Morrow, Multnomah, Polk, Sherman, Tillamook, and Washington

Winter Storms

Winter storms bring freezing rain, sleet, black ice, heavy snow, ice accumulation, extreme cold, and snow avalanches to areas across the state. These storms may last several days and can paralyze a community. People can become homebound; motorists can become trapped in their vehicles; utilities and other services can be disrupted, and crops and other vegetation can be damaged by freezing temperatures. Airport and other transportation system closures can stop the flow of supplies and disrupt essential services.

Counties most vulnerable to winter storms: Linn, Benton, Marion, Polk, Yamhill, Columbia, Washington, Multnomah, Clackamas, Lane, Douglas, Josephine, and Jackson

Mitigation Strategy

Oregon's mission, vision, and goals for natural hazard mitigation are purposefully aspirational, providing the foundation for the state's overall mitigation strategy. Natural hazard mitigation planning in Oregon is funded by the state, post-disaster FEMA mitigation grants, and non-disaster FEMA grant funding.

Given the current economic climate, it is important to acknowledge that state resources are limited. Oregon is not unique in that regard. Even so, Oregon is committed to remaining at the forefront of mitigation planning and will continue to innovate and leverage limited resources to reduce losses resulting from natural hazards in our state. The mitigation strategy presented in this 2015 Oregon NHMP reflects that commitment.

<u>MISSION</u> Create a disaster-resilient state of Oregon.

<u>VISION</u> Natural hazard events result in no loss of life, minimal property damage, and limited long-term impacts to the economy.

<u>GOALS</u>

1 Protect life and reduce injuries resulting from natural hazards.

2 Minimize public and private property damages and the disruption of essential infrastructure and services from natural hazards.

3 Increase the resilience of local, regional, and statewide economies.

4 Minimize the impact of natural hazards while protecting, restoring, and sustaining environmental processes.

5 Enhance and maintain state capability to implement a comprehensive statewide hazard loss reduction strategy.

6 Document and evaluate Oregon's progress in achieving hazard mitigation.

7 Motivate the public, private sector, and government agencies to mitigate against the effects of natural hazards through information and education.

8 Eliminate development within mapped hazardous areas where the risks to people and property cannot be mitigated.

9 Minimize damage to historic and cultural resources.

10 Increase communication, collaboration, and coordination among agencies at all levels of government and the private sector to mitigate natural hazards.

11 Integrate local NHMPs with comprehensive plans and implementing measures.

Goals: Linking the Risk Assessment and Mitigation Actions

The risk assessment speaks directly to protection of life and property; infrastructure and services; and local, regional, and state economic resilience, the topics of Goals 1, 2, and 3. The vulnerability assessments for each hazard and the potential loss estimates highlight the importance of informing and educating citizens about the risks and what they can do to reduce potential losses, including eliminating development where risks cannot be mitigated, the topics of Goals 7 and 8. Environmental stewardship, the topic of Goal 4, plays a role in mitigating some hazards, and must be considered in designing mitigation projects. While not specifically called out in the goal language, mitigation of repetitive loss and severe repetitive loss properties is unquestionably supported by these goals.

The risk assessment also brought to light similarities and differences between state and local vulnerability assessments, highlighting the need to develop a statewide standardized risk assessment methodology across all hazards. Enhancing communication and education among state and local staff responsible for assessing vulnerability is also an important element of improving the risk assessment.

The need for more communication between state and local agencies was also highlighted in county-level risk assessments. Goal 10 identifies this need directly. During this update, goals from all 36 Oregon County NHMPs were reviewed for consistency with the state NHMP goals. Goals 9, 10, and 11 were added to better align state and local natural hazard mitigation planning goals.

While these and other issues raised by the risk assessment sparked discussion around the Plan goals, they also suggested some new mitigation actions. In particular, these mitigation actions were developed in direct response to those issues:

#15 Develop new standardized risk assessment methodology across all hazards, at the state and local levels.

#31 Improve state agency procedures for tracking data on state-owned and -leased buildings and critical or essential facilities.

#59 Schedule three opportunities over the life of this Plan for state-local dialogue on vulnerability assessments to improve consistency and mutual understanding.

#77 Develop an improved methodology for gathering data and identifying the communities most vulnerable to drought and related impacts.

#78 Establish a program for studying winter storms and their impacts statewide. As a part of that program, develop a system for gathering snowfall data statewide.

The connections between the risk assessment, goals, and mitigation actions are clear.

Mitigation Actions

Identification, Evaluation, Prioritization

2012 Oregon NHMP mitigation actions were reviewed to ascertain their status. They were evaluated against statutory criteria (cost-effective, technically feasible, environmentally sound), SMART criteria (specific, measurable, achievable, realistic, time-oriented), and whether they were integrated with other state initiatives. As a result, some were revised, some were considered complete or would not be completed, new actions were added, and all were placed into one of three categories: priority, ongoing, removed. Next the actions in the priority category were prioritized. They were evaluated against the STAPLEE criteria (social, technical, administrative, political, legal, economic, and environmental) in two steps: first scoring using a worksheet that weighted most of the criteria, then ranking by the implementing agency as to the likelihood that it would be funded and undertaken during the life of the 2015 Oregon NHMP. Finally, the actions in the ongoing category were ranked according to the number of hazards then the number of goals addressed. A mitigation action crosswalk shows the disposition of the 2012 Oregon NHMP mitigation actions in the 2015 Oregon NHMP.

Changes in Mitigation Action Priorities

While specific actions or wording of actions may have changed, in terms of themes mitigation action priorities have remained aligned with those of the 2012 Oregon NHMP:

- Obtaining legislative support for implementation of natural hazards policies and mitigation actions
- Implementing Statewide Goal 7, including supporting local government integration of NHMPs with comprehensive plans; and developing, distributing, and assisting local governments with implementing risk reduction techniques and model codes
- Enhancing coordination of state and local mitigation planning
- Enhancing implementation of the Community Rating System statewide
- Inventorying and protecting state-owned and -leased buildings from natural hazards
- Improving reliability and resiliency of critical infrastructure statewide

Funding Sources for Mitigation Actions

Oregon's mitigation activities are funded directly and most visibly through FEMA grant programs as well as NOAA grants. These grants require a non-federal cost share which is provided by State, local, or private funding sources. The State provides direct funding for earthquake mitigation projects through its Seismic Rehabilitation Grant Program. The Oregon Disaster Assistance Loan and Grant Account provides post-disaster mitigation funds to local governments and school districts.

Mitigation Successes

Oregon maintains documentation of "mitigation success stories." These are completed mitigation actions that have shown to be successful by either (a) avoiding potential losses; or (b) demonstrating cost-effectiveness through benefit-cost analysis, qualitative assessment, or both. Likewise, actions that support mitigation efforts, like risk or vulnerability assessment studies, are included. Mitigation success stories are completed by or with input from the action's coordinating agency. Thirteen mitigation success stories from the period 2012–2014 are showcased in the 2015 Oregon NHMP.

Capability Assessment

State Capability Assessment

There have been a number of positive changes in Oregon's natural hazard mitigation capability since 2012. Among them are:

- The Oregon Department of Land Conservation and Development (DLCD) accepted responsibility for the Oregon NHMP and hired two planners focused on natural hazard mitigation, including implementation of Statewide Planning Goal 7.
- Completion of *Oregon Seismic Lifeline Routes (OSLR) Identification* project that establishes a three-tiered system of seismic lifelines to help prioritize investment in seismic retrofits on state-owned highways and bridges.
- Publication of the *Oregon Resilience Plan*, highlighting the state's vulnerabilities in the event of a Cascadia earthquake and tsunami and identifying mitigation actions. Publication of *Preparing for a Cascadia Subduction Zone Tsunami: A Land Use Guide for Oregon Coastal Communities* (http://www.oregon.gov/lcd/ocmp/docs/publications/tsunamiguide20140108.pdf), which provides information on planning techniques to mitigate loss from a Cascadia earthquake and tsunami event.
- Began work on integrating Community Wildfire Protection Plans with local NHMPs and comprehensive plans.
- *The North Coast Resilience Project*, a cooperative endeavor of DLCD, Oregon Partnership for Disaster Resilience (OPDR), and Oregon Sea Grant is engaging north coast communities in hazard mitigation and resilience planning.
- *The Regional Framework for Climate Adaptation* is aligning agency climate adaptation priorities and building capacity at the state and local levels to plan for climate variability and change.
- Initiation of two Community Rating System (CRS) Users Groups to encourage current participants to maintain their participation and increase their ratings, and to encourage non-participating communities to join the CRS Program.
- The Oregon Climate Change Research Institute and Oregon Climate Service joined the State IHMT and lent expertise to the 2015 Oregon NHMP in the areas of climate change, droughts, and windstorms.
- The State Department of Administrative Services hired two new staff who are working on improving data on state-owned/leased buildings and critical and essential facilities.

Oregon continues to maintain robust pre- and post-disaster natural hazard mitigation policy and program frameworks, coordinated through the State Interagency Hazard Mitigation Team.

Funding comes from FEMA and NOAA grant programs, as well as the state's Seismic Rehabilitation Grant Program, Oregon Disaster Assistance Loan and Grant Account. The federal grant programs require a non-federal cost share which is funded by the state, local governments, and private entities. The State General Fund covers in-kind services performed by state employees. State funding to support hazard mitigation and risk reduction remains limited. However, Oregon has an excellent track record of leveraging limited local resources to successfully complete mitigation planning and projects throughout the state.

Local Capability Assessment

Local natural hazard mitigation policies, programs, and capabilities along with a general assessment of their effectiveness are presented in table format as is the status of each community's NHMP and its participation in the National Flood Insurance Program and Community Rating System.

Coordinating State and Local Mitigation Planning

The State of Oregon continues to build local capacity in developing and implementing risk reduction strategies through plan development support, professional assistance, resource sharing, and technical assistance. Local mitigation planning continues to be accomplished in great measure through the state's Pre-Disaster Mitigation (PDM) Planning Program, systematically providing funding and technical assistance to local governments for natural hazards mitigation planning on a five-year rotational basis to ensure that local governments maintain FEMA-approved NHMPs. While some municipalities elect not to participate, all 36 counties in Oregon currently participate.

In 2014, the Oregon Military Department's Office of Emergency Management (OEM) and OPDR developed a "pre-application" process to screen local communities interested in participating in regional FEMA PDM grant applications. Because it was so successful, the state intends to continue using the pre-application process. Over the past 3 years, Oregon has used PDM funds to support plan updates in 21 of Oregon's 36 counties. In addition, the state supported Yamhill County's NHMP update with state general funds through its Emergency Management Performance Grant (EMPG) Program.

OPDR is a chief source of direct technical hazard mitigation planning assistance for local governments in Oregon. OPDR assists local jurisdictions with grant writing, local plan development, plan update, process facilitation, stakeholder engagement, public outreach, and hazard research services and serves as a liaison between local communities and state, federal and NGO partners during the mitigation planning process.

Direct State technical planning assistance for local NHMPs is provided primarily by OEM, DLCD, and the Oregon Department of Geology and Mineral Industries (DOGAMI). OEM houses the State Hazard Mitigation Officer (SHMO) who assists with mitigation project development, execution, and grant compliance. Others provide oversight of mitigation plans; assistance with mitigation for natural, cultural, and historic resources; public information and outreach, particularly for earthquake and tsunami hazards; and tsunami evacuation planning. DOGAMI develops specific technical hazard information, risk and vulnerability assessment products.

DLCD houses the National Flood Insurance Program (NFIP) and Risk Mapping, Assessment, and Planning (Risk MAP) Program Coordinators. The NFIP Coordinator implements the NFIP and the CRS Program, assisting local government staff, citizens, and other stakeholders with NFIP implementation through an extensive and intensive outreach program and regular Community Assistance Visits (CAVs). The Risk MAP Coordinator works closely with FEMA, DOGAMI, OEM, OPDR, local governments, and citizens in developing and providing access to natural hazard data. Planners provide local governments assistance in complying with Statewide Planning Goal 7 and beginning in 2014, all three provide assistance with various aspects of updating and developing local NHMPs.

Technical assistance is also provided indirectly, in the form of access to products and information.

Planning Process

Developing the Plan

Two major changes occurred in the planning process during this update cycle.

First, DLCD accepted responsibility for updating and maintaining the Oregon NHMP. Prior to this, OPDR had facilitated Oregon NHMP updates. DLCD hired two natural hazards planners to manage the plan update and implement other natural hazard mitigation initiatives. The transfer of responsibility and hiring process consumed the first year of the update cycle, significantly abbreviating the project timeline.

Second, effective May 27, 2014, amendments to 44 CFR 201 changed the state mitigation planning update cycle from 3 to 5 years. Due to contract obligations, Oregon is completing the 3-year update already in progress.

The State requested and received a one-year no-cost extension for the project to ease the abbreviated timeline and better align the grant performance period with the state legislative session. The 2015 Oregon NHMP is therefore the result of an approximately two-and-a-half-year, collaborative interagency plan update process.

DLCD managed and facilitated the update process with oversight and direction from the State IHMT, guidance from FEMA, and in close cooperation with OEM and the State Hazard Mitigation Officer, DOGAMI, and OPDR. Many other state and federal agencies also contributed substantively and substantially to the update. New to the process are the Oregon Climate Change Research Institute (OCCRI), the Oregon Climate Service (OCS), and the Silver Jackets. OCCRI and the OCS lent expertise in the areas of climate change, drought, and windstorms. The Silver Jackets, a U.S. Army Corps of Engineers program and new sub-committee of the State IHMT, fosters collaboration among several federal and State agencies and has been successful in advancing flood hazard mitigation during this update cycle.

During this abbreviated planning cycle, the entire 2012 Oregon NHMP was reviewed, revised, and reorganized. The State IHMT served as the steering committee for the update, receiving reports, discussing issues, and providing direction at its quarterly meetings. Information was distributed and public input solicited through a new project website and associated listserv, and a new State IHMT website. Comments received from local governments were addressed and posted on the project website. Information was presented at a joint meeting of the Land Conservation and Development Commission and the DOGAMI Governing Board, as well as at FEMA's Local Mitigation Planning Training.

Maintaining the Plan

The State will prepare three annual progress reports before beginning the next plan update in 2018. Progress on state mitigation actions will be monitored through the annual reporting process. OEM will continue systematically monitoring the implementation of FEMA-funded mitigation actions and projects for which it is the grantee at both state and local levels.

The next update process will begin with evaluation of the 2015 Plan using the information from the annual reports and a set of evaluation criteria. The approach to the update will be discussed and decided by the State IHMT. Issues and conditions that could affect the next update include:

- Potentially changing the suite of hazards addressed by the Oregon NHMP;
- Prioritizing hazards addressed by the Oregon NHMP;
- The extent of progress on developing the new risk assessment model;
- The availability of new or updated hazard, probability, and vulnerability data, including climate change and cultural and historic resources;
- The extent of progress on enhancing coordination of state and local natural hazard mitigation planning;
- The extent of progress on establishing the 2015 Oregon NHMP as a “living document” that can be updated as necessary during the life of the Plan; and
- Addressing any new requirements in FEMA’s revised state NHMP guidance to be issued in 2015.

Enhanced Plan

In 2012, Oregon lost enhanced plan status due to program management issues. Much effort has been expended during this update cycle on making the changes necessary to regain enhanced plan status. OEM and the State Hazard Mitigation Officer led the charge, working closely with FEMA. On February 27, 2015, FEMA re-approved the 2012 Oregon NHMP as an enhanced plan.

Enhanced plan approval constitutes FEMA’s recognition that a state has demonstrated its commitment to maintaining a comprehensive natural hazard mitigation program and supporting that commitment through skilled and effective management of mitigation funding, projects, and planning; support of local mitigation plans and projects; integration of mitigation plans and projects with other state and federal plans, programs, and initiatives; and continual progress in implementation. This exceptional level of effort and demonstration of excellence yields dividends in the form of increased federal mitigation funding after disaster strikes.

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Chapter 1 INTRODUCTION TO THE PLAN

1.1 Background

The dramatic increase in the costs associated with natural disasters over the past decades fostered interest in identifying and implementing effective means of reducing vulnerability. On February 26, 2002, the Federal Emergency Management Agency (FEMA) published Interim Final Rule 44 CFR Part 201, which required all states and local governments to develop natural hazards mitigation plans to be eligible for certain hazard mitigation grant programs, and in the case of the states, to be eligible for certain categories of disaster assistance.

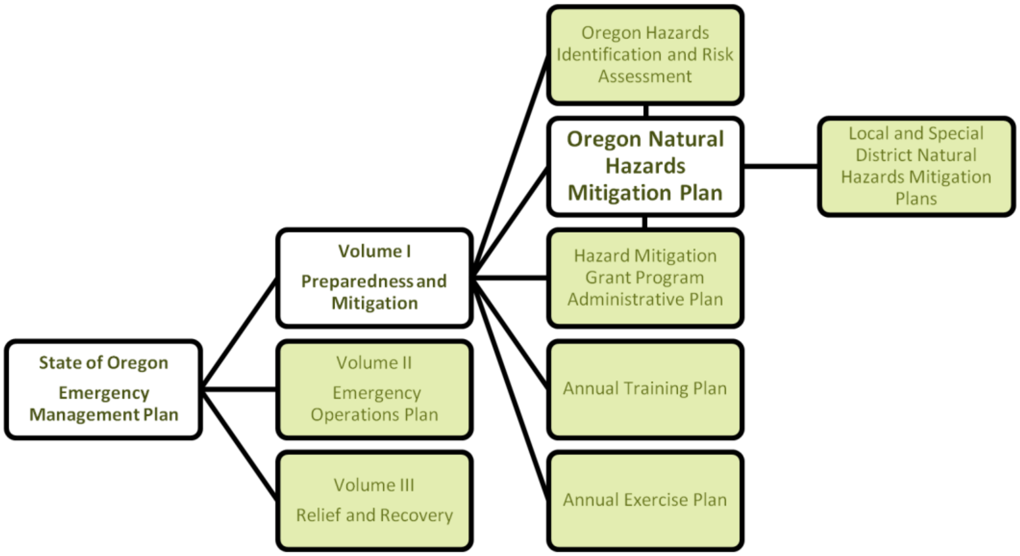
Disasters occur as a predictable interaction among three broad systems: natural systems (e.g., watersheds and continental plates), the built environment (e.g., cities and roads), and social systems (community organization infrastructure that includes demographics, business climate, service provision, etc.). What is not predictable is exactly when natural hazards will occur or the extent to which they will affect communities within the state. However, with careful planning and collaboration it is possible to minimize the losses that can result from natural hazards.

Hazard mitigation is defined at 44 CFR 201.2 as *any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards*. Hazard mitigation is the responsibility of individuals, private businesses and industries, state and local governments, and the federal government. Engaging in mitigation actions provides the state, counties, cities, businesses, and citizens with a number of benefits: fewer injuries and deaths; less damage to buildings, critical facilities, and infrastructure; diminished interruption in essential services; reduced economic hardship; minimized environmental harm; and quicker, lower-cost recovery.

The Oregon Natural Hazards Mitigation Plan (NHMP, Plan) guides mitigation actions throughout the state. It contains the most complete and up-to-date description of Oregon's natural hazards and their probability, the state's vulnerabilities, its mitigation strategies and implementation resources. Oregon's counties and cities can rely upon this information when preparing local natural hazards mitigation plans. Similarly, local NHMPs provide the state with a deeper understanding of local and regional mitigation goals and issues, advancing alignment of mitigation goals and strategies statewide. Further, Oregon's Natural Hazards Mitigation Plan meets FEMA eligibility requirements for enhanced hazard mitigation and disaster assistance funding, benefitting the state and local communities alike.

The Oregon NHMP is one component of the first volume of the *Oregon Emergency Management Plan,* administered by the Oregon Military Department's Office of Emergency Management. **Figure 1-1** illustrates this organizational relationship. Relationships with other state and federal plans and programs are discussed in the **ENHANCED PLAN** chapter.

Figure 1-1. The Oregon NHMP as a Component of the Oregon Emergency Management Plan



Source: Modified from Oregon Partnership for Disaster Resilience

1.2 Plan Structure

The Oregon Natural Hazards Mitigation Plan is an Enhanced Plan, meeting the requirements of both 44 CFR 201.4 (Standard State Mitigation Plans) and 201.5 (Enhanced State Mitigation Plans).

The Standard Plan contains three main chapters: (a) Risk Assessment, (b) Mitigation Strategy, and (c) Planning Process.

The Enhanced Plan is a stand-alone chapter demonstrating the state's commitment to a comprehensive natural hazard mitigation program and its proficiency in project and program management.

A list of acronyms, a glossary, and a list of references follow these chapters.

The Plan closes with links to appendices providing additional information illuminating the Risk Assessment, Mitigation Strategy, Enhanced Plan, and Planning Process chapters.

1.3 Standard Plan

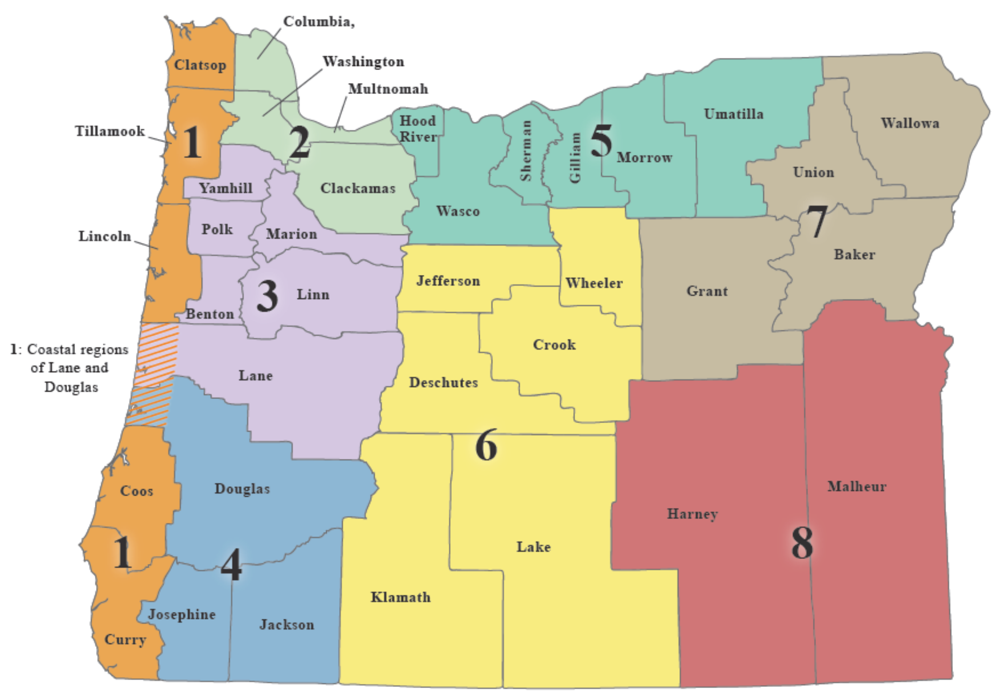
1.3.1 Risk Assessment

The Risk Assessment is presented on two levels: statewide and regional.

The State Risk Assessment profiles each of Oregon's 11 natural hazards and introduces the predicted impacts of climate change on each of the hazards. It also discusses Oregon's vulnerabilities to each hazard and provides loss estimates for state-owned/leased buildings and critical/essential facilities. Finally, it describes enhancements for which Oregon is striving over the life of this Plan to improve the Risk Assessment at the next update.

The Regional Risk Assessment consists of eight separate risk assessments, one for each of the eight Oregon NHMP Natural Hazard Regions (Figure 1-2) established by the Oregon Military Department's Office of Emergency Management (OEM). Each Regional Risk Assessment begins with a summary, then profiles the region's unique demographic, natural environment, land use, and economic characteristics. Finally, each Regional Risk Assessment describes how each hazard presents in the region; analyzes the region's vulnerabilities, including seismic lifeline vulnerabilities, to each hazard; and provides loss estimates for state-owned/leased buildings and critical/essential facilities located in the region's hazard areas.

Figure 1-2. Oregon NHMP Natural Hazards Regions



1.3.2 Mitigation Strategy

The Mitigation Strategy establishes the state's mission, vision, and goals for natural hazard mitigation. A set of tables describe mitigation actions the state has completed, continues to perform, and desires to achieve over the life of this Plan. Current and potential funding sources for implementing mitigation actions are identified.

This chapter also assesses the state's ability to implement the mitigation strategy, both before and after a disaster, through its policies, programs, and funding sources. It also generally assesses the effectiveness of local mitigation policies, programs, and other capabilities.

Finally, the Mitigation Strategy describes the state's support of local mitigation planning, prioritization of funding for local mitigation plans and projects, and coordination of local NHMPs with the Oregon NHMP.

1.3.3 Planning Process

This chapter details the process of updating the Oregon NHMP and identifies the changes made to the Plan through the update process. It frames processes for tracking implementation progress, and for monitoring, evaluating, and eventually updating this edition of the Plan. It highlights how the Oregon NHMP is related to, coordinates with, or is integrated with other planning initiatives.

1.4 Enhanced Plan

The Enhanced Plan chapter is the state's opportunity to showcase its commitment to a comprehensive natural hazard mitigation program and its ability to support that commitment through skilled and effective management of funding, projects, and planning; support of local mitigation plans and projects; integration of mitigation plans and projects with other state and federal plans, programs, and initiatives; and continual progress in implementation. It contains detailed information about how funding was obtained and used during the life of the previous Plan; how funding decisions are made; how completed mitigation projects are evaluated; and how the state provides funding and technical assistance to cities and counties for developing and updating local NHMPs and accomplishing mitigation actions. This exceptional level of effort and demonstration of excellence earns dividends in the form of increased federal funding.

Chapter 2 RISK ASSESSMENT

In This Chapter

The Oregon NHMP Risk Assessment chapter is divided into three sections: (a) Introduction, (b) State Risk Assessment, and (c) Regional Risk Assessment. Following is a description of each section.

1. **Introduction:** States the purpose of the risk assessment and explains risk.
2. **State Risk Assessment:** Includes the following components:
    - Oregon Hazards: Profiles each of Oregon's hazards by identifying each hazard, its generalized location, and presidentially declared disasters; introduces how the state is impacted by climate change; characterizes each hazard that impacts Oregon; lists historic events; identifies the probability of future events; and introduces how climate change is predicted to impact each hazard statewide.
    - Oregon Vulnerabilities: Includes an overview and analysis of the state's vulnerability to each hazard by identifying which communities are most vulnerable to each hazard based on local and state vulnerability assessments; providing loss estimates for state-owned/leased facilities and critical/essential facilities located in hazard areas; and identifying seismic lifeline vulnerabilities.
    - Future Enhancements: Describes ways in which Oregon is planning to improve future state risk assessments.
3. **Regional Risk Assessment:** Includes the following components for each of the eight Oregon NHMP Natural Hazard Regions:
    - Summary: Summarizes the region's statistical profile and hazard and vulnerability analysis and generally describes projected impacts of climate change on hazards in the region.
    - Profile: Provides an overview of the region's unique characteristics, including a natural environment profile, social/demographic profile, economic profile, infrastructure profile, and built environment profile.
    - Hazards and Vulnerability: Further describes the hazards in each region by characterizing how each hazard presents itself in the region; listing historic hazard events; and identifying probability of future events based on local and state analysis. Also includes an overview and analysis of the region's vulnerability to each hazard; identifies which communities are most vulnerable to each hazard based on local and state analysis; provides loss estimates for state-owned/leased facilities and critical/essential facilities located in hazard areas; and identifies the region's seismic lifeline vulnerabilities.

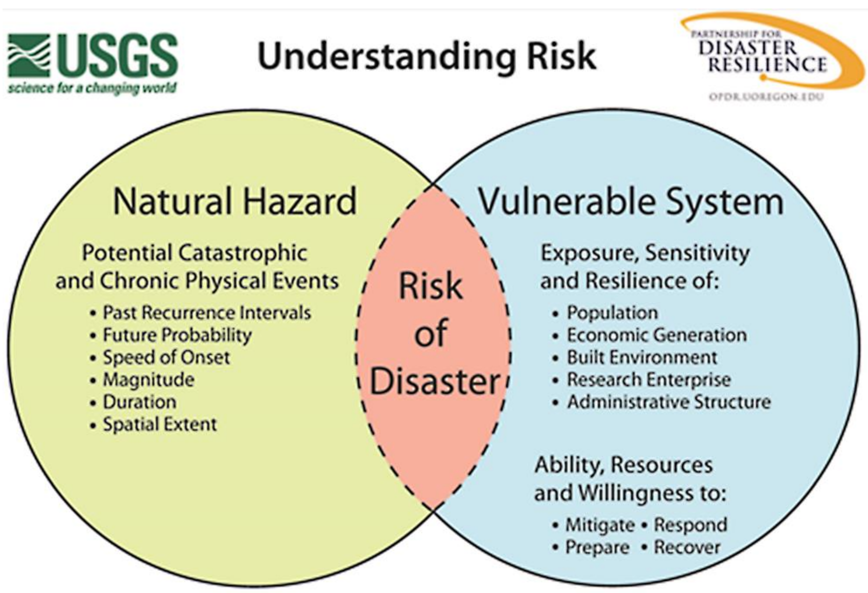
2.1 Introduction

Requirement 44 CFR §201.4(c)(2), [The plan must include] risk assessments that provide the factual basis for activities proposed in the strategy portion of the mitigation plan. Statewide risk assessments must characterize and analyze natural hazards and risks to provide a statewide overview. This overview will allow the State to compare potential losses throughout the State and to determine their priorities for implementing mitigation measures under the strategy, and to prioritize jurisdictions for receiving technical and financial support in developing more detailed local risk and vulnerability assessments.

The purpose of the Oregon NHMP Risk Assessment is to identify and characterize Oregon's natural hazards, determine which jurisdictions are most vulnerable to each hazard, and estimate potential losses to vulnerable structures and infrastructure and to state facilities from those hazards.

It is impossible to predict exactly when natural hazards will occur or the extent to which they will affect communities within the state. However, with careful planning and collaboration, it is possible to minimize losses that can result from natural hazards. The identification of actions that reduce the state's sensitivity and increase its resilience assist in reducing overall risk — the area of overlap in **Figure 2-1**. The Oregon NHMP Risk Assessment informs the State's mitigation strategy, found in **Chapter 3**.

Figure 2-1. Understanding Risk



Source: Wood (2007)

Assessing the state's level of risk involves three components: characterizing natural hazards, assessing vulnerabilities, and analyzing risk. Characterizing natural hazards involves determining hazards' causes and characteristics, documenting historic impacts, and identifying future probabilities of hazards occurring throughout the state. The section in this risk assessment titled "Oregon Hazards" characterizes each of the state's natural hazards.

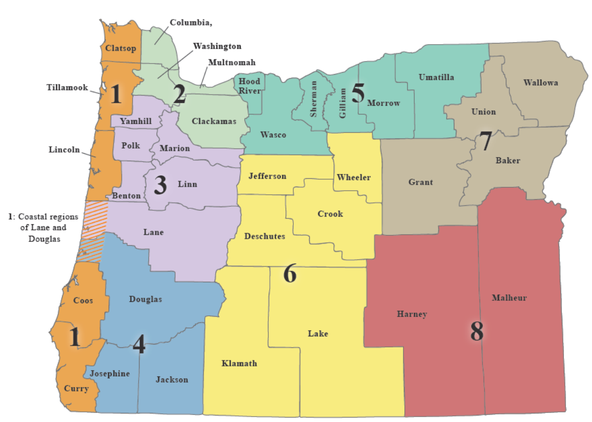
A vulnerability assessment combines information from the hazard characterization with an inventory of the existing (or planned) property and population exposed to a hazard and attempts to predict how different types of property and population groups will be affected by each hazard. Vulnerability is determined by a community's exposure, sensitivity, and resilience to natural hazards as well as by its ability to mitigate, prepare for, respond to, and recover from a disaster. The section Oregon Vulnerabilities identifies and assesses the state's vulnerabilities to each hazard identified in the Oregon Hazards section of this risk assessment.

A risk analysis involves estimating damages, injuries, and costs likely to be incurred in a geographic area over a period of time. Risk has two measurable components: (a) the magnitude of the harm that may result, defined through vulnerability assessments; and (b) the likelihood or probability of the harm occurring, defined in the hazard characterization. Together, the "Oregon Hazards" and "Oregon Vulnerabilities" sections form the risk analysis at the state level.

This Plan also analyzes risk at the regional level. Regional risk assessments begin with a description of the region's assets in the Regional Profile section. The Profile is followed by a characterization of each hazard and identification of the vulnerabilities and potential impacts of each hazard. Regions are defined in the Oregon NHMP Natural Hazards Regions map (**Figure 2-2**):

- **Region 1 – Coast:** Clatsop, Tillamook, Lincoln, coastal Lane, coastal Douglas, Coos, and Curry Counties;
- **Region 2 – Northern Willamette Valley/Portland Metro:** Colombia, Clackamas, Multnomah, and Washington Counties;
- **Region 3 – Mid/Southern Willamette Valley:** Benton, Lane, Linn, Marion, Polk, and Yamhill Counties;
- **Region 4 – Southwest:** Douglas (non-coastal), Jackson, and Josephine Counties;
- **Region 5 – Mid-Columbia:** Gilliam, Hood River, Morrow, Sherman, Umatilla, and Wasco Counties;
- **Region 6 – Central:** Crook, Deschutes, Jefferson, Klamath, Lake, and Wheeler Counties;
- **Region 7 – Northeast:** Baker, Grant, Wallowa, and Union Counties; and
- **Region 8 – Southeast:** Harney and Malheur Counties.

Figure 2-2. Oregon NHMP Natural Hazards Regions



2.2 State Risk Assessment

2.2.1 Oregon Hazards

2.2.1.1 Overview

Requirement: 44 CFR §201.4(c)(2)(i): The risk assessment shall include… (i) An overview of the type and location of all natural hazards that can affect the State…

The State of Oregon is subject to 11 primary natural hazards. **Table 2-1** lists each hazard and describes in general terms where the hazard is located. Each hazard is described in greater detail (introduction, description, historical events, and probability) later in this State Risk Assessment, beginning in subsection **2.2.1.3, Hazards**. The state's vulnerability to each hazard is discussed in subsection **2.2.2, Oregon Vulnerabilities**.

Table 2-1. Oregon Hazard Overview

Hazard	Generalized Locations
Coastal Hazards	Oregon coast
Droughts	generally east of the Cascades, with localized risks statewide
Dust Storms	generally east of the Cascades
Earthquakes	
Cascadia Subduction	primarily western Oregon
Other active earthquake faults	localized risks statewide
Floods	localized risks statewide
Landslides	localized risks statewide
Tsunamis	Oregon coast*
Volcanoes	central Oregon, Cascade Range and southeast Oregon, High Lava Plains
Wildfires	primarily southwest, central and northeast Oregon, with localized risks statewide
Windstorms	localized risks statewide
Winter Storms	localized risks statewide

*Maps and GIS files showing potential tsunami inundation for five levels of local Cascadia scenarios and two maximum-considered distant tsunami scenarios are available as DOGAMI Open-File Report O-13-19 (Priest et al., 2013).

Source: Oregon NHMP lead state agency(ies) for each hazard

Since 1955 (the year the United States began formally tracking natural disasters), Oregon has received 28 major disaster declarations, two emergency declarations, and 49 fire management assistance declarations. **Table 2-2** lists each of the major disaster declarations, the hazard that the disaster is attributed to, and the counties impacted. Since 1955, Clatsop, Douglas, Lincoln, Tillamook, and Yamhill Counties have each been impacted by 10 or more federally declared non-fire related disasters. Of the 28 major disasters to impact Oregon, the vast majority have resulted from storm events. Notably, flooding impacts from those events are reported in over two thirds of the major disaster declarations.

The reported federal disaster declarations (including fire management assistance declarations) document that storm events, floods, and wildfires have been the primary chronic hazards with major disaster impacts in Oregon over the last half century. The data also show a trend geographically of a greater number of major federal disaster declarations in the northwest corner of the state. Anecdotally, this pattern plays out for non-federally declared hazard events in the state as well. The following subsections summarize type, location, history, and probability information for each of the hazard types listed above.

Table 2-2. Presidential Major Disaster Declarations Since 1955

Disaster	Incident Period	Disaster Type	Baker	Benton	Clackamas	**Clatsop**	Columbia	Coos	Crook	Curry	Deschutes	**Douglas**	Gilliam	Grant	Harney	Hood River	Jackson	Jefferson	Josephine	Klamath	Lake	Lane	**Lincoln**	Linn	Malheur	Marion	Morrow	Multnomah	Polk	Sherman	Siletz IR*	**Tillamook**	Umatilla	Union	Wallowa	Warm Springs IR*	Wasco	Washington	Wheeler	**Yamhill**
DR-4169	Feb. 6–14, 2014	severe winter storm		x																		x	**x**	x																
DR-4055	Jan. 17–21, 2013	severe winter storm / flooding / landslides / mudslides		x			x	x		x		**x**				x						x	**x**	x		x			x			**x**								
DR-1964	Mar. 11, 2011	tsunami						x		x													**x**																	
DR-1956	Jan. 13–21, 2011	winter storms / flooding / mudslides/ landslides / debris flows			x	**x**			x			**x**											**x**									**x**								
DR-1824	Dec. 13, 2007– Jan. 26, 2008	winter storms / flooding			x	**x**	x																				x		x	X		**x**						x		**x**
DR-1733	Dec. 1–17, 2007	storms / flooding / landslides / mudslides																												X		**x**						x		**x**
DR-1683	Dec. 14–15, 2006	winter storms / flooding		x		**x**	x																**x**							x	x	**x**					x		x	**x**
DR-1672	Nov. 5–8, 2006	storms / flooding / landslides / mudslides				**x**										x							**x**									**x**								
DR-1632	Dec. 18, 2005– Jan. 21, 2006	storms / flooding / landslides / mudslides		x	x	**x**	x	x	x	x		**x**	x				x	x	x				**x**	x						x	x	**x**				x			x	**x**
DR-1510	Dec. 26, 2003– Jan. 14, 2004	winter storms	x	x	x	**x**	x		x		x	**x**	x	x	x	x		x			x	x	**x**	x	x	x	x	x	x	x		**x**	x	x	x		x		x	**x**
DR-1405	Feb. 7-8, 2002	winter storm						x		x		**x**										x		x																
DR-1221	May 28–June 3, 1998	flooding							x																															
DR-1160	Dec. 25, 1996– Jan. 6, 1997	winter storm / flooding						x				**x**					x		x	x	x	x													x					
DR-1107	Dec. 10–12, 1995	storms / high winds		x		**x**	x					**x**										x	**x**	x								**x**						x		**x**
DR-1099	Feb. 4–21, 1996	storms / flooding		x	x	**x**	x	x			x	**x**	x			x		x	x			x	**x**	x		x	x	x	x	x		**x**	x	x	x		x	x		**x**
DR-1061	July 8–9, 1995	flash flooding																																			x			
DR-1036	May 1–Oct. 31, 1994	El Niño effects				**x**	x	x		x		**x**										x	**x**									**x**								
DR-1004	Sep. 20, 1993	earthquakes																		x																				
DR-985	Mar. 25, 1993	earthquake			x																					x												x		**x**
DR-853	Jan. 6-9, 1990	storms / flooding				**x**																										**x**								
DR-413	Jan. 25, 1974	storms / flooding / snow melt		x	x		x	x		x		**x**	x			x	x		x			x	**x**			x			x			**x**			x		x	x		**x**
DR-319	Jan. 21, 1972	storms / flooding			x	**x**		x				**x**										x	**x**	x				x				**x**						x		
DR-301	Feb. 13, 1971	storms / flooding				**x**																										**x**								
DR-184	Dec. 24, 1964	heavy rains / flooding	x	x	x	**x**	x	x	x	x	x	**x**	x	x	x	x	x	x	x	x	x	x	**x**	x	x	x	x	x	x	x		**x**	x	x	x		x	x	x	**x**
Total number of disasters by county / IR* post 1964			2	7	9	**13**	9	8	5	5	3	**10**	5	2	2	5	4	4	5	3	3	8	**11**	7	2	6	3	5	8	4	1	**14**	3	3	5	1	6	8	4	**10**
DR-144	Feb. 25, 1963	flooding	No individual county impact data available																																					
DR-136	Oct. 16, 1962	storms																																						
DR-69	Mar. 1, 1957	flooding																																						
DR-60	July 20, 1956	storm / flooding																																						
DR-49	Dec. 29, 1955	flooding																																						

*IR = Indian Reservation

Bold "x" = A county that has been impacted by 10 or more federally declared non-fire related disasters

Source: Oregon Office of Emergency Management (2013)

2.2.1.2 Introduction to Climate Change

This section presents an overview of climate change in Oregon. Climate is an important element in certain natural hazards, even though in itself, climate is not a distinct natural hazard.

In broad terms, climate in the Pacific Northwest is characterized by variability, and that variability is largely dominated by the interaction between the atmosphere and ocean in the tropical Pacific Ocean that is responsible for El Niño and La Niña. Human activities are changing the climate, particularly temperature, beyond natural variability. Climate change is already affecting Oregon communities and resources, and needs to be recognized in various planning efforts as an important stressor that significantly influences the incidence — and in some cases the location — of natural hazards and hazard events. Climate change is anticipated to affect the frequency and/or magnitude of some kinds of natural hazards in Oregon. A brief review of some of the observed changes in Oregon or the Pacific Northwest will give some idea of the influence of climate on natural hazards. First, temperatures increased across the Pacific Northwest by 1.3 ˚F in the period 1895–2011 (the observed record). In that same timeframe, Cascade Mountain snowpacks have declined, and higher temperatures are causing earlier spring snowmelt and spring peak streamflows. On the coast, increasing deep-water wave heights in recent decades are likely to have increased the frequency of coastal flooding and erosion. In Oregon's forested areas, large areas have been impacted by disturbances that include wildfire in recent years, and climate change is probably one major factor. Closer to home for some Oregonians, a three-fold increase in heat-related illness has been documented in Oregon with each 10 ˚F rise in daily maximum temperature. (Dalton et al., 2013; Dello & Mote, 2010).

Oregon Responses to Climate Change

The human influence on the climate is clear (IPCC, 2013). Global greenhouse gas emissions will determine the amount of warming both globally and here in Oregon. On that basis, Oregon and other states and local communities have undertaken measures to reduce greenhouse gas emissions as a way to slow the warming trend. Similarly, states and local communities are beginning to implement measures to adapt to future climate conditions that cannot be avoided. The global climate has considerable inertia, so the changes that can be anticipated today are largely a result of conditions that occurred up to several decades, almost a century ago. Inertia in the global climate system cannot be immediately influenced, so states and communities are beginning to do "climate adaptation planning" in local and regional scales. In many cases, planning for climate change — or adaptation planning — quickly comes down to improved planning for natural hazards, since many of the anticipated effects of climate change will be experienced in the form of natural hazard events. That said, planning to adapt to climate change and planning to mitigate natural hazards are not entirely the same thing, although there is considerable overlap.

In 2010, the State of Oregon produced the Oregon Climate Adaptation Framework. This framework identifies 11 climate-related risks for which the state must plan. Five of those 11 climate risks — drought, coastal erosion, fire, flood, and landslides — are directly identified in the Oregon NHMP. In addition, three other hazards in the Oregon NHMP — wind storms, winter storms, and dust storms — have an underlying climate component.

Oregon and the Pacific Northwest have been rich in climate impacts research over the last 18 years. In 2007 the Oregon Legislature created the Oregon Climate Change Research Institute (OCCRI) under HB 354. Much of the material in this section is drawn from two reports from OCCRI: the 2010 Oregon Climate Assessment Report (Dello & Mote, 2010) and the 2013 Northwest Climate Assessment Report (Dalton et al., 2013), both found at http://occri.net/reports. This section is not meant to be a comprehensive assessment of climate change and impacts in Oregon or an all-encompassing overview of each hazard. Rather, it presents future projections of temperature and precipitation, and describes some of the effects of such future conditions based on the frequency and magnitude of natural hazards in Oregon.

Past and Future Climate in Oregon (Mote et al., 2013)

Historical (1895–Present)

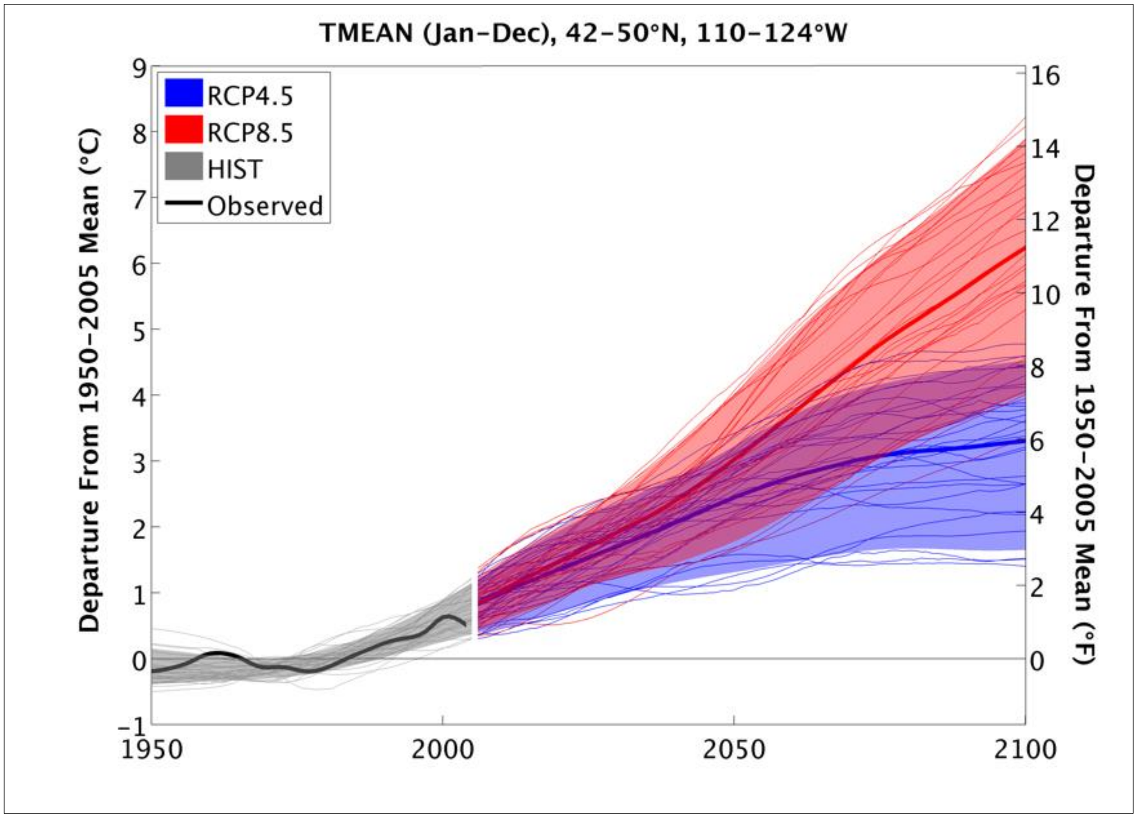
The impacts of climate change in Oregon are largely driven by temperature and precipitation. Temperatures in the Pacific Northwest increased 1.3 °F over the historical period (1895–2011 observed period). Over the last 30 years, temperatures in Oregon have generally been above the 20th century average (**Figure 2-3**). The average annual temperatures in all but two years since 1998 have been above the average annual temperatures for the 20th century. Within the same historical time period, annual precipitation amounts fall within the normal range of natural annual variability.

Future Climate

Climate modeling is mostly performed at global to regional scales because of the computational power required. The temperature and precipitation projections relied on for this summary use data from the grid cells covering the Pacific Northwest in Global Climate Models. Since the Pacific Northwest region is relatively homogenous in its climate, Global Climate Model projections for the Pacific Northwest are relevant for planning in Oregon.

A number of research centers around the world run computerized Global Climate Models (GCMs), which provide scientists and decision makers with simulations of future global climate for comparison purposes. One such project, the Coupled Model Intercomparison Project (CMIP), involves many of these modeling centers worldwide. CMIP offers many simulations for scientists to use to assess the range of future climate projections for the globe. The latest CMIP experiment is the 5th phase of the project and is thus referred to as the CMIP5. CMIP5 simulations of the 21st century climate are driven by what are called “representative concentration pathways” (RCPs). RCPs represent the total amount of extra energy (in watts per square meter) entering the climate system throughout the 21st century and beyond.

Figure 2-3. Observed and Simulated Regional Mean Annual Temperature for Selected Global Climate Models for RCP 4.5 and 8.5 Scenarios



Note: Black line shows observed (1950–2011) regional mean annual temperature; blue and red lines simulate regional mean annual temperature (1950–2100) for global climate model representative concentration pathway (RCP) 4.5 and 8.5 scenarios.

Source: Dalton et al. (2013)

This summary and the Pacific Northwest section of the National Climate Assessment use scenario RCP 4.5, which represents a significant reduction in global greenhouse gases, and RCP 8.5, which represents increasing greenhouse gases over time. **Figure 2-3** shows observed mean global temperatures from 1950 to 2011, and simulated mean temperatures under the two different RCPs from 2011 to 2100. Note that the projected temperature trends under different RCPs generally track closely until about 2030 or so, and they dramatically diverge after 2050.

Seasonality

Some of the most relevant climate data for planning purposes, and the most crucial to some of the hazards addressed in this Plan, are seasonal projections of temperature, seasonal projections of precipitation, and change in extreme precipitation events (**Table 2-3**, **Table 2-4**, and **Table 2-5**, respectively).

Table 2-3 and **Table 2-4** summarize a lot of information drawn from analyses of CMIP5 data. **Table 2-3** contains the maximum, mean, and minimum projected changes in Pacific Northwest temperatures from historical (1950–1999) to mid-21st century (2041–2070), using both RCP 4.5 and RCP 8.5 scenarios. Projected changes are shown annually and for each season.

Every climate model shows an increase in temperature for the Pacific Northwest, with the magnitude of the increase depending on rate or magnitude of global greenhouse gas emissions. *There is no plausible scenario in which the Pacific Northwest cools in the next century*. New models project an increase by mid-century (2041–2070) in annual temperatures in the PNW of 2.0°F to 8.5°F over the recent past (1970–1999). The lower projection is possible only if greenhouse gas emissions are significantly reduced (**Figure 2-3**, RCP4.5 scenario). Both scenarios show a similar amount of warming through about 2040, meaning that temperatures beyond 2040 depend on global greenhouse emissions occurring now (Mote et al., 2013).

Of particular note in **Table 2-3** is that both scenarios (for RCP 4.5 and RCP 8.5) show increased average temperatures for the year *and for every season*. All models are in agreement that each season will be warmer in the future, and that the largest amount of warming will occur in the summer. Increased average winter temperatures will result in less snowpack in Oregon. Increased summer temperatures have the potential to increase the potential for wildfires and increase health-threats from poor air quality conditions and the potential for heat waves.

Table 2-3. Projected Change in Average Temperatures (Maximum, Mean, and Minimum), from Last Half of 20th to Mid-21st Centuries

Time Period	Annual		Winter (Jan, Feb, Mar)		Spring (Apr, May, Jun)		Summer (Jul, Aug, Sep)		Fall (Oct, Nov, Dec)	
Representative concentration pathway scenario	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Maximum change	3.7 °F	4.7 °F	4.0 °F	5.1 °F	4.1 °F	4.6 °F	4.1 °F	5.2 °F	3.2 °F	4.6 °F
Mean change	2.4 °F	3.2 °F	2.5 °F	3.2 °F	2.4 °F	3.0 °F	2.6 °F	3.6 °F	2.2 °F	3.1 °F
Minimum change	1.1 °F	1.7 °F	0.9 °F	1.3 °F	0.5 °F	1.0 °F	1.3 °F	1.9 °F	0.8 °F	1.6 °F

Note: Maximum, mean, and minimum values represent the maximum model projection, the multi-model mean, and the minimum model projection.

Source: Dalton et al. (2013)

Table 2-4 contains a summary of projected change, *in percent*, in average precipitation for the Pacific Northwest (maximum, mean, and minimum) from historical (1950–1999) to mid-21st century (2041–2070), under both RCP 4.5 and RCP 8.5 scenarios. Projected changes are shown annually and for each season.

Note in the “Annual” column in **Table 2-4** that precipitation amounts are projected to remain within the range of current natural variability. However, **Table 2-4** also shows that there is some indication from climate models that summers will be drier in the future.

Table 2-4. Projected Change in Average Precipitation (Maximum, Mean and Minimum) for Two Scenarios, from Last Half of 20th to Mid-21st Centuries

	Annual		Winter (Jan, Feb, Mar)		Spring (Apr, May, Jun)		Summer (Jul, Aug, Sep)		Fall (Oct, Nov, Dec)	
Representative concentration pathway scenario	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Maximum change	10.1%	13.4%	16.3%	19.8%	18.8%	26.6%	18%	12.4%	13.1%	12.3%
Mean change	2.8%	3.2%	5.4%	7.2%	4.3%	6.5%	-5.6%	-7.5%	3.2%	1.5%
Minimum change	-4.3%	-4.7%	-5.6%	-10.6%	-6.8%	-10.6%	-33.6%	-27.8%	-8.5%	-11%

Note: Maximum, mean, and minimum values represent the maximum model projection, the multi-model mean, and the minimum model projection.

Source: Dalton et al. (2013)

Extreme Precipitation

Natural hazards are often an expression of extreme conditions — wind storms, rain storms, floods, droughts, and so on. Extreme precipitation is perhaps the most common and widespread natural hazard in Oregon. Many people may associate extreme rainfall events almost exclusively with western Oregon, but in fact extreme precipitation events occur across the entire state.

Projected future changes in extreme precipitation are less ambiguous (**Table 2-5**) than changes in total seasonal precipitation. The North American Regional Climate Change Assessment Program (NARCCAP) results indicate increases throughout the Northwest in the number of days above every threshold. **Table 2-5** shows the projected *percent change* in the number of days when rainfall will exceed thresholds of one, two, three, and four inches. These projections (which are based on different models from those summarized in **Table 2-3** and **Table 2-4**) show there will likely be an increase in extreme events of several different magnitudes. Note that the higher magnitude events show the largest overall increase. Note that although the frequency of extreme events rises in percentage with the magnitude of the extreme, the standard deviation rises faster. In other words, only modest events (>2.5 cm, or 1 inch) increase by much more than one standard deviation (Mote et al., 2013).

Table 2-5. Change in the Number of Days with Extreme Precipitation (from mid-Century [2041–2070] Minus Historical [1971–2000]) over Four Thresholds

	NARCCAP Mean Change, %	NARCCAP Standard Deviation
Change in the number of days with precipitation ***over one inch***	+13%	7%
Change in the number of days with precipitation ***over two inches***	+15%	14%
Change in the number of days with precipitation ***over three inches***	+22%	22%
Change in the number of days with precipitation ***over four inches***	+29%	40%

Note: NARCCAP (North American Regional Climate Change Assessment Program) is a multi-institution regional modeling effort with a coordinated approach similar to CMIP NARCCAP (http://www.narccap.ucar.edu/).

Source: Dalton et al. (2013)

Effect of Oregon's Future Climate Conditions on Natural Hazards

In 2010, Oregon achieved a significant milestone in the release of two reports for two important initiatives that developed in parallel; both reports addressed climate change across the state. In November 2010, OCCRI released the Oregon Climate Assessment Report (**Appendix 9.1.17**; Dello & Mote, 2010), the first ever comprehensive scientific assessment of climate change in Oregon. At the same time, the state released the Oregon Climate Change Adaptation Framework (**Appendix 9.1.19**), representing the efforts of over a dozen state agencies and institutes, including OCCRI, to begin to establish a rigorous framework for addressing the effects of climate change across the state. More recently, the 2010 Oregon Climate Assessment Report was updated by the 2013 Northwest Climate Assessment Report (**Appendix 9.1.18**), also produced by OCCRI. The Framework, however, has not been updated since its release in 2010.

Development of Oregon's Climate Change Adaptation Framework was significant in that the state began to address the need to plan for the effects of future climate conditions. Furthermore, Oregon's Framework is the first state-level adaptation strategy based on *climate risks* as opposed to *affected sectors*. Oregon's Framework lays out 11 climate risks that are of concern to the state. The risks provide a consistent basis for agencies and communities to review plans and decisions to identify measures to reduce those risks. Many of the risks in the Oregon Framework are natural hazards.

Following is a summary of the principal effects of changing climate conditions on the natural hazards addressed in the Oregon NHMP. Hazards are discussed together where the climate changes and drivers are essentially the same. How each hazard (or group of hazards) affects each of the eight Oregon NHMP Natural Hazard Regions is then summarized.

Relationship between Adaptation Framework *Risks* and *Hazards* in the Oregon NHMP

Table 2-6. Relationship Between Adaptation Framework Risks and Hazards in the Oregon NHMP

	Oregon NHMP Hazards								
Adaptation Framework climate *risks*	**Coastal Erosion**	**Droughts**	**Dust Storms**	**Wildfire**	**Floods/ CMZ**	**Landslides**	**Wind-storms**	**Winter Storms**	**Heat Wave***
Increased temperatures	x	X	x	X					X
Changes in hydrology		X	x		X	X			
Increased wildfires		x	x	X	x	x			
Increase in ocean temperatures and changes in ocean chemistry	X				x			X	
Increased drought		X		X					
Increased coastal erosion	X					x			
Changes in habitat									
Increase in invasive species and pests		x		X					
Loss of wetland ecosystems and services		X	X		X				
Increased frequency of extreme precipitation events and flooding					X	X		x	
Increased landslides						X			

*Heat waves are not identified as a natural hazard in the current natural hazards mitigation plan.

What is contained in Table 2-6: The leftmost column contains the climate *risks* in the Oregon Climate Change Adaptation Framework. Column headings show natural hazards identified in the Oregon Natural Hazards Mitigation Plan (NHMP).

How to read this table: Cells with an *x* or *X* show which *climate risks* will affect the frequency, intensity, magnitude, or duration of which *natural hazards*. A big *X* shows a primary relationship between the risk and the hazard. A small *x* shows a secondary relationship. The green cells in the body of the table show where an Adaptation Framework *risk* and a natural hazard in the Oregon NHMP are essentially the same thing.

Note that the first two risks — increased temperatures and changes in hydrology — are *the primary climate drivers* for natural hazards. The other climate risks represent known environmental or ecosystem responses to one or both of the primary drivers. Note also that a clear link has not been established between climate change and the frequency or intensity of wind storms.

Coastal Erosion and Coastal Flooding

Regions affected: 1

Oregon's ocean shoreline is constantly subject to the dynamic and powerful forces of the Pacific Ocean, and it changes at timescales that vary from days to decades. Variable and changing ocean conditions continuously reshape the ocean shoreline, particularly where the shore is composed primarily of sand. Sand levels on Oregon's beaches generally experience an annual cycle of erosion through winters and rebuilding in summer months. Over any extended time period, sandy beaches and shores will build out and retreat several times, due in part to the effects of winds, storms, tides, currents and waves. These cycles can occur over decades. In the annual cycle, beach profiles do not always recover to the heights and extent of previous years. In recent years, sand levels have remained fairly low at many locations on the Oregon coast.

The shape of Oregon's ocean shoreline is a function in part of ocean water levels and wave heights. Ocean water levels are also a primary factor in the frequency of flooding around the fringes of Oregon's estuaries. In other words, erosion of the ocean shore is directly affected by sea levels and wave heights. Flooding on the estuarine fringe is affected by ocean water levels — including tides and storm surges — in addition to freshwater inflow from the estuarine watershed. Other factors influence coastal erosion, but sea levels and wave heights are the primary climate-related drivers that influence rates of coastal erosion.

Recent studies make it clear that global ocean water levels are rising. Global sea levels are projected to rise 8–23 cm by 2030 and 18–48 cm by 2050 (NRC, 2012). In Oregon (as elsewhere) the rates of *relative* sea level rise are not the same as rates of change in global sea levels, because of a number of factors related to ocean conditions and vertical movement of the land. Oregon's western edge is rising, so the rates of sea level rise in Oregon are not as high as rates seen in other west coast locations. But even after factoring in local conditions, sea levels along Oregon's coast are rising. For more information on coastal erosion and see level rise, see the **Coastal Hazards** section.

Recent research also indicates that significant wave heights off Oregon are increasing. Increasing significant wave heights may be a factor in the observed increase of coastal flooding events in Oregon. During El Niño events, sea levels can rise up to about 1.5 feet (0.5 meters) higher over extended periods (seasons).

Rising sea levels and increasing wave heights are both expected to increase coastal erosion and coastal flooding.

One of the climate risks discussed in the Oregon Climate Adaptation Framework is "Increased coastal erosion and risk of inundation from increasing wave heights and storm surges." The executive summary of the Adaptation Framework provides a summary of various challenges associated with increased coastal erosion:

> *Increased wave heights, storm surges, and sea levels can lead to loss of natural buffering functions of beaches, tidal wetlands, and dunes. Accelerating shoreline erosion has been documented, and is resulting in increased applications for shore protective structures. Shoreline alterations typically reduce the ability of beaches, tidal wetlands, and dunes to adjust to new conditions.*
>
> *Increasing sea levels, wave heights, and storm surges will increase coastal erosion and likely increase damage to private property and infrastructure situated on coastal shorelands. Coastal erosion and the common response to reduce shoreland erosion can lead to long-term loss of natural buffering functions of beaches and dunes. Applications for shoreline alteration permits to protect property and infrastructure are increasing, but in the long term they reduce the ability of shore systems to adjust to new conditions.*

Droughts, Wildfires, and Dust Storms

Regions affected: 1-8

All eight regions in the Oregon NHMP are potentially affected by increasingly common droughts and wildfires. Moreover, areas that have historically been both hotter and drier than the statewide average — southwest Oregon counties and central and eastern Oregon — are at somewhat higher risk of increased drought and wildfire than the state overall.

There is no current research available on the direct effects of future climate conditions on the incidence of dust storms. However, because drought conditions have the effect of reducing wetlands and drying soils, droughts can increase the amount of soil particulate matter available to be entrained in high winds, in particular where agriculture practices include tilling. This correlation between drought conditions and dust storms means that an increase in future droughts could increase the incidence of dust storms, even though the drought is unrelated to the storm.

Droughts, fires, and dust storms are addressed as separate hazards in this Plan. However, the underlying climate mechanism is similar for each. These hazards all occur in conjunction with warmer and drier conditions.

Virtually all climate models project warmer, drier summers for Oregon, with mean projected seasonal increases in summer temperatures of 2.6 to 3.6 ˚C by mid-century, and a decline in mean summer precipitation amounts of 5.6 to 7.5% by mid-century. These summer conditions will be coupled with projected decreases in mountain snowpack due to warmer winter temperatures. Models project a mean increase in winter temperatures of 2.5 to 3.2 ˚C by mid-century. This combination of factors exacerbates the likelihood of drought, which in turn often leads to an increase in the incidence and likelihood of wildfires and dust storms.

Two climate risks that are somewhat prominent in the Framework are “Increase in wildfire frequency and intensity” and “Increased incidence of drought.” Dust storms were not addressed in the Framework as a climate risk; at the time the Framework was developed, research literature on the climatic conditions behind dust storms was scarce or nonexistent.

The executive summary of Oregon’s Climate Change Adaptation Framework provides a summary of challenges associated with increased incidence of both wildfires and drought, as follows.

Wildfire

Increased temperatures, the potential for reduced precipitation in summer months, and accumulation of fuels in forests due to insect and disease damage present high risk for catastrophic fires, particularly in forests east of the crest of the Cascade Range. An increase in frequency and intensity of wildfire will damage larger areas, and likely cause greater ecosystem and habitat damage. Larger and more frequent wildfires will increase human health risks due to exposure to smoke.

Increased risk of wildfire will result in increased potential for economic damage at the urban-wildland interface. Wildfires destroy property, infrastructure, commercial timber, recreational opportunities, and ecosystem services. Some buildings and infrastructure subject to increased fire risk may not be adequately insured against losses due to fire. Increased fire danger will increase the cost to prevent, prepare for, and respond to wildfires.

Droughts

Longer and drier growing seasons and droughts will result in increased demand on ground water resources and increased consumption of water for irrigation, which will have potential consequences for natural systems. Droughts affect wetlands, stream systems, and aquatic habitats. Droughts will result in drier forests and increase likelihood of wildfire.

Droughts will cause significant economic damage to the agriculture industry through reduced yields and quality of some crops. Droughts can increase irrigation-related water consumption, and thus increase irrigation costs. Drought conditions can also have a significant effect on the supply of drinking water.

Winter Storms, Floods, and Landslides

Regions affected: 1–4

Flooding and landslides are projected to occur more frequently throughout western Oregon, in Oregon NHMP Regions 1 through 4. While winter storms affect all areas of the state, there is no current research available indicating any change in the incidence of winter storms due to changing climate conditions.

The increase in extreme precipitation that is projected to occur at all thresholds from 1 to 4 inches per day (**Table 2-5**) is expected to result in a greater risk of flooding in certain basins. Changes in flood risk are strongly associated with the dominant form of precipitation in a basin, with mixed rain-snow basins in Washington and Oregon already seeing increases in flood risk. Generally, western Oregon basins are projected to experience increased flood risk in future decades. Increased flood risk involves both an increased incidence of flooding of a certain magnitude and an increase in the magnitude of floods of a certain return interval. In other areas of the state, flood risk may decrease in some basins and increase in others.

Landslides in Oregon are strongly correlated with rainfall, so increased rainfall — particularly in extreme events — will likely trigger increased landslides.

The executive summary of Oregon's Climate Change Adaptation Framework provides a summary of challenges associated with both flooding and landslides:

Floods

Extreme precipitation events have the potential to cause localized flooding due partly to inadequate capacity of storm drain systems. Extreme events can damage or cause failure of dam spillways. Increased incidence and magnitude of flood events will increase damage to property and infrastructure and will increase the vulnerability of areas that already experience repeated flooding. Areas thought to be outside the floodplain may begin to experience flooding. Many of these areas have improvements that are not built to floodplain management standards and are not insured against flood damage; therefore being more vulnerable to flood events. Finally, increased flooding will increase flood-related transportation system disruptions, thereby affecting the distribution of water, food, and essential services.

Landslides

Increased landslides will cause increased damage to property and infrastructure and will disrupt transportation and the distribution of water, food, and essential services. Widespread damaging landslides that accompany intense rainstorms (such as “Pineapple Express” winter storms) and related floods occur during most winters. Particularly high consequence events occur about every decade; recent examples include those in February 1996, November 2006, and December 2007.

Windstorms

Regions affected: Unknown

There is little research on changing wind in the Pacific Northwest as a result of climate change.

2.2.1.3 Hazards

Requirement: 44 CFR §201.4(c)(2)(i): The risk assessment shall include… (i) An overview of the type and location of all natural hazards that can affect the State, including information on previous occurrences of hazard events, as well as the probability of future hazard events, using maps where appropriate;

Coastal Hazards

Figure 2-4. Erosion at The Capes Condominiums, Oceanside, Oregon

Notes: The Capes, a multi-million dollar condominium complex constructed on an old Holocene dune field adjacent to Oceanside. Due to erosion of the sand at the toe of the bluff during the 1997-98 El Niño winter, the bluff face began to fail threatening several of the homes built nearest the bluff edge.

Source: DOGAMI

The Pacific Northwest (PNW) coast of Oregon is without doubt one of the most dynamic coastal landscapes in North America, evident by its long sandy beaches, sheer coastal cliffs, dramatic headlands and vistas, and ultimately the power of the Pacific Ocean that serves to erode and change the shape of the coast. It is these qualities along with its various natural resources that have drawn people to live along its narrow shores. However, coastal communities are increasingly under threat from a variety of natural hazards that all come together along the coastal strip. These include wave-induced coastal erosion (both short and long term), wave runup and overtopping (wave-induced flood hazards), inundation of homes by wind-blown sand, coastal landslides, earthquakes, and potentially catastrophic tsunamis generated by the Cascadia Subduction Zone (CSZ). Over time, these hazards are gradually being compounded, in part due to the degree of development that has evolved along the Oregon coast in recent decades. A particular concern is that the local geology and geomorphology of the region have restricted development to low-lying areas, chiefly along dunes, barrier spits, or along coastal bluffs present along the open coast that are subject to varying rates of erosion, and to low-lying areas adjacent to the numerous estuaries that make up the coast. All of these sites are highly susceptible to increased impacts as erosion processes and flood hazards intensify, driven by rising sea level and increased storminess.

Figure 2-5. A) Emergency Riprap Being Placed in Front of a Home at Gleneden Beach, Following a Recent Bluff Failure (February 2013). B) Homes Being Inundated with Excess Sand during a Strong Wind Event in November 2001

Source: DOGAMI

Beaches and coastal bluffs are some of the most dynamic landforms, responding to a myriad of variables. Both landforms are constantly changing (at varying time scales) as they respond to changes in the ocean processes (waves, nearshore currents and tides) that affect the beach and toe of the bluff as well as those sub-aerial processes (rainfall, sun, wind) that directly affect coastal bluffs. There are many dangers inherent in living on the coast. While coastal bluffs gradually erode over the long-term, they can also respond very rapidly, at times sliding away (in a matter of minutes to a few hours) so that homes and sections of highways are damaged or destroyed (**Figure 2-5A**). Beaches are especially dynamic features, as sand is constantly shifted about. This is especially noticeable in major storms, with the shoreline retreating rapidly, periodically destroying homes built too close to the sea. At other times, large quantities of sand migrate back onto beaches, burying homes built atop coastal dunes (**Figure 2-5B**). There is no location on the Oregon coast that is immune to coastal hazards.

Without question, the most important natural variables that influence changes to the shape and width of the beach and ultimately its stability are the beach sand budget (balance of sand entering and leaving the system) and the processes (waves, currents, tides, and wind) that drive the changes.

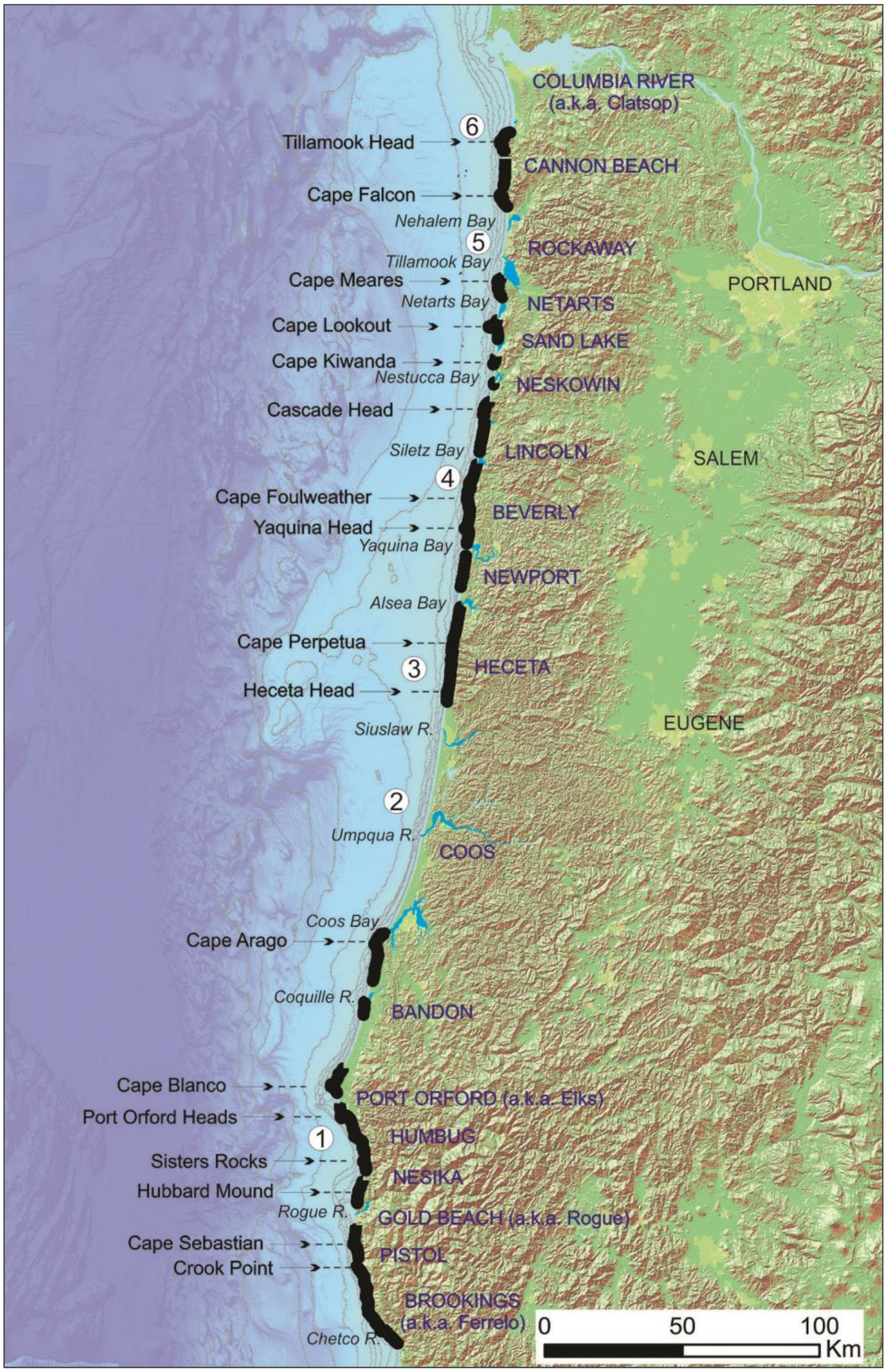
Human influences associated with jetty construction, dredging practices, coastal engineering, and the introduction of non-native dune grasses have all affected the shape and configuration of the beach, including the volume of sand on a number of Oregon's beaches, ultimately influencing the stability or instability of these beaches.

Analysis and Characterization

Geology and Geomorphology

The Oregon coast is 366 miles long from the Columbia River to the California border. The present coastline is the result of geologic processes that include a rise in sea level as Ice Age glaciers melted. The coastal geomorphology of this landscape reflects a myriad of geomorphic features (**Figure 2-6**) that range from plunging cliffs (in Regions 1, 4, and 5), rocky shorelines and shore platforms (Regions 1, 3, 5, and 6), wide and narrow sandy beaches backed by both dunes (Regions 2, 5, and 6) and cliffs (Regions 3 and 4), gravel and cobble beaches backed by cliffs (Regions 1, 5, and 6), barrier spits (Regions 2, 4, and 5), and estuaries (Regions 1–6). Cliffed or bluff-backed shorelines make up the bulk of the coast accounting for 58% of the coastline, the remainder being dune-backed. Geomorphically, the coast can be broken up into a series of “pocket beach” littoral cells (**Figure 2-6**) that reflect resistant headlands (chiefly basalt) interspersed with short to long stretches of beaches backed by both less resistant cliffs and dunes (e.g., Lincoln and Tillamook Counties [Regions 3 and 5 in **Figure 2-6**; also see **Figure 2-7**]). The headlands effectively prevent the exchange of sand between adjacent littoral cells. Some beaches form barrier spits, creating estuaries or bays behind them (e.g., Netarts, Nestucca, and Siletz spits). About 75.6% of the coastline consists of beaches composed of sand or gravel backed by either dunes or bluffs, while the remaining 24.4% of the coast is composed of a mixture of rocky cliffs (including headlands) and shores. Of the 18 littoral cells on the Oregon coast, the largest is the Coos cell, which extends from Cape Arago in the south to Heceta Head in the north, some 62.6 miles long.

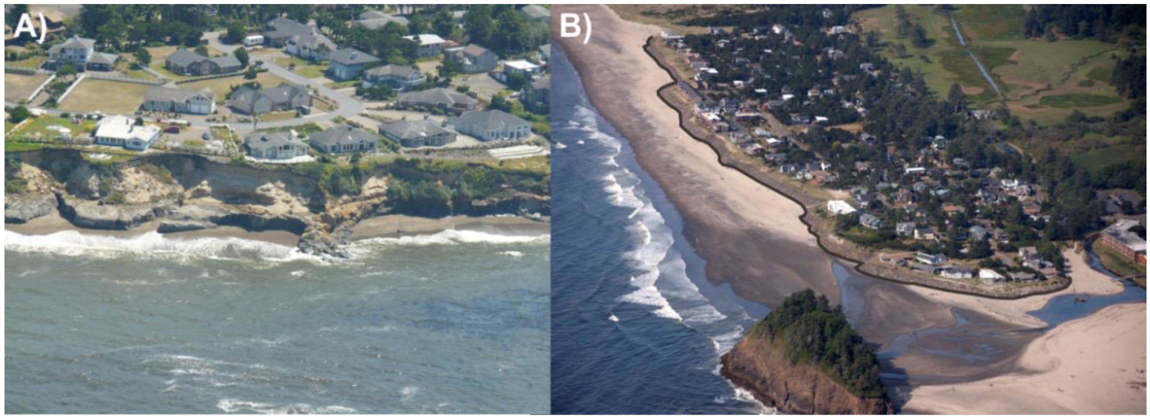
Figure 2-6. Oregon's Coastal Geomorphology and Littoral Cells



Note: Bold black lines denote the locations of cliffs and rocky shores. Faint grey lines denote faulting. Numbers indicate regional coastal geomorphic features: plunging cliffs (1, 4, and 5); rocky shorelines and shore platforms (1, 3, 5, and 6); wide and narrow sandy beaches backed by dunes (2, 5, and 6) and cliffs (3 and 4); gravel and cobble beaches backed by cliffs (1, 5, and 6); barrier spits (2 and 5); and estuaries (1–6).

Source: DOGAMI

Figure 2-7. (A) Houses Line the Cliff at Fogarty Creek in Lincoln County. (B) Extensive Erosion along the Dune-Backed Beaches in Neskowin Have Resulted in the Construction of Massive Riprap



Note the proximity of the eroding cliff edge to homes.

Source: L. Stimely, DOGAMI

Interspersed among the littoral cells are 21 estuaries that range in size from small, such as the Winchuck estuary (0.5 km^2) adjacent to the Oregon/California border, to large, such as the Columbia River (380 km^2), which separates the states of Oregon and Washington. The estuaries are all ecologically important to many fish and wildlife species and in many cases are the sites of important recreational and commercial enterprise. In general, Oregon estuaries can be divided into two broad groups based on physiographic differences between estuaries located on the north and south coast. On the northern Oregon coast, the prevalence of pocket beach littoral cells and weaker rock formations in the coast range has resulted in more rapid erosion of the region's rock formations. This produces ample material at the coast, and coupled with alongshore sediment transport, has aided the formation of barrier spits across drowned river valleys and hence estuaries. In contrast, sediment loads on the southern Oregon coast are comparatively lower due to there being more resistant rock formations. Furthermore, the region is generally much steeper, which essentially limits the landward extent of the tide in drowned rivers and, hence, ultimately the size of the estuaries.

Unlike much of the U.S. coast, population pressure on the Oregon coast is relatively low and is largely confined to small coastal towns separated by large tracts of coast with little to no development. The bulk of these developments are concentrated on the central to northern Oregon coast in Lincoln, Tillamook, and Clatsop Counties. On the cliffed shores of the central Oregon coast, between Newport and Lincoln City, homes are perched precariously close to the edge of the cliffs (**Figure 2-7A**). In some areas the erosion has become acute, requiring various forms of coastal engineering (commonly riprap) to mitigate the problem **(Figure 2-7B**), and in a few cases the landward removal of the homes. In other areas, critical infrastructure such as US-101 tracks close to the coast, and in a few areas, erosion of the cliffs has resulted in expensive remediation (e.g., adjacent to Nesika Beach in Curry County). Although the processes driving coastal erosion on bluff-backed shores are entirely a function of the delicate balance between the assailing forces (waves, tides, and currents) and properties of the rock (rock type, bedding, strength, etc.), increasing development pressure, weak land-use regulations, a lack of quantitative information, and ignorance of the physical processes have contributed to the need for remediation in many coastal areas.

Elsewhere, significant development is typically located along the most seaward dune (foredune) system (**Figure 2-7B**), as developers seek to capitalize on ocean views and proximity to the beach. However, major storms, especially in the late 1990s have resulted in extensive erosion, with many communities (e.g., Neskowin and Rockaway Beach in Tillamook County) having to resort to major coastal engineering in order to safeguard individual properties. The magnitude and extent of these erosion events have now left entire communities entirely dependent on the integrity of the structures.

Sand Budget

The beach sand budget is the rate at which sand is brought into the coastal system versus the rate at which sand leaves the system. A negative balance means that more sand is leaving than is arriving and results in erosion of that segment of shoreline. A positive balance means that more sand is arriving than is leaving, enabling that segment of shoreline to gain sand and accrete and potentially advance seaward. Along the Oregon coast, potential sources of sand include rivers, bluffs, dunes, and the inner shelf. Potential sand sinks include bays (estuaries), dunes, dredging around the mouths of estuaries, and mining of sand.

Attention is often focused on the effects of beach and dune erosion. Yet, there are segments of Oregon's coast where periodically the concern is excess sand build-up, as has occurred in places like Pacific City, Manzanita, Bayshore Spit, Nedonna, and Cannon Beach.

Classifying Coastal Hazards

Natural hazards that affect coastal regions can be divided into two general classes, *chronic* and *catastrophic*.

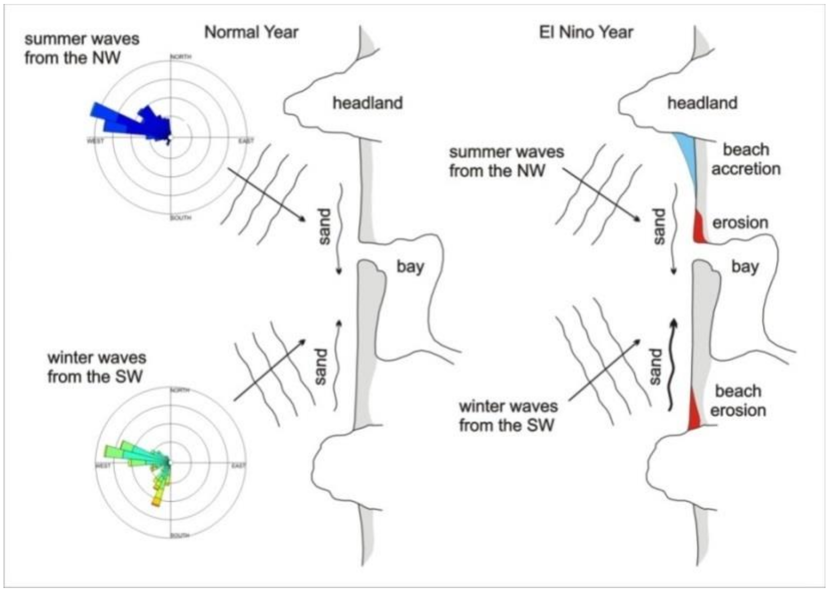
Chronic hazards such as beach, dune, and bluff erosion; landslides; slumps; and flooding of low-lying lands during major storms usually cause gradual and cumulative damage. However, storms that produce large winter waves, heavy rainfall, and/or high winds may result in very rapid erosion or other damage that can affect properties and infrastructure over a matter of hours. The regional, oceanic, and climatic environments that result in intense winter storms determine the severity of chronic hazards along the Oregon coast. Chronic hazards are typically local in nature, and threats to human life and property that arise from them are generally less severe than those associated with catastrophic hazards. However, the wide distribution and frequent occurrence of chronic hazards makes them a more immediate concern.

Catastrophic hazards are regional in scale and scope. Cascadia Subduction Zone earthquakes, and the ground shaking, subsidence, landsliding, liquefaction, and tsunamis that accompany them are catastrophic hazards. Tsunamis generated from distant earthquakes can also cause substantial damage in some coastal areas. The processes associated with earthquakes, tsunamis, floods, and landslides are discussed later in this chapter.

Causes of Coastal Hazards

Chronic coastal hazards include periodic high rates of beach and dune erosion, sand inundation, "hotspot erosion" due to the occurrence of El Niños and from rip current embayments, intermittent coastal flooding as a result of El Niños, storm surges and high ocean waves, and the enduring recession of coastal bluffs due to long-term changes in mean sea level, variations in the magnitude and frequency of storm systems, and climate change. Other important hazards include mass wasting of sea cliffs such as slumping and landslides, which may be due to wave attack and geologic instability.

Figure 2-8. Patterns of Sediment Transport During "Normal" and El Nino Years



Source: Komar (1986)

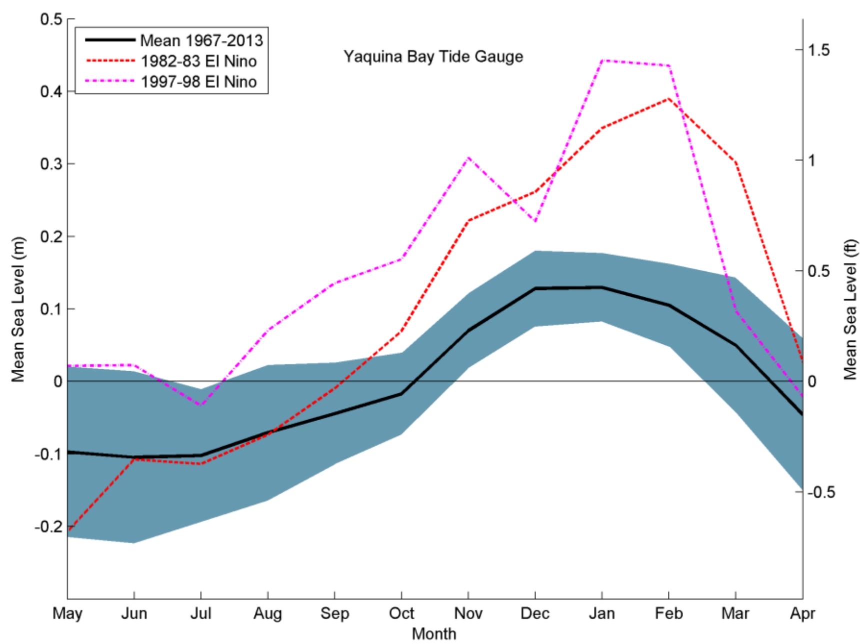
Most of these hazards are the product of the annual barrage of rain, wind, and waves that batter the Oregon coast, causing ever-increasing property damage and losses. A number of these hazards may be further exacerbated by climate cycles such as the El Niño Southern Oscillation, or longer-term climate cycles associated with the Pacific Decadal Oscillation. Other hazards, such as subduction zone earthquakes and resulting tsunamis, can have catastrophic impacts on coastal communities' residents and infrastructure, and in many areas these impacts will persist for many decades following the event due to adjustments in the coastal morphodynamics following subsidence or uplift of the coast. All of these processes can interact in complex ways, increasing the risk from natural hazards in coastal areas.

Waves

Along dune- and bluff-backed shorelines, waves are the major factor affecting the shape and composition of beaches. Waves transport sand onshore (toward the beach), offshore (seaward to form nearshore bars etc.), and along the beach (longshore transport). Short-term beach and shoreline variability (i.e., storm related changes) is directly dependent on the size of the waves that break along the coast, along with high ocean water levels, and cell circulation patterns associated with rip currents. In contrast, long-term shoreline change is dependent on the balance of the beach sediment budget, changes in sea level over time, and patterns of storminess.

The Oregon coast is exposed to one of the most extreme ocean wave climates in the world, due to its long fetches and the strength of the extratropical storms that develop and track across the North Pacific. These storms exhibit a pronounced seasonal cycle producing the highest waves (mean = 12.8 ft) in the winter, with winter storms commonly generating deep-water wave heights greater than 33 ft, with the largest storms in the region having generated waves in the range of 45 to 50 ft. In contrast, summer months are dominated by considerably smaller waves (mean = 5.3 ft), enabling beaches to rebuild and gain sand eroded by the preceding winter. When large waves are superimposed on high tides, they can reach much higher elevations at the back of the beach, contributing to significantly higher rates of coastal erosion and flood hazards. It is the combined effect of these processes that leads to the erosion of coastal dunes and bluffs, causing them to retreat landward.

Figure 2-9. Average Monthly Tides for the Yaquina Bay Tide Gage Expressed as an Average for the Period 1967–2013, and as Monthly Averages for the 1982-83 and 1997-98 El Niños



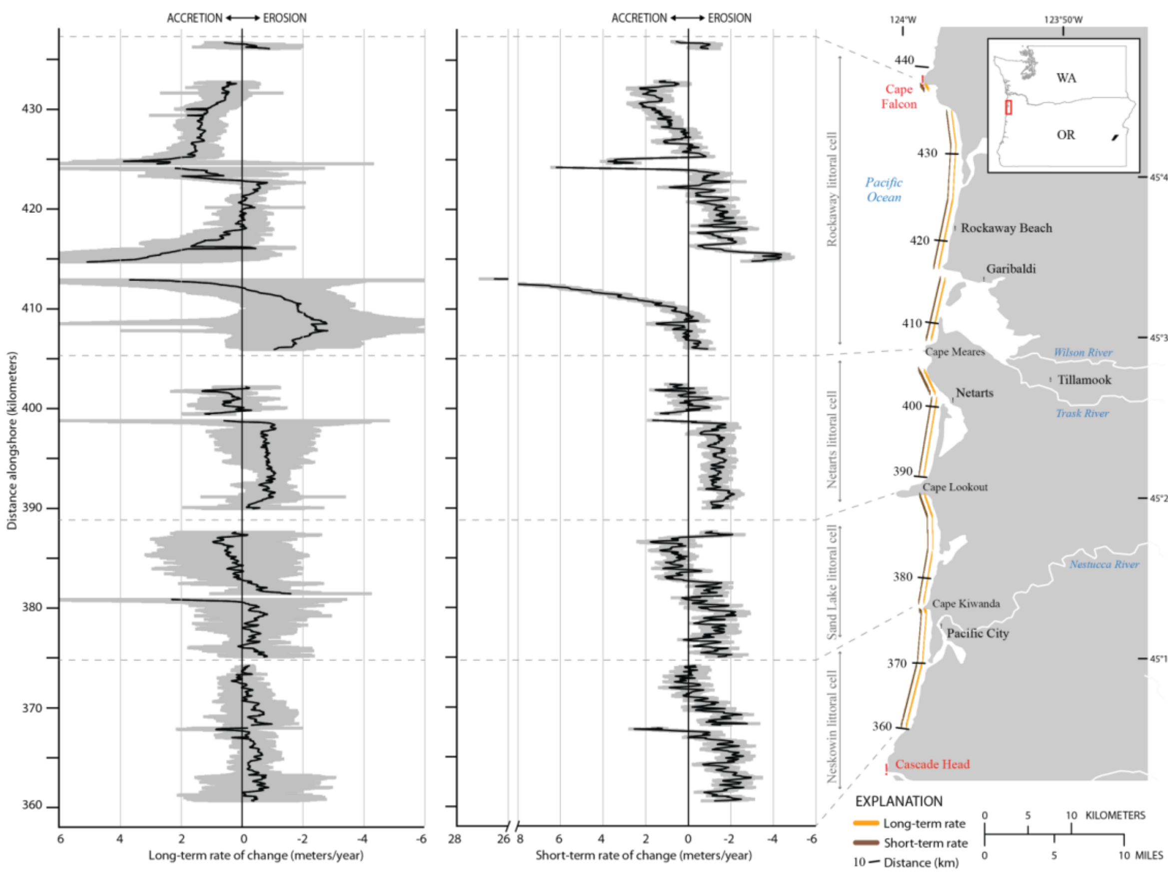
Note: Shaded region= ±1 standard deviation providing a measure of normal ranges.
Source: Jonathan Allen, DOGAMI

Winds and waves tend to arrive from the southwest during the winter and from the northwest during the summer. Net sand transport tends to be offshore and to the north in winter and onshore and to the south during the summer (**Figure 2-8**). El Niño events can exaggerate the characteristic seasonal pattern of erosion and accretion, and may result in an additional 60–80 feet of "hotspot" dune erosion along the southern ends of Oregon's littoral cells, particularly those beaches that are backed by dunes, and on the north side of estuary inlets, rivers and creeks.

Ocean Water Levels

The elevation of the sea is controlled in part by the astronomical tide. High ocean water levels at the shoreline may be the product of combinations of high tides, storm surges, strong onshore-directed winds, El Niños, and wave runup. As can be seen in **Figure 2-9**, the Oregon coast experiences a seasonal cycle in its measured tides, with the tides tending to be highest in the winter and lowest in the summer. This seasonal variation is entirely a function of ocean upwelling during the summer months, which brings cold dense water to the surface; due to the Coriolis effect and ocean currents, this water is directed landward where it piles up along the coast depressing sea level. In the winter this process breaks down resulting in a warming of the ocean, which raises the mean sea level. The typical seasonal variability in water levels is about 0.8 ft, increasing to as much as 2 ft during an El Niño (**Figure 2-9**), essentially raising the mean shoreline elevation, enabling waves to break closer to dunes or along the base of coastal bluffs.

Figure 2-10.Long- and Short-Term Shoreline Change Rates for the Tillamook County Region



Source: http://envision.bioe.orst.edu/StudyAreas/Tillamook/ruggiero_talk_PelicanPub_02102014.pdf

Source: Ruggiero et al. (2013)

Shoreline Changes

Dune-backed beaches respond very quickly to storm wave erosion, sometimes receding tens of feet during a single storm and hundreds of feet in a single winter season. Beach monitoring studies undertaken by DOGAMI staff (http://nvs.nanoos.org/BeachMapping) have documented storm induced erosion of 30–60 ft from single storm events, while seasonal changes may reach as much as 90–130 ft on the dissipative, flat, sandy beaches of Oregon, and as much as 190 ft on the more reflective, steeper beaches of the south coast (e.g., adjacent to Garrison Lake, Port Orford). Furthermore, during the past 15 years a number of sites on the northern Oregon coast (e.g., Neskowin, Netarts Spit, and Rockaway Beach) have experienced considerable erosion and shoreline retreat. For example, erosion of the beach in Neskowin has resulted in the foredune having receded landward by as much as 150 ft since 1997. South of Twin Rocks near Rockaway, the dune has eroded about 140 ft over the same time period. Continued monitoring of these study sites are now beginning to yield enough data from which trends (erosion or accretion rates) may be extrapolated. These latter datasets are accessible via the web (http://nvs.nanoos.org/BeachMapping).

Recently, studies undertaken by the USGS provide additional insights into the spatial extent of erosion patterns on the Oregon coast. **Figure 2-10** provides analyses of both long-term (about 1900s to 2002) and short-term (about 1960s/80s to 2002) shoreline change patterns along the Tillamook County coast, confirming measured data reported by DOGAMI. As can be seen from the figure, long-term erosion rates (albeit low rates) dominate the bulk of Tillamook County (i.e., Bayocean Spit, Netarts, Sand Lake, and Neskowin littoral cells), while accretion prevailed in the north along Rockaway Beach and on Nehalem Spit. The significant rates of accretion identified adjacent to the mouth of Tillamook Bay are entirely due to construction of the Tillamook jetties, with the north jetty completed in 1917 and the south jetty in 1974. Short-term shoreline change patterns indicate that erosion has continued to dominate the bulk of the shoreline responses observed along the Tillamook County coast. Erosion is especially acute in the Neskowin, Sand Lake and Netarts littoral cells, and especially along Rockaway Beach. In many of these areas, the degree of erosion remains so significant, that were we to experience a major storm(s) in the ensuing winters, the risk of considerable damage to property and infrastructure in these areas would likely be high.

Figure 2-11. Alsea Bay Spit Erosion as a Result of the 1982-83 El Niño (left), and State of the Beach in 2009 (right)

Note: Yellow/black line delineates a riprap structure constructed to protect the properties from further erosion. Orange line defines the maximum extent of dune erosion due to wave attack as a result of the 1982-83 event. Note the northward migration of the estuary mouth compared to its position in 2009.

Source: DOGAMI

The processes of wave attack significantly affect shorelines characterized by indentations, known as inlets. Waves interact with ocean tides and river forces to control patterns of inlet migration. This is especially the case during El Niños. During an El Niño, large storm waves tend to arrive out of the south, which causes the mouth of the estuary to migrate to the north, where it may abut against the shoreline, allowing large winter waves to break much closer to the shore. This can result in significant "hotspot" erosion north of the estuary mouth. Recent examples of the importance of inlet dynamics during an El Niño are Alsea Spit near Waldport (**Figure 2-11**), Netarts Spit near Oceanside, and at Hunter Creek on the southern Oregon coast at Gold Beach.

Floods

Flood Insurance Rate Maps (FIRMs) and Flood Insurance Studies (FISs) are also often used in characterizing and identifying flood-prone areas. FEMA conducted many FISs in the late 1970s and early 1980s. Included were "VE" zones, areas subject to wave action and ocean flooding during a "100-year" event that encompass the area extending from the surf zone to the inland limit of wave runup, and/or wave overtopping and inundation, and/or the location of the primary frontal dune or any other area subject to high-velocity wave action from coastal storms. Areas identified as VE zones are subject to more development standards than other flood zones.

Currently, DOGAMI is working with FEMA to update and remap FEMA coastal flood zones established for Oregon's coastal communities.

Landslides

Simple surface sloughing is the dominant process along bluff-backed shorelines. Other shorelines are backed by steep slopes, where deep-seated landslides and slumping are the dominant processes (**Figure 2-12**). The geologic composition of the bluff is a primary control on slope stability.

Headlands, generally composed of basalt, are more resistant to erosion and do not readily give way. In contrast, soft bluff-forming sandstone and mudstone are highly susceptible to slope movement. Prolonged winter rains saturate these porous bluff materials, increasing the likelihood of landslides.

The geometry and structure of bluff materials also affect slope stability by defining lines of weakness and controlling surface and subsurface drainage. As waves remove sediment from the toe of the bluff, the bluffs become increasingly vulnerable to slope failure due to increased exposure to wave attack. The extent to which the beach fronting the bluff acts as a buffer is thus important in this regard. Thus a reduction in the sand beach volume in front of a bluff increases its susceptibility to wave erosion along its toe, which can eventually contribute to the failure of the bluff.

A recent example of such a process occurred at Gleneden Beach in Lincoln County in November 2006 (**Figure 2-12**), when a large rip current embayment (an area of the beach that exhibits more erosion and beach narrowing due to removal of sand by rip currents) formed in front of a portion of the bluff, allowing waves to directly attack the base of the bluff. In a matter of two days, the bluff eroded back by up to 30 ft, undermining the foundations of two homes, and almost resulting in their destruction.

Figure 2-12. Bluff Failure Due to Toe Erosion by Ocean Waves

Note: The top of the bluff eroded landward by about 30 ft over a 48-hour period in November 2006.

Photo source: OPDR

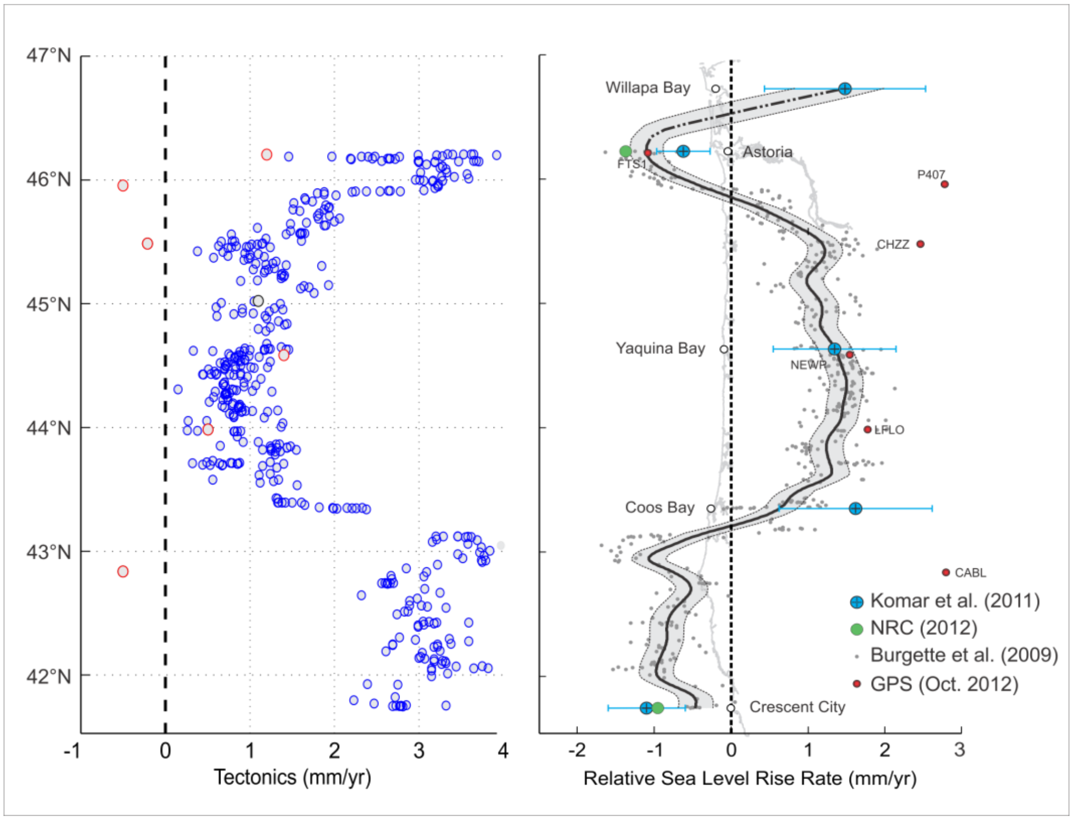
Similar processes occurred nearby during the 1972-73 winter, which led to one home having to be pulled off its foundation. Both examples provide a stark reminder of the danger of building too close to the beach and that these types of changes do occur relatively frequently

Climate Change and Sea Level Rise

An understanding of the trends and variations in sea level on the Oregon coast provides important insights as to the spatial patterns of erosion and flood hazards. In general, tectonic uplift is occurring at a much faster rate (about 2–4 mm/year) on the south coast (south of about Coos Bay), while the uplift rates on the central to northern Oregon coast are much lower, averaging about 1 mm/year (**Figure 2-13**, left). When combined with regional patterns of sea level change (**Figure 2-13**, right), it is apparent that the southern Oregon coast is essentially an emergent coast, with the coast rising at a much faster rate when compared with sea level. In contrast, the central to northern Oregon coast is a submergent coast due to the fact that sea level is rising faster than the land. Not surprisingly, it is the north coast that exhibits the most pervasive erosion and flood hazards when compared with the south coast.

In 2012, the National Research Council completed a major synthesis of the relative risks of sea level rise on the U.S. West Coast. The consensus from that report is that sea level has risen globally by on average 1.7 mm/year, while rates derived from satellite altimetry indicate an increase in the rate of sea level rise to 3.2 mm/year since 1993 (NRC, 2012). Combining our knowledge of glacial isostatic rebound (the rate at which the earth responds to the removal of ice from the last glaciations), regional tectonics, and future temperature patterns, the committee concluded that sea level on the Oregon coast would increase by approximately 2.1 ft by 2100.

Figure 2-13. Coast Variations in Rates of Tectonic Uplift, and Relative Sea Level Trends for the Oregon Coast



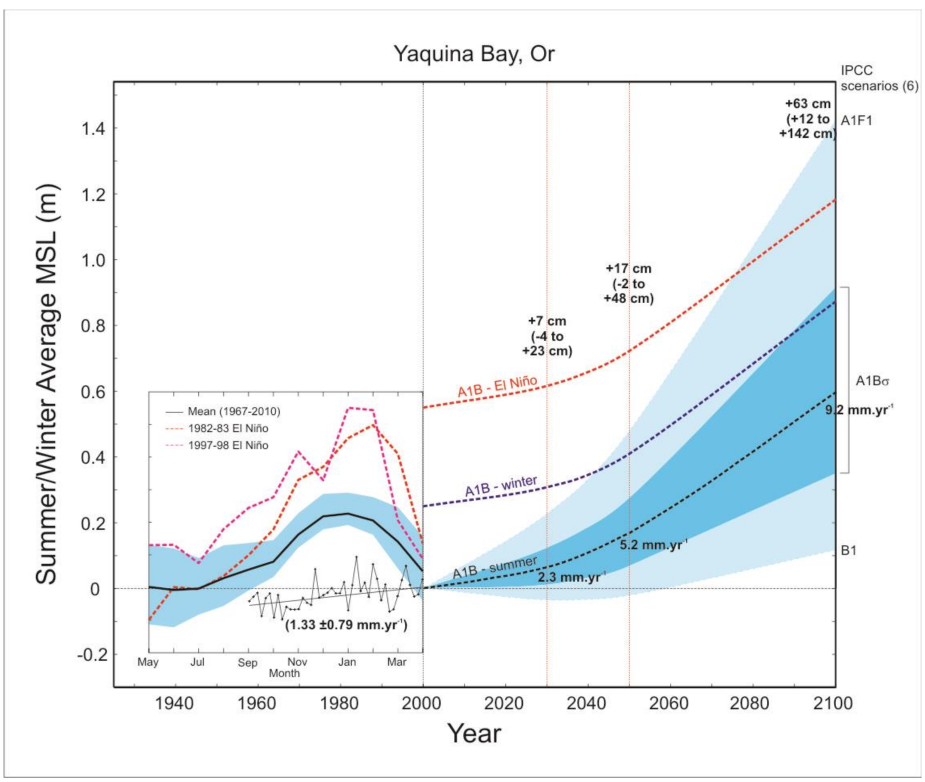
Source: Komar and Allan (2010); website: http://www.aviso.oceanobs.com/en/news/ocean-indicators/mean-sea-level/

Table 2-7. Projected Sea Level Rise for the Central Oregon Coast

By Year 2030		By Year 2050		By Year 2100	
Projection	Range	Projection	Range	Projection	Range
0.2 ft	-0.1–0.7 ft	0.6 ft	-0.07–1.6 ft	2.1 ft	0.4–4.7 ft

Table 2-7 presents the NRC (2012) projected sea level rise findings for the Central Oregon coast. The largest increase in regional sea level is estimated to be 4.7 ft by 2100. Of importance, these projections assume that sea level is uniform year round. However, as noted previously, sea level on the Oregon coast exhibits a pronounced seasonal cycle of about 0.8 ft between summer and winter, increasing to as much as 2 ft in response to the development of a strong El Niño. Thus, when combined with projected future increases in regional sea level, it becomes apparent that the potential increase in mean sea level could be substantially greater depending on the time of year (Figure 2-14). For example, by 2100, sea level during an El Niño winter will have increased by a total of 6.6 ft, raising the mean shoreline position by that amount, which will have shifted upward and landward as beaches respond to the change in mean water levels. Based on these projections, it can be expected that areas presently classified as emergent (e.g., the southern Oregon coast), will become submergent over time as the rate of sea level rise surpasses tectonic uplift. Furthermore, erosion and flood hazards on the northern Oregon coast will almost certainly accelerate, increasing the risk to property.

Figure 2-14. Projected Future Changes in Regional Sea Levels on the Oregon Coast



Source: Created by Jonathan Allan, DOGAMI, with integrated sea level rise projections from the National Resource Council (2012).

Human Activities

Human activities affect the stability of all types of shoreline. Large-scale human activities such as jetty construction and maintenance dredging have a long-term effect on large geographic areas. This is particularly true along dune-backed and inlet-affected shorelines such as the Columbia River and Rockaway littoral cells (**Figure 2-6**). The planting of European beach grass (*Ammophila arenaria*) since the early 1900s and, more recently, American beach grass (*Ammophila breviligulata*) has locked up sand in the form of high dunes. Such a process can contribute to a net loss in the beach sand budget and may help drive coastal erosion.

Residential and commercial development can affect shoreline stability over shorter time periods and smaller geographic areas. Activities such as grading and excavation, surface and subsurface drainage alterations, vegetation removal, and vegetative as well as structural shoreline stabilization can all affect shoreline stability.

While site-specific coastal engineering efforts such as the construction of riprap revetments is less likely to cause direct adverse impacts to the beach, the cumulative effect of constructing many of these structures along a particular shore (e.g., as has occurred along the communities of Gleneden Beach, Siletz Spit, Lincoln City, Neskowin, Pacific City, and Rockaway) will almost certainly decrease the volume of sediment being supplied to the beach system**,** potentially affecting the beach sediment budget and hence the stability of beaches within those littoral cells.

Heavy recreational use in the form of pedestrian and vehicular traffic can affect shoreline stability over shorter time frames and smaller spaces. Because these activities may result in the loss of fragile vegetative cover, they are a particular concern along dune-backed shorelines. Graffiti carving along bluff-backed shorelines is another byproduct of recreational use that can damage fragile shoreline stability.

Historic Coastal Hazard Events

Table 2-8 lists historic coastal erosion and flood hazard events in Oregon.

Table 2-8. Historic Coastal Hazard Events in Oregon

Date	Location	Description
Jan. 1914	Newport	damage (Nicolai Hotel)
1931	Rockaway	coastal damage from December storm
Oct–Dec. 1934	Waldport and Rockaway	flooding (Waldport) coastal damage (Rockaway Beach)
Dec. 1935	Cannon Beach and Rockaway Beach	coastal damage
Jan. 1939	coastwide	severe gale; damage: coastwide severe flooding (Seaside, and Ecola Creek near Cannon Beach): • multiple spit breaches (southern portion of Netarts Spit) • storm damage (along the shore of Lincoln City and at D River) • flooding (Waldport) • extensive damage (Sunset Bay Park) • storm surge overtopped foredune (Garrison Lake plus Elk River lowland)
Dec. 1940	Waldport	flooding
1948	Newport	wave damage (Yaquina Arts Center)
Jan. 1953	Rockaway	70-ft dune retreat; one home removed
Apr. 1958	Sunset Bay State Park Newport	flooding (Sunset Bay); wave damage (Yaquina Arts Center in Newport)
Jan.–Feb. 1960	Sunset Bay State Park	flooding
1964	Cannon Beach	storm damage
Dec. 1967	Netarts Spit Lincoln City Newport Waldport	damage: coastwide State constructed wood bulkhead to protect foredune along 600 ft section (Cape Lookout State Park campground) flooding and logs (Lincoln City) wave damage (Yaquina Arts Center, Newport) flooding (Waldport) Storm damage (Beachside State Park washed up driftwood (Bandon south jetty parking lot)
1971–73	Siletz Spit	high tide line eroded landward by 300 ft Feb. 1973; one home completely destroyed; spit almost breached logs through Sea Gypsy Motel (Nov. 1973)
1982–83	Alsea Spit	northward migration of Alsea Bay mouth; severe erosion
1997–98	Lincoln and Tillamook Counties	El Niño winter (second strongest on record); erosion: considerable
1999	coastwide	five storms between January and March; coastal erosion: extensive, including: • significant erosion (Neskowin, Netarts Spit, Oceanside, Rockaway beach); • overtopping and flooding (Cape Meares) • significant erosion along barrier beach (Garrison Lake); overtopping 27-ft high barrier
Dec. 2007	Tillamook and Clatsop Counties	wind storm

Sources: Allan and Priest (2001); Allan and Komar (2002); Allan et al. (2003, 2006); Allan and Hart (2007, 2008); Allan et al. (2009, 2012); Allan and Stimely (2013); Komar (1986, 1987); Komar and Rea (1976); Komar and McKinney (1977), Komar (1997); Komar and Allan (2010); Peterson et al. (1990); Priest (1999); Revell et al. (2002); Schlicker et al. (1973); Stembridge (1975); and Terich and Komar (1974)

Probability

The erosion of the Oregon coast is exceedingly complex, reflecting processes operating over both short and long time scales, and over large spatial scales. However, the most significant erosion effects are largely controlled by high-magnitude (relatively infrequent) events that occur over the winter (the months of October to March), when wave heights and ocean water levels tend to be at their highest.

Waves

Previous analyses of extreme waves for the Oregon coast estimated the "100-year" storm wave to be around 33 feet. In response to a series of large wave events that occurred during the latter half of the 1990s, the wave climate was subsequently re-examined and an updated projection of the 100-year storm wave height was determined, which is now estimated to reach approximately 47–52 feet (**Table 2-9**), depending on which buoy is used. These estimates are of considerable importance to the design of coastal engineering structures and in terms of defining future coastal erosion hazard zones.

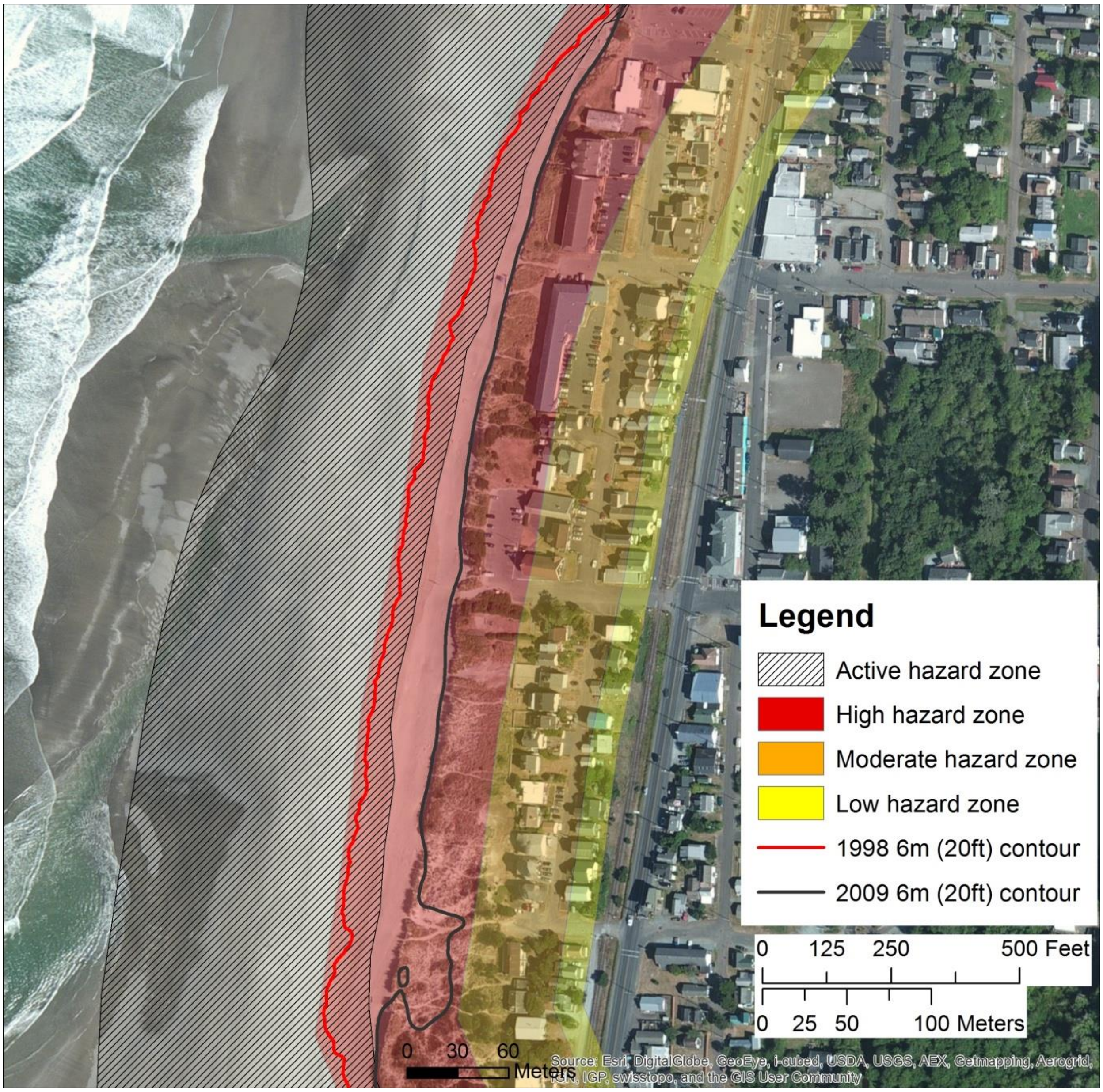
Table 2-9. Projection of Extreme Wave Heights for Various Recurrence Intervals

Recurrence Interval (years)	Extreme Wave Heights (feet)	
	NDBC buoy#46002* (Oregon)	NDBC buoy#46005+ (Washington)
10	42.5	41.7
25	46.2	44.0
50	48.8	
75	50.1	45.7
100	51.2	47.1

Note: Each wave height is expected to occur on average once during the recurrence interval. NDBC is National Data Buoy Center

Source: Jonathan Allan, DOGAMI

Figure 2-15. Example Map Product Showing Erosion Hazard Zones Developed for Rockaway Beach in Tillamook County



Note: The erosion that has taken place since 1998 (red line) up through 2009 (black line).
Photo source: DOGAMI

Coastal Erosion Hazard Zones

For the purposes of providing erosion hazard information for the Oregon coast, DOGAMI has completed coastal erosion hazard maps for Lincoln, Tillamook, and Clatsop Counties, as well in the Nesika Beach area in Curry County. Maps were completed for these areas mainly because these areas contain the largest concentration of people living along the coastal strip, and in the case of Nesika Beach in response to a specific request by the Department of Land Conservation and Development agency. In all cases, the maps depict erosion hazard zones that fall into four categories (**Figure 2-15**):

- **Active Hazard Zone (AHZ):** For dune-backed shorelines, the AHZ encompasses the active beach to the top of the first vegetated foredune, and includes those areas subject to large morphological changes adjacent to the mouths of the bays due to inlet migration. On bluff-backed shorelines the AHZ includes actively eroding coastal bluff escarpments and active or potentially active coastal landslides.
- **High Hazard Zones (HHZ):** This scenario is based on a large storm wave event (wave heights about 47.6 ft high) occurring over the cycle of an above average high tide, coincident with a 3.3 ft storm surge. The wave heights associated with this scenario have an expected recurrence interval of 50-60 years or a 2% chance in any given year.
- **Moderate Hazard Zones (MHZ):** This scenario is based on an extremely severe storm event (waves about 52.5 ft high) and may or may not encompass a long-term rise in sea level (depends on the coastal region). As with the HHZ, the wave event occurs over the cycle of an above average high tide, coincident with a 5.6 ft storm surge. The wave heights associated with this scenario have an expected recurrence interval of 100 years or a 1% chance in any given year.
- **Low Hazard Zones (LHZ):** This scenario is analogous to the MHZ scenario described previously, with the addition of a 3.3 ft coseismic subsidence of the coast.

In July 2014, DOGAMI completed new updated maps for the dune-backed beaches in Tillamook County using a probabilistic approach to map the erosion hazard zones. The revised modeling used three total water level scenarios (10%, 2%, and 1% events) produced by the combined effect of extreme wave runup (R) plus the tidal elevation (T), and erosion due to sea level rise (low/mean/maximum estimates) at 2030, 2050, and 2100. In total 81 scenarios of coastal erosion were modeled; an additional two scenarios were also modeled that considered the effects of a Cascadia subduction zone earthquake, and the effects of a single (1%) storm, where the storm's duration was taken into account. The completed study ultimately recommended five hazard zones for consideration.

Climate Change

Recent research indicates that sea levels along Oregon's coast are rising as are wave heights off the Oregon coast. Increasing significant wave heights may be a factor in the observed increase of coastal flooding events in Oregon. During El Niño events, sea levels can rise up to about 1.5 feet (0.5 meters) higher over extended periods (seasons). Rising sea levels and increasing wave heights are both expected to increase coastal erosion and coastal flooding.

Droughts

Despite its rainy reputation, the state of Oregon is often confronted with continuing challenges associated with drought and water scarcity. 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.

Oregon’s 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.

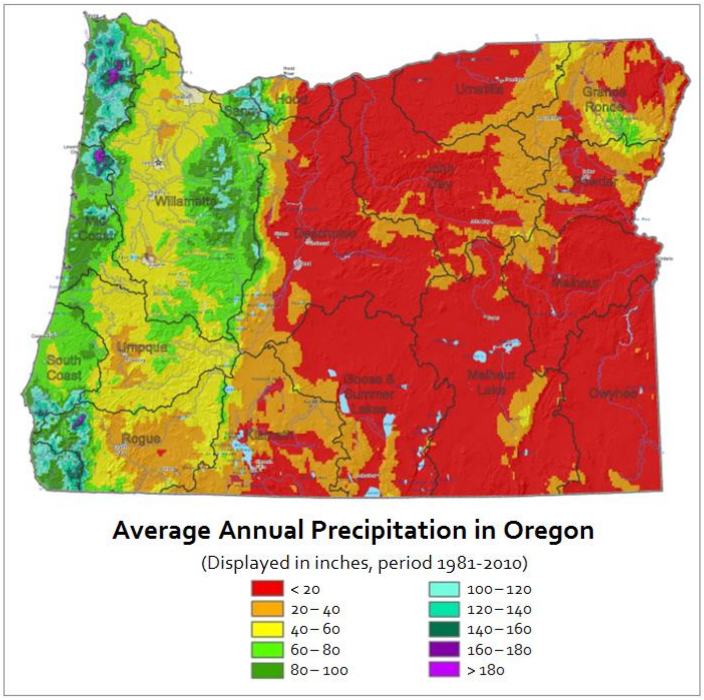
Drought is typically measured in terms of water availability in a defined geographic area. It is common to express drought with a numerical index that ranks severity. Most federal agencies use the Palmer Method which incorporates precipitation, runoff, evaporation, and soil moisture. However, the Palmer Method does not incorporate snowpack as a variable. Therefore, it is does not provide a very accurate indication of drought conditions in Oregon and the Pacific Northwest, although it can be very useful because of its a long-term historical record of wet and dry conditions.

Oregon’s Emergency Operations Plan includes a Drought Annex for the purposes of coordinating state and federal agency response to drought emergencies caused by water shortages and to provide emergency water supplies for human consumption under conditions of inadequate supply. The Annex outlines several steps and lists major responsibilities of various federal, state, and local jurisdictions. It also includes a description of federal drought assistance programs and guidelines for water curtailment planning and program development.

Analysis and Characterization

Defining drought can be difficult given the issue of both water supply and demand. Redmond (2002) puts forth a simple definition that encapsulates both supply and demand, “drought is insufficient water to meet needs.” 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 (Oregon Revised Statute §539.710).

Figure 2-16. Oregon Average Annual Precipitation, 1981–2010



Sources: PRISM Climate Group, Oregon State University (http://www.prism.oregonstate.edu/); map by Oregon Water Resources Department

Droughts can be characterized by the dominant impact caused by increased demand or decreased supply. In the early 1980s, researchers with the National Drought Mitigation Center and the National Center for Atmospheric Research located more than 150 published definitions of drought. There clearly was a need to categorize the hazard by "type of drought." The following definitions are a response to that need. However, drought cannot always be neatly characterized by the following definitions, and sometimes all four definitions can be used to describe a specific instance of drought.

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

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 refer to deficiencies in surface water and sub-surface water supplies. It is reflected in the level of streamflow, lakes, reservoirs, and groundwater. 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 sub-surface water levels.

Socioeconomic droughts occur when physical water shortage begins to affect people, individually and collectively. Most socioeconomic definitions of drought associate it with supply, demand, and economic good. One could argue that a physical water shortage with no socio-economic impacts is a policy success.

History of Droughts in Oregon

Oregon records, dating back to the late 1800s, associate drought with a departure from expected precipitation. Droughts in the Pacific Northwest can persist for a few years, but rarely prolong for a decade. The Dust Bowl era (1930s) had many years with below average precipitation, which caused problems for agriculture, but every year in that decade was not considered to be a drought year. However, three water years in the 1930s fall in the top five lowest statewide Palmer Drought Severity Index (PDSI) values on record (1895–2012). Despite the imperfections with the PDSI for the Pacific Northwest, it was chosen to define drought for purposes of this Plan because of its long-term record. While droughts are often referred to as happening in a calendar year, it is more appropriate to define them by water year. The water year begins at the start of the cool, rainy season on October 1 and continues through September 30 of the following year. For example, Water Year 2014 started on October 1, 2013.

Table 2-10. Water Years with the Lowest PDSI Values, Averaged Statewide, on Record for the State of Oregon

Rank	Water Year	PDSI Value
1	1931	-3.63
2	1930	-3.47
3	2001	-3.17
4	1929	-2.96
5	1939	-2.87

Source: NOAA National Climatic Data Center, Climate at a Glance, Time Series, http://www.ncdc.noaa.gov/cag/time-series/us/35/01/pdsi/12/09/1895-2015?trend=true&trend_base=10&firsttrendyear=1896&lasttrendyear=2014

Low streamflows prevailed in western Oregon during the period from 1976-81, but the worst year, by far, was 1976-77, the single driest year of the century. The Portland Airport received only 7.19 inches of precipitation between October 1976 and February 1977, only 31% of the average 23.16 inches for that period. This drought also impacted California and other parts of the West Coast. It is often acknowledged as one of the most significant droughts in Oregon's history, but it does not show up in the top five or 10 PDSI values statewide. This can be attributed to both the imperfections in the PDSI for Oregon, varying degrees of severity statewide, and an increased population.

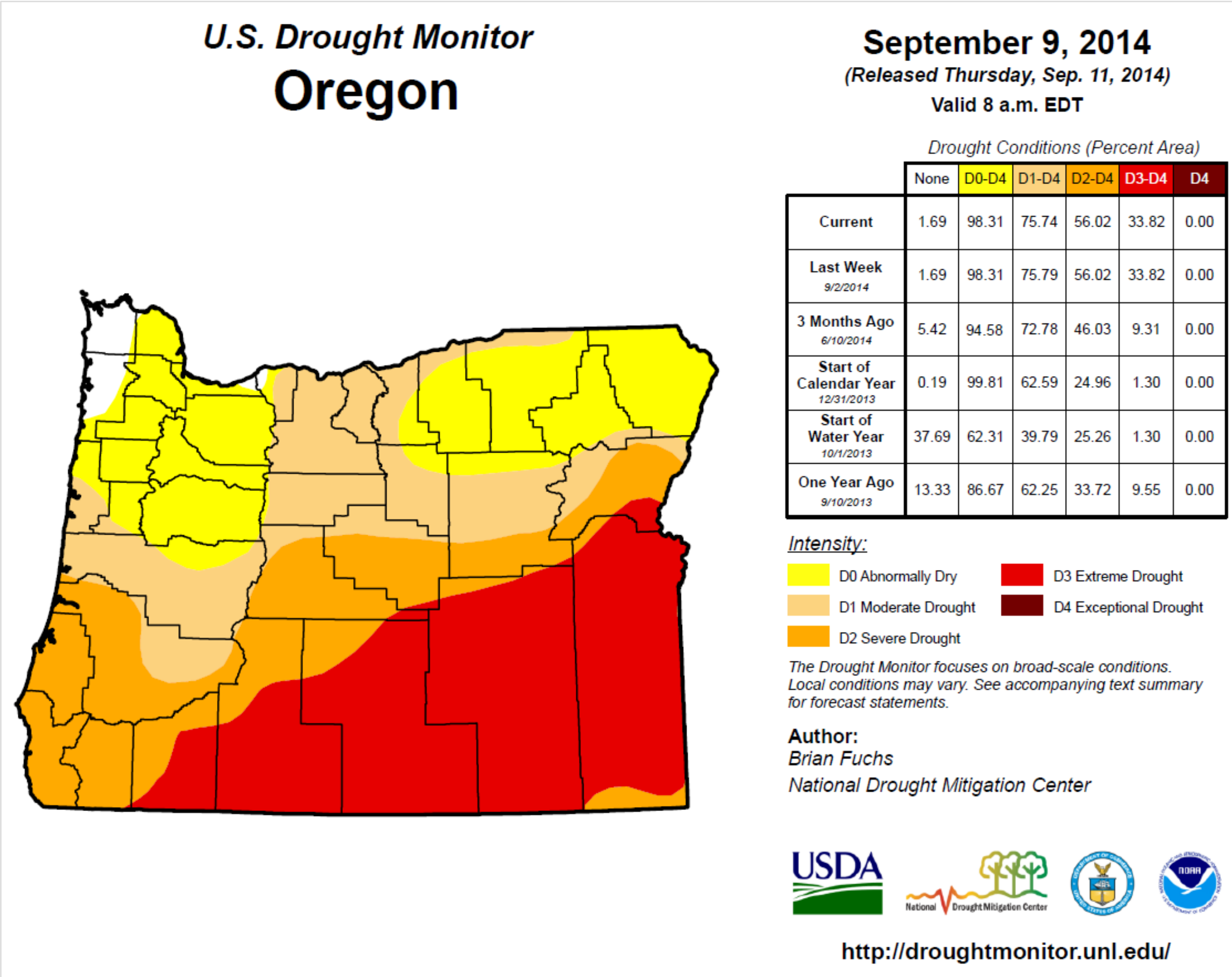
The 1992 drought was not as severe as the 1976-77 drought; however, it did occur toward the end of several years of drier than normal conditions in the late 1980s and early 1990s, making it the peak year for drought conditions. The Governor declared a drought emergency for all Oregon counties (Executive Order 92-21). Forests throughout the state suffered from a lack of moisture. Fires were common and insect pests, which attacked the trees, flourished.

In 2001 and 2002, Oregon experienced drought conditions, affecting six out of eight regions. During the 2005 drought, the Governor issued declarations for 13 counties, all east of the Cascades, and the USDA issued three drought declarations, overlapping two of the Governor's. State declarations were made for Baker, Wallowa, Wheeler, Crook, Deschutes, Klamath, Lake, Hood River, Wasco, Sherman, Gilliam, Morrow, and Umatilla Counties. Federal declarations were made in Coos, Klamath, and Umatilla Counties. Federal drought declarations, similar to declarations by Oregon's governor, provide emergency relief and response actions by various agencies. The U.S. Department of Agriculture, for example, can provide accessibility to emergency loans for crop losses. Since 2001, the Governor has declared a drought every year, with the exception of 2006, 2009, and 2011, in at least one Oregon county. Most of these declarations have involved one or more counties in Regions 5-8.

Impacts

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 on the entire state, especially in terms of hydroelectric power generation, irrigation, recreation, and industrial uses. In March of 2014, Mount Ashland Ski Resort in southern Oregon announced that it would be unable to open due to the lack of snow. The lack of snow has affected other regions of the state as well. In the Klamath Basin, the Natural Resources Conservation Service reports that the mountains are generally snow-free below 5,000 feet. The Taylor Butte SNOTEL site at elevation 5,030 feet was snow-free on March 1, 2014, a first for the site since it was installed in 1979. Five long-term snow measurement sites in the Klamath basin set new record lows for March 1 snowpack. The lack of snow and precipitation during the winter months led Governor Kitzhaber to declare a drought for four Oregon counties — Klamath, Lake, Harney, and Malheur — in February 2014. As of September 2014, the U.S. Drought Monitor reports that 56% of the state is experiencing a severe drought, and more than one third is in an extreme drought (**Figure 2-17**). So far this year, the Governor has declared drought in 10 counties, including Crook, Jackson, Grant, Josephine, Wheeler, and Baker.

Figure 2-17. September 9, 2014 U.S. Drought Monitor Report for Oregon



Source: U.S. Drought Monitor (http://droughtmonitor.unl.edu/)

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. In the Willamette Valley, for example, there has been an unusual pattern of tree mortality involving Douglas fir, grand fir, and western red cedar. Water stress brought on by drought and other factors is the central cause in these mortality events (Oregon Department of Forestry, 2008).

A moisture-deficient forest constitutes a significant fire hazard (see the **Wildfire** section of this Plan). In addition, drought and water scarcity add another dimension of stress to imperiled species. The following information addresses the impact of a severe or prolonged drought on the population, infrastructure, facilities, economy, and environment of Oregon:

Population: Droughts can affect all segments of Oregon's population, particularly those employed in water-dependent activities (e.g., agriculture, hydroelectric generation, recreation, etc.). Also, domestic water-users may be subject to stringent conservation measures (e.g., rationing) during times of drought and could see increases in electricity consumption and associated costs.

Infrastructure: Infrastructure such as highways, bridges, energy and water conveyance systems, etc., is typically unaffected by drought. However drought can cause structural damage. An example would include be areas of severe soil shrinkage. In these uncommon situations, soil shrinkage would affect the foundation upon which the infrastructure was built. In addition, water-borne transportation systems (e.g., ferries, barges, etc.) could be impacted by periods of low water.

Critical/essential facilities: Facilities affected by drought conditions include communications facilities, hospitals, and correctional facilities that are subject to power failures. Storage systems for potable water, sewage treatment facilities, water storage for firefighting, and hydroelectric generating plants also are vulnerable. Low water also means reduced hydroelectric production especially as the habitat benefits of water compete with other beneficial uses.

State-owned or -operated facilities: A variety of state-owned or -operated facilities could be affected by a prolonged drought. The most obvious include schools, universities, office buildings, health-care facilities, etc. Power outages are always a concern. Maintenance activities (e.g., grounds, parks, etc.) may be curtailed during periods of drought. The Oregon Parks and Recreation Department operates several campground and day-use facilities that could be impacted by a drought.

Economy: Drought has an impact on a variety of economic sectors. These include water-dependent activities and economic activities requiring significant amounts of hydroelectric power. The agricultural sector is especially vulnerable as are some recreation-based economies (e.g., boating, fishing, water or snow skiing). Whole communities can be affected. This was particularly evident during the 2001 water year when many Oregon counties sought relief through state and federal drought assistance programs.

Water Year 2001 was the third driest water year in Oregon's climate history; the drought was one of the most economically significant in the state's history. The community of Detroit, in Marion County, suffered economic hardships when lake levels became too low to support recreational summer activities. The drought directly affected over 200,000 irrigated acres in the Klamath River Basin. Farmers were among the first to be affected, followed by local agricultural support industries (e.g., pesticides, fertilizer, farm equipment, etc.), as well as Native American Tribes which depend on local fisheries.

Environment: Oregon has several fish species listed as threatened or endangered under the Endangered Species Act (ESA). Some of these species have habitat requirements that are jeopardized by the needs or desires of humans. For example, in times of scarcity, the amount of water needed to maintain habitat for fish species may conflict with the needs of consumptive uses of water. The state of Oregon is committed to implementation of the ESA and the viability of a productive economic base. There are no easy solutions, only continuous work to resolve difficult drought situations.

Historic Drought Events

Table 2-11. Historic Droughts and Dry Periods in Oregon

Date	Location	Description
1928-41	statewide	prolonged drier than normal conditions that caused major problems for agriculture; the three Tillamook burns, in the normally wet coastal range, the first in 1933, were the most significant impacts of this very dry period
1976-77	western Oregon	the 1977 drought was one of the most significant on record in western Oregon
1985–94	statewide	generally dry period, capped by statewide droughts in 1992 and 1994; 10 consecutive years of dry conditions caused problems throughout the state, such as fires and insect outbreaks
2001-02	affected all regions except Regions 2, 3	the second most intense drought in Oregon's history; 18 counties with state 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
2003	Regions 5–8	Governor-declared drought issued in seven counties: Sherman, Wheeler, Crook, Baker, Wallowa, Malheur, and Harney
2004	Regions 5–8	Governor-declared drought issued in four counties: Morrow, Klamath, Baker, and Malheur
2005	Regions 5–7	affected area: 13 of Oregon's 36 counties
2007	Regions 6–8	Governor-declared drought emergency in Lake, Grant, Baker, Union, Malheur, and Harney Counties
2008	Region 5	Governor-declared drought emergency in Sherman and Gilliam Counties
2010	Region 6	Governor-declared drought emergency for Klamath County and contiguous counties
2012	Region 6	Governor-declared drought emergency for the Lost River Basin, located in Klamath County and Lake County
2013	Regions 5–8	Governor-declared drought in Gilliam, Morrow, Klamath, Baker, and Malheur Counties
2014	Regions 4, 6–8	Governor-declared drought in 10 counties: Klamath, Lake, Malheur, Harney, Jackson, Josephine, Crook, Wheeler, Grant, and Baker; Oregon experienced its third driest Nov.–Jan. period since 1895

Sources: Taylor and Hatton (1999); Governor-declared drought declarations obtained from the Oregon State Archives division

Probability

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.

Climate Variability

The variability of Oregon's climate often can be attributed to long-term oscillations in the equatorial Pacific Ocean: El Niño and La Niña. Simply stated, these systems involve the movement of abnormally warm or cool water into the eastern Pacific, dramatically affecting the weather in the Pacific Northwest. El Niño tends to bring warm and dry winters; the inverse is true with La Niña. However, there have been wet years during an El Niño event, dry years in a La Niña, and both types of water years in neutral conditions. In other words, El Niño and La Niña do not explain all of the variability in every given winter. Also, climate change is reducing the robustness of the low-elevation snowpack, which will likely influence the frequency of drought conditions and associated impacts on Oregon communities.

Drought – The Nebulous Natural Hazard

- Drought is often associated with water scarcity, which usually is perceived as a "human-caused" hazard, rather than a "natural" hazard.
- Drought is frequently an "incremental" hazard, 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.
- Quantifying impacts and provisions for disaster relief is a less clear task than it is for other natural hazards.
- The lack of a precise and universally accepted definition adds to the confusion about whether or not a drought actually exists.
- Droughts are often defined by growing seasons, the water year, and livestock impacts.

An El Niño system moves heat, both in terms of water temperature and in atmospheric convection. The heat is transported toward North America, producing mild temperatures and dry conditions in Oregon. Its effects are most pronounced from December through March.

La Niña conditions are more or less opposite of those created by El Niño. It involves the movement of abnormally cool water into the eastern Pacific. This event produces cooler than normal temperatures in Oregon and increased precipitation. It also is most pronounced from December to March.

Predicting Droughts in Oregon

Predicting weather patterns is difficult at best; however, the 1997-98 El Niño event marked the first time in history that climate scientists were able to predict abnormal flooding and drought months in advance for various locations around the United States (http://www.nationalgeographic.com/elnino/mainpage2.html). The methodology consists of monitoring water temperatures, air temperatures, and relative humidity plus measuring sea-surface elevations. Once an El Niño or La Niña pattern is established, climatologists can project regional climatic behavior. Although the scientific community is optimistic about its recent forecasting achievements, not all droughts are associated with El Niño or La Niña events.

Climate Change

Climate models project warmer, drier summers for Oregon, with mean projected seasonal increases in summer temperatures of 2.6 to 3.6 ˚C by mid-century, and a decline in mean summer precipitation amounts of 5.6 to 7.5% by mid-century. These summer conditions will be coupled with projected decreases in mountain snowpack due to warmer winter temperatures. Models project a mean increase in winter temperatures of 2.5 to 3.2 ˚C by mid-century. This combination of factors exacerbates the likelihood of drought. These same conditions often lead to an increase in the likelihood of wildfires.

Dust Storms

A dust storm is a strong, violent wind that carries fine particles such as silt, sand, clay, and other materials, often for long distances. The fine particles swirl around in the air during the storm. A dust storm can spread over hundreds of miles and rise over 10,000 feet. They have wind speeds of at least 25 miles per hour.

Dust storms usually arrive with little warning and advance in the form of a big wall of dust and debris. The dust is blinding, making driving safely a challenge. A dust storm may last only a few minutes at any given location, but often leave serious car accidents in their wake, occasionally massive pileups.

Think Dust Storms Aren't a Serious Natural hazard?

Over the past 40 years in Oregon, more than ten people have been killed and more than 60 injured—some very seriously—due to automobile accidents caused by dust storms, often exacerbated by excessive speed.

Dust storms occur most frequently over deserts and regions of dry soil, where particles are loosely bound to the surface. Dust storms don't just happen in the middle of the desert, however. They happen in any dry area where loose dirt can easily be picked up by wind. Grains of sand, lofted into the air by the wind, fall back to the ground within a few hours, but smaller particles remain suspended in the air for a week or more and can be swept thousands of kilometers downwind. Dust from the Sahara desert regularly crosses the Atlantic, causing bright red sunrises and sunsets in Florida, traveling as far as the Caribbean and the Amazon Basin. (Some of the preceding material is from http://www.kidzworld.com/site/p707.htm#.)

Airborne dust particles, or dust aerosols, alter the climate by intercepting sunlight intended for the surface. By shading the earth from the sun's radiation, dust aerosols have the same effect as a rain cloud. While solar radiation is reduced beneath the dust cloud, the absorption of sunlight by dust particles heats the cloud itself.

Approximately half of the dust in today's atmosphere may result from changes to the environment caused by human activity, including agriculture, overgrazing, and the cutting of forests. Data from dust traps near urban areas like Las Vegas show that the spread of housing and other human construction across the desert directly causes increases in dust storms by destabilizing the surface and vegetation.

Analysis and Characterization

Intensive tillage of soils in agricultural uses is also a significant condition releasing soil to make it easily transportable by high winds. Depending on the crop and region involved, tillage may be occurring in the spring and/or in the autumn. Research in north-central Oregon and south-central Washington indicates that region's dust problem isn't simply a matter of soil being redistributed from one field to another by the wind. Fine particulate becomes suspended in the air and may travel thousands of miles. Scientists indicate that the region is truly losing soil.

1999 Dust Storm in Umatilla County

> "In September of 1999, after a long dry summer, a farmer was plowing his wheat fields in Eastern Oregon on a blue-sky day. A freak wind whipped up and dust covered the roadway. Instantly, everything went black. Later, they found dead people in cars with the cruise controls still set as high as 75 miles an hour. One person involved in the accident tried to go back to warn others. He waved at them, but the passing drivers just waved back... The last sight the young man had of one trucker was the trucker driving full bore into the dust storm, both hands off the wheel as he waved at the young man."
>
> —April Henry from *Learning to Fly*

During this September 25, 1999 dust storm, high winds blowing dust set off a chain-reaction of crashes that killed eight people and injured more than twenty. In all, more than forty vehicles crashed in separate pileups in both freeway directions between Hermiston and Pendleton. Parts of I-84 were blocked from mid-morning until nearly midnight.

Huge dust clouds set off by 50 mile per hour winds, dry soil, recent planting of nearby wheat fields, and harvesting of potato fields created extremely hazardous driving conditions that fateful morning. However, an Oregon State Police (OSP) report on the dust storm didn't blame the weather. It reported that driving too fast for conditions was the primary cause of the pileups.

The report indicated that neither OSP nor ODOT had enough warning time to close the freeway before the chain reaction crashes started. Five minutes after OSP noticed that visibility on the freeway was rapidly getting worse, the accidents started.

Community Solutions Team meetings held in early 2000 determined that focusing on the Natural Resources Conservation Service, and Soil and Water Conservation District practices will help reduce the volume of materials available to be whipped-up in dust storms.

These meetings also resulted in initiatives to increase detection and warning time. These allow OSP and ODOT to temporarily close certain highways, as well as better inform and advise the traveling public.

Several other ideas were examined for possible implementation along the I-84 corridor. Most were determined to be either ineffective or impractical for solving the problems of dust storms that occasionally occur in the area.

Source: Derived from the reports developed by a Community Solutions Team and Oregon State Police after the September 25, 1999 Umatilla County dust storm.

Air quality is adversely affected by windblown dust. Oregon's Department of Environmental Quality (DEQ) has developed a rule concerning air pollution caused by particulates from volcanic ashfall or windblown dust. Excerpts from that rule are shown in **Appendix 9.1.1.**

> "We called the weather service about 9:30 saying that visibility was getting bad… I could see the dust coming in a big cloud from the southwest. There's too much tillage to the west and southwest of us. You get a wind event like we had and that soil is loose, powdery and lifting, and I don't think you can stop it… Farming by its very nature, particularly in this country on these soils, at some time is going to involve tillage, and when it does… you're going to have exposure to winds… have wind and exposed soil, you're going to have dust."
>
> Source: Pendleton area farmer and member of the Oregon Wheat Growers League, talking about the September 25, 1999 event

Although many people are aware of the negative effects of dust storms such as vehicle crashes on highways, erosion of topsoil, dust in electronic equipment and aircraft engines, and poor air quality, a less obvious but important effect of dust storms and volcanic ashfall is not widely known: dust and ash deposited on the ground surface in new locations is eventually carried down into the soil by rain, providing important nutrients for plants in those locations.

> "(Farmers) say this is a problem the Columbia Basin, composed of mostly sandy soils, has experienced every spring before the rapid farm development that has followed circle irrigation… Luther Fitch, county extension agent in Hermiston… facetiously said Wednesday's winds 'probably sent a foot of topsoil back to Montana… undoubtedly there will be considerable need to replant spring wheat and potatoes. Fertilizer will have moved on and needs to be reapplied.' "
>
> Source: *East Oregonian*, Steve Clark, Friday, March 26, 1976, p. 1

> "…dust from freshly plowed fields hung heavy over much of Oregon last night as a windstorm of gale proportions continued unabated. One death and several injuries were attributed to the storm… Political storms abated for the moment, Salem lay yesterday under a pall of Eastern Oregon dust, which the oldest old-timers said was unique in the city's history. A swirling northeast wind drove tons of Eastern Oregon dust before it, down the Columbia Gorge and into Western Oregon. Diverting down the Willamette River at Portland, the dust clouds reached the valley early Wednesday morning and shrouded the entire country… Lights went on in schools, homes, and business houses as though the day was mid-winter… Old-timers in Salem scratched their heads yesterday and tried to recall a parallel in storm history for the dust invasion… but no precedent for the gale of dirt could be recalled. 'I recall a terrific storm in January 1880,' said A.N. Moores. 'However, it was a wind storm alone and there was no dirt accompanying it'… (Mill City) was surprised Tuesday evening when a heavy bank of clouds filled with dust began to work its way over the mountains and shut off the view of the surrounding hills by its denseness."
>
> Source: *Oregon Statesman*, Thursday, April 23, 1931, p. 1-2

Competition for Scarce Water Can Affect the Location and Frequency of Dust Storms

During June 2004, a group of residents of Summer Lake, known as Friends of Summer Lake, asked the state to divert to the lake a third of the water that currently feeds a wildlife sanctuary and irrigates pastures, contending that these uses make the lake dry-up sooner and more often. Another factor in the lake drying-up, however, is increased development in and around the basin, which has reduced the underground aquifer, decreasing the flow of springs.

Rainfall in the area, mostly during winter, averages 12 inches per year, but evaporation in the high desert - where summer temperatures can climb to 105 degrees - averages 40 to 50 inches per year.

Darrell Seven, who owns Summer Lake Inn with his wife, Jean Sage, said wind whipping over the dry lakebed causes alkali dust storms. "It’s hard to breathe, it’s irritating and it makes you sick," said Seven, who has been in the valley for 30 years. "I lose customers all the time who say they just can't handle it."

Alan Withers, president of the Summer Lake Irrigation District said, however, "This lake isn't very pretty, and we get a lot of dust down here. It’s nature’s way.”

Source: Based on an Associated Press article

Historic Dust Storm Events

Table 2-12. Historic Dust Storms in Oregon

Date	Location	Description
1906	Mid-Willamette Valley	news reports from the April 1931 event[1] make historical reference to "the great sandstorm of 1906 that lasted two weeks"
Apr. 1931[1]	Columbia Gorge, central Oregon, north and Mid-Willamette Valley, and Santiam Canyon	a swirling northeast wind drove tons of dust down the Columbia Gorge and into Portland and the north and mid-Willamette Valley; a heavy bank of clouds filled with dust also reportedly worked their way over mountain passes into the Santiam Canyon
May 1975[2]	near Echo Junction	winds up to 45 mph blew dust from nearby plowed fields, resulting in a seven-car accident on a Friday afternoon in the eastbound lanes of I-80 (now I-84); four injured
Mar. 1976[3]	near Stanfield	18 vehicles piled up in two separate accidents on I-80, now I-84; these accidents killed one and injured 20 people; they were caused by a dust storm (referred to in the press as a sand storm) that produced "near zero" visibility; one of the pile-ups was a fiery accident involving a loaded fuel tanker truck, two other trucks, and two cars; this dust storm also caused road closures both south and north of Hermiston, and caused other accidents on OR-207 about nine miles south of I-80 (I-84)
July 1979[4]	near Stanfield	this dust storm caused two deaths and six injuries in a freeway pile-up on I-80 (84) very close to the location of the previous event; winds near 60 mph; some of the injured were hit as pedestrians while trying to assist those already injured or pinned in automobiles
Sept. 1999[5]	Morrow and Umatilla Counties	blowing dust off wheat fields killed eight and injured more than twenty people in chain-reaction auto crashes
Apr. 2001[6]	near Klamath Falls	US-97 about 5 miles north of Klamath Falls was closed for approximately 6 hours following three separate crashes; 11 cars were involved, sending nine people to the hospital; the accidents were due to severely limited visibility caused by high winds blowing dust from a recently plowed field across the highway
Sept. 2001	near Pendleton	blowing dust contributed to an eight-vehicle accident on OR- 11 10 miles northeast of Pendleton; windy conditions, combined with loose topsoil from a freshly plowed field, created blowing dust that locally reduced visibilities to less than 100 feet; a series of chain reaction collisions occurred as vehicles slowed as they entered into the area of low visibility. Five minor injuries were reported according to the Oregon State Police[7]
Mar. 2005[8]	near Boardman, and in Deschutes County	weather stations at nineteen locations measured peak wind gusts of 45–64 mph; visibility restrictions down to near zero due to blowing dust occurred along I-84 between Boardman and Pendleton; extremely low visibilities led to road closures and multiple vehicle pileups; vehicles pulled off the road to avoid collisions; visibilities of a half mile or less due to flowing dust were also reported in Deschutes County
Jan. 2008[9]	Baker, Morrow, Umatilla and Union Counties	ODOT closed the freeway's westbound lanes between Baker City and La Grande about noon because of blowing snow, dust, and debris that created near-zero visibility in the Ladd Canyon area east of La Grande; the eastbound freeway lanes were closed between mile point 193 west of Pendleton and Baker City because of high winds, crashes, and visibility issues; five patrol cars and two pickup trucks operated by troopers responding to overturned vehicles received windshield and body damage from wind-blown rocks; ODOT also closed Oregon 11 between Pendleton and Milton-Freewater; police reported several accidents caused by low visibility, blowing dust, and debris

Date	Location	Description
May 2010	Morrow and Umatilla Counties	“blowing dust in the Columbia Basin reduced visibility to near zero around Stanfield, Pendleton, and between Lexington and Hermiston. The blowing dust caused traffic accidents with an injury near Stanfield on I-84”[10]
Aug. 2012[11]	Harney and Malheur Counties	a massive dust storm due to 50 to 60 mph winds produced by thunderstorms eventually blew on into Idaho; some media reports indicate this event darkened the skies in some areas for more than two hours

Sources:

(1) Oregon Statesman, “Dust, Wind, and Fire Cause Great Damage,” April 23, 1931 and “Dust Storm Precedent on Record 88 Years Ago,” April 26, 1931; information on this event, as well as the 1906 event, may also be found in *Pacific Northwest Quarterly*, “The Pacific Northwest Dust Storm of 1931,” Paul C. Pitzer, April 1988, pp. 50–55

(2) East Oregonian, May 24, 1975

(3) East Oregonian, March 24, 25, and 26, 1976, including articles titled “18 Vehicles Crash in Dust Storm; Woman Killed” and “Dust Problem Stymies Farmers”; Oregon Statesman, “Dust Storms Hit E. Oregon…”, March 25, 1976

(4) Oregon Statesman, “2 Dead, 6 Injured in Freeway Accident; Dust Storm Blamed,” July 11, 1979

(5) La Grande Observer, “State Gives Dust Storm Driving Advice,” October 1, 1999 and “Report Blames Speed,” November 20, 1999; Statesman Journal, “Six Die in 50-car Pileup on I-84: Dust Blinds Drivers on the Interstate near Pendleton,” September 26, 1999, “Dust Brownout Led to Fatal Wrecks: Dry Weather and High Winds Created the Deadly Eastern Oregon Storm,” September 27, 1999, and “Road Warnings Needed: Motorists Can Learn from Last Week’s Fatal Dust Storm Collisions,” October 5, 1999; Corvallis Gazette-Times, “Corvallis Couple Recovering from Highway Crash,” September 27, 1999; Learning to Fly, April Henry; East Oregonian, Mitchell Zach; Associated Press news story dated September 26, 1999; also post-event documents of the Community Solutions Team (meeting minutes) and Oregon State Police

(6) Weather Channel website, April 18, 2001

(7) https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5268728

(8) https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5439648, https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5439653, and https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5439654

(9) The Oregonian, January 3, 2008
(10) https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=222144

(11) Idaho Press Tribune (Tom Dale), August 6, 2012; KTVB, August 5, 2012; KBOI, August 5, 2012; USGS, Dust, an emerging problem in the Great Basin: insights from 2012, January 23, 2013; YouTube, Brenda Burns, published August 6, 2012 and Zeronieo, published August 14, 2012; Mother Recounts Her Encounter with an Oregon Dust Storm, Yahoo Voices, August 8, 2012

Probability

Based on a literature search conducted by the Oregon Office of Emergency Management (OEM), 10 significant dust storms have been recorded in Oregon over the past 40 years. If one strictly does an average, the recurrence interval is about once every 3-4 years for significant dust storms. However, the mid ‘70s, the millennium roll-over years, and other short time periods seem to have produced more storms. There may be a relationship with ENSO, droughts, or some other weather pattern. This would benefit by more research.

Climate Change

There is no research available either on the historic correlation between drought and windstorms in the Pacific Northwest or on the direct effects of future climate conditions on the incidence of dust storms. So it is virtually impossible to make any kind of reliable statement about the effect of climate change on the likelihood of dust storms in Oregon. However, because drought conditions have the effect of reducing wetlands and drying soils, droughts can increase the amount of soil particulate matter available to be entrained in high winds, in particular where agriculture practices include tilling. This correlation between drought conditions and dust storms means that an increase in future droughts could increase the incidence of dust storms, even though the drought is unrelated to the storm.

Earthquakes

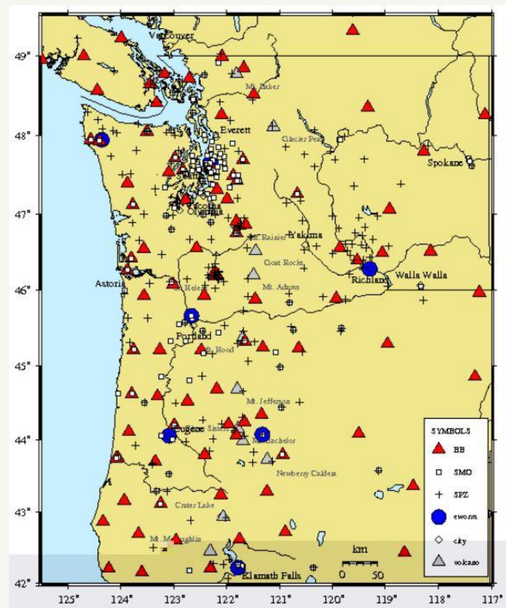
Oregon has experienced few damaging earthquakes during its recorded history, leading to complacency and lack of attention to earthquake-resistant design and construction. Since the mid-1980s, an increasing body of geologic and seismologic research has changed the scientific understanding of earthquake hazards in Oregon, and in recent years several large and destructive earthquakes around the world have heightened public awareness. Recognized hazards range from moderate sized crustal earthquakes in eastern Oregon to massive subduction zone megathrust events off the Oregon coast. All have the potential for significant damage as long as most of Oregon’s buildings and infrastructure have inadequate seismic resistance. The scale of structural retrofit and replacement needed to make Oregon earthquake safe is huge, and beyond our capacity to implement in anything less than decades. To manage the human and economic impact of the next damaging earthquake will require thoughtful and comprehensive emergency response planning, based on realistic loss estimates driven by accurate and detailed geologic and seismologic, structural and cultural information. To minimize the human and economic impact of the next damaging earthquake will require a sustained program of public education, forward-thinking research, and structural replacement and retrofit, based on cost-effective earthquake resistant design and a combination of public funding and private sector incentives.

Analysis and Characterization

Earthquake Sources

Earthquakes are a highly variable natural phenomenon. The vast majority occur when two masses of rock in the earth's crust abruptly move past each other along a large crack or fracture called a fault. The energy released as the two parts slide along the fault produces waves of shaking that we perceive as an earthquake. Faults typically build up stress over decades to millennia in response to large-scale movement of the earth's tectonic plates. Even the most active faults only produce damaging earthquakes at intervals of a century or more, and for many the intervals are much longer. As a result, it is very difficult to forecast the likelihood of an earthquake on a particular fault because we rarely have a long enough record to determine a statistically meaningful return period (average time between earthquakes).

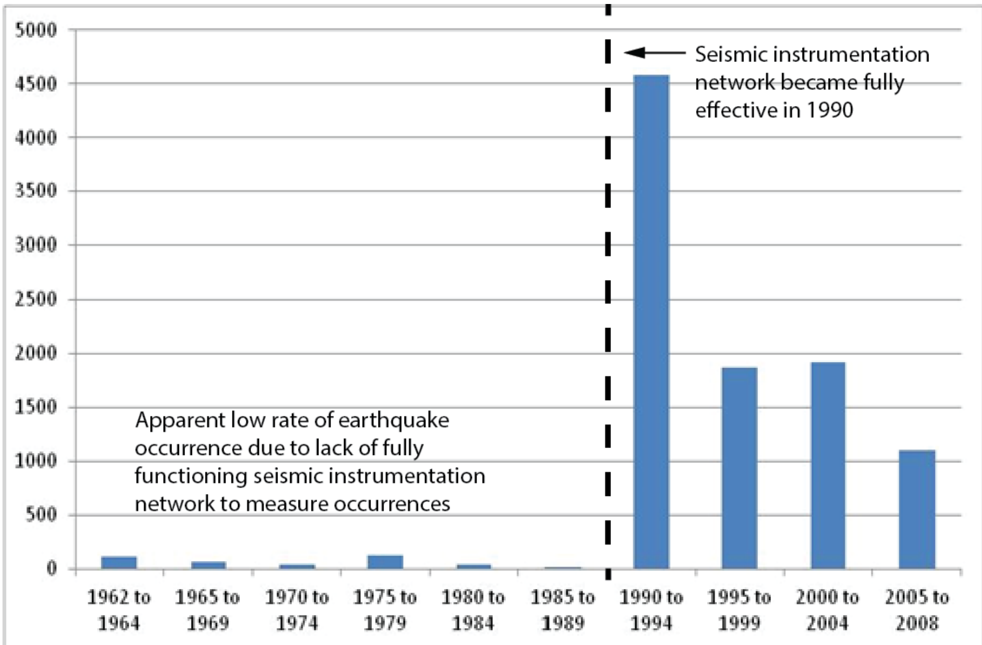
Figure 2-18. Earthquake Monitoring Stations in the Pacific Northwest



Note: The earthquake monitoring network system is operated out of the University of Washington by the Pacific Northwest Seismic Network.

Source: Pacific Northwest Seismic Network (http://www.pnsn.org/)

Figure 2-19. Annual Rate of Earthquake Occurrence in Oregon, in 5-Year Increments



Note: Seismic instruments began operation in 1970, but the network only became fully effective in 1990. Spike in earthquake numbers in the early 1990s is due to aftershocks from the 1993 Scotts Mills and Klamath Falls earthquakes.

Source: Unknown

The history of earthquakes in a region comes from three types of information. Instrumental data comes from networks of seismic recording instruments (seismographs) that are widely deployed in the Pacific Northwest.

Seismic networks can detect very small earthquakes, locate them to within a few miles, and determine their magnitude accurately. Seismographs have only existed for about a century, and in Oregon, the instrumental record is really only complete and modern from about 1990 on. Historical felt location data comes from verbal and written reports of earthquake effects. The felt record extends back to the mid-1800s for Oregon, but only locates moderate to large earthquakes, and those only with an accuracy of tens or even hundreds of miles.

Paleoseismic data use geologic records of earthquake effects to determine the approximate size and timing of earthquakes that happened in prehistoric times. The paleoseismic record can extend back for thousands or tens of thousands of years, but provides only approximate information about the size, time and place of past large earthquakes.

Figure 2-20. Deep Sea Sediment Cores that Record Past Megathrust Earthquakes off the Oregon Coast

Note: Red T's mark the top of each layer

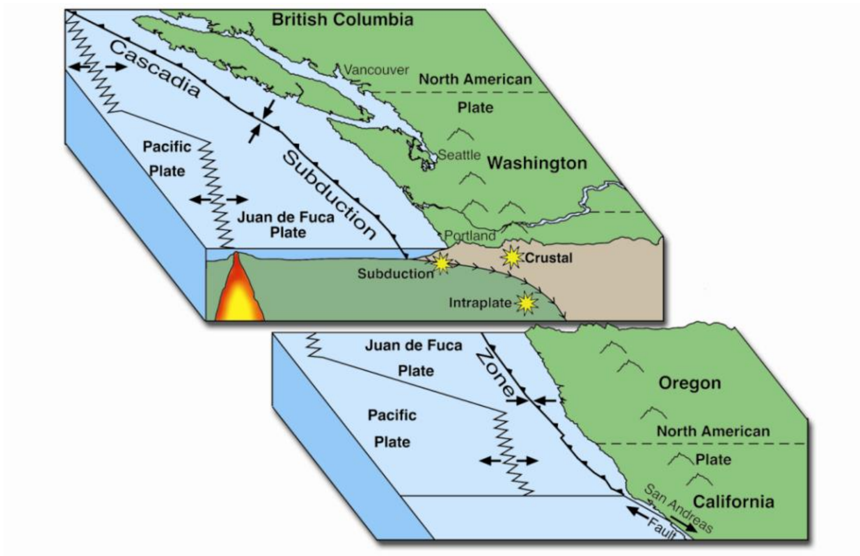
Source: Goldfinger et al. (2011)

In Oregon, the combined earthquake history derived from these three sources clearly outlines two major types of earthquake hazard and two less significant sources. By far the greatest is the hazard posed by infrequent **megathrust earthquakes** on the Cascadia Subduction Zone. The second major hazard comes from smaller **crustal earthquakes** on faults in or near populated areas, which includes all of Oregon's damaging historic earthquakes. Intraplate earthquakes, which have been historically damaging in the Puget Sound area, are possible in Oregon but no damaging prehistoric or historic events are known. Finally, earthquakes associated with Oregon's many young volcanoes may produce damaging shaking in communities close to the volcano.

The Cascadia Subduction Zone is the boundary between two of the earth's crustal plates. These continent-sized plates are in constant slow motion, and the boundaries between plates are the site of most earthquake activity around the globe. At the Cascadia Subduction Zone, the Juan De Fuca plate, located offshore of Oregon and Washington, slides to the northeast and under the North American plate, which extends from the Oregon coast clear to the middle of the Atlantic Ocean. The Juan de Fuca plate slides beneath the continent (subducts) at about 1.5 inches per year, a speed which has been directly measured using high-accuracy GPS. The fault that separates the plates extends from Cape Mendocino in Northern California to Vancouver Island in British Columbia, and slopes down to the east from the sea floor. The fault is usually locked, so that rather than sliding slowly and continuously, the 1.5 inches per year of subduction motion builds tremendous stress along the fault. This stress is periodically released in a megathrust earthquake, which can have a magnitude anywhere from 8.3 to 9.3.

Figure 2-21 is a schematic three-dimensional diagram with the generalized locations of the three types of earthquake sources found in Oregon: subduction zone, crustal, and intraplate.

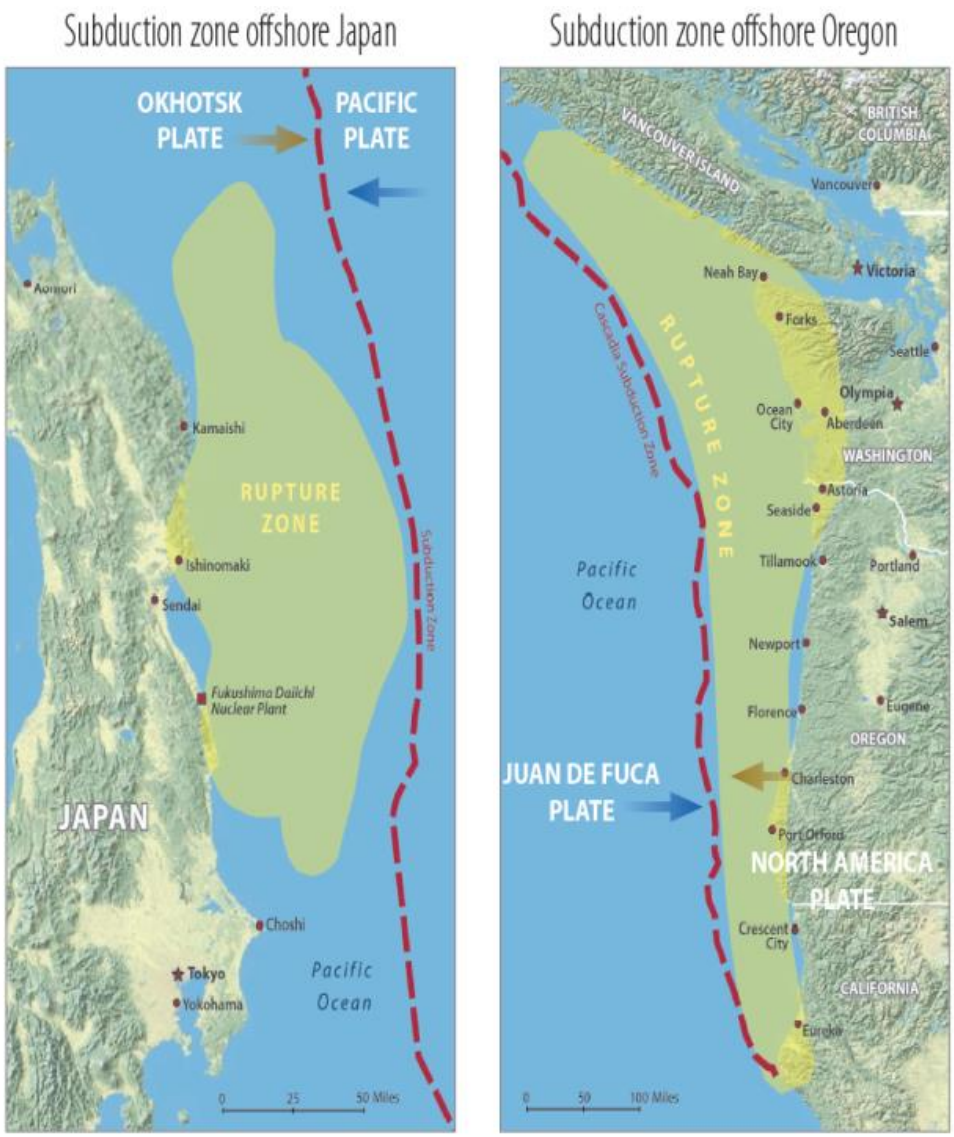
Figure 2-21. General Source Areas for Subduction Zone, Crustal Earthquakes, and Intraplate Earthquakes



Source: DOGAMI

The Cascadia Subduction Zone closely mirrors the subduction zone in northern Japan that produced the 2011 Tohoku earthquake (**Figure 2-22**). This magnitude 9 megathrust event and its associated tsunami captured the world's attention with unforgettable images of destruction on a massive scale. Oregon should regard this as a window into our future, as this is the very type of earthquake that our best science tells us is likely on the Cascadia Subduction Zone. Particular attention must be paid to the incredibly destructive tsunami that accompanied the Tohoku earthquake, and we must plan for a similar tsunami in Oregon. (See the **Tsunami** section of this Plan for more information about tsunamis in Oregon.)

Figure 2-22. Comparison of the Northern Japan Subduction Zone in and the Cascadia Subduction Zone



Note: Yellow patches are the measured earthquake rupture zone in Japan, modeled earthquake rupture zone in Oregon.

Source: DOGAMI

Crustal earthquakes occur for the most part on shore on much smaller faults located in the North American plate. These are the more familiar "California-style" earthquakes with magnitudes in the 5 to 7 range. Although much smaller than the megathrust earthquakes, crustal earthquakes may occur much closer to population centers, and are capable of producing severe shaking and damage in localized areas. For many parts of eastern Oregon, crustal faults dominate the hazard, and they may also have a significant impact in the Portland region and Willamette Valley.

2011 Tohoku Earthquake Numbers

- about 16,000 dead
- 92% of deaths due to tsunami (drowning)
- Fatality rate within the tsunami inundation zone about 16%
- about 4,000 missing (as of 10/12/2011)
- about 6,000 injuries
- Population within 40 km of coastline about 3,000,000
- about 300,000 homes destroyed
- about 600,000 homes damaged

Intraplate earthquakes are a third type that is common in the Puget Sound, where they represent most of the historical record of damaging events. In Oregon, these earthquakes occur at much lower rates, and none have ever been close to a damaging magnitude. They contribute little to the aggregate hazard in most of Oregon.

Earthquake Effects

Earthquake damage is largely controlled by the strength of shaking at a given site. The strength of shaking at any point is a complex function of many factors, but magnitude of the earthquake (which defines the amount of energy released) and distance from the epicenter or fault rupture, are the most important. The ripples in a pond that form around a dropped pebble spread out and get smaller as they move away from the source. Earthquake shaking behaves in the same way: you can experience the same strength of shaking 10 miles from a magnitude 6 earthquake as you would feel 100 miles from a magnitude 9 earthquake.

Two measurement scales are used to describe the magnitude and intensity of earthquakes. To measure the magnitude, the "moment magnitude" (M_w, or M) scale uses the Arabic numbering scale. It provides clues to the physical size of an earthquake (NOAA-OAR-CPO-2014-2003692) and is more accurate than the previously used Richter scale for larger earthquakes. The second scale, the "modified Mercalli," measures the shaking intensity and is based on felt observations and is therefore more subjective than the mathematically derived moment magnitude. It uses Roman numerals to indicate the severity of shaking. It is important to understand the relationship between the intensity of shaking the amount of damage expected from a given earthquake scenario.

Table 2-13 gives an abbreviated description of the 12 levels of Modified Mercalli intensity.

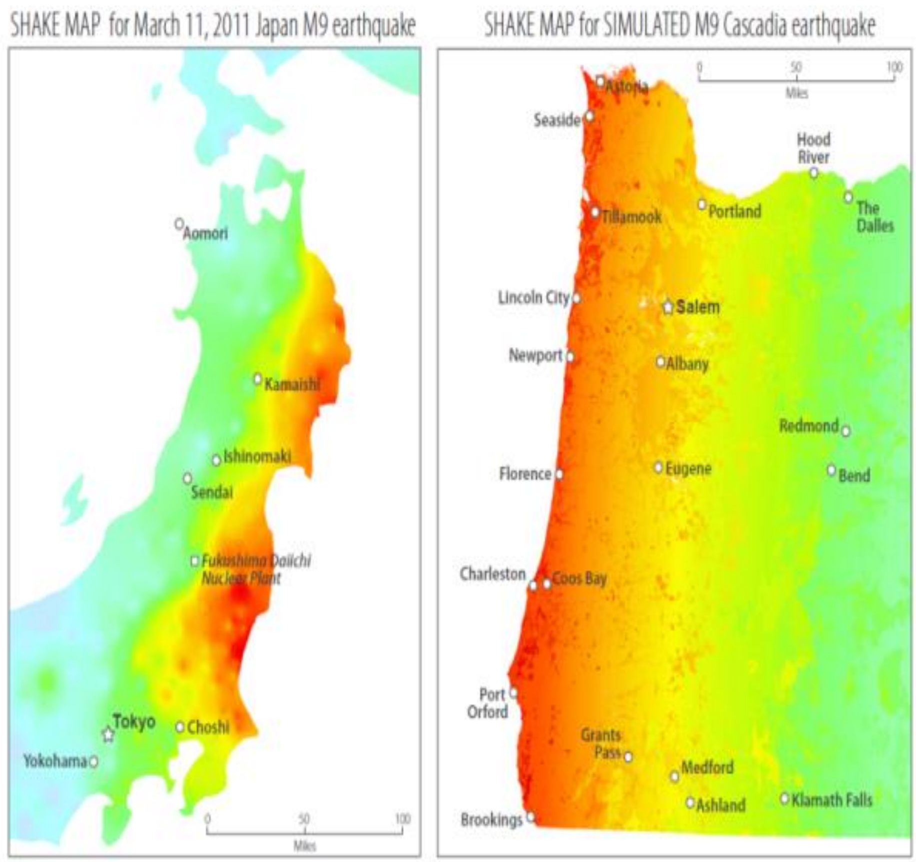
Table 2-13. Levels of Modified Mercalli Intensity

Level	Intensity
I	not felt except by a very few under especially favorable conditions
II	felt only by a few persons at rest, especially on upper floors of buildings
III	felt quite noticeably by persons indoors, especially on upper floors of buildings; many people do not recognize it as an earthquake; standing motor cars may rock slightly; vibrations similar to the passing of a truck; duration estimated
IV	felt indoors by many, outdoors by few during the day; at night, some awakened; dishes, windows, doors disturbed; walls make cracking sound; sensation like heavy truck striking building; standing motor cars rocked noticeably
V	felt by nearly everyone; many awakened; some dishes, windows broken; unstable objects overturned; pendulum clocks may stop
VI	felt by all, many frightened; some heavy furniture moved; a few instances of fallen plaster; damage slight
VII	damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken
VIII	damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse; damage great in poorly built structures; fall of chimneys, factory stacks, columns, monuments, walls; heavy furniture overturned
IX	damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; damage great in substantial buildings, with partial collapse; buildings shifted off foundations
X	some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; rails bent
XI	few, if any (masonry) structures remain standing; bridges destroyed; rails bent greatly
XII	damage total; lines of sight and level are distorted; objects thrown into the air

Sources: http://earthquake.usgs.gov/learn/topics/mercalli.php, abridged from *The Severity of an Earthquake* (http://pubs.usgs.gov/gip/earthq4/severitygip.html); U.S. Geological Survey General Interest Publication 1989-288-913

Future megathrust earthquakes on the Cascadia Subduction Zone (CSZ) will occur off the coast, and the strength of shaking will decrease inland. Oregon coastal communities will experience severe shaking, but the Portland area and Willamette Valley communities are far enough inland that they will feel much less shaking. Because of the size of the megathrust fault, the shaking will impact all of Oregon west of the Cascades, and will still be felt to the east of the Cascades, and will extend to northern California and British Columbia. The other unique characteristic of megathrust earthquakes is that the strong shaking will last for several minutes, in contrast to a large crustal earthquake, which might shake for only 30 seconds. The long duration of shaking contributes greatly to damage, as structures go through repeated cycles of shaking. **Figure 2-23** shows a side-by-side comparison of ShakeMaps for (a) the 2011 M9 earthquake in Japan, and (b) a simulated M9 CSZ event in Oregon.

Figure 2-23. Comparison of Measured Shaking from Tohoku Earthquake and Simulated Shaking from M9 Cascadia Megathrust Earthquake

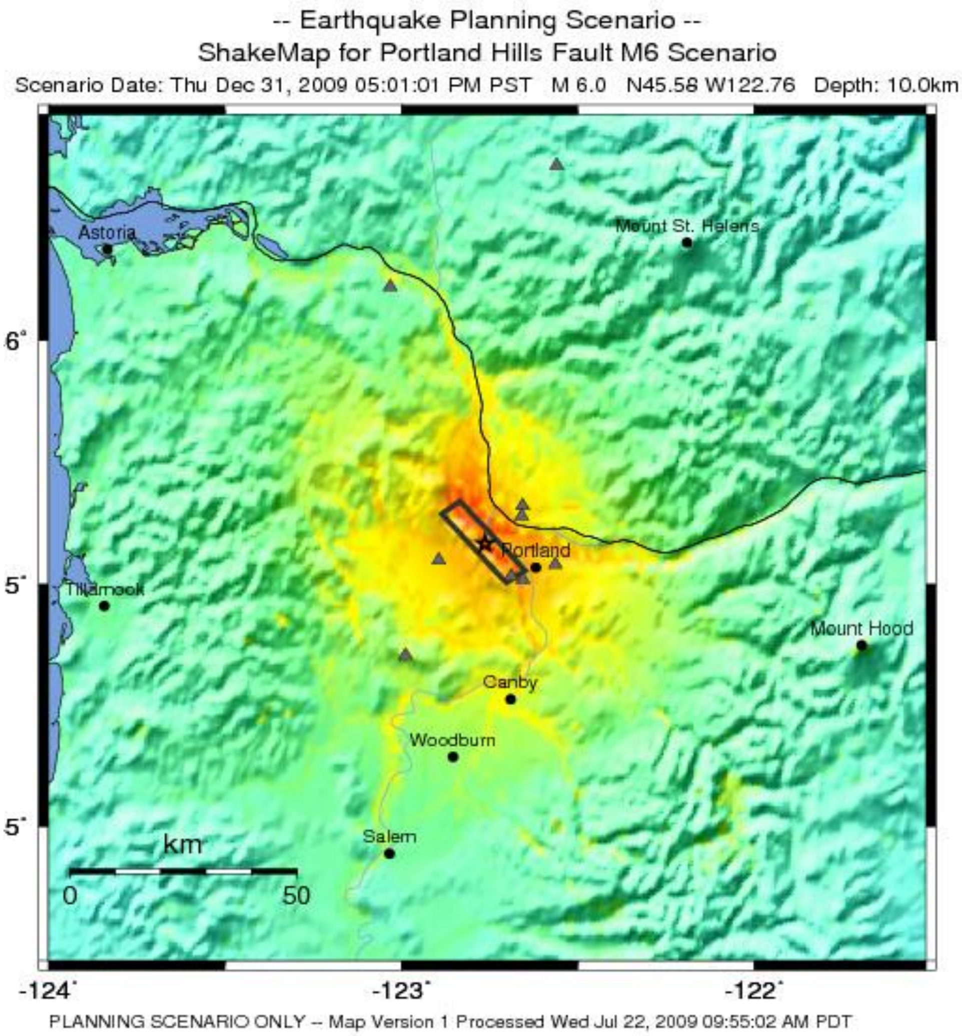


PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Source: DOGAMI, *Cascadia* Winter 2012(http://www.oregongeology.org/pubs/cascadia/CascadiaWinter2012.pdf)

Future crustal earthquakes will occur along one of many Oregon fault lines, and the shaking will be strongest near the epicenter, and will decrease fairly quickly as you move away. So a magnitude 6 earthquake in Klamath Falls may cause significant damage near the epicenter, but will be only weakly felt in Medford or Eugene. **Figure 2-24** shows a M6 crustal fault ShakeMap scenario along the Portland Hills fault.

Figure 2-24. Simulated Shaking from M6.0 Crustal Earthquake on the Portland Hills Fault

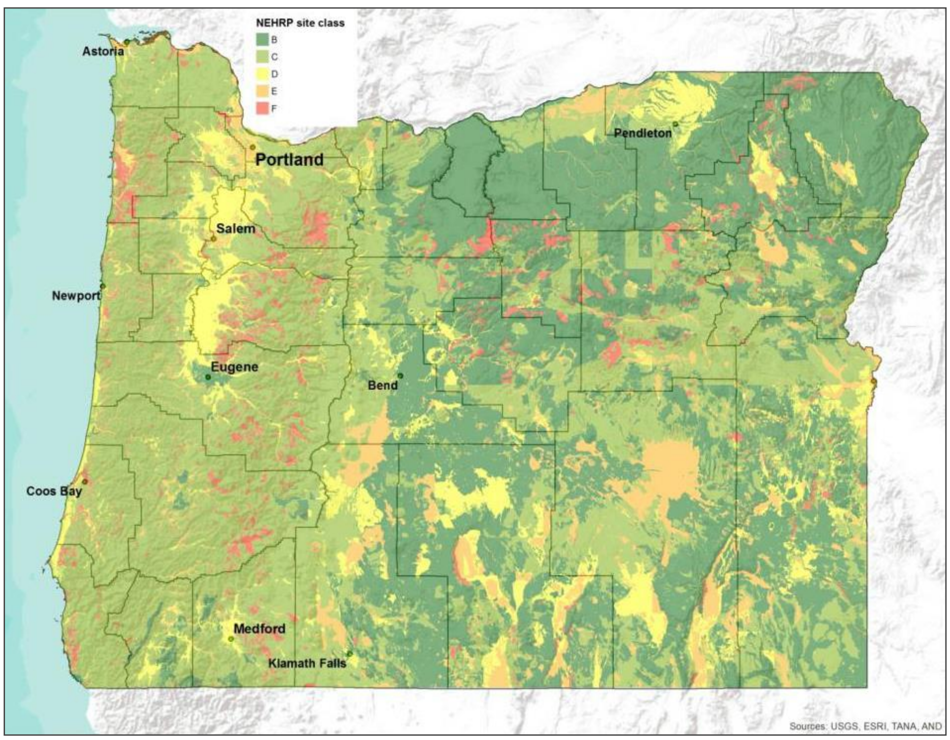


PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Source: U.S. Geological Survey

The other important factor in controlling earthquake damage is the contribution of local geology. Soft soils can strongly amplify shaking (**Figure 2-25**), loose saturated sand or silt can liquefy, causing dramatic damage, and new landslides can occur on steep slopes while existing landslide deposits may start to move again. These effects can occur regardless of earthquake source, and the geologic factors that cause them can be identified in advance by geologic and geotechnical studies. Liquefaction- and earthquake-induced landslides are both more likely to occur during the several minutes of shaking produced by a megathrust earthquake, and these effects are expected to be widespread during the next event (**Figure 2-26**, **Figure 2-27**, and **Figure 2-28**). In 2013, DOGAMI published a suite of statewide earthquake hazard maps with GIS files in Open-File Report O-13-06, *Ground motion, ground deformation, tsunami inundation, coseismic subsidence, and damage potential maps for the 2012 Oregon Resilience Plan for Cascadia Subduction Zone earthquakes* (Madin and Burns, 2013; http://www.oregongeology.org/pubs/ofr/p-O-13-06.htm).

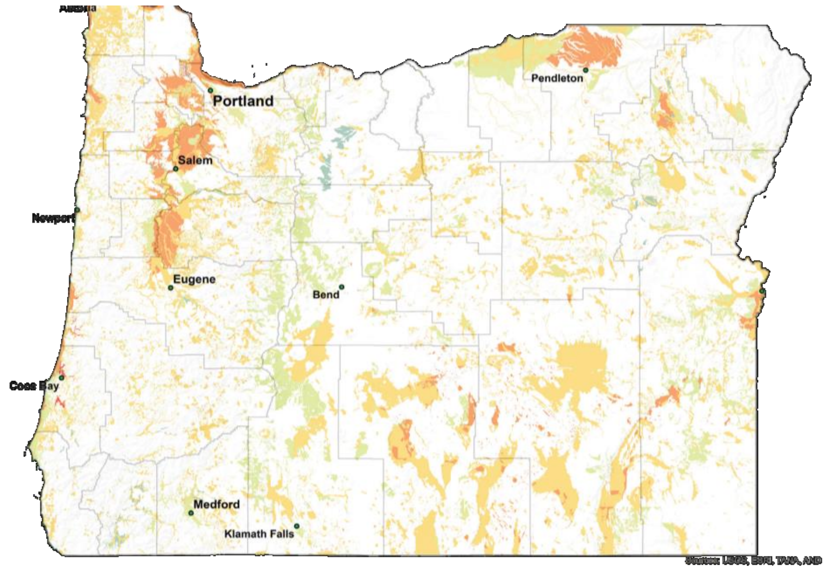
Figure 2-25. Soils Map Showing Where Soils Can Amplify Earthquake Ground Shaking



Note: This NEHRP soils map shows areas where soils can amplify the earthquake ground shaking. NEHRP site class F soils (dark orange on map) are prone to produce the greatest amplification.

Source: Madin and Burns (2013)

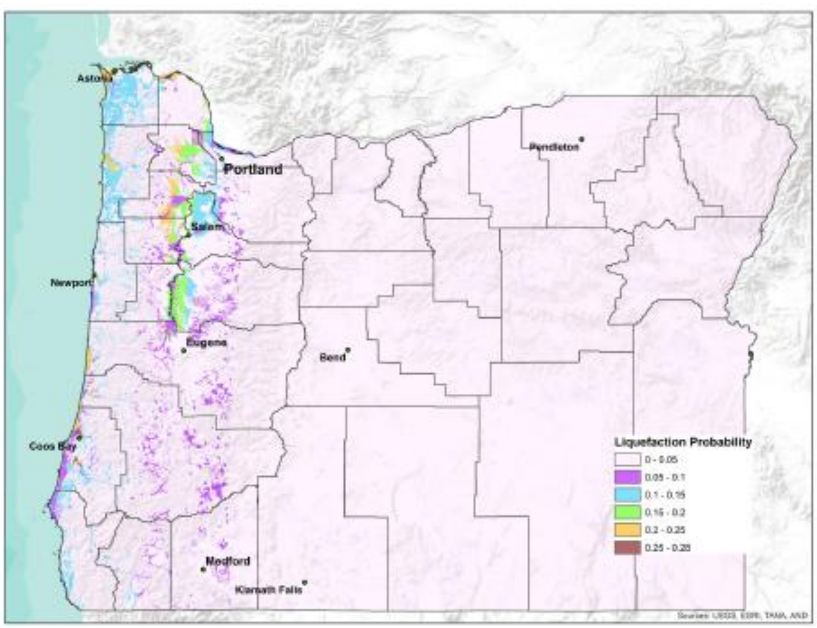
Figure 2-26. Liquefaction Susceptibility Map



Note: This liquefaction susceptibility map shows areas where soils can liquefy due to the earthquake ground shaking. Areas in red are most prone to liquefy.

Source: Madin and Burns (2013)

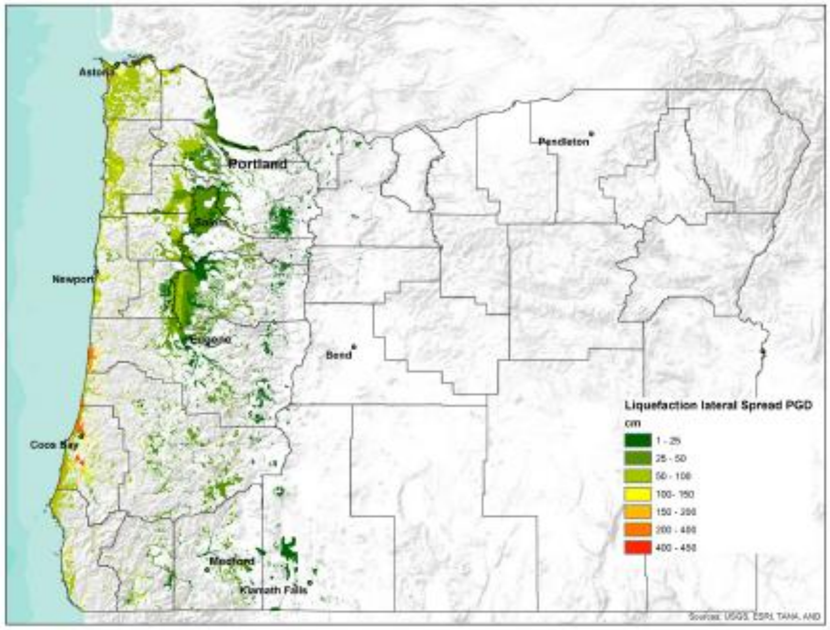
Figure 2-27. Liquefaction Probability Map



Note: This liquefaction probability map shows the probability of soil liquefaction due to a magnitude 9 Cascadia earthquake. Areas in dark red have the highest probability.

Source: Madin and Burns (2013)

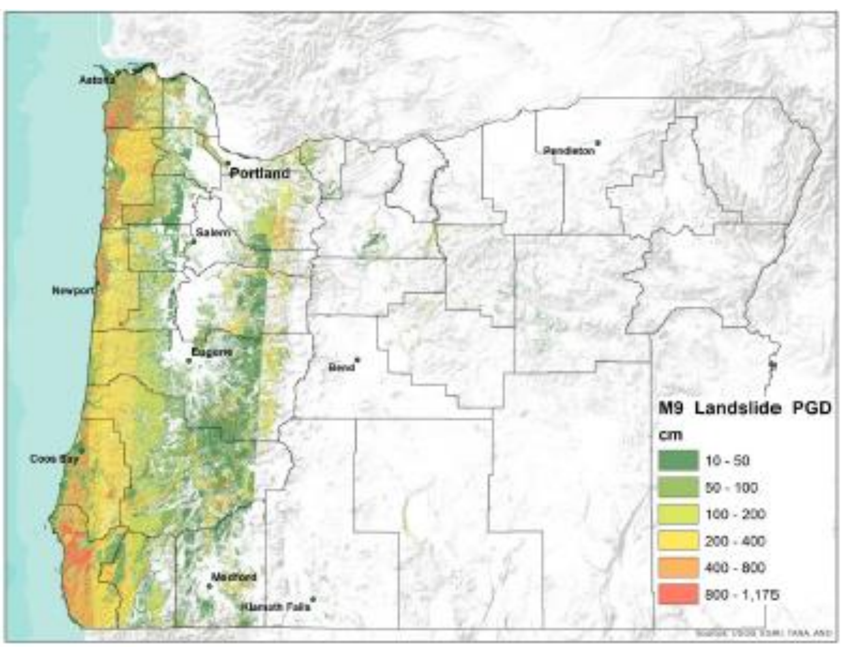
Figure 2-28. Lateral Spreading Map



Note: This lateral spreading map shows areas of lateral spreading hazard due to a magnitude 9 Cascadia earthquake. Areas in red have the highest displacement.

Source: Madin and Burns (2013)

Figure 2-29. Expected Displacement Map



Note: This landslide hazard map shows areas and amount of expected displacement due to a magnitude 9 Cascadia earthquake. Areas in red have the highest displacement.

Source: Madin and Burns (2013)

Historic Earthquake Events

Table 2-14 lists historic earthquakes in Oregon from both CSZ events and combined crustal events.

Table 2-14. Historic Earthquakes in Oregon

Date	Location	Description
1873[1]	Del Norte County, Calif.	felt in Portland; localized chimney damage as far north as Port Orford, Oregon
1877[1]	Portland, Oregon	intensity VII; chimney damage
1892[1]	Portland, Oregon	intensity VI; affected area: 26,000 square kilometers; buildings swayed, people terrified and rushed into the street; felt in Astoria and Salem
1893[1]	Umatilla, Oregon	intensity VI-VII; damage to buildings in Umatilla
1896[1]	McMinnville, Oregon	intensity VI; three shocks in succession in McMinnville; main shock felt at Portland and Salem
1906[1]	Paisley, Oregon	intensity V; three additional shocks followed within 1.5 hours
1913[1]	Seven Devil's Mountains of western Idaho	intensity V; broke windows and dishes
1915[1]	Portland, Oregon	intensity V; three shocks reported; rattled dishes, rocked chairs, and caused fright at Portland
1923[1]	southern Oregon	intensity V; plaster fell at Alturas, California; tremor felt at Lakeview, Oregon
Apr. 8, 1927[1]	eastern Baker County,	maximum intensity V (Halfway and Richland); center: eastern Baker County; felt widely over eastern Oregon
July 15 – Nov. 1936[1]	Milton-Freewater, Oregon	intensity VII; magnitude 5.75; center: near the State line between Milton-Freewater, Oregon, and Walla Walla, Washington; affected area: 272,000 sq km in the two states and Idaho; ground cracking observed 6.5 km west of Freewater; marked changes in flow of well water chimneys damaged, plaster broken and walls cracked in Freewater and Umapine; total damage: $100,000; numerous aftershocks up to Nov. 17 (more than 20 moderate shocks during the night and stronger ones (V) on July 18 and Aug. 4 and 27)
Dec. 29, 1941[1]	Portland, Oregon	intensity VI; affected area: 13,000 sq km (Portland); felt at Hillsboro, Sherwood, Yamhill, and into Washington (Vancouver and Woodland); windows broken
Apr. 13, 1941[1]	Olympia, Wash.	magnitude 7.0; at Olympia, Washington, and a broad area around the capital city; fatalities: 8; damage: $25 million; affected area: 388,000 sq km; damage: widespread (Oregon); injuries: several (Astoria and Portland); maximum intensity: VIII (Clatskanie and Rainier); chimneys twisted and fell; damage to brick and masonry
Dec. 15, 1953[1]	Portland, Oregon	intensity: VI; minor damage (Portland area); affected area: 7,700 sq km; one cracked chimney and slight damage to fireplace tile; plaster cracking (Portland and Roy, Oregon, and Vancouver, Washington)
Nov. 16, 1957[1]	Salem, Oregon	intensity VI; affected area: 11,600 sq km (northwestern Oregon); frightened all in the city and cracked plaster (West Salem)
Aug. 18, 1961[1]	Albany/Lebanon, Oregon	intensity VI; magnitude 4.5; affected area: 18,000 sq km; felt region extended into Cowlitz County, Wash; damage: minor (Albany and Lebanon, south of the 1957 center); felt in both cities; two house chimneys toppled, and plaster cracked
Nov. 6, 1961[1]	Portland, Oregon	intensity VI; affected area: 23,000 sq km (northwestern Oregon and southwestern Washington); principle damage: plaster cracking; part of a chimney fell, and windows and lights broke

Date	Location	Description
May 26 – June 11, 1968[1]	Oregon/Calif. border	intensity: VI; magnitude: 4.7; affected area: 18,000 sq km (in the two states); series of earthquakes near the Oregon-California border; chimneys fell or cracked, and part of an old rock cellar wall fell; ground fissures in Bidwell Creek Canyon, near Fort Bidwell, California
1993[2]	Scott's Mills, Oregon	5.7 M_w; largest earthquake since 1981; felt from Puget Sound to Roseburg, Oregon[4]
1993[3]	Klamath Falls, Oregon	5.9 M_w and 6.0 M_w[3]; affected area: 130,000 sq km (southwestern Oregon and northern California); losses: concentrated in downtown area; intensity VII in downtown Klamath Falls and immediate vicinity and to the Oregon Institute of Technology, but surrounding experienced intensity VI[5]; fatalities: 2
2001[2]	Nisqually, Wash.	felt as far south as central Oregon

Sources:

(1) USGS. Oregon Earthquake History. Retrieved October 28, 2013, http://earthquake.usgs.gov/earthquakes/states/oregon/history.php

(2) USGS. Earthquake Archive. Retrieved October 28, 2013, http://earthquake.usgs.gov/earthquakes/search/

(3) Sherrod, D. R. (1993)

(4) Thomas et al. (1996)

(5) Dewey (1993

(6) Bott and Wong (1993)

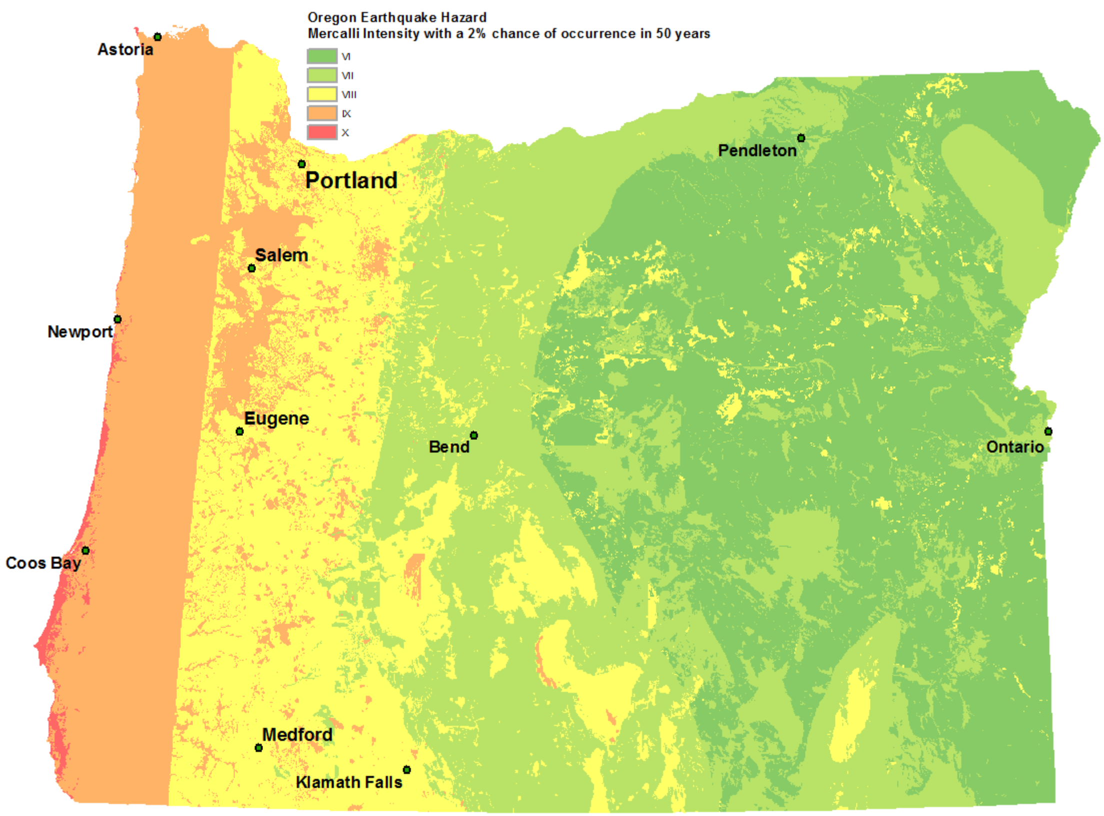
Probability

The probability of damaging earthquakes varies widely across the state. In coastal and western Oregon, the hazard is dominated by Cascadia subduction earthquakes originating from a single fault with a well-understood recurrence history. For eastern Oregon the hazard is dominated by numerous crustal faults and background seismicity, with poorly understood probability that varies from region to region.

Figure 2-30 shows the probabilistic hazard for the entire state. This map shows the expected level of earthquake damage that has a 2% chance of occurring in the next 50 years. The map is based on the 2008 USGS National Seismic Hazard Map and has been adjusted to account for the effects of soils following the methods of Madin and Burns (2013). In this case, the strength of shaking calculated as peak ground acceleration and peak ground velocity is expressed as Mercalli intensity, which describes the effects of shaking on people and structures. This map incorporates all that is known about the probabilities of earthquake on all Oregon faults, including the Cascadia Subduction Zone.

For Oregon west of the crest of the Cascades, the Cascadia subduction zone is responsible for most of the hazard, as shown in Figure 2-30. The paleoseismic record includes 18 magnitude 8.8–9.1 megathrust earthquakes in the last 10,000 years that affected the entire subduction zone. The return period for the largest earthquakes is 530 years, and the probability of the next such event occurring in the next 50 years ranges from 7 to 12%. An additional 10–20 smaller, magnitude 8.3–8.5, earthquakes affected only the southern half of Oregon and northern California. The average return period for these is about 240 years, and the probability of a small or large subduction earthquake occurring in the next 50 years is 37–43%.

Figure 2-30. Statewide Probabilistic Earthquake Hazard



Color zones show the maximum level of earthquake shaking and damage (Mercalli Intensity Scale) expected with a 2% chance of occurrence in the next 50 years. A simplified explanation of the Mercalli levels is:

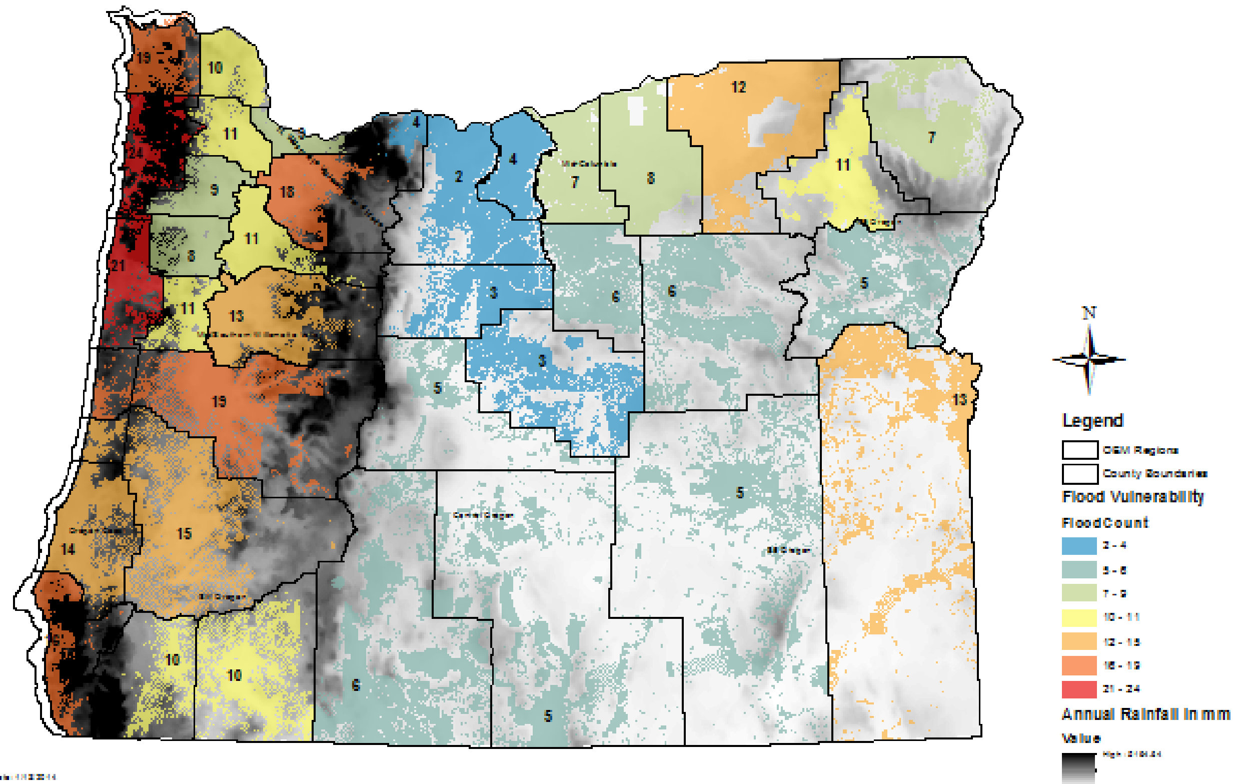
VI	Felt by all, weak buildings cracked;
VII	Chimneys break, weak buildings damaged, better buildings cracked;
VIII	Partial collapse of weak buildings, unsecured wood frame houses move;
IX	Collapse and severe damage to weak buildings, damage to wood-frame structures; and
X	Poorly built structures destroyed, heavy damage in well-built structures.

Source: Madin and Burns (2013)

Floods

Floods are a common and widespread natural hazard in Oregon; the state has an extensive history of flooding (**Figure 2-31**). Flooding typically results from large-scale weather systems that generate prolonged rainfall or rain-on-snow events that result in large amounts of runoff. Other sources of flooding include flash floods associated with locally intense thunderstorms, channel migration, ice or debris jams, and, much less frequently, dam failures.

Figure 2-31. Number of Damaging Flood Events by County since 1978



Note: The frequency of damaging floods is overlaid upon annual precipitation (mm). Damaging floods are depicted only on lands in private ownership.

Source: Oregon Department of Land Conservation and Development

The National Flood Insurance Program (NFIP) identifies 251 communities in Oregon as flood-prone including locations in all 36 counties, 212 cities, and three Tribal Nations. Every county and all but two of these flood-prone cities belong to the NFIP, allowing residents to purchase flood insurance. Nine additional cities for which FEMA has not mapped Special Flood Hazard Areas also belong to the NFIP, indicating that they believe a flood hazard exists within their jurisdiction.

Analysis and Characterization

History of Flooding in Oregon

Oregon has an extensive history of flooding. **Table 2-15** and **Table 2-16** summarize major floods within the state. Oregon's deadliest recorded flood occurred in Heppner in 1903 when a June 14th storm dropped 1.5 inches of rain within a twenty-minute period. The storm was centered in the headwaters area of Willow Creek above Heppner in Northeastern Oregon. Within minutes, a five-foot wall of water and debris poured through Heppner with enough velocity to rip homes off foundations. These floodwaters claimed 247 lives.

Another late spring flood in 1948 is best remembered for destroying the entire city of Vanport (now Delta Park). Record flow levels on the Columbia River caused the structural failure of a dike. Much of Vanport was destroyed in minutes and was never rebuilt. Nineteen thousand people lost their homes and eighteen people lost their lives.

Many of Oregon's floods of records occurred in December 1964 and January 1965 during the "Christmas Flood." Damage from these floods totaled over $157 million dollars and twenty Oregonians lost their lives. From December 20 through 24, 1964, the most severe rainstorm to occur in Central Oregon and one of the most severe west of the Cascades left many areas with two thirds their normal annual rainfall in five days. The ensuing floods destroyed hundreds of homes and businesses, forced the evacuation of thousands of people, destroyed at least 30 bridges, and washed out hundreds of miles of roads and highways.

A similar flood event occurred in February 1996. Following an extended period of unseasonably cold weather and heavy snowfall in the Pacific Northwest, warming temperatures and rain began thawing the snowpack and frozen rivers throughout Oregon. On February 6, a strong subtropical jet stream or "Pineapple Express" reached Oregon. This warm, humid air mass brought record rainfall amounts, quickly melting the snowpack. At least twenty-five rivers reached flood stage. Many reached flood levels comparable to those reached in the 1964 flood. Twenty-seven of Oregon's 36 counties were eventually covered by a Presidential major disaster declaration due to this event. Statewide, damages totaled over $280 million.

A series of powerful wind and rain storms caused extensive flooding in northwestern in December of 2007. Three people were killed as a result of these storms. The City of Vernonia was hard hit with over 200 buildings substantially damaged and subsequently elevated or bought-out by FEMA.

Types of Flooding

Riverine: Riverine flooding is the most common flood hazard in Oregon. It is caused by the passage of a larger quantity of water than can be contained within the normal stream channel. The increased stream flow is usually caused by heavy rainfall over a period of several days. Examples of riverine events are the flooding in December 2007, February 1996, and December 1964 to January 1965. The most severe flooding conditions occur, however, when heavy rainfall is augmented by rapid snowmelt. These rain-on-snow events occur on mountain slopes within the low elevation snow zones of the Pacific Northwest. These events make more water available for runoff than does precipitation alone by melting the snowpack and by adding a small amount of condensate to the snowpack (van Heeswijk et al., 1996). If the ground is frozen, stream flow can be increased even more by the inability of the soil to absorb additional runoff. Rain falling on snow also is a major cause of mid-winter avalanches, which tend to coincide with flood events. Significant rain-on-snow events occur in years that are colder and wetter than normal because snow accumulates at lower elevations, and then is melted off during subsequent rain events (Ferguson, 2000). Rain-on-snow events, including those that occurred in 1894, 1948, 1964, 1977, and 1996 (**Table 2-16**), are associated with some of the State's most damaging floods.

Flash floods: Flash flooding is caused by extremely intense rainfall over a short period of time, commonly within a single drainage. Flash floods usually occur in the summer during the thunderstorm season. The two key contributors to flash flooding are rainfall intensity and duration. Topography, soil conditions, and ground cover also impact flooding. Flash floods, because of their intensity, often pick up large loads of sediment and other solid materials. In these situations, a flash flood may arrive as a fast moving wall of debris, mud, and water.

Occasionally, floating debris or ice accumulates at a natural or man-made obstruction and restrict the flow of water. Water held back by the ice jam or debris dam can cause flooding upstream. Subsequent flash flooding can occur downstream if the obstruction suddenly releases. Areas subject to flash floods are not as obvious as a typical riverine floodplain. However, flash floods may be associated with recognizable locations such as canyons or arroyos. There is also always some potential for flash floods associated with dam failure.

The most notorious flash flood in Oregon was the June 14, 1903, event in Heppner summarized previously. More recent flash floods have occurred in Wallowa Co. (July 2002) and the City of Rufus (August 2003).

Alluvial fan flooding: 44 CFR Part 59.1 defines alluvial fan flooding as flooding occurring on the surface of an alluvial fan. Alluvial fans are fan-shaped deposits of water-transported material (alluvium) that typically form at the base of steep topographic features where there is a marked break in slope. FEMA notes that alluvial fans can make attractive, but dangerous, development sites. Attractive because they provide commanding views and good drainage, but dangerous because flood flows can happen quickly over unpredictable flow paths, at high velocity, and carry large amounts of debris (FEMA, 1989).The potential for this type of flooding in Oregon is unstudied and past events (if any) have been poorly documented.

Coastal floods: Coastal areas have additional flood hazards. Winds generated by tropical storms or intense off shore low-pressure systems can drive ocean water inland and cause significant flooding. The height of storm surge is dependent on the wind velocity, water depth and the length of open water (the fetch) over which the wind is flowing. Storm surges are also affected by the shape of the coastline and by the height of tides.

Coastal flooding also may result from tsunamis. A tsunami is a series of traveling ocean waves generated by an earthquake or landslide that occurs below or on the ocean floor. Oregon's seven coastal counties and many coastal cities are susceptible to flood damage associated with tsunamis. Both "distant" tsunamis generated from seismic events in the Pacific basin and "near shore" tsunamis generated from activity associated with the Cascadia Subduction Zone can impact Oregon's coast. For more information, see the Tsunami chapter of this Plan.

Shallow area flooding: Some areas are characterized by FEMA as being subject to shallow flooding. These are areas that are predicted to be inundated by the 100-year flood with flood depths of one to three feet. Flooding events are expected to be low velocity events characterized by “sheet flows” of water.

Urban flooding: As land is converted from fields or woodlands to roads, roofs, and parking lots, it loses its ability to absorb rainfall. This transition from pervious surfaces to impervious surfaces results in more and faster runoff of water. During periods of urban flooding, streets can become swift moving rivers, and basements can fill with water. Storm drains may back up with yard waste, causing additional nuisance flooding.

Playa flooding: Playa flooding results from greater than normal runoff into a closed basin. Closed basin systems are those areas that have one or more rivers emptying into one or more lakes that have no outlet. In these situations, water can only leave the system through evaporation. Thus, if annual precipitation in the basin increases significantly, evaporation is not enough to reduce water levels. Lake levels rise and inundate the surrounding properties.

The best-known example of playa basin flooding in Oregon occurs at Malheur and Harney lakes in Harney County. In higher than average precipitation years, the lakes flood adjacent ranches and public roads. Malheur and Harney lakes flooded during the years 1979 to 1986, and then gradually receded. During the wetter years of 1997 to 1999, these lakes again flooded. By 2005, following a number of dry years, they had receded significantly. In spring 2011, as a result of a heavy snowpack and persistent rainfall, Harney Lake’s water level increased significantly with flooding observed in low-lying areas.

Ice jams: Ice jams happen in colder regions of the State during winter and early spring while rivers are frozen. Sudden warming at higher altitudes melts snow resulting in increased runoff which breaks the ice from reaches of frozen river below. On the way downstream, the floating ice can “jam” in a narrow reach of the drainage or against a road crossing which then dams melting water. As the ice weakens, water breaches the dam releasing a torrent of water.

Dam failure: Dam failures and accidents, though rare, can result in extreme flooding downstream of the dam. Catastrophic dam failures have occurred in other parts of the country and around the world. The South Fork Dam failure (1889 Johnstown flood) resulted in over 2000 fatalities in western Pennsylvania. The Saint Francis Dam in southern California failed in 1928 with a loss of an estimated 600 people. Oregon's dam safety statutes (ORS 540.350 through 400) came into effect shortly after the Saint Francis disaster. Many historical dam failures were triggered by flood events, others by poor dam construction, and some have been triggered by earthquakes.

Dam Safety

Dam Safety is one of the Oregon Water Resources Department's roles. The dam safety program reviews designs for dam construction or modification and approves designs when they are shown to be safe; conducts routine inspections; determines hazard rating and condition; encourages emergency action plans for high-hazard dams; and takes enforcement on unsafe dams. The dam safety program also coordinates with federal agencies that are responsible for their dams, and is the Oregon Emergency Response System contact in the event of a major emergency for any dam in the State.

Without safety standards for design, construction, maintenance, operations and inspections there is an increased risk of dam safety problems. Oregon has a very good dam safety record, with no fatalities from dam failures. The vast majority of Oregon's approximately 55 recorded dam failures occurred before 1987. About one third of these 55 dam failures resulted in significant property damage. Much of Oregon's dam infrastructure is aging, and many dams were designed prior to the current understanding of earthquake hazard and especially the risk associated with the Cascadia subduction zone. Primary dam safety program goals are: conducting timely inspections; reducing the number of dams in poor or unsatisfactory condition; having emergency action plans for most high-hazard dams; and responding to events that might trigger dam failures. Additional information on dams and dam safety in Oregon is found at: http://www.oregon.gov/owrd/pages/SW/dams_in_oregon.aspx

The Dam Safety Program has been ensuring the over 900 dams under its jurisdiction are inspected on schedule, with recommendations sent to dam owners. At times this requires urgent dam safety notices and/or enforcement action. Other high-priority functions include determining dam hazard to people and changing hazard ratings based on hydraulic analyses, and development of emergency action plans for high-hazard dams. The Dam Safety Program also coordinates with the National Weather Service and OEM on severe flood potential that could affect dams and other infrastructure. The program exceeds FEMA guidance for dam safety inspections on schedule and for condition classification, and should be at the FEMA standard for Emergency Action Plans shortly.

Channel Migration in Association with Flooding

Channel migration is the process by which streams move laterally over time. It is typically a gradual phenomenon that takes place over many years due to natural processes of erosion and deposition. In some cases, usually associated with flood events, significant channel migration can happen rapidly. In high flood flow events stream channels can “avulse” and shift to occupy a completely new channel.

Areas most susceptible to channel migration are transitional zones where steep channels flow from foothills into broad, flat floodplains. The most common physiographic characteristics of a landscape prone to channel migration include moderate channel steepness, moderate to low channel confinement (i.e., valley broadness), and erodible geology.

Channel migration can and has created hazardous conditions within Oregon’s developed riparian areas. Rapid migration can undercut structure foundations and damage infrastructure. The upper Sandy River in eastern Clackamas County is an example of where channel migration and development intersect. A recent January 2011 flood resulted in temporary avulsion that washed out section of Lolo Pass Road and also bank erosion that damaged and destroyed several homes.

Channel migration is not a standard consideration of the NFIP and has not been mapped systematically in Oregon. The Oregon Department of Geology and Mineral Industries (DOGAMI) recently mapped channel migration zones for select areas with known susceptibility using procedures developed by the State of Washington for administration of its regulatory Shoreline Management Act (http://www.ecy.wa.gov/programs/sea/sma/st_guide/jurisdiction/cmz.html). DOGAMI has also initiated a statewide study to objectively identify areas highly susceptible to channel migration. The study will be used to prioritize future detailed channel migration zone mapping as funding becomes available.

The El Niño Southern Oscillation (ENSO) Cycle

- El Niño and La Niña are opposite phases of what is known as the El Niño-Southern Oscillation (ENSO) cycle. The ENSO cycle is a scientific term that describes the fluctuations in temperature between the ocean and atmosphere in the east-central Equatorial Pacific.
- La Niña is sometimes referred to as the cold phase of ENSO and El Niño as the warm phase of ENSO. These deviations from normal surface temperatures can have large-scale impacts not only on ocean processes, but also on global weather and climate.
- El Niño and La Niña episodes typically last nine to 12 months, but some prolonged events may last for years. They often begin to form between June and August, reach peak strength between December and April, and then decay between May and July of the following year.
- While their periodicity can be quite irregular, El Niño and La Niña events occur about every 3 to 5 years. Typically, El Niño occurs more frequently than La Niña.

Source: NOAA, What are El Niño and La Niña?, http://oceanservice.noaa.gov/facts/ninonina.html

El Niño and La Niña Events in Oregon and Relationship to Flooding

One of the most prominent aspects of Oregon’s weather and climate is its variability. This variability ranges over many time and space scales, from small-scale phenomena such as wind gusts and localized thunderstorms, to larger-scale features like fronts and storms, to even more prolonged features such as droughts and periods of flooding. Fluctuations occur on multi-seasonal, multi-year, multi-decade and even multi-century time scales. Examples of these longer time-scale fluctuations include an abnormally hot and dry summer, an abnormally cold and snowy winter, a consecutive series of abnormally mild or exceptionally severe winters, and even a mild winter followed by a severe winter. Human inputs into our geophysical environment are also imposing cumulative impacts with measurable changes to global climate, sea-level and even localized weather. These human inputs along with the normal climate cycles may be working together in unpredictable ways and lead to future climate scenarios that do not resemble past, historic cycles. For example, recent research suggests that a warming climate reinforces the possibility that El Niño events (a warmer phase) could be stronger and more frequent while La Niña episodes (a colder phase) may be weaker and less frequent.

The terms El Niño and La Niña represent opposite extremes of the ENSO cycle in an otherwise continuum of global climate events, with "average" conditions generally prevailing between those extremes. In the past three decades there have been several El Niños, with the 1982 to 1983 and 1997 to 1998 events having been the strongest on record, while the period between 1990 and 1995 was characterized by persistent El Niño conditions, the longest on record (Trenberth, 1999).

Table 2-15. Recent ENSO Events in Oregon

El Niño Events	La Niña Events
1982-1983	1988-1989
1994-1995	1995-1996
1997-1998	1999-2000
2002-2003	
2004-2005	
2006-2007	2007-2009
2009-2010	2010-2012

Source: NOAA, Multivariate ENSO Index (MEI)
http://www.esrl.noaa.gov/psd/enso/mei/

In general, the longer time-scale phenomena are associated with changes in oceanic and atmospheric circulation that encompass areas far larger than a particular affected region. At times, these persistent features occur simultaneously over vast, and seemingly unrelated, parts of the hemisphere, or even the globe, resulting in abnormal weather, temperature, and rainfall patterns throughout the world. During the past several decades, scientists have discovered that important aspects of this interannual variability in global weather patterns are linked to a global-scale, naturally occurring phenomenon known as the El Niño Southern Oscillation (ENSO) cycle. A measure of this cycle is the Southern Oscillation Index (SOI), which is "calculated from the monthly or seasonal fluctuations in the air pressure difference between Tahiti and Darwin, Australia."

Historical El Niño and La Niña events in Oregon

The earliest systematic study of ENSO in the Northwest was Redmond and Koch (1991). The results were sufficiently strong that the authors suggested a cause-effect relationship between the SOI and Oregon weather. They determined that the Southern Oscillation Index (SOI) can be used as a predictor for weather, especially for winter weather. Greatest correlations between SOI and winter weather patterns occur with about a four-month time lag with summer average SOI correlating well with weather in the Northwest during the following winter. SOI values less than zero represent El Niño conditions, near zero values are average, and positive values represent La Niña conditions.

In Oregon El Niño impacts associated with these climate features generally include warmer winter temperatures and reduced precipitation with drought conditions in extreme events.

What Oregonians should especially plan for and monitor, however, is La Niña. Severe flooding during the winters of 1995-96, 1998-99, and 2007-08 are attributable largely to the combination of heavy snows and warm, intense tropical rain. During La Niña events, heavy rain arrives in

Oregon from the western tropical Pacific, where ocean temperatures are well above normal, causing greater evaporation, more extensive clouds, and a greater push of clouds across the Pacific toward Oregon. During February 1996, for example, severe flooding — the worst in the state since 1964 — killed several people and caused widespread property damage. Nearly every river in Oregon reached or exceeded flood stage, some setting all-time records. Debris flows and landslides were also numerous. (Note that debris flow events are typically associated with periods of heavy rainfall or rapid snowmelt on steeply sloping ground. The term “mudslide” is often used interchangeably but is poorly defined as a natural hazard. FEMA uses the terms “mudslide” and “mudflow” in the context of the National Flood Insurance Program, e.g., 44 CFR 59.1 and 206.2(a)(17).)

Historic Flood Events

Table 2-16 lists historic damaging floods in Oregon.

Table 2-16. Historic Damaging Floods in Oregon

Date	Location	Notes
Sep. 1861	Klamath, Willamette, and Umpqua	
June 1880	Columbia	
Jan. 1881	Willamette Basin	
Dec. 1882	Umatilla	
June 1884	John Day	
May-June 1894	Columbia River Basin	rain on snowpack; highest flood stage ever recorded at Vancouver, Washington (33.6 ft)
June 1903	Willow Creek	flash flood in Heppner; 247 people killed
Apr. 1904	Silvies and Klamath	
Feb. 1907	western Oregon and John Day	
Nov. 1909	Deschutes, Willamette, Santiam, Umpqua, Coquille, and Rogue	
Mar. 1910	Powder and Malheur	
June 1913	Columbia	
Jan. 1923	Clackamas, Santiam, Sandy, Deschutes, Hood, and McKenzie	record flood levels
Feb. 1925	Malheur	
Feb. 1927	Klamath, Willamette, Umpqua, Rogue, and Illinois	major flooding
May 1928	Columbia	
Mar. 1931	Umatilla, Sandy, Clackamas, and Santiam	
Mar. 1932	Malheur, Grande Ronde, John Day, and Umpqua	
Jan. 1933	Coquille	
Nov.–Dec. 1942	Willamette Basin	10 deaths; $34 million damage
Dec. 1945	Coquille, Santiam, Rogue, and McKenzie	9 deaths and homes destroyed in Eugene area
Dec. 1946	Willamette, Clackamas, Luckiamute, and Santiam	
May - June 1948	Columbia River	rain on snow; destruction of the City of Vanport
Mar. 1952	Malheur, Grand Ronde, and John Day	highest flood stages on these rivers in 40 years
Dec. 1955	Rogue, Umpqua, Coquille	11 deaths; major property damage
July 1956	central Oregon	flash floods
Feb. 1957	SE Oregon	$3.2 million in flood damages
Dec. 1961	Willamette Basin	$3.8 million in flood damages
Dec. 1964–Jan. 1965	Pacific Northwest	rain on snow; record flood on many rivers
Dec. 1967	central Oregon coast	storm surge
Jan. 1972	western Oregon	record flows on coastal rivers
Jan. 1974	western Oregon	$65 million in damages
Nov. –Dec. 1977	western Oregon	rain-on-snow event; $16.5 million in damages
1979 to present	Harney County	cyclical playa flooding on Harney and Malheur lakes
Dec. 1981	Umpqua and Coquille	
Jan. 1982	Tillamook County	
Feb. 1982	Malheur and Owyhee Basins	

Date	Location	Notes
Jan. 1990	Clatsop and Tillamook Counties	
July 1995	Fifteenmile Creek	flash flood in Wasco County (DR-1061)
Feb. 1996	nearly statewide	damages totaling over $280 million (DR-1099)
Nov. 1996	SW Oregon	flooding, landslides, and debris flows; eight deaths in Douglas County (DR-1149)
Jan. 1997	SE and NE Oregon	(DR-1160)
May–June 1998	Crook County and Prineville	Ochoco River (DR-1221)
Dec. 1998	Lincoln and Tillamook Counties	
Nov. 1999	Coastal rivers in Lincoln and Tillamook Counties	heavy rainfall and high tides
July 2002	Wallowa County	flash flood above Wallowa Lake damaged Boy Scout Camp facility
August 2003	City of Rufus	flash flood (Gerking Canyon)
Dec. 2005–Jan. 2006	western and central Oregon, Malheur County	multiple heavy precipitation events on snow and/or saturated or frozen ground (DR-1672)
Nov. 2006	Clatsop, Hood River, Lincoln, and Tillamook Counties	heavy precipitation and wind resulted in flooding, landslides, and mudslides (DR-1672)
Feb. 2007	western and central Oregon, and the Confederated Tribes of the Siletz Indians	severe winter storm and flooding (DR-1683)
Dec. 2007	Northwestern Oregon, Southern Coast	heavy precipitation and wind resulted in flooding, landslides, mudslides, and tree blow down (DR-1733)
Dec. 2008	Tillamook County	Flooding caused by convergence of heavy precipitation and high tides
Jan. 2009	Tillamook and Washington Counties	severe winter storm/snow event which included snow, high winds, freezing rain, ice, blizzard conditions, mudslides, and landslide (flooding, post DR-1824)
Jan. 2011	Clackamas, Clatsop, Crook, Douglas, Lincoln, and Tillamook Counties	severe winter storm, flooding, mudslides, landslides, and debris flows (DR-1956)
Apr. 2011	Harney County	widespread basin flooding; Oregon DOT closed and breached U.S. 20 at milepost 132.6 on April 8, 2011, for flood relief; the breach was done at the request of Harney County Emergency Operations Center to avoid damage to nearby residences; larger culverts were later installed
May – June 2011	Union and Grant Counties	melting heavy snowpack caused riverine and playa flooding
June 2011	Heppner	persistent showers with heavy rainfall of 1 to 2 inches produced flooding on Willow and Hinton Creeks; flash flooding on Hinton and Willow Creeks damaged roads, bridges, and the Morrow County Fairgrounds; the Heppner elementary school was evacuated as a precaution
Jan. 2012	Columbia, Hood River, Tillamook, Polk, Marion, Yamhill, Lincoln, Benton, Linn, Lane, Douglas, Coos, and Curry Counties	heavy rain and wind; ice (DR-4055); flooding in the Willamette Valley; 130 homes and seven businesses were damaged in the City of Turner; 21 streets were closed in the City of Salem; the state Motor Pool lost 150 vehicles and thousands of gallons of fuel; Thomas Creek in the City of Scio overtopped, damaging several buildings

Date	Location	Notes
Nov. 2012	Curry, Josephine, and Lane Counties	heavy precipitation; the Curry Coastal Pilot reported over 2 million dollars in infrastructure damage in Brookings and another 2 million in Curry County due to recent heavy rains; sinkholes and overflowing sewage facilities were also reported; according to KVAL news, Eugene Public Works has opened its emergency command center to deal with numerous flooding incidents, including two flooded intersections
Sep. 2013	Multnomah and Tillamook Counties	heavy rain resulted in flooding of the Wilson River near Tillamook as well as urban flooding in the Portland Metro area; KPTV-KPDX Broadcasting reported that heavy rain resulted in flooding and damage to the Legacy Good Samaritan Medical Center and several businesses in Northwest Portland; besides damage to the hospital's emergency and operating room, some elective surgeries were cancelled

Source: FEMA and NOAA Storm Events Database (http://www.ncdc.noaa.gov/stormevents/)

Probability

Flood risk or probability is generally expressed by frequency of occurrence. Since 1960 one or more damaging floods have occurred somewhere in Oregon in 42 of 52 years reported by NOAA (NOAA Storm Events Database, https://www.ncdc.noaa.gov/stormevents/). Probability of flooding is measured as the average recurrence interval of a flood of a given size and place. It is stated as the percent chance that a flood of a certain magnitude or greater will occur at a particular location in any given year.

Base Flood Elevation (BFE)

Base Flood Elevation is the projected depth of floodwater at the peak of a base flood, generally measured as feet above sea level.

Source: DLCD

FEMA's NFIP extends regulation to an area covered by the "base flood," a flood that has a 1% chance of occurring in any year. Flood Insurance Rate Maps depict the inundation area of the 1% annual flood. It is important to recognize, however, that floods occur more frequently near the flooding source. Information regarding the probability of flooding at a given location in the regulated flood zones is provided by Flood Insurance Studies (FIS) for large watersheds. FEMA does not provide information about floods emanating from small watersheds (less than one square mile), or for floods caused by local drainage issues. Probabilities for these types of flood are, as a result, difficult to obtain.

The majority of flood studies in Oregon were conducted in the late 1970s and early 1980s. These studies represent flood risk at a point in time and don't reflect changing conditions in the watershed. Many of Oregon's metropolitan areas have significantly developed during the past twenty years resulting in increased impervious surface which causes higher velocities and increased volume of water. While FEMA's Map Modernization Program did result in updated FIRMs for 14 counties, many of these maps were produced using models from old flood insurance studies. Whether or by how much these old models underestimate current flood potential is unknown.

In 2009 FEMA transitioned from Map Modernization, intended to provide FIRMs in a digital format, to a Risk Mapping, Assessment, and Planning Program (Risk MAP), intended to direct FEMA's investment in new flood models and to provide communities with flood risk management products and services beyond the traditional FIRM. FEMA has initiated Risk MAP watershed-based projects in Clackamas, Clatsop, Curry, Douglas, Harney, Hood River, Jackson, Klamath, Lane, Lincoln, Malheur, and Marion Counties. Not all of these projects will result in new FIRMs. Rather, as part of the Risk MAP program, FEMA will evaluate the need to revised FIRMs based on national metrics. In any case, communities in the studied watersheds are expected to receive non-regulatory mapping products to assist them with floodplain risk management. Mapping projects in Tillamook and Washington Counties, which have yet to receive modernized FIRMs, will be completed under Risk MAP. Effective FIRM dates are presented in each Regional Risk Assessment.

Despite shortcomings of NFIP Flood Insurance Rate Maps, most Oregon communities exclusively rely on them to characterize the risk of flooding. Some jurisdictions use their own flood hazard maps derived from aerial photos of past flood events in conjunction with FEMA FIRMs to better reflect their communities' flood risks. Others have implemented a higher regulatory standard to address changing conditions; for example Metro's balanced cut and fill requirements, and Tillamook County's and the City of Vernonia's requirement that new homes and substantial improvements to existing homes be elevated at least three feet above base flood elevation (BFE).

Channel migration associated with flooding also can be identified with respect to a probability of migration over a period of 100 years. Historic aerial photos are catalogued to calculate past rates of migration which are then projected out to define a channel migration zone. Avulsion (i.e., channel shifting) zones, which are a component of the larger channel migration zone, are an exception to the migration rate approach. Areas of likely avulsion are identified by professional judgment of a fluvial geomorphologist, using high-resolution topographic data, aerial photos, and field observation.

Identification of channel migration susceptibility at the regional level is described in terms of low, moderate, and high relative probabilities. Probability is determined by assessing physiographic parameters of channel gradient, confinement, and pattern.

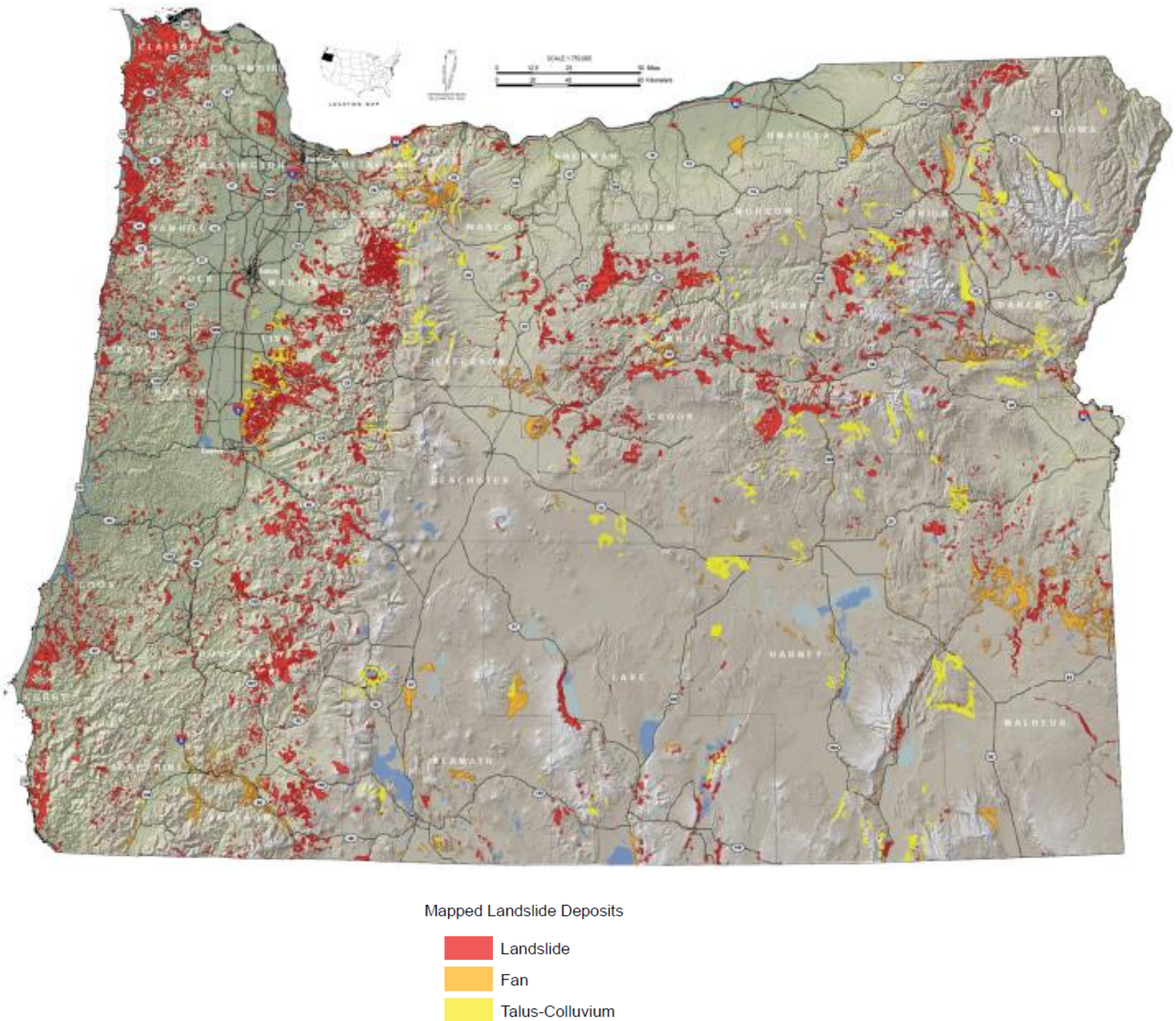
Climate Change

Flood risk is strongly associated with the dominant form of precipitation in a basin, with mixed rain-snow basins in Oregon already seeing increases in flood risk. Generally, western Oregon basins are projected to experience increased precipitation, and therefore flood risk, in future decades. Increased flood risk involves both an increased incidence of flooding of a certain magnitude and an increase in the magnitude of floods of a certain return interval. In other areas of the state, flood risk may decrease in some basins and increase in others. Finally, the incidence of extreme precipitation events — that is, days with over one inch of precipitation — is projected to increase throughout the Pacific Northwest.

Landslides

Landslides can be found throughout the state of Oregon, as seen in the current statewide landslide inventory database, SLIDO-2, in **Figure 2-32** and **Table 2-17** (Burns et al., 2011a). Systematic statewide landslide mapping has not been performed; however in general the areas of the state with more relief and steeper slopes, such as the Coast Range Mountains and the Cascade Mountains, tend to have more landslides. In general counties in Oregon have hundreds to thousands of existing landslides as shown in **Table 2-17** derived from the SLIDO-2 database.

Figure 2-32. Statewide Landslide Inventory



Note: Clackamas County has many more landslides than most other counties, which is partially because new very detailed lidar based mapping was completed in the NW portion of this county.

Source: Burns et al. (2011a)

Table 2-17. Number of Identified Landslides within or Touching Each County in Oregon

County	Number of Identified Landslides	County	Number of Identified Landslides
Baker	499	Lake	204
Benton	885	Lane	1,353
Clackamas	3,013	Lincoln	773
Clatsop	774	Linn	1528
Columbia	212	Malheur	737
Coos	1,524	Marion	622
Crook	397	Morrow	56
Curry	384	Multnomah	1,330
Deschutes	83	Polk	52
Douglas	1,526	Sherman	18
Gilliam	35	Tillamook	1,332
Grant	477	Umatilla	151
Harney	435	Union	483
Hood River	178	Wallowa	62
Jackson	809	Wasco	237
Jefferson	274	Washington	538
Josephine	380	Wheeler	413
Klamath	582	Yamhill	187

Source: Burns et al. (2011a)

DOGAMI found that in order to truly understand the landslide hazard in Oregon, lidar (light detection and ranging) topographic data must be collected and used during the mapping of existing landslides and modeling of future susceptibility. In fact, DOGAMI estimates that SLIDO-2 captures between 0% and 25% of the existing landslides in Oregon. This variance in landslide detail can be seen when examining the small NW portion of Clackamas County which has been recently mapped.

One of the most common and devastating geologic hazards in Oregon is landslides. Average annual repair costs for landslides in Oregon exceed $10 million and individual severe winter storm losses can exceed $100 million (Wang et al., 2002). As population growth continues to expand and development into landslide susceptible terrain occurs, greater losses are likely to result.

Landslides in Oregon are typically triggered by periods of heavy rainfall and/or rapid snowmelt. Earthquakes, volcanoes, and human activities also trigger landslides.

Three main factors influence an area’s susceptibility to landslides: geometry of the slope, geologic material, and water. Certain geologic formations are more susceptible to landslides than others. In general, locations with steep slopes are most susceptible to landslides, and the landslides occurring on steep slopes tend to move more rapidly and therefore may pose life safety risks.

Analysis and Characterization

The term "landslide" encompasses a wide range of geologic processes and a variety of nomenclatures that can lend itself to confusion. The general term landslide refers to a range of mass movement including rock falls, debris flows, earth slides, and other mass movements. One very important thing to understand is the fact that all landslides have different frequencies of movements, triggering conditions, and very different resulting hazards.

All landslides can be classified into one the following six types of movements: (a) slides, (b) flows, (c) spreads, (c) topples, (d) falls, and (f) complex (**Figure 2-33**). Most slope failures are complex combinations of these distinct types, but the generalized groupings provide a useful means for framing discussion of the type of hazard associated with the landslide, the landslide characteristics, identification methods, and potential mitigation alternatives.

El Niño Southern Oscillation and Effects on Landslides

The strongest impacts of intra-seasonal variability on the U.S. occur during the winter months over the western U.S. During the winter this region receives the bulk of its annual precipitation. Storms in this region can last for several days or more and are often accompanied by persistent atmospheric circulation features. Of particular concern are the extreme precipitation events which are linked to flooding and landslide. There is strong evidence for a linkage between weather and climate in this region from studies that have related the El Niño-Southern Oscillation (ENSO) to regional precipitation variability. From these studies it is known that extreme precipitation events can occur at all phases of the El Niño-Southern Oscillation (ENSO) cycle, but the largest fraction of these events occur during La Niña episodes and during ENSO-neutral winters. During La Niña episodes much of the Pacific Northwest experiences increased storminess, increased precipitation and more overall days with measurable precipitation. The risk of flooding and rain-induced landslides (and debris flows) in this region can be related to La Niña episodes.

Source: NOAA/Climate Prediction Center, http://www.cpc.noaa.gov/products/intraseasonal/intraseasonal_faq.html#usimpactsSource: NOAA/Climate Prediction Center, http://www.cpc.noaa.gov/products/intraseasonal/intraseasonal_faq.html#usimpacts

These types of movements can be combined with other aspects of the landslide such as type of material, rate of movement, depth of failure, and water content for a better understanding of the type of landslide.

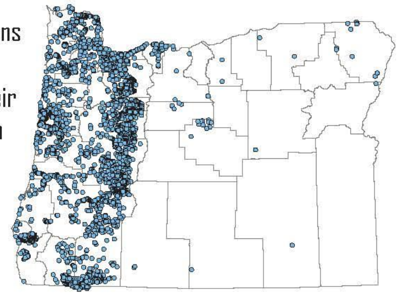
One potentially life-threatening type of landslide is the channelized debris flow or "rapidly moving landslide," which initiates upslope, moves into and down a steep channel (or drainage) and deposits material, usually at the mouth of the channel. Debris flows are also commonly initiated by other types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

Areas that have failed in the past often remain in a weakened state, and many of these areas tend to fail repeatedly over time. This commonly leads to distinctive geomorphology that can be used to identify landslide areas, although over time the geomorphic expression may become subtle, making the landslide difficult to identify. Other types of landslides tend to occur in the same locations and produce distinctive geomorphology, such as channelized debris flows, which form a fan at the mouth of the channel after repeated events. This is also true for the talus slopes, which form after repeated rock fall has taken place in an area.

Figure 2-33. Common Types of Landslides in Oregon

Oregon Geology Fact Sheet | **Landslide Hazards in Oregon**

Landslides affect thousands of Oregonians every year. Protect yourself and your property by knowing landslide types, their triggers and warning signs, how you can help prevent landslides, and how to react when one happens.

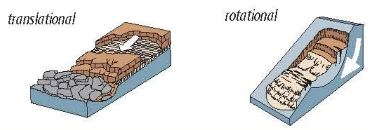


9,500 landslides were reported in Oregon in winter 1996 -97 ▶

Common landslide triggers in Oregon
- intense rainfall
- rapid snow melt
- freeze/thaw cycles
- earthquakes
- volcanic eruptions
- human
  - changing the natural slope
  - concentrating water
- combinations of the above

COMMON LANDSLIDE TYPES	TRIGGERS AND CONDITIONS	EXAMPLES

SLIDES — downslope movement of soil or rock on a surface of rupture (failure plane or shear-zone). Commonly occurs along an existing plane of weakness or between upper, relatively weak and lower, stronger soil and/or rock. The main modes of slides are translational and rotational.

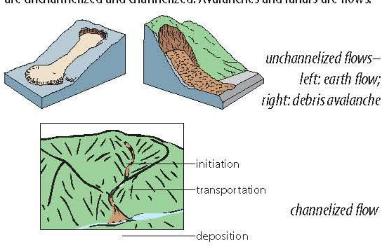


Slides are commonly triggered by heavy rain, rapid snow melt, earthquakes, grading/removing material from bottom of slope or adding loads to the top of the slope, or concentrating water onto a slope (for example, from agriculture/landscape irrigation, roof downspouts, or broken water/sewer lines).

Slides generally occur on moderate to steep slopes, especially in weak soil and rock.

translational slide *rotational slide*
(most slides are combinations of translational and rotational movement)

FLOWS — mixtures of water, soil, rock, and/or debris that have become a slurry and commonly move rapidly downslope. The main modes of flows are unchannelized and channelized. Avalanches and lahars are flows.



Flows are commonly triggered by intense rainfall, rapid snow melt, or concentrated water on steep slopes. Earth flows are the most common type of unchannelized flow. Avalanches are rapid flows of debris down very steep slopes.

A channelized flow commonly starts on a steep slope as a small landslide, which then enters a channel, picks up more debris and speed, and finally deposits in a fan at the outlet of the channel.

Debris flows, sometimes referred to as rapidly moving landslides, are the most common type of channelized flow. Lahars are channelized debris flows caused by volcanic eruptions.

debris avalanche (unchannelized flow) *earth flow (unchannelized flow)*

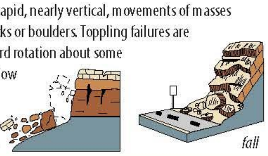
channelized debris flow *lahar aftermath (note the flow height indicated by stained trees)*

SPREADS — extension and subsidence of commonly cohesive materials overlying liquefied layers.

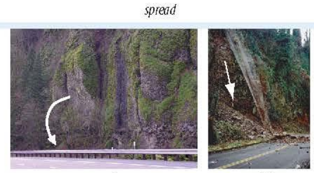
Spreads are commonly triggered by earthquakes, which can cause liquefaction of an underlying layer. Spreads usually occur on very gentle slopes near open bodies of water.

spread

TOPPLES / FALLS — rapid, nearly vertical, movements of masses of materials such as rocks or boulders. Toppling failures are distinguished by forward rotation about some pivotal point below or low in the mass.



Topples and falls are commonly triggered by freeze-thaw cycles, earthquakes, tree root growth, intense storms, or excavation of material along the toe of a slope or cliff. Topples and falls usually occur in areas with near vertical exposures of soil or rock.



topple *fall*

Landslide diagrams modified from USGS Landslide Fact Sheet FS2004-3072. Photos — Translational slide: Johnson Creek, OR (Landslide Technology). Rotational slide: Oregon City, OR, January 2006. Debris avalanche flow: Cape Lookout, OR, June 2005 (Ancil Nance). Earth flow: Portland, OR, January 2006 (Gerrit Huizenga). Channelized debris flow: Dodson, OR, 1996 (Ken Cruikshank, Portland State University). Lahar: Mount St. Helens, WA, 1980 (Lyn Topinka, USGS/Cascades Volcano Observatory). Spread: induced by the Nisqually earthquake, Sunset Lake, Olympia, WA, 2001 (Steve Kramer, University of Washington). Fall: Portland, OR (DOGAMI). Topple: I-80 near Portland, OR, January 2006 (DOGAMI).

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LAST REVISED 11-12-2008

Source: DOGAMI, Landslides in Oregon fact sheet (http://www.oregongeology.org/pubs/fs/landslide-factsheet.pdf)

Previously impacted areas are particularly important to identify, as they may pose a substantial hazard for future instability and help identify areas that are susceptible to future events. Large, slow moving landslides frequently cause significant property damage, but are far less likely to result in serious injuries. The 1998 Kelso, Washington, the 1997 Tillamook County, and the 2005 Oregon City slides are examples.

The velocity of landslides varies from imperceptible to over 35 miles per hour. Some volcanic induced landslides have been known to travel between 50 to 150 miles per hour. On less steep slopes, landslides tend to move slowly and cause damage gradually. Debris flows typically start on steep hillsides as shallow landslides, enter a channel, then liquefy and accelerate. Canyon bottoms, stream channels, and outlets of canyons can be particularly hazardous. Landslides can move long distances, sometimes as much as several miles. The Dodson debris flows in 1996 started high on Columbia River Gorge cliffs, and traveled down steep canyons to form debris fans in the Dodson-Warrendale area.

Landslide recurrence interval is highly variable. Some large landslides move continuously at very slow rates. Others move periodically during wet periods. Very steeply sloped areas can have relatively high landslide recurrence intervals (10 to 500 years on an initiation site basis).

Because debris flows can be initiated at many sites over a watershed, in some cases recurrence intervals can be less than 10 years. Slope alterations can greatly affect recurrence intervals for all types of landslides, and also cause landslides in areas otherwise not susceptible. Most slopes in Western Oregon steeper than 30 degrees (about 60%) have a risk of rapidly moving landslide activity regardless of geologic unit. Areas directly below these slopes in the paths of potential landslides are at risk as well.

Based on the Oregon Department of Forestry Storm Impacts Study, the highest debris flow hazard occurs in western Lane County, western Douglas County, and Coos County. The combination of steep slopes and geologic formation (sedimentary rock units) contributes to the increased hazard. The debris flow hazard is also high in much of the Coast Range and Cascade Mountains and in the Columbia River Gorge.

Deep landslides are generally defined as having a failure plane within the regional bedrock unit (generally greater than 15 feet deep), whereas the failure plane of shallow landslides is commonly between the thin soil mantle and the top of the bedrock. Deep landslide hazard is high in parts of the Coast Range. Deep landslides are fairly common in pyroclastic rock units of the Western Cascade Mountains, and in fine-grained sedimentary rock units of the Coast Range. Deep landslides also occur in semi-consolidated sedimentary rocks at or near the Oregon coast particularly around Newport, Lincoln County, and Tillamook County, and in the Troutdale Formation around the Portland area.

Infrequent very large landslides and debris flows may occur in any of the larger mountain ranges or in deep gorges throughout Oregon.

During 1996 and 1997, heavier than normal rains caused over 700 landslides within the Portland Metropolitan region, which totaled over $40 million for mitigation (Burns et al., 1998). In the City of Portland, 17 homes were completely destroyed and 64 were badly damaged. There were no serious injuries associated with the landslides in Portland or in other urban areas within Oregon during the 1996 storms.

The Oregon Department of Forestry Storm Impacts Study estimated that tens of thousands of landslides occurred on steep slopes in the forests of Western Oregon during 1996. The Oregon Department of Geology and Mineral Industries Slope Failures in Oregon inventoried thousands of reports of landslides across the state resulting from the 1996-1997 storms. There are a significant number of locations in Oregon that are impacted frequently (every 10 to 100 years) by dangerous landslides. The number of injuries and deaths in the future will be directly related to vulnerability: the more people in these areas, the greater the risk of injury or death.

Historic Landslide Events

Oregon has declared 28 major disaster declarations from 1955 through 2012. Most of these are related to storm events causing flooding and landslides. One of the most significant of these disasters is the 1996 and 1997 storms, which caused thousands of landslides in Oregon.

Table 2-18. Historic Landslides in Oregon from SLIDO-2

Date	No. of Landslides	Comments
1931–1935	2	
1946–1950	1	
1951–1955	2	
1956–1960	1	
1961–1965	14	Presidential DR-184
1966–1970	1	
1971–1975	11	
1976–1980	24	
1981–1985	9	
1986–1990	8	
1991–1995	42	
1996–2000	7,903	Presidential DR-1099
2001–2005	648	Presidential DR-1510
2006–2010	1,960	Presidential DR-1824 and DR-1956
Total	**10,626**	

Source: Burns et al. (2011a, 2013)

Probability

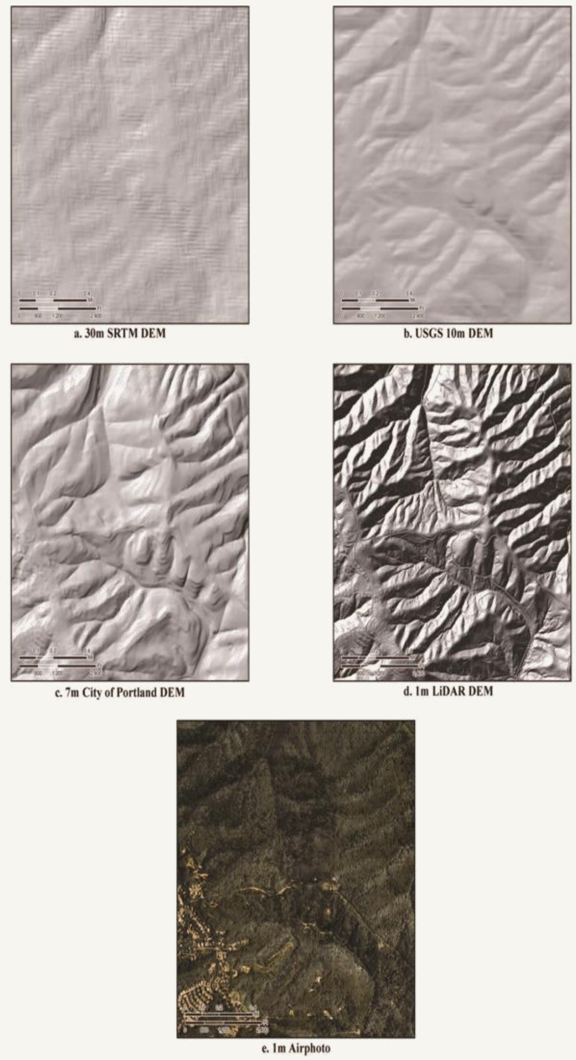
Landslides are found in every county in Oregon as shown in **Table 2-17**. There is a 100% probability of landslides occurring in Oregon in the future. Although we do not know exactly where and when they will occur, they are more likely to happen in the general areas where landslides have occurred in the past. Also, they will likely occur during heavy rainfall events or during a future earthquake.

In order to reduce losses from landslides, areas of landslide hazard must first be identified. The first step in landslide hazard identification is to create an inventory of past (historic and prehistoric) landslides. Once this inventory is created, it can be used to create susceptibility maps which display areas that are likely to have landslides in the future. Once the landslide hazards are identified on inventory and susceptibility maps, the risk can be quantified, mitigation projects prioritized and implemented.

In 2005, DOGAMI began a collaborative landslide research program with the U.S. Geological Survey (USGS) Landslide Hazards Program to identify and understand landslides in Oregon. In order to begin the extensive undertaking of mapping existing landslides throughout Oregon, a pilot project area was selected to compare remote sensing data/images for effectiveness. The remote sensing data sets compared included (Burns, 2007) (**Figure 2-34**):

1. 30-m (98 ft) digital elevation model (DEM) from the Shuttle Radar Topography Mission;
2. 10-m (33 ft) DEM derived from USGS topographic quadrangles;
3. Photogrammetric and ground-based 1.5-m (5 ft) interval contour data;
4. Stereo aerial photographs from 1936 to 2000; and
5. Lidar imagery with an average of 1 data point per square meter (3.2 ft) and with a vertical accuracy of about 5 cm (6 in).

Figure 2-34. Visual Comparison of Five Remote Sensing Data Sets



Note: The air photo is draped over a DEM so that it appears to have the 3-dimensional view provided by a stereo-pair

Source: Burns (2007)

Two key findings of the pilot project were: (a) the use of the lidar data resulted in the identification of between 3 to 200 times the number of landslides identified using the other data sets, and (b) the ease and accuracy of mapping the spatial extent of the landslides identified from lidar data were greatly improved compared to other mapping methods.

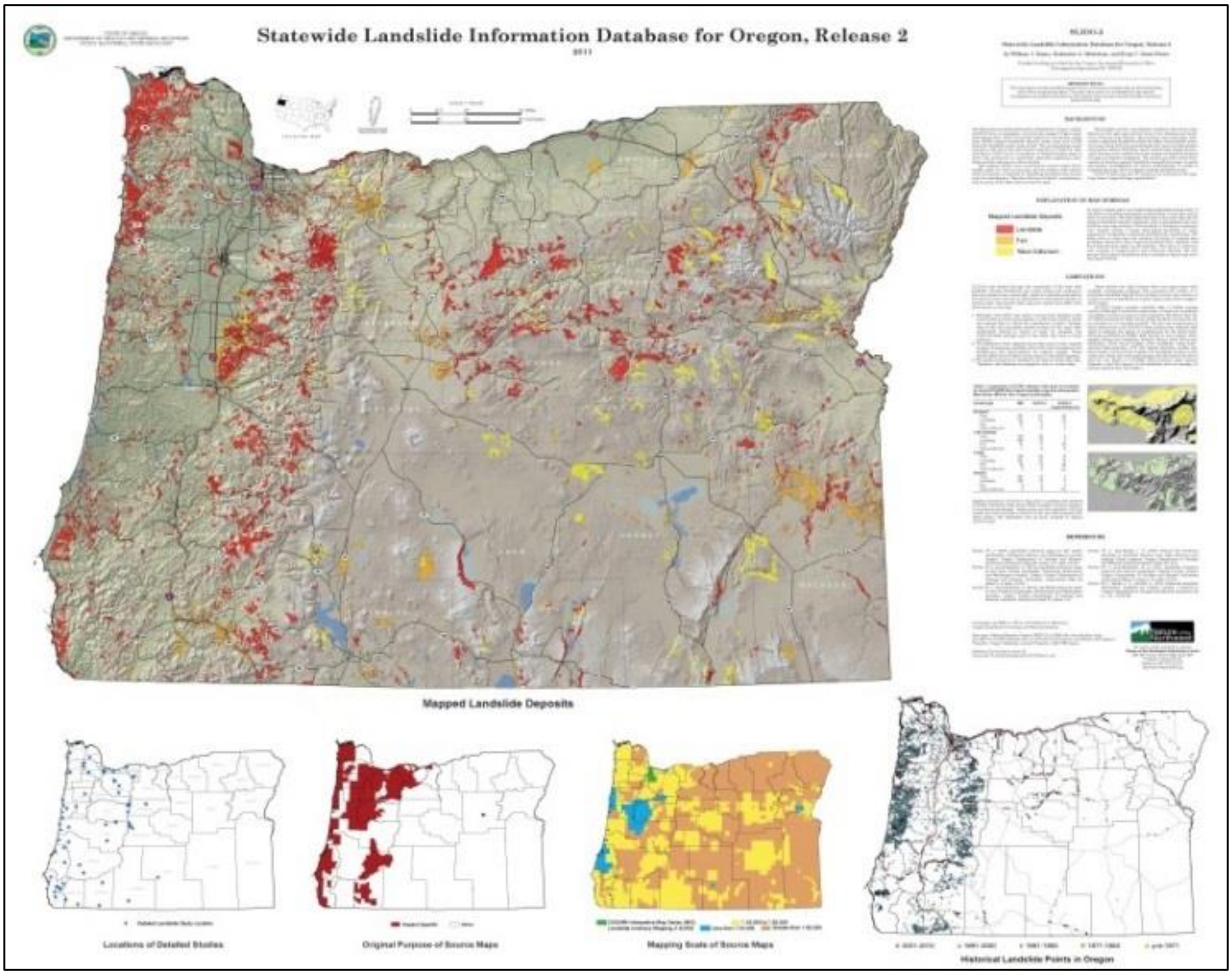
When examining the results of the comparison of remote sensing data, several debris flow fans at the mouths of channels or potential channelized debris flow deposits, were identified with serial stereo-pair aerial photos, which did not get identified on the lidar-derived DEMs. Dense development has taken place in Oregon in the last 40 years, which can mask landslide features, especially if major earthwork has taken place. In most of the populated areas of Oregon, if historic air photos are available, at least one review of (greater than 40 years old) photos should be performed (Burns, 2007).

In order to develop accurate large-scale landslide inventory maps, DOGAMI recommends the following minimal requirements:

1. All previously identified landslides from geologic maps, previous landslide studies, and other local sources should be compiled.
2. The mapper should have experience identifying all types and ages of landslides within the area being studied.
3. Lidar data should be used to identify landslides and accurately locate the extents of previously mapped landslides (from step 1).
4. An orthophoto of similar age to the lidar data should be used to minimize the misidentification of man-made cuts and fills as landslides.
5. The mapper should use at least one set of historical stereo-pair aerial photography to locate landslides in the area being studied.
6. Non-spatial data should also be collected at the time of the mapping so that a comprehensive database can be formed. Non-spatial data should generally include confidence of interpretation, movement class, direction of movement, etc. and are described in detail in section 6.0 of this paper. A comprehensive check of spatial (map) and non-spatial data should be developed and implemented including technical review of mapped landslides and field checks where possible.

Step 1 was accomplished in 2008 with the publication of SLIDO-1. This publication has been updated and again published as SLIDO-2 (**Figure 2-35**).

Figure 2-35. Statewide Landslide Information Database for Oregon, Release 2

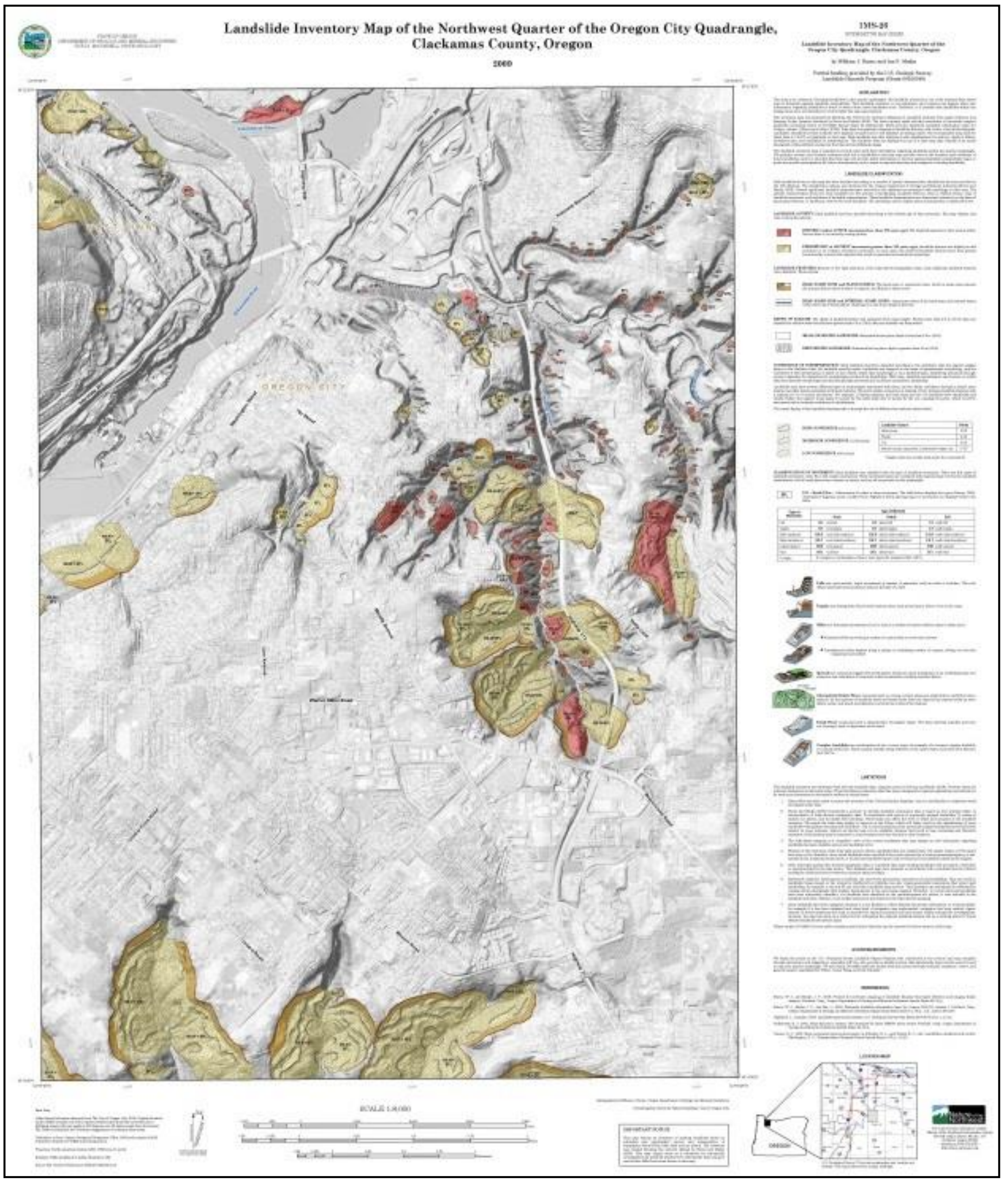


Note: The resulting SLIDO-2 geodatabase includes 22,542 landslide deposit polygons and landslide-related features from 313 published and unpublished studies, 10,636 historical landslide point locations (including all points from the 1996-97 events), and 72 locations of detailed studies on individual landslides, a significant increase over SLIDO-1.

Source: Burns et al. (2011a)

A protocol was developed by DOGAMI so that we can produce consistent lidar-based landslide inventory maps at an accelerated rate without having to describe how the mapping was done every time a new area is mapped (Burns and Madin, 2009). The results of following this protocol in any particular area include a very detailed database and map of the landslide inventory (**Figure 2-36**).

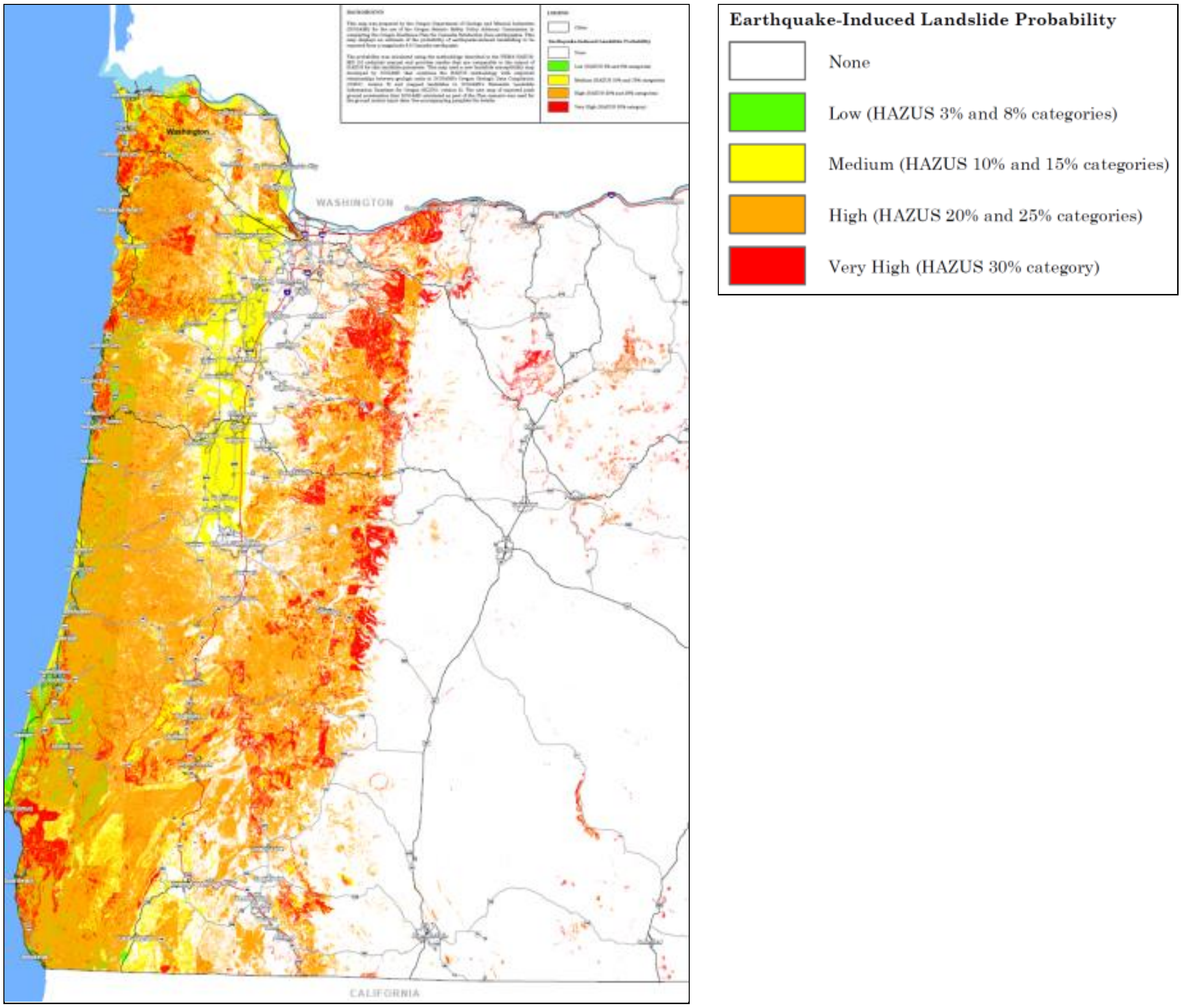
Figure 2-36. Example of a Lidar-Based Landslide Inventory (Oregon City, Oregon)



Source: Burns and Mickelson (2010)

With an accurate landslide inventory in hand, the next step in a complete landslide hazard mapping program is developing susceptibility maps for common types of landslides (see **Figure 2-37**). DOGAMI has completed a shallow landslide susceptibility protocol and is in progress of completing deep landslide and channelized debris flow susceptibility mapping protocols.

Figure 2-37. Example of an Earthquake-Induced Landslide Susceptibility Map



Source: Madin and Burns (2013)

Climate Change

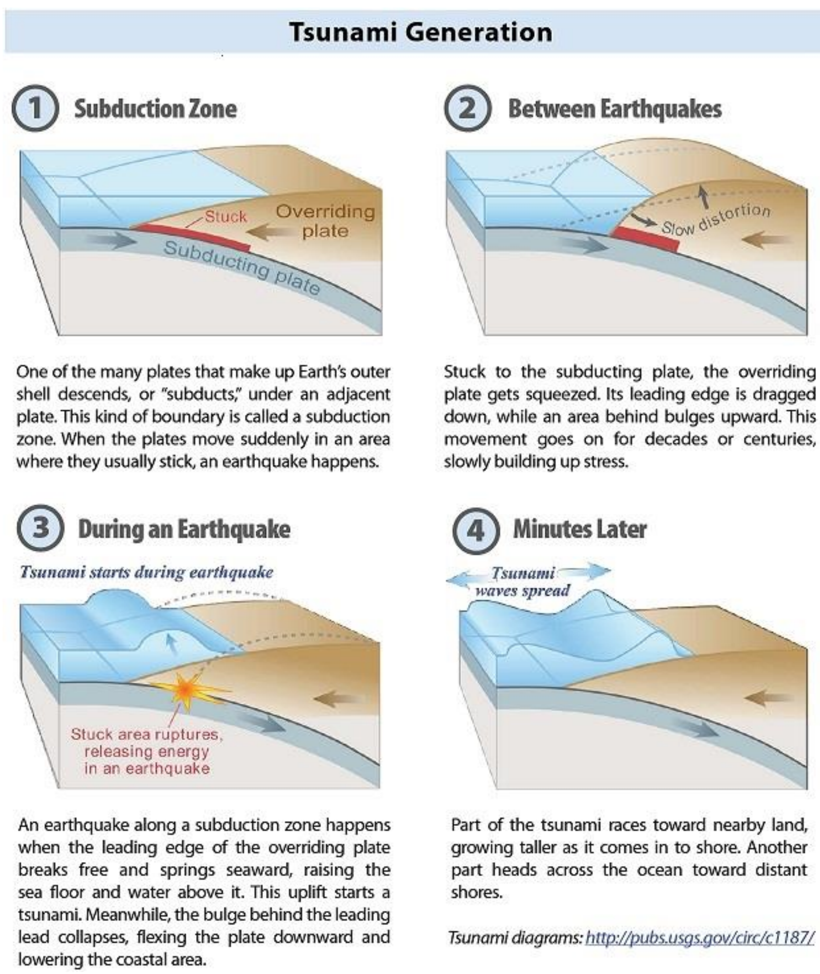
Flooding and landslides are projected to occur more frequently throughout western Oregon. In other areas of the state, flood risk may decrease in some basins and increase in others. Landslides in Oregon are strongly correlated with rainfall, so the likelihood of landslides may increase in areas where rainfall is projected to increase.

Tsunamis

Tsunamis are a low frequency natural hazard in Oregon and are restricted almost exclusively to coastal areas. Tsunamis are most often caused by the abrupt change in the seafloor accompanying an earthquake (**Figure 2-38**). The most common sources of the largest tsunamis are earthquakes that occur at subduction zones like the Cascadia Subduction Zone (CSZ), where an oceanic plate descends beneath a continental plate (**Figure 2-39**). Other important processes that may trigger a tsunami include underwater volcanic eruptions and landslides (includes landslides that start below the water surface and landslides that enter a deep body of water from above the water surface). Tsunamis can travel thousands of miles across ocean basins, so that a particular coastal area may be susceptible to two different types of tsunami hazard caused by:

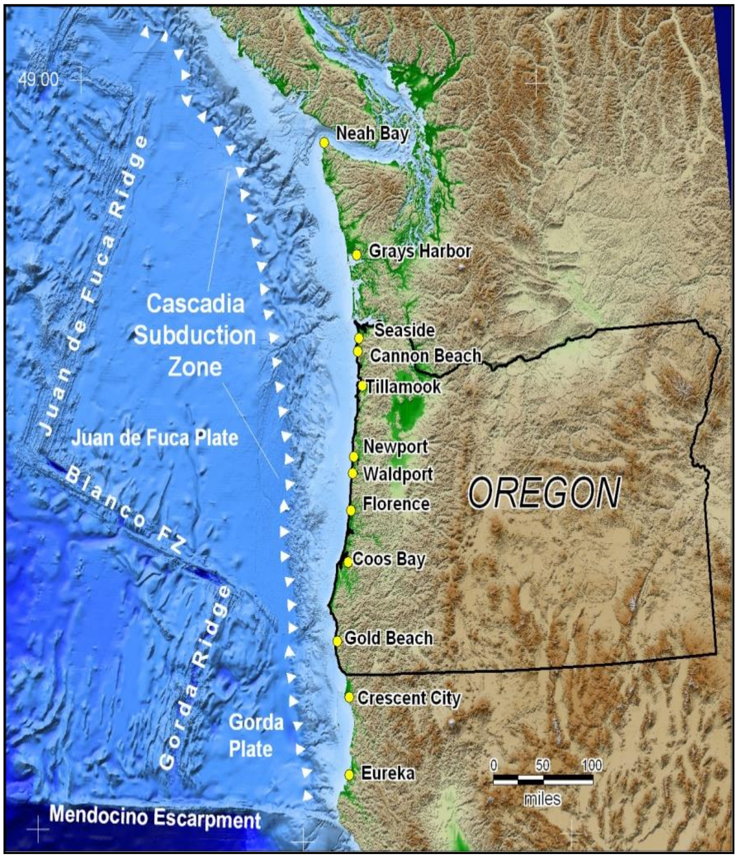
1. Distant sources across the ocean basin, and
2. Local sources that occur immediately adjacent to a coast.

Figure 2-38. Generation of a Tsunami by Subduction Zone Earthquakes



Source: DOGAMI, *Cascadia,* Winter 2012 (http://www.oregongeology.org/pubs/cascadia/CascadiaWinter2012.pdf)

Figure 2-39. Cascadia Subduction Zone (CSZ) Active Fault Map



Note: The fault, indicated by the triangles, is the contact where the Juan de Fuca Plate plunges beneath the North American continental plate.

Source: DOGAMI

Distant tsunamis that may threaten the Oregon Coast are usually generated by a subduction zone earthquake elsewhere in the Pacific and would take at least 4 hours to reach the Oregon coastline from the closest source, the subduction zone in the Gulf of Alaska. For example, the 1964 Alaska tsunami reached the Oregon Coast in four to five hours after the magnitude 9.2 earthquake that generated it. In contrast, a local tsunami generated by a CSZ earthquake, would take about 15-20 minutes to reach most of the coast.

Most locally-generated tsunamis will be higher and travel farther inland (overland and up river) than distant tsunamis. By the time the tsunami wave hits the coastline, it may be traveling at 30 mph and have heights of 20 to about 100 feet, depending on the local coastal bathymetry (water depths), shape of the shore, and the amount of fault movement on the subduction zone. The tsunami wave will break up into a series of waves that will continue to strike the coast for a day or more, with the most destructive waves arriving in the first 4-5 hours after the local earthquake. As was seen in the 2004 Sumatra tsunami, the first wave to strike the coast is not always the most destructive. This was again the case during the 2011 Japan tsunami.

The coasts of Washington, Oregon, and northern California are particularly vulnerable to tsunamis from magnitude 9+ earthquakes that occur about every 500 years on the CSZ (**Figure 2-39**). Additional, smaller tsunamis and earthquakes occur in the subduction zone south of Waldport. The combined recurrence for both types of Cascadia earthquake can be as low as about 230 years in Curry County.

The initial tsunami wave mimics the shape and size of the sea floor movement that causes it, but quickly evolves into a series of waves that travel away from the source of disturbance, reflect off of coastlines, and then return again and again over many hours. The tsunami is thus "trapped" owing to the processes of reflection and refraction. In the deep ocean, tsunami waves may be only a few feet high and can travel at wave speeds of 300–600 mph. As a tsunami approaches land where the water depth decreases, the forward speed of the wave will slow as wave height increases dramatically. When the wave makes landfall, the water is mobilized into a surging mass that floods inland until it runs out of mass and energy. The wave then retreats, carrying all sorts of debris. Successive waves then batter the coast with this debris. Swimming through such turbulent debris-laden water is next to impossible.

Tsunamis are potentially more destructive than the earthquake that caused them. Loss of lives from the tsunami can often be many times the loss from the earthquake ground shaking. This was highlighted by the December 26, 2004 tsunami, associated with a magnitude 9.3 earthquake, which occurred offshore from the Indonesian island of Sumatra. The tsunami impacted almost every county located around the Indian Ocean rim and claimed the lives of approximately 350,000 people. The greatest loss of life occurred along the coast of Sumatra, close to the earthquake epicenter. The event displaced some 2 to 3 million people and its economic impact continues to be felt to the present. The Sumatra event is a direct analogue for what can be expected to occur along the Oregon Coast due to its close proximity to the Cascadia Subduction Zone.

In addition, fires started by the preceding earthquake are often spread by the tsunami waves, if there is a gasoline or oil spill. As was seen in the Sumatra 2004 tsunami, flood inundation from a tsunami may be extensive, as tsunamis can travel up rivers and streams that lead to the ocean. Delineating the inland extent of flooding, or inundation, is the first step in preparing for tsunamis.

Analysis and Characterization

The entire coastal zone is highly vulnerable to tsunami impact. Distant tsunamis caused by earthquakes on Pacific Rim strike the Oregon coast frequently but only a few of them have caused significant damage or loss of life. Local tsunamis caused by earthquakes on the Cascadia Subduction Zone (CSZ) happen much less frequently but will cause catastrophic damage and, without effective mitigation actions, great loss of life.

On March 11, 2011, a magnitude (M_w) 9.0 earthquake struck off the east coast of Japan. This caused a massive tsunami that inundated much of the eastern coastline of Japan, and reached the west coast of the U.S. many hours later. There was one death and millions of dollars of damage to ports and harbors in Oregon and California (**Figure 2-40**). Japan suffered many thousands of dead and missing as well as a nuclear catastrophe which will continue to be a hazard far into the future. Oregon received a Presidential Declaration of Disaster (DR-1964) which brought millions of dollars of financial aid to repair and mitigate future tsunami damage. Debris from tsunami-damaged buildings in Japan floated across the Pacific Ocean and began arriving on the Canadian and U.S. West Coast in December 2011 and is expected to continue to arrive for years.

Figure 2-40. Tsunami Damage on the Chetco River, Oregon from the Tsunami Generated by an Earthquake Offshore Japan in 2011

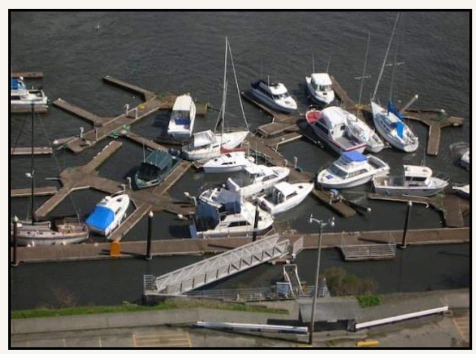


Photo source: U.S. Coast Guard

In March 1964, a tsunami struck southeastern Alaska following an earthquake beneath Prince William Sound and arrived along the Alaska coastline between 20 and 30 minutes after the quake, devastating villages. Damages were estimated to be over $100 million (1964 dollars). Approximately 120 people drowned. The tsunami spread across the Pacific Ocean and caused damage and fatalities in other coastal areas, including Oregon. The tsunami killed five people in Oregon and caused an estimated $750,000 to $1 million in damage. In Crescent City, California, there were 10 fatalities, while damage to property and infrastructure was estimated to range from $11 to 16 million.

Going still further back in time, there is scientific consensus that the Pacific Northwest experienced a subduction zone earthquake estimated at magnitude 9 on January 26, 1700. The earthquake generated a tsunami that caused death and damage as far away as Japan, where it was well-documented in the literature of the time. The earthquake and tsunami left behind geologic “footprints” in the form of (a) tsunami sand sheets in marshes, (b) layers of marsh vegetation covered by tide-borne mud when the coast abruptly subsided, and (c) submarine sand and silt slurries shaken off the continental shelf by the earthquake (turbidites). The widespread and large body of oral traditional history of the Thunderbird and Whale stories passed down by First Nations people depict both strong ground shaking and marine flooding that may have been inspired by this event. Although this earthquake undoubtedly produced tsunamis that reached on the order of 30–40 feet at the coast, geologic evidence from study of 10,000 years of turbidite deposits suggests that the 1700 earthquake was just an average event. Some Cascadia earthquakes have been many times larger, so, while devastating, the earthquake and tsunami were far from the worst case.

In 2010 the Oregon Department of Geology and Mineral Industries (DOGAMI) completed an analysis of the full range of Cascadia tsunamis and earthquakes, separating the results into five size classes with "T-shirt" names, S, M, L, XL, and XXL. The XL or XXL events probably only happened once or twice in the last 10,000 years, but estimated tsunami heights were comparable to those of the 2011 Japan and 2004 Sumatra tsunamis, the largest known.

The tsunami wave tends to arrive at the coast as a fast moving surge of rising water. As the tsunami enters coastal bays and rivers, it may move as a high-velocity current or a breaking wave that travels up an estuary as a bore (wall of turbulent water like the waves at the coast after they break). This inland wave of water can often cause most or all of the damage, and the current may be just as destructive when it is retreating from the land as when it is advancing. For example, in Seaside the damage from the 1964 Alaskan tsunami occurred along the Necanicum River and Neawanna Creek, well inland from the coast. In addition, storm waves and wind waves may ride on top of the tsunami waves, further compounding the level of destruction.

During Cascadia earthquakes there is also the added effect of coastal subsidence, or the downward movement of the land relative to the sea level, during the earthquake. This is due to the release of the accumulated strain that caused the western edge of the North American Plate to bend and bulge. The new earthquake models used for the local tsunami scenarios indicate that portions of the Oregon coast could drop by a few to several feet.

Seven tsunami flooding (inundation) zones are mapped by DOGAMI: five Cascadia tsunami scenarios, S, M, L, XL, XXL, and two maximum-considered distant tsunami scenarios (the 1964 Alaska tsunami and a larger hypothetical maximum Alaska tsunami, AKmax). All 7 are depicted on DOGAMI tsunami inundation maps (TIMs, **Figure 2-41**) plus digital files for use in geographic information systems (GIS). The five local CSZ-sourced inundation scenarios involve greater and greater amounts of movement on the subduction zone fault, ranging from 30 feet (S scenario) to 144 feet (XXL scenario). The seven inundation lines are reduced to two for evacuation planning: AKmax inundation is the distant tsunami evacuation zone, and XXL is the local tsunami evacuation zone (**Figure 2-41**). Brochures illustrating these zones and evacuation routes are available for all population centers, but both zones can also be viewed for any part of the coast using an interactive map portal and mobile phone apps at www.oregontsunami.org. The evacuation zones are critical for life safety planning and preparation. All seven scenarios assumed a maximum high tide (MHHW) and include the effects of subsidence from the earthquake fault process (release of strain on the North American Plate).

Figure 2-41. Examples of DOGAMI Tsunami Inundation Maps (TIMs) and Tsunami Evacuation Maps for North Bend (Coos Bay Area)

The top map illustrates inundation for five "T-shirt" size CSZ scenarios (S, M, L, XL, and XXL); the middle map shows inundation from two maximum considered distant tsunamis from subduction zone earthquakes in the Gulf of Alaska, a hypothetical maximum (termed Alaska Maximum or AKmax in DOGAMI databases), and the largest historical event that struck the Oregon coast in 1964. Note the close similarity of Alaska Maximum to the Small CSZ inundation.

Source: DOGAMI, *Cascadia* Winter 2012 (http://www.oregongeology.org/pubs/cascadia/CascadiaWinter2012.pdf)

Historic Tsunami Events

Table 2-19. Historic Tsunamis in Oregon

Date	Origin of Event	Affected Oregon Community	Damage	Remarks
Apr. 1868	Hawaii	Astoria		observed
Aug. 1868	N. Chile	Astoria		observed
Aug. 1872	Aleutian Islands	Astoria		observed
Nov. 1873	N. California	Port Orford		debris at high tide line
Apr. 1946	Aleutian Islands	Bandon		barely perceptible
Apr. 1946		Clatsop Spit		water 3.7 m above MLLW
Apr. 1946		Depoe Bay		bay drained; water returned as a wall
Apr. 1946		Seaside		wall of water swept up Necanicum River
Nov. 1952	Kamchatka	Astoria		observed
Nov. 1952		Bandon	log decks broke loose	
May 1960	S. Cent. Chile	Astoria		observed
May 1960		Seaside	bore on Necanicum River damaged boat docks	
May 1960		Gold Beach		observed
May 1960		Newport		observed for about 4 hours
May 1960		Netarts	some damage observed	
Mar. 1964	Gulf of Alaska	Cannon Beach	bridge and motel unit moved inland; $230,000 damage	
Mar. 1964		Coos Bay	$20,000 damage	
Mar. 1964		Depoe Bay	$5,000 damage; 4 children drowned at Beverly Beach	
Mar. 1964		Florence	$50,000 damage	
Mar. 1964		Gold Beach	$30,000 damage	
Mar. 1964		Seaside	1 fatality (heart attack); damage to city: $41,000; private: $235,000; four trailers, 10–12 houses, two bridges damaged	
May 1968	Japan	Newport		observed
Apr. 1992	N. California	Port Orford		observed
Oct. 1994	Japan	coast		tsunami warning issued, but no tsunami observed
Mar. 2011	Japan	coast	$6.7 million; extensive damage to the Port of Brookings	tsunami warning issued, observed ocean waves

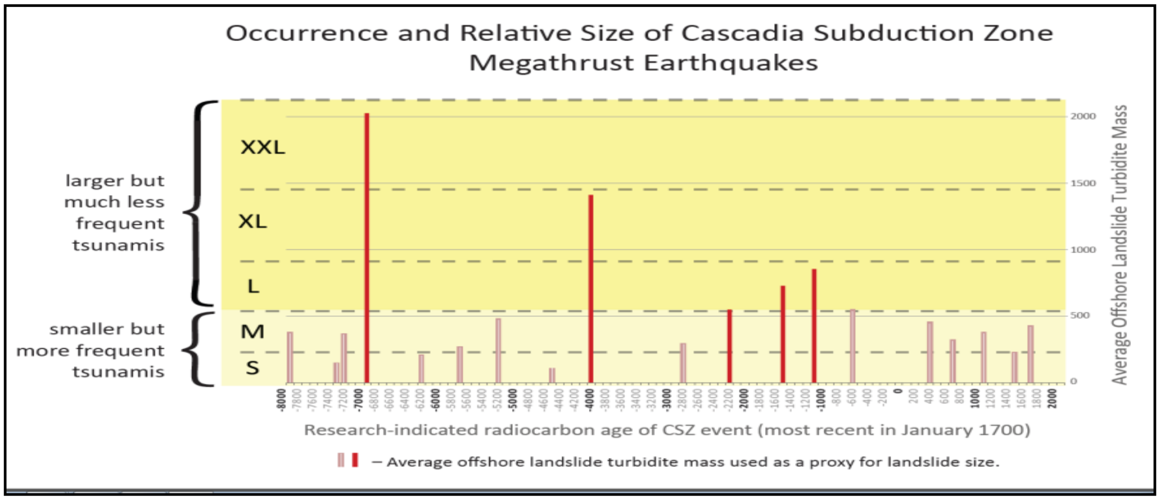
Sources: Lander et al., 1993; FEMA, 2011, Federal Disaster Declaration

In addition to the historical distant tsunamis of **Table 2-19**, the last CSZ tsunami struck at 9 PM on January 26, 1700. This may be considered a historical event, because the tsunami was recorded in historical port records in Japan. The date and time of occurrence here in Oregon were inferred by Japanese and USGS researchers from a tsunami and earthquake model.

Probability

While large (about magnitude 9) CSZ earthquakes and associated tsunamis have occurred on average every 500 years over the last 10,000 years, the time interval between events has been as short as decades and as long as 1,150 years. Smaller earthquakes on the southern part of the CSZ have occurred about as often as larger earthquakes, making CSZ events in southernmost Oregon about twice as likely as in northern Oregon. The size and frequency of the 19 large earthquakes on the CSZ are inferred from offshore turbidite deposits and are shown in **Figure 2-42**. All 19 of these large CSZ events were likely magnitude 8.7–9.2 earthquakes.

Figure 2-42. Occurrence and Relative Size of Cascadia Subduction Zone Megathrust Earthquakes



Source: DOGAMI *Cascadia*, Winter 2012 (http://www.oregongeology.org/pubs/cascadia/CascadiaWinter2012.pdf)

In April 2008 the USGS wrote that for the next 30 years there is a 10% probability of a magnitude 8-9 earthquake somewhere along the 750-mile-long Cascadia Subduction Zone. In 2012 USGS Professional Paper 1661-F (http://pubs.usgs.gov/pp/pp1661f/) showed that the southern part of the CSZ also ruptures in segments, so probabilities some type of CSZ earthquake increase from north to south, as illustrated in **Figure 2-43**. Segment earthquakes and tsunamis will generally be smaller than full-margin events. Segment tsunamis, by the time they travel more than about 43 miles north of a segment, are similar in size to distant tsunamis with the largest waves striking 2 hours or more after the earthquake (Priest et al., 2014; http://link.springer.com/article/10.1007/s11069-014-1041-7). New tsunami inundation maps from DOGAMI illustrate the range of inundation from all full-margin and significant segment ruptures on the CSZ.

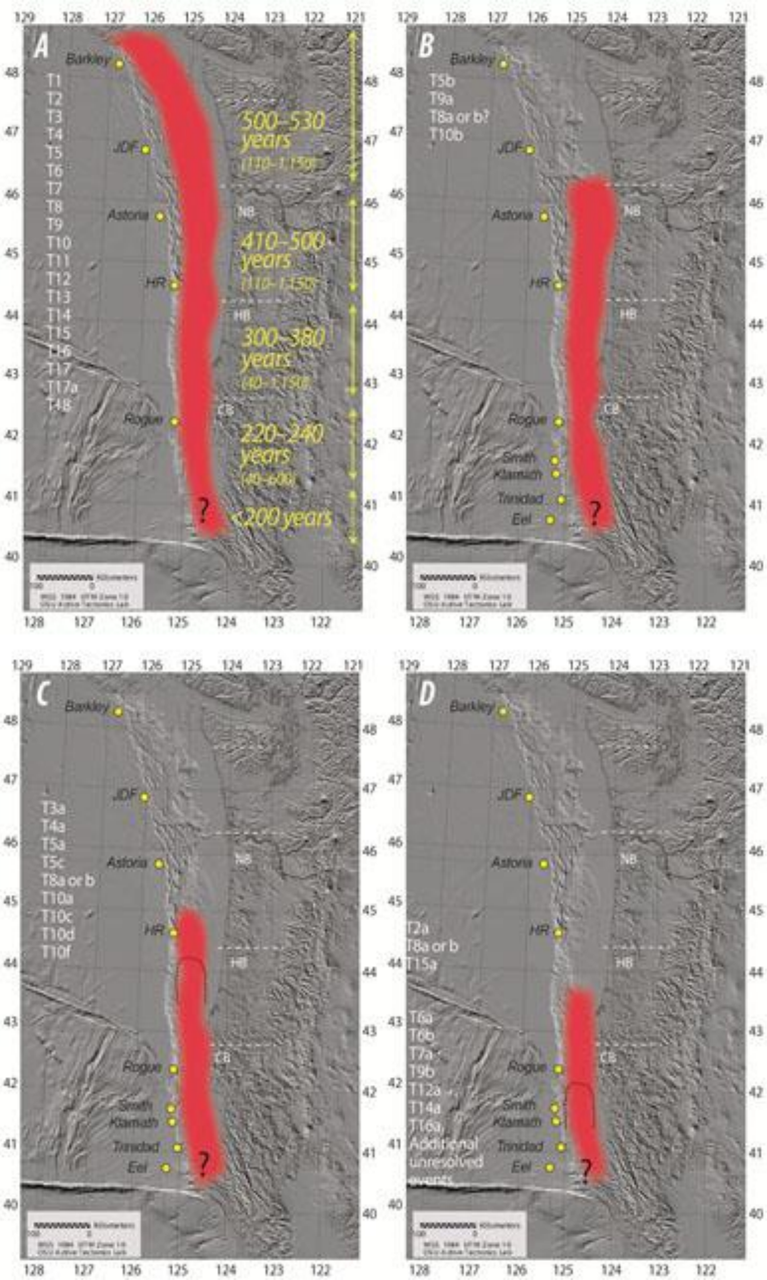


Figure 2-43. Hypothetical Rupture Patches of Cascadia Subduction Zone (CSZ) Earthquakes over Last 10,000 Years

White line with triangles marks the CSZ deformation front also visible as boundary between smooth to rough terrain. Numbers with “T” prefixes are offshore turbidite layers correlated with each rupture patch and arranged with youngest at the top. The white dashed lines are inferred segment boundaries of CSZ ruptures designated segments A (full-margin rupture), B (rupture north to Nehalem Bank [NB]), C (rupture north to Heceta Bank [HB]), and D (rupture north to Coquille Bank [CB]). Northern extents of segment D events break into two groups, one terminating south of the Rogue submarine canyon, indicated by dashed line. The second group extends north of Rogue but is not observed at Hydrate Ridge (HR). Although presumed to extend no further south than the southern terminus of the CSZ at Cape Mendocino, southern rupture limits are poorly known for all events indicated by query, limited by temporal coverage of turbidites and probable non-seismic turbidites in the early Holocene. Uncertainty in the northern extent of segments C and D are shown as the difference between the red patches and the black dashed lines. In the map of segment A, mean return in years of CSZ earthquakes is listed at each latitude and is calculated by dividing the number of turbidite layers into 10,000 years; minimum and maximum time intervals between turbidites at each latitude is given in parentheses. See Priest et al. (2014; http://link.springer.com/article/10.1007/s11069-014-1041-7) for estimates of height and arrival times of Segment C and D tsunamis.

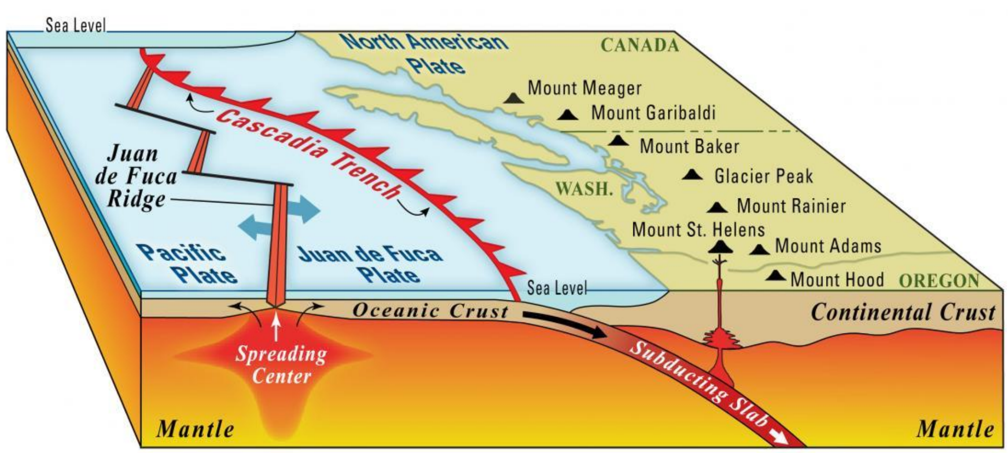
Note: Red areas depict hypothetical rupture patches of Cascadia subduction zone (CSZ) earthquakes over the last 10,000 years inferred by Goldfinger et al. (2012) from marine and onshore paleoseismic data plus geological and geophysical data
Source: Goldfinger et al. (2012)

Volcanoes

Volcanoes are potentially destructive natural phenomena, constructed as magma ascends and then erupts onto the earth's surface. Volcanic eruptions are typically focused around a single vent area, but vary widely in explosivity. Therefore volcanic hazards can have far reaching consequences. Volcanic hazards may occur during eruptive episodes or in the periods between eruptions. Eruptive events may include hazards such as, pyroclastic surges and flows, ashfall, lava flows, or slurries of muddy debris and water known as lahars. Eruptions may last days to weeks or years, and have the potential to dramatically alter the landscape for decades. Unlike other geologic hazards (e.g., earthquakes, tsunamis), impending eruptions are often foreshadowed by a number of precursors including ground movements, earthquakes, and changes in heat output and volcanic gases. Scientists use these clues to recognize a restless volcano and to prepare for events that may follow. Hazards occurring between eruptive periods are typically related to earthquakes or natural erosion, which may trigger debris avalanches or debris flows on the flanks of the volcano. Such events often occur without warning.

Potentially hazardous volcanoes in Oregon are present along the crest of the Cascade Range and to a much lesser extent in the High Lava Plains. The volcanoes within these regions provide some of Oregon's most spectacular scenery and popular recreational areas, yet the processes that led to their formation also present significant challenges and hazard to communities within the region. The catastrophic eruption of Washington's Mount St. Helens in 1980 and subsequent activity demonstrate both the power and detrimental consequences that Cascade-type volcanoes can have on the region. Lessons learned at Mount St. Helens, led the U.S. Geological Survey (USGS) to establish the Cascades Volcano Observatory (CVO) in Vancouver, Washington. Scientists at CVO continually monitor volcanic activity within the Cascade Range and in cooperation with the Oregon Department of Geology and Mineral Industries (DOGAMI), study the geology of volcanic terrains in Oregon.

Figure 2-44. Generalized Subduction Zone Setting



Source: Cascades Volcano Observatory Popular Graphics image gallery,
http://volcanoes.usgs.gov/vsc/multimedia/cvo_popular_graphics_gallery.html

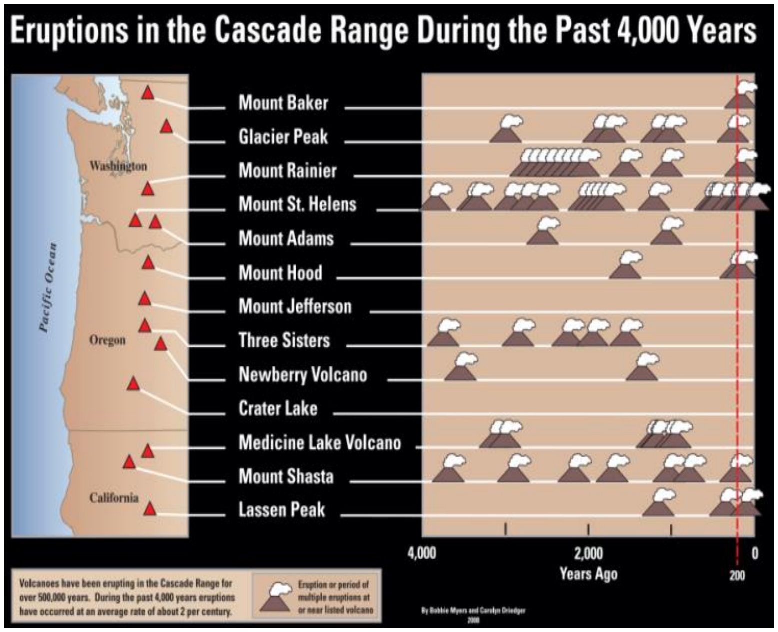
Analysis and Characterization

The volcanic Cascade Range extends southward from British Columbia into northern California. The volcanoes are a result of the complex interaction of tectonic plates along the Cascadia Subduction Zone (CSZ). Subduction is the process that results in the Juan de Fuca plate (oceanic crust) subducting, or sinking, underneath the North American plate (continental crust) on which we live (**Figure 2-44**). As the subducted plate descends, it heats up and begins to melt. This provides the reservoir of heat and molten rock needed to create the magma chambers that lie kilometers deep, beneath the Cascades.

Stratovolcanoes like Mount Hood, also called composite volcanoes, are generally tall, steep, conical shaped features, built up through layering of volcanic debris, lava, and ash. Eruptions tend be explosive, for example, the violent 1980 eruption of Mount St. Helens, and they produce volcanic mudflows (lahars) that can travel far from the mountain. Future eruptions are likely to be similar and present a severe hazard to the surrounding area. Volcanoes also pose other hazards because of their geology and resulting geomorphology. The relatively high elevation of volcanoes usually results in the meteorological effect called orographic lifting, which causes high precipitation and snow on the mountains that can result in flooding. The geologic material tends to be relatively weak and, when combined with the steep slopes, can cause frequent and hazardous landslides. Cascade Mountain Range volcanoes are also located near the active CSZ and nearby potentially active crustal faults, which contribute to moderate seismic hazard in the area.

The volcanoes of the Cascade Range have a long history of eruption and intermittent quiescence. Note that in **Figure 2-45**, each volcano has a different frequency of eruption. Not all Cascade volcanoes have been active in the recent past. This is typical of a volcanic range and is one of the reasons forecasting eruptions can be difficult.

Figure 2-45. Eruptions in the Cascade Range During the Past 4,000 Years



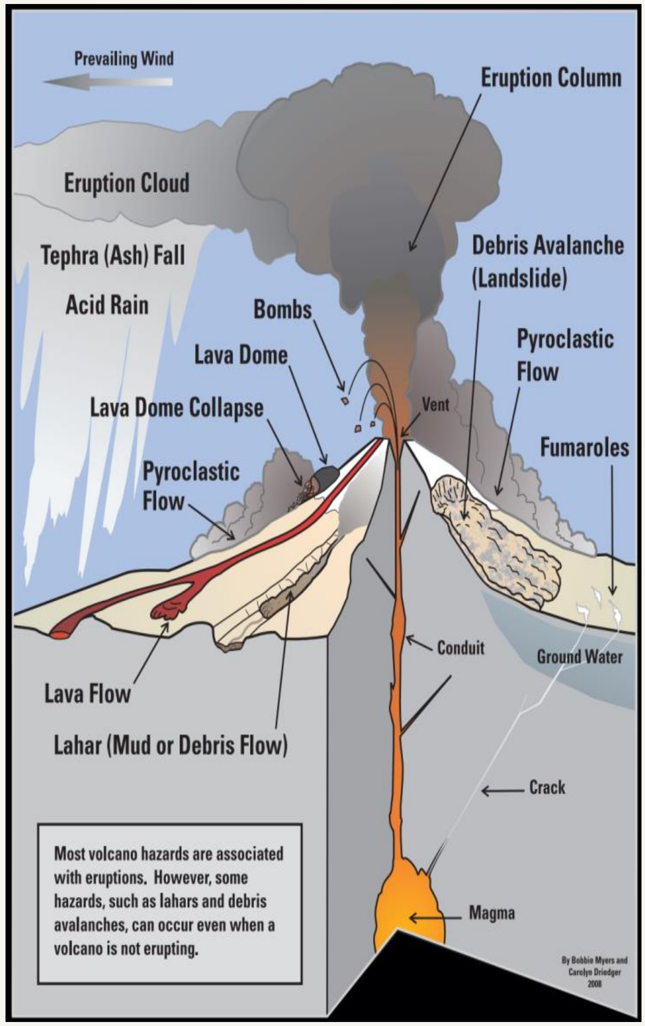
Source: Myers and Driedger (2008)

Several smaller volcanoes, including Diamond Craters and Jordan Craters, in the High Lava Plains of southeast Oregon have experienced eruptions in the last 6,000 years. Generally nonexplosive eruptions at these sites have built complexes of lava flow fields and cinder cones. Unlike the far-reaching effects that may be generated by large, potentially explosive stratovolcanoes in the Cascade Range, hazards associated with future eruptions in sparsely populated southeast Oregon are most likely limited to localized lava flows.

Volcano-Associated Hazards

A number of hazards are associated with volcanoes (**Figure 2-46**). In general, volcanic hazards are commonly divided into those that occur in proximal (near the volcano) and distal (far from the volcano) hazard zones. In the distal hazard zone, volcanic activity includes lahars (volcanic mudflows or debris flows) and fallout of ash; in the proximal hazard zone, activity can be much more devastating and includes rapidly moving pyroclastic flows (glowing avalanches), lava flows, and landslides. Each eruption is a unique combination of hazards. Not all hazards will be present in all eruptions, and the degree of damage will vary. It is important to know that during an active period for a volcano many individual eruptions may occur and each eruption can vary in intensity and length. For example, while Mount St. Helens is best known for its catastrophic May 1980 eruption, periodic eruptions of steam and ash and the growth of a central lava dome have continued to pose a hazard since that time.

Figure 2-46. Potential Hazards at a Stratovolcano



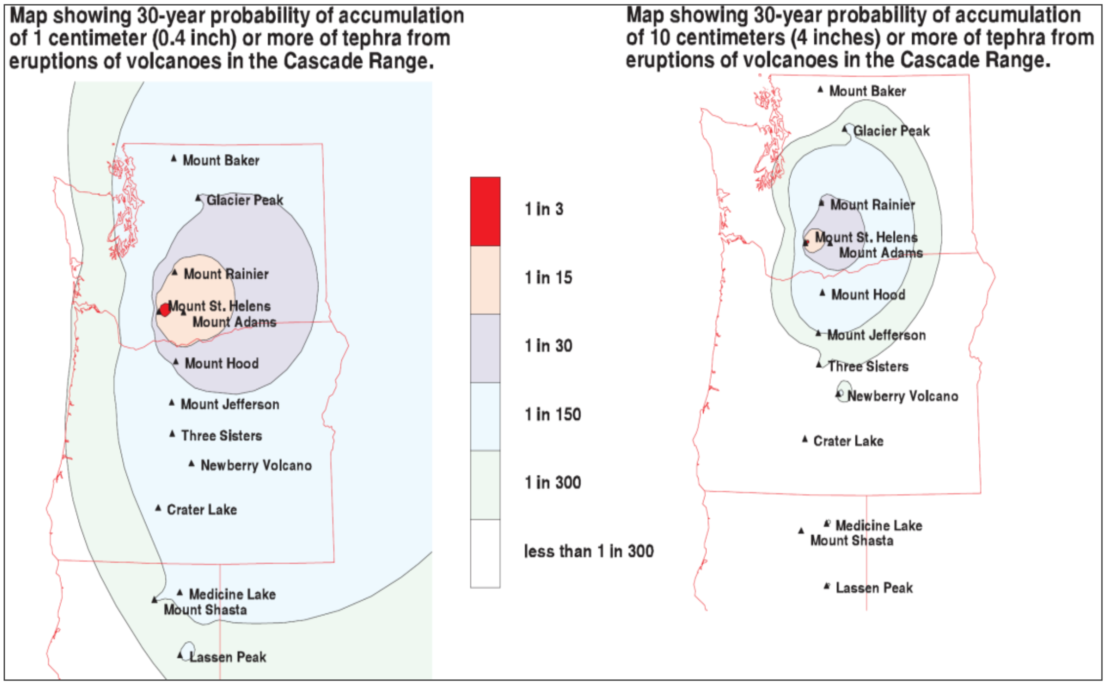
Source: Myers et al. (1997)

Eruptive Hazards

ASHFALL

Dust-sized ash particles are the by-products of many volcanic eruptions. Ash, when blown into the air, can travel large distances causing significant problems for distal hazard zones. During ash-dominated eruptions, deposition is largely controlled by the prevailing wind direction. The predominant wind pattern over the Cascade Range is from the west to the east. Previous eruptions documented in the geologic record indicate most ashfall drifting to and settling in areas to the east of the Cascade volcanoes. The probable geographic extent of volcanic ashfall from select volcanic eruptions in the Pacific Northwest is shown in **Figure 2-47**.

Figure 2-47. Probable Geographic Extent of Volcanic Ashfall from Select Volcanic Eruptions in the Pacific Northwest



Source: Scott et al. (1997)

Within a few miles of the vent, the main ashfall hazards to man-made structures and humans include high temperatures, being buried, and being hit by falling fragments. Within 10–12 miles, hot ashfall may set fire to forests and flammable structures.

Structural damage can also result from the weight of ash, especially if it is wet. Four inches of wet ash may cause buildings to collapse. Accumulations of a half inch of ash can impede the movement of most vehicles, disrupt transportation, communication, and utility systems, and cause problems for human and animal respiratory systems. It is extremely dangerous for aircraft, particularly jet planes, as volcanic ash accelerates wear to critical engine components, can coat exposed electrical components, and erodes exposed structure. Ashfall may severely decrease visibility, or even cause darkness, which can further disrupt transportation and other systems. Recent work by the Volcano Hazards Group of the U.S. Geological Survey has attempted to rank the relative hazard of volcanoes in North America. According to this study, Oregon has four Very High Threat Volcanoes: Crater Lake, Mount Hood, Newberry Volcano, and South Sister (Ewert et al., 2005).

Ashfall can severely degrade air quality and trigger health problems. In areas with considerable ashfall, people with breathing problems might need additional services from doctors or emergency rooms. In severe events an air quality warning could be issued, informing people with breathing problems to remain inside

Ashfall can create serious traffic problems as well as road damage. Vehicles moving over even a thin coating of ash can cause clouds of ash to swell. This results in visibility problems for other drivers, and may force road closures. Extremely wet ash creates slippery and hazardous road conditions. Ash filling roadside ditches and culverts can prevent proper drainage and cause shoulder erosion and road damage. Blocked drainages can also trigger debris flows if the blockage causes water to pool on or above susceptible slopes. Removal of ash is extremely difficult as traditional methods, such as snow removal equipment, stir up ash and cause it to continually resettle on the roadway.

LAHARS

Cascade Range volcanoes and the floodplains that drain them contain abundant evidence for past lahar events. Lahars or volcanic debris flows are water-saturated mixtures of soil and rock fragments originating from a volcano. These sediment gravity flows can travel very long distances (over 62 mi) and travel as fast as 50 mi per hour in steep channels close to a volcano; further downstream, where they reach gently sloping valley flows speeds generally slow to 10 to 20 mi per hour. The largest of these flows are known to transport boulders exceeding 30 ft in diameter. Lahars are often associated with eruptions, but they can also be generated by rapid erosion of loose rock during heavy rains or by sudden outbursts of glacial water. Highly erodible, unconsolidated lahar deposits may be easily remobilized by normal rainfall, snowmelt, and streams for years after their deposition.

Hazards associated with lahars include direct impact and burial by the advancing flow (**Figure 2-48**), burial of valuable infrastructure or agricultural land, and secondary flooding due to temporary damming and breakouts along tributary streams. Because of their relatively high viscosity, lahars can move, or even carry away, vehicles and other large objects such as bridges. Municipalities, industries, and individuals who take their water from streams affected by lahars may have water quality and/or quantity issues. Wildlife could be adversely affected by changes in streams, including the deposition of debris in streambeds and floodplains. For example, salmonids trying to spawn could find it impossible to swim upstream. Long-term drainage pattern alteration and increased sedimentation rates downstream may persist for decades following such an event.

Figure 2-48. Trees Buried in Volcanic Sediment, Sandy River, Oregon

Note: Trunks of forest trees, initially growing on a terrace above the Sandy River (Oregon) at Oxbow Regional Park, were buried by rapid deposition of sediment following a dome-building eruption at Mount Hood in 1781. Erosion during a flood about a week before the photo was taken exposed this "ghost forest."

Photo source: T.C. Pierson, U.S. Geological Survey, 1/15/2009

Lava Flows

Lava flows are streams of molten rock that erupt relatively non-explosively from a volcano and move downslope. Hazards associated with lava flow events include ashfalls near vents; extensive damage or total destruction of objects in the lava flow path(s) by burning, crushing, or burial; and disruption of local stream drainages. Lava flows are generally not life threatening because people can usually outwalk or outrun them. The Parkdale Lava Flow, located along the north flank of Mount Hood, erupted from a small vent about 7,600 years ago (**Figure 2-49**).

Figure 2-49. Oblique Air-View of the Parkdale Lava Flow

Note: The flow erupted around 7,600 years ago from a small vent located about 6 miles south of Parkdale, Oregon.

Image source: Bill Burns, DOGAMI

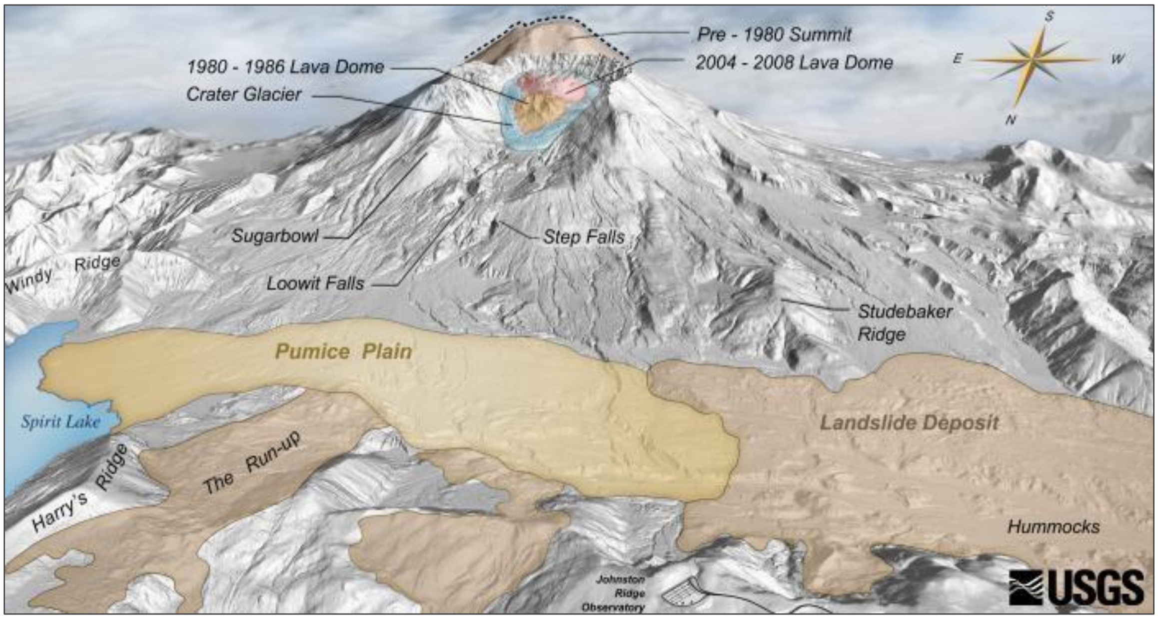
Pyroclastic Flow and Surges

Pyroclastic flows are avalanches of rock and gas at temperatures of 600 to 1,500 ˚F. They typically sweep down the flanks of volcanoes at speeds of up to 150 miles per hour. Pyroclastic surges are a more dilute mixture of gas and rock. They can move even more rapidly than a pyroclastic flow and are more mobile. Both generally follow valleys, but surges especially may have enough momentum to overtop hills or ridges. 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 composed of a combination of ash, pumice, and rock fragments. These deposits may accumulate to hundreds of feet thick and can harden to a resistant rock called tuff. Pyroclastic flows and surges are considered a proximal hazard, but in some instances may extend tens or even hundreds of miles from the volcanic vent.

Landslides

Because the stratovolcanoes that form the Cascade Mountains are composed of layers of weak fragmented rock and lava, they are prone to landslides. Landslides range in size from small to massive summit or flank failures like the one in May 1980 at Mount St Helens (**Figure 2-50**). They may be triggered by volcanic activity or during times of excessive rainfall or snowmelt. Speeds of movement range from slow creep to more catastrophic failure. If enough water is incorporated into the material, the failure will become a lahar.

Figure 2-50. Mount St. Helens



Source: USGS, Geology and history summary for Mount St. Helens,
http://volcanoes.usgs.gov/volcanoes/st_helens/st_helens_geo_hist_101.html

Non-Eruptive Hazard

EARTHQUAKES

Earthquake effects are a significant threat along the Cascade Mountains and come from three main sources: the CSZ, crustal faults, and volcanic activity. The CSZ is generally over 150 miles away, but it produces earthquakes as a large as M9.0 every 240 to 500 years. Crustal earthquakes occur in the North American plate at relatively shallow depths of approximately 6 to12 miles below the surface. However, some can rupture through the surface. The distance from a potentially active fault is critical to the evaluation of the earthquake shaking hazard. Volcanic earthquakes are usually small and frequent, but they can be as large as or larger than the M4.5 earthquake on Mount Hood in 2002. During 2002, a swarm of earthquakes ranging from M3.2 to M4.5 occurred on the southeast flank of Mount Hood. The damaging effects of all three kinds of earthquakes can be enhanced by amplification of shaking in soft soils, liquefaction, or induced landslides.

FLOOD AND CHANNEL MIGRATION

The relatively high elevation of volcanoes usually results in the meteorological affect called orographic lifting, which causes high precipitation and snow on the mountains. The result can be very high levels of rainfall and/or rapid snowmelt that can result in flooding.

Floods cause damage to assets through inundation of water and by erosion and deposition of soil and/or large objects. Defining the hazard associated with inundation by flooding is done by calculating the area that is likely to be flooded during different levels of flooding. Larger floods are less frequent than smaller floods, so flood levels may be defined by their return period. The longer the return period, the deeper the flood waters, and hence the larger the area that is inundated. Some common return periods used in flood hazard mapping include 10-year, 25-

year, 100-year, and 500-year floods. Most flooding on Cascade Range volcanoes occurs when heavy, warm rain during large winter or spring storms falls on accumulations of low-elevation snow. Channel migration hazards can occur slowly, for example, by continuous erosion along a cutbank meander and deposition onto a point bar during high flows, or very rapidly during storm events through avulsion or rapid abandonment of the current river channel for a new one. Such rapid migration can not only destroy structures but even remove the land beneath structures.

For more information on flooding and channel migration zones see the **Flood** section.

LANDSLIDES

The general term landslide refers to a range of geologic events including rock falls, debris flows, earth slides, and other mass movements. Most landslides that occur on volcanoes are large deep-seated landslide complexes or debris flows. Deep-seated landslides have failure surfaces usually tens of feet below the surface and can cover large areas from acres to square miles. These types of landslides tend to move relatively slowly, but they can lurch forward if shaken by an earthquake or if disturbed by removal of material from the toe, by addition of material to the head, or by addition of water into the slide mass. Debris flows tend to initiate in the upper portion of a drainage, picking up water, sediment, and speed as they come down the drainage. As they reach the mouth of the confined/steep portion of the drainage, they tend to spread out and deposit the majority of the material, generally creating a fan. Debris flows are also commonly initiated by other types of landslides that occur on slopes near a channel. They can also initiate within the channel in areas of accelerated erosion during heavy rainfall or snowmelt.

Characterization of Individual Volcanoes

The history of volcanic activity in the Cascade Range is contained in its geologic record. The ages, eruptive history, and hazards associated with each volcano vary considerably. Cascade volcanoes may be characterized by intermittent periods of activity, followed by longer periods of relative quiescence. The incompleteness of eruptive records, even at relatively well-studied volcanoes, makes prediction of probability and recurrence intervals of future eruptions difficult to determine. **Table 2-20** lists Cascade Volcanoes in southwest Washington and Oregon that can affect Oregon communities. The discussion that follows further details those volcanic centers from **Table 2-20** for which the U.S. Geological Survey has developed hazard assessments and ranked as having a high to very high threat potential. Threat potential is described as very high, high, moderate, low, or very low based upon eruption history, distance to population centers, and potential impacts to aviation (Ewert et al., 2005). From north to south these high-threat volcanoes are: Mount St. Helens (Wolfe and Pierson, 1995), Mount Adams (Scott et al., 1995), Mount Hood (Scott et al., 1997; Burns et al., 2011b), Mount Jefferson (Walder et al., 1999), the Three Sisters Region (Scott et al., 2001), Newberry Volcano (Sherrod et al., 1997), and Crater Lake (Bacon et al., 1997). Digital hazard data for some of these volcanoes have been produced by Schilling (1996); Schilling et al. (1997), Schilling et al. (2008a,b, c). For a detailed inventory of each volcano's history and hazards, please refer to the appropriate report referenced above or **Table 2-20**. Further information can also be obtained from the U.S. Geological Survey Cascade Volcano Observatory at http://volcanoes.usgs.gov/observatories/cvo/.

Table 2-20. Prominent Volcanoes in the Cascade Range of Oregon and Southwest Washington

Volcano Name	Elevation	Volcano Type	Most Recent Eruptions	USGS Threat Potential	Nearby Towns	Remarks/Hazard Study
Mount St. Helens (Washington)	8,363 ft	strato-volcano	1980–1986; 2004–2008	high to very high	Portland, Castle Rock (Washington), Olympia (Washington), Vancouver (Washington), Yakima (Washington)	major explosive eruption and debris avalanche in 1980; widespread ashfall; Wolfe and Pierson (1995)
Mount Adams (Washington)	12,277 ft	strato-volcano	about 520,000 to 1,000 YBP	high to very high	Portland, Hood River, Vancouver (Washington), Yakima (Washington)	numerous eruptions in last 15,000 year; major debris avalanches effecting White Salmon River at 6,000 and 300 YBP; Scott et al. (1995)
Mount Hood	11,240 ft	strato-volcano	1760–1865	high to very high	Portland, Sandy, Welches, Brightwood, Parkdale, Hood River	pyroclastic flows in the Upper White River drainage; lahars in Old Maid Flat; lava dome at Crater Rock; steam explosions; Scott et al. (1997); Schilling et al. (2008a)
Mount Jefferson	10,495 ft	strato-volcano	280,000 to 15,000 YBP	low to very low	Idanha, Detroit, Warm Springs, Madras, Lake Billy Chinook	potentially active and capable of large explosive eruptions; recent history of lava domes, small shields, and lava aprons; Walder et al. (1999); Schilling et al. (2007).
Mount Washington	7,796 ft	mafic volcano		low to very low		no hazard study
North Sister	10,085 ft	mafic volcano	300,000 to 120,000 YBP	high to very high	Sisters, Bend, Redmond, Sunriver, La Pine, Blue River, McKenzie Bridge, Vida, Springfield	deep glacial erosion; ashfall, pyroclastic flows, lava flows and domes, and lahars; Scott et al. (2001); Schilling et al. (2008c)
Middle Sister	10,047 ft	strato-volcano	about 40,000 to 14,000 YBP	high to very high	Sisters, Bend, Redmond, Sunriver, La Pine, Blue River, McKenzie Bridge, Vida, Springfield	potentially active, capable of large explosive eruptions, ashfall, pyroclastic flows, lava flows and domes, and lahars; Scott et al. (2001); Schilling et al. (2008c)

Volcano Name	Elevation	Volcano Type	Most Recent Eruptions	USGS Threat Potential	Nearby Towns	Remarks/Hazard Study
South Sister	10,358 ft	strato-volcano	about 50,000 to 2,000 YBP	high to very high	Sisters, Bend, Redmond, Sunriver, La Pine, Blue River, McKenzie Bridge, Vida, Springfield	potentially active, capable of large explosive eruptions, ashfall, pyroclastic flows, lava flows and domes, and lahar; most silicic of the cones in the Three Sisters complex; phase of uplift started in 1997 within a broad area about 6 km west of South Sister; Scott et al. (2001); Schilling et al. (2008c)
Broken Top	9,152 ft	strato-volcano	300,000–100,000 YBP	low to very low	Bend, Sunriver, La Pine	deep glacial erosion; lava flows, pyroclastic flows, ashfall; no hazard study
Mount Bachelor	9,068 ft	mafic volcano	about 18,000 to 7,700 YBP	moderate	Bend, Sunriver, La Pine	lava flows and near vent cinder and ashfall; no hazard study
Newberry Volcano	7,986 ft	shield volcano/ caldera	about 400,000 to 1,300 YBP	high to very high	Bend, Sunriver, La Pine	potentially active and capable of large explosive eruptions; lava flows and near vent cinder and ashfalls; present-day hot springs; Sherrod et al. (1997); Schilling et al. (2008b)
Mount Thielsen	9,187 ft	shield volcano	> 250,000	low to very low	Chemult	Deep glacial erosion; Lava flows, pyroclastic eruptions; no hazard study.
Crater Lake Caldera (Mount Mazama)	8,159 ft	caldera	about 420,000 to 7,700 YBP	high to very high	Grants Pass, Roseburg, Chemult, La Pine, Fort Klamath, Chiloquin, Klamath Falls	lava flows, pyroclastic flows, ashfall; source of the widespread Mazama ash; Bacon et al. (1997)
Mount McLaughlin	9,496 ft	strato-volcano	>80,000 YBP	low to very low	Medford, Grants Pass, Klamath Falls	lava flows, pyroclastic flows; no hazard study

Note: YBP is years before present.

Sources: U.S. Geological Survey, Cascades Volcano Observatory: http://volcanoes.usgs.gov/observatories/cvo/;
Wolfe and Pierson (1995); Scott et al. (1995, 1997, 2001); Sherrod et al. (1997); Bacon et al. (1997); Walder et al. (1999)

Mount St. Helens (Washington)

The May 18, 1980, eruption of Mount St. Helens is the best-known example of volcanism to most Oregonians. That eruption included a debris avalanche, as part of the volcanic edifice collapsed (**Figure 2-50**). This caused a lateral blast of rock, ash, and gas that devastated areas to the north of the volcano. Lahars rushed down the Toutle and Cowlitz River valleys, reaching the Columbia River and halting shipping for some time. All other river valleys on the volcano experienced smaller lahars. Pyroclastic flows devastated an area up to five miles north of the volcano. Ashfall deposits affected people as far away as Montana, and ash circled the earth in the upper atmosphere for over a year.

Except for the debris avalanche and lateral blast, the events of this eruptive period are typical of a Mount St. Helens eruption and can be expected to occur again (**Table 2-20**). The primary hazards that will affect Oregonians are ashfall and lahars that affect the Columbia River. Since the major eruptive activity in the early 1980s, Mount St. Helens has experienced two episodes of dome building activity. The latest activity lasted from 2004 until 2008. Another eruption from Mount St. Helens is very likely in the near future.

Mount Adams (Washington)

Mount Adams, located 35 miles north of Hood River, Oregon, is the largest active volcano in Washington State and among the largest in the Cascade Range (**Table 2-20**). The volcano was active from about 520,000 to about 1,000 years ago. Eruptions from Mount Adams within the last 500,000 years have mainly consisted of effusive lava flows; highly explosive events are rare in the geologic record of Mount Adams. Eruptions have also occurred from 10 vents in the vicinity of Mount Adams since the last period of glaciation about 15,000 years ago. Approximately 6,000 and 300 years ago, debris avalanches from the southwest face of Mount Adams generated clay-rich lahars that traveled down the White Salmon River. The summit of Mount Adams contains a large section of unstable altered rock that can spawn future debris avalanches and lahars.

Potential hazards from Mount Adams include lava flows near the central vent area and lahars that could reach and disrupt the Columbia River channel. Such lahars may have little or no advanced warning.

Mount Hood

The last major eruption of Mount Hood occurred in approximately 1781 (232 years ago) (**Table 2-20** and **Table 2-21**). The Sandy River that drains the volcano's northwest side was originally named the Quicksand River by Lewis and Clark, who traversed the area only a couple of years after an eruption. Lahars had filled the river channel with debris, much of which has now been scoured away. There were two other minor periods of eruptions during the last 500 years, the last in the mid-1800s. Typically, these involved lava flows near the summit, pyroclastic flows, and lahars but little ashfall. From its recent eruptive history, the volcano is most likely to erupt from the south side, but planning should be done assuming eruptions could be centered anywhere on the mountain. A large eruption could generate pyroclastic flows and lahars that could inundate the entire length of the Sandy and White River valleys. An eruption from the north flank could affect the Hood River Valley.

Due to its proximity to the Portland Metro area, major east-west highways, the Bull Run Reservoir (which supplies water to a majority of Portland area residents), and ski and summer recreation areas, Mount Hood poses the greatest potential volcanic hazard to Oregonians. In addition, a large volume of debris and sediment in lahars could affect shipping lanes in the Columbia River and operation of Bonneville and The Dalles dams.

In recent years, numerous debris flows caused by winter storms have flowed down river drainages. OR-35 is periodically closed for repair work after these events damaged the bridge over the White River. If a volcanic event occurred, the same drainages would be affected.

Table 2-21. Notable Geologic Events near Mount Hood

Date or Age	Event	Deposits
A.D. 1859, 1865, 1907?	minor explosive eruptions of Mount Hood	scattered pumice
late 19th century	late neoglacial advance	prominent, sharp-crested moraines
late 18th century	Old Maid eruptive period	lava dome, pyroclastic-flow and lahar deposits, tephra
about 500 years ago	debris flows in Zigzag River	debris-flow deposits
1,000 years ago	debris flows in upper Sandy River	debris-flow deposits
1,500 years ago	Timberline eruptive period	lava dome, pyroclastic-flow and lahar deposits, tephra
7,700 years ago	eruptions from vent near Parkdale; Mount Mazama ashfall	Basaltic andesite of Parkdale lava flow; about 5 cm of Mazama ash
11,000 to 20,000 years ago	waning phases of Evans Creek glaciation	moraines
13,000 to 20,000 years ago	Polallie eruptive period	lava domes, pyroclastic-flow and lahar deposits, tephra
20,000 to 25,000 years ago	maximum of Evans Creek glaciation	belts of moraines in most valleys
20,000 to 30,000 years ago	Mount Hood dome eruptions	lava domes, pyroclastic-flow and lahar deposits
30,000(?) to 50,000(?) years ago	Mount Hood lava-flow eruptions	andesite lava flows of Cathedral Ridge and Tamanawas Falls

Source: Bill Burns, DOGAMI, modified from Scott et al. (1997b)

MOUNT JEFFERSON

Mount Jefferson is located in a relatively unpopulated part of the Cascade Range. The last eruptive episode at Mount Jefferson was about 15,000 years ago. Research at stratovolcanoes around the world indicates that Mount Jefferson should be regarded as dormant, not extinct.

The steep slopes of the volcano provide the setting for possible debris flows and lahars, even without an eruption. These would be confined to valleys, generally within 10 miles of the volcano.

A major eruption, however unlikely in the short term, could generate pyroclastic flows and lahars that would travel up to a few dozen miles down river valleys. Two reservoirs could be affected by pyroclastic flows from a major eruption: Detroit Lake and Lake Billy Chinook. An explosive eruption could spew ash for hundreds of miles in the downwind direction.

Many smaller volcanoes are located between Mount Jefferson and Mount Hood to the north and Three Sisters to the south. Eruptions from any of these would be primarily erupt *cinders* and ash to form cinder cones.

Three Sisters Region

North Sister has probably been inactive for at least 100,000 years (**Table 2-20**). Middle Sister last erupted between 25,000 and 15,000 years ago. South Sister had a very small ongoing uplift, which began in 1996 and became undetectable by 2003. The uplift was about one inch a year and likely indicated movement of a small amount of magma. At this writing, there is no indication that the uplift will ever develop into a volcanic eruption. However, that possibility cannot be ruled out. Hence, the Cascade Volcano Observatory has increased their monitoring of the area over the past several years.

Future eruptions at South Sister (and possibly Middle Sister) are likely to include lava flows, pyroclastic flows, and lahars. The possibility exists for lahars to travel many miles down valley floors, if an eruption melts a large amount of snow and ice. Ashfall would likely be contained within 20 miles of the vent.

Newberry Volcano

Newberry Volcano, unlike the stratovolcanoes of the Cascade Range, is a shield volcano with broad, relatively gently sloping flanks composed of stacked basaltic lavas flows (**Table 2-20**). The volcano is about 400,000 years old and has had thousands of eruptions both from the central vent area and along its flanks. The present 4 by 5 mi wide caldera at Newberry Volcano's summit formed about 75,000 years ago by a major explosive eruption and collapse event. This was the most recent of at least three caldera-forming eruptions that lofted pumice and ash high into the air and spread pyroclastic flows across the volcano's surface. The most recent eruption was 1,300 years ago when the "Big Obsidian Flow," a glassy rhyolitic lava flow, erupted within the caldera. Future eruptions are likely to include lava flows, pyroclastic flows, lahars, and ashfall. Newberry Volcano has attracted interest for its geothermal potential. The heat under the volcano, with temperatures in some areas in excess of 509 ˚F, is evidence that it is only dormant.

Crater Lake Caldera

About 7,700 years ago, Mount Mazama erupted with great violence, leaving the caldera that Crater Lake now occupies (**Table 2-20**). Layers of ash produced from that eruption have been found in eight western states and three Canadian provinces. The countryside surrounding Crater Lake was covered by pyroclastic flows. Wizard Island is the result of much smaller eruptions since that cataclysm. The most recent eruption was about 5,000 years ago and occurred within the caldera. No eruptions have occurred outside the caldera since 10,000 years ago.

This potentially active volcanic center is contained within Crater Lake National Park. The western half of the caldera is considered the most likely site of future activity. Effects from volcanic activity (e.g., ashfall, lava flows) are likely to remain within the caldera. If an eruption occurs outside the caldera, pyroclastic flows and lahars could affect valleys up to a few dozen miles from the erupting vent. The probability of another caldera-forming eruption is very low, as is the probability of eruptions occurring outside the caldera.

Other Volcanic Areas of Oregon

On the scale of geologic time, volcanic eruptions may occur in other parts of Oregon. However, on a human time scale, the probability of an eruption outside the Cascades is so low as to be negligible.

Although the high, snow-topped mountains of the Cascades are Oregon's most visible volcanoes, other potential eruptive centers exist. These include smaller peaks, such as the

Belknap shield volcano in central Oregon, which had a lava flow about 1,400 years ago. Several smaller volcanoes, including Diamond Craters and Jordan Craters, in the High Lava Plains of southeast Oregon have experienced recent eruptions in the last 7,000 years. Generally non-explosive eruptions at these sites have built complexes of lava flow fields and cinder cones. Hazards associated with future eruptions in sparsely populated southeast Oregon would most likely include lava flows covering many square miles; ash and volcanic gases derived from these eruptions may be regionally significant.

Historic Volcanic Events

Table 2-22. Historic Volcanic Events in Oregon over the Last 20,000 Years

Date	Location	Description
about 18,000 to 7,700 YBP	Mount Bachelor, central Cascades	cinder cones, lava flows
about 20,000 to 13,000 YBP	Polallie Eruptive episode, Mount Hood	lava dome, pyroclastic flows, lahars, tephra
about 13,000 YBP	Lava Mountain, south-central Oregon	Lava Mountain field, lava flows
about 13,000 YBP	Devils Garden, south-central Oregon	Devils Garden field, lava flows
about 13,000 YBP	Four Craters, south-central Oregon	Four Craters field, lava flows
about 7,780 to 15,000 YBP	Cinnamon Butte, southern Cascades	basaltic scoria cone and lava flows
about 7,700 YBP	Crater Lake Caldera	formation of Crater Lake caldera, pyroclastic flows, widespread ashfall
about 7,700 YBP	Parkdale, north-central Oregon	eruption of Parkdale lava flow
<7,000 YBP	Diamond Craters, eastern Oregon	lava flows and tephra in Diamond Craters field
< 7,700 YBP; 5,300 to 5,600 YBP	Davis Lake, southern Cascades	lava flows and scoria cones in Davis Lake field
about 10,000 to <7,700 YBP	Cones south of Mount Jefferson; Forked Butte and South Cinder Peak	lava flows
about 4,000 to 3,000 YBP	Sand Mountain, central Cascades	lava flows and cinder cones in Sand Mountain field
< 3,200 YBP	Jordan Craters, eastern Oregon	lava flows and tephra in Jordan Craters field
about 3,000 to 1,500 YBP	Belknap Volcano, central Cascades	lava flows, tephra
about 2,000 YBP	South Sister Volcano	rhyolite lava flow
about 1,500 YBP	Timberline eruptive period, Mount Hood	lava dome, pyroclastic flows, lahars, tephra
about 1,300 YBP	Newberry Volcano, central Oregon	eruption of Big Obsidian flow
about 1,300 YBP	Blue Lake Crater, central Cascades	Spatter cones and tephra
1760–1810	Crater Rock/Old Maid Flat on Mount Hood	pyroclastic flows in upper White River; lahars in Old Maid Flat; dome building at Crater Rock
1859/1865	Crater Rock on Mount Hood	steam explosions/tephra falls
1907 (?)	Crater Rock on Mount Hood	steam explosions
1980	Mount St. Helens (Washington)	debris avalanche, ashfall, flooding on Columbia River
1981–1986	Mount St. Helens (Washington)	lava dome growth, steam, lahars
1989–2001	Mount St. Helens (Washington)	hydrothermal explosions
2004–2008	Mount St. Helens (Washington)	lava dome growth, steam, ash

Note: YBP is years before present.

Sources: U.S. Geological Survey, Cascades Volcano Observatory: http://volcanoes.usgs.gov/observatories/cvo/;
Wolfe and Pierson (1995); Sherrod et al. (1997); Scott et al. (1997, 2001); Bacon et al. (1997); Walder et al. (1999)

Probability

Geologists can make general forecasts of long-term volcanic activity from careful characterization of past activity, but they cannot supply a timeline. Several U.S. Geological Survey open-file reports provide the odds of certain events taking place at particular volcanoes. However, the U.S. Geological Survey stresses that government officials and the public must realize the limitations in forecasting eruptions and be prepared for such uncertainty.

Short-range forecasts, on the order of months or weeks, are often possible. There are usually several signs of impending volcanic activity that may lead up to eruptions. The upward movement of magma into a volcano prior to an eruption generally causes a significant increase in small, localized earthquakes and an increase in emission of carbon dioxide and compounds of sulfur and chlorine that can be measured in volcanic springs and the atmosphere above the volcano. Changes in the depth or location of magma beneath a volcano often cause changes in elevation. These changes can be detected through ground instrumentation or remote sensing. This, in fact, was how the South Sister Bulge uplift was discovered).

The Cascades Volcanic Observatory (CVO) employs scientists from a range of disciplines to continually assess and monitor volcanic activity in the Cascade Ranges. If anomalous patterns are detected (for example, an increase in earthquakes), CVO staff coordinate the resources necessary to study the volcano.

Wildfires

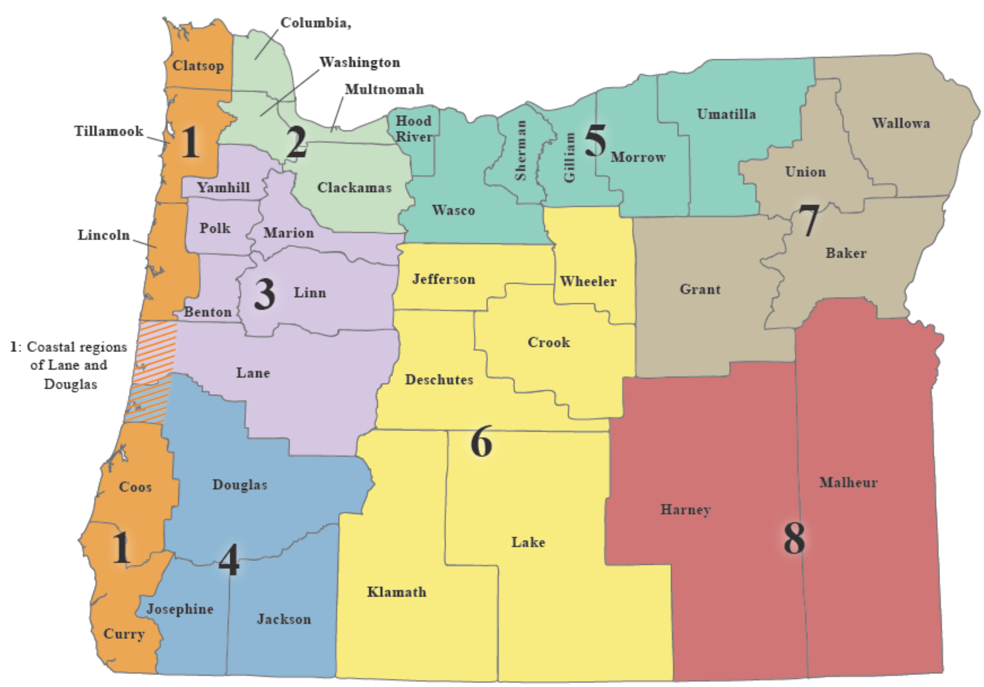
Wildfires are a common and widespread natural hazard in Oregon; the state has a long and extensive history of wildfire. A significant portion of Oregon's forestland is dominated by ecosystems dependent upon fire for their health and survival. In addition to being a common, chronic occurrence, wildfires frequently threaten communities. These communities are often referred to as the "wildland-urban interface" (WUI), the area where structures and other human development meet or intermingle with natural vegetative fuels.

Oregon has in excess of 41 million acres (more than 64,000 square miles) of forest and rangeland that is susceptible to damage from wildfire. In addition, significant agricultural areas of the Willamette Valley, north central, and northeastern Oregon grow crops such as wheat that are also susceptible to damage by wildfire.

Wildfires occur throughout the state and may start at any time of the year when weather and fuel conditions combine to allow ignition and spread.

The majority of wildfires take place between June and October, and primarily occur in Oregon NHMP Natural Hazard Regions 4, 5, 6, and 7 (**Figure 2-51**). However, even areas classified as low or moderate are susceptible to wildfires if the right combination of fuels, weather, and ignition conditions exist. Historically, Oregon's largest wildfires have burned in the Coast Range (Regions 1 and 2) where the average rainfall is high, but heavy fuel loads created low-frequency, high-intensity fire environment during the dry periods.

Figure 2-51. Oregon NHMP Natural Hazard Regions



According to OEM, extreme winds are experienced in all of Oregon's eight regions. The most persistent high winds occur along the Oregon Coast and the Columbia River Gorge. The Columbia River Gorge is the most significant east-west gap in the mountains between California and Canada. It serves as a funnel for east and west winds, where direction depends solely on the pressure gradient. Once set in motion, the winds can attain speeds of 80 mph. Wind is a primary factor in fire spread, and can significantly impede fire suppression efforts.

Historically, 70% of the wildfires suppressed on lands protected by the Oregon Department of Forestry (ODF) result from human activity. The remaining 30% result from lightning. Typically, large wildfires result primarily from lightning in remote, inaccessible areas.

El Niño Southern Oscillation and Wildfire Hazards

El Niño winters can be warmer and drier than average in Oregon. This often leads to an increased threat for large wildfires the following summer and autumn.

ODF's analysis of large fire potential is nearly complete: 12 of 14 identified Fire Danger Rating Areas have completed their analysis. These analyses will be reevaluated annually based on each year's weather and fire occurrence data. State firefighting agencies will continue to monitor correlations between seasonal weather conditions and wildfire occurrences and severity to refine planning tools for fire seasons and to aid in the pre-positioning of firefighting resources to reduce the vulnerability posed by large wildfires to natural resources and structures.

Source: Oregon Department of Forestry

According to a University of Oregon study, The Economic Impacts of Large Wildfires, conducted between 2004 and 2008, the financial and social costs of wildfires impact lives and property, as well as the negative short and long-term economic and environmental consequences they cause.

Life safety enhancement and cost savings may be realized by appropriate mitigation measures, starting with coordinated fire protection planning by local, state, tribes, federal agencies, the private sector, and community organizations. Additionally, and often overlooked, is the role that individual WUI property owners play in this coordinated effort.

Wildfire suppression costs escalate dramatically when agencies must adjust suppression tactics to protect structures. The cost of mobilizing personnel and equipment from across the state is significant. Non-fire agencies may also incur costs for providing or supporting evacuations, traffic control, security, public information, and other services during WUI fire incidents. These costs vary widely and have not been well documented.

The number of people living in Oregon's WUI areas is increasing. Where people have moved into these areas, the number of wildfires has escalated dramatically. Many people arriving from urban settings expect an urban level of fire protection. The reality is many WUI homes are located in portions of the state with limited capacity for structural protection and sometimes no fire protection whatsoever. Many Oregon communities (incorporated and unincorporated) are within or abut areas subject to serious wildfire hazards. In Oregon, there are about 240,000 homes worth around $6.5 billion within the WUI which has greatly complicated firefighting efforts and significantly increased the cost of fire suppression. While Oregon's Emergency Conflagration Act helps protect WUI communities that have depleted their local resources when threatened by an advancing wildfire, the escalating number of fires has led to the recognition that citizens in high fire risk communities need to provide mitigation and an appropriate level of local fire protection. Oregon's seller disclosure law requires a statement of whether or not property is classified as forestland-urban interface. Collaboration and coordination is ongoing among several agencies to promote educational efforts through programs like Firewise, the Oregon Forestland-Urban Interface Fire Protection Act, and Fire Adapted Communities from the National Cohesive Wildfire Strategy.

Increasing construction in vulnerable areas increases risk for vulnerable populations. Oregon's Goal 4 and Goal 7 play critical roles in guiding development in these areas. Measures to enhance life safety enhancement and save costs include Community Wildfire Protection Plans (CWPPs), coordinated fire protection planning, and coordination by local, state, tribal, federal agencies, the private sector, and community organizations. Many local communities incorporate their CWPPs into their Local Natural Hazards Mitigation Plans (LNHMPs).

Wildfire mitigation discussions are focused on reducing overabundant, dense forest fuels, particularly on public lands. The Healthy Forest Restoration Act aims to create fuel breaks by reduce overly dense vegetation and trees. It provides funding and guidance to reduce or eliminate hazardous fuels in National Forests, improve forest fire fighting, and research new methods to reduce the impact of invasive insects.

Oregon's efforts in and near WUI areas are massive, and are resulting in improvements. Sustaining the work over the many years it takes requires a substantial, ongoing financial commitment. Progress is often challenging because fuel mitigation methods are not universally accepted and are often controversial. However, recurring WUI fires continue to bring the issue into public focus as well as unite communities and stakeholders in a common set of objectives.

Analysis and Characterization

History of Wildfire

Wildfires have been a feature of the Oregon landscape for thousands of years. Prehistoric fires resulted from lightning and from the practices of Native Americans. The Blue Mountains in northeastern Oregon were named so by early immigrants because of the existence of a perpetual, blue colored wildfire smoke haze that lingered over the region. Between 1840 and 1900, wildland fires burned at least two million acres of forestland in western Oregon. It is believed settlers caused many of these fires. Following the establishment of the U.S. Forest Service and Oregon Department of Forestry, in 1905 and 1911, respectively, an aggressive and coordinated system of fire prevention and suppression emerged. However, it took several decades before significant gains were made.

Major wildfires in 1933, 1939, 1945, and 1951 burned across more than 355,000 acres in the northern Coast Range and became known collectively as the "Tillamook Burn."

Better suppression and more effective fire prevention campaigns combined to reduce large wildfire occurrences following World War II. Suppression improvements included the establishment of organized and highly trained crews, which replaced the previous system of hiring firefighters on an as-needed basis. Additional improvement resulted from construction of an extensive system of forest roads, lookouts and guard stations, the use of aircraft for the detection of fires and the delivery of fire suppression retardant, the invention and modification of modern and efficient fire suppression equipment, and refinements in weather forecasting and fire reporting. Prevention benefited from war-era campaigns, which united prevention activities with patriotism, and birthed movements such as the Smokey Bear campaign and the Keep Oregon Green Association.

A pattern of frequent, large WUI fires emerged during the 1970s as people began flocking to more rural settings. Suburban growth increased and continued through the 1980s. This introduced substantially more structures into what had previously been wildland areas that historically depended on periodic fires to sustain a healthy forest ecosystem.

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. Project Wildfire is the community organization that facilitates, educates, disseminates and maximizes community efforts toward effective fire planning and mitigation.

Project Wildfire achieves its mission by:

- Developing long-term wildfire prevention and education strategies designed to reach an ever-changing community.
- Creating disaster 175 resistant communities through collaboration with community members and a network of specialized partners.
- Reducing the severity and amount of damage caused by wildfire in wildland urban interface (WUI) areas through hazardous fuels reduction programs.
- Reducing the impact of fuels reduction on the environment by recycling the woody biomass resulting from hazardous fuels reduction projects.

Source: Oregon Department of Forestry, Project Wildfire (http://www.projectwildfire.org/

By the early 1990s, frequent, destructive WUI fires had become a major concern of the State Forester, the State Fire Marshal, and the Oregon Legislature. By the mid-1990s, over 100 structures had been destroyed by wildfires. Thousands more had been threatened and suppression costs were increasing sharply. The same trends were occurring in surrounding states, at an even greater pace.

Oregon Forestland-Urban Interface Fire Protection Act

In 1988, following the very difficult and expensive fire season of 1987, Oregon developed "An Action Plan for Protecting Rural/Forest Lands from Wildfire." The work was funded by FEMA's Fire Suppression Assistance (FSA) Program. The action plan was updated in 1991 with an Awbrey Hall Fire Appendix, in response to a fire which burned 22 structures on the western fringe of Bend. The 1988 action plan and the 1991 update led to the Legislature's attachment of a Budget Note to ODF's 1995-1997 budget, which required an examination of the WUI situation and the development of *"…recommendations which may include…statutory changes on how to minimize the costs and risks of fire in the interface."* Spurred by the loss of additional homes during the 1996 Skeleton Fire, these recommendations became the basis for passage of the *Oregon Forestland-Urban Interface Fire Protection Act of 1997*.

The Act recognized that "…*forestland-urban interface property owners have a basic responsibility to share in a complete and coordinated protection system*..." In addition, during the 1990s, prevention and mitigation of WUI fires included enactment of the Wildfire Hazard Zone process and the inclusion of defensible space requirements in the land use planning process. Significant efforts were made to increase voluntary landowner participation, through aggressive awareness campaigns, such as FireFree, Project Wildfire, Project Impact, Firewise, and other locally driven programs.

Through the years, Oregon's wildfire suppression system continued to improve. Firefighters benefited from improved training, coordination, and equipment. Better interagency initial attack cooperation, the growth of private crew and fire engine wildfire suppression resources, formation of structural incident management teams, and regional coordination of fire suppression are additional examples of these continued improvements. Technology has improved as well with the addition of lightning tracking software and fire detection cameras to support or replace deteriorating lookout towers.

Nevertheless, the frequency of wildfires threatening WUI communities continues to underscore the need for urgent action. The summer of 2002 included 11 Emergency Conflagration Act incidents, with as many as five running concurrently. More than 50 structures burned and, at one point, the entire Illinois Valley in Josephine County seemed under siege from the Biscuit Fire, Oregon's largest wildfire on record. This wildfire threatened the homes of approximately 17,000 people, with over 4,000 homes under imminent evacuation alert. At almost 500,000 acres, it was the nation's largest wildfire of the year. The summer of 2013 once again brought to bear one of the worst fire season's in Oregon. For the first time since 1951, more than 100,000 acres burned on lands protected by the Oregon Department of Forestry. Five incident management teams were deployed in a period of three days following a dry lightning thunderstorm event in late July that sparked nearly 100 fires in southern Oregon from more than 300 lightning strikes. Another storm that passed over central and eastern Oregon in mid-August produced significant fires that threatened the communities of John Day and The Dalles. Since 1996, Oregon has had 62 declared Conflagrations under the Act. Oregon's mitigation efforts since 2002 have influenced a dramatic decrease in these types of fires, resulting in none to four per year through 2014. (See **Appendix 9.1.2** for more information on Conflagration Fires from 1996 to 2014.)

Types of Wildfire

Wildfires burn primarily in vegetative fuels located outside highly urbanized areas. Wildfires may be broadly categorized as agricultural, forest, range, or WUI fires.

Agricultural: Fires burning in areas where the primary fuels are flammable cultivated crops, such as wheat. This type of fire tends to spread very rapidly, but is relatively easy to suppress if adequate resources are available. Structures threatened are usually few in number and generally belong to the property owner. There may be significant losses in terms of agricultural products from such fires.

Forest: The classic wildfire; these fires burn in fuels composed primarily of timber and associated fuels, such as brush, grass, and logging residue. Due to variations of fuel, weather, and topography, this type of fire may be extremely difficult and costly to suppress. In wilderness areas these types of fires are often monitored and allowed to burn for the benefits brought by the ecology of fire, but also pose a risk to private lands when these fires escape these wilderness areas.

Range: Fires that burn across lands typically open and lacking timber stands or large accumulations of fuel. Such lands are used predominantly for grazing or wildlife management purposes. Juniper, bitter-brush, and sage are the common fuels involved. These fires tend to spread rapidly and vary from being easy to difficult to suppress. They often occur in areas lacking both wildland and structural fire protection services.

Wildland-urban interface (WUI): These fires occur in portions of the state where urbanization and natural vegetation fuels are mixed together. This mixture may allow fires to spread rapidly from natural fuels to structures and vice versa. Such fires are known for the large number of structures simultaneously exposed to fire. Especially in the early stage of WUI fires, structural fire suppression resources may be quickly overwhelmed, which may lead to the destruction of a large number of structures. Nationally, wildland interface fires have frequently resulted in catastrophic structure losses.

Secondary Hazards

Increased risk of landslides and erosion are secondary hazards associated with wildfires that occur on steep slopes. Wildfires tend to denude the vegetative cover and burn the soil layer creating a less permeable surface prone to sheetwash erosion. This - in turn - increases sediment load and the likelihood of downslope failure and impact.

Wildfires can also impact water quality (e.g., drinking water intakes). During fire suppression activities some areas may need coordinated efforts to protect water resource values from negative impact.

Wildfire smoke may also have adverse effects on air quality and visibility, and create nuisance situations. Strategies to limit smoke from active wildfires are limited, but interagency programs exist to alert the public of potential smoke impact areas where hazardous health or driving conditions may occur.

Source: Unknown

Common Sources of Wildfire

For statistical tabulation purposes, wildland fires are grouped into nine categories based on historically common wildfire ignition sources. Graphs displaying trends for some of these sources are located in **Appendix 9.1.3**.

Lightning: There are tens of thousands of lightning strikes in Oregon each year. Of the nine categories, lightning is the leading ignition source of wildfires. In addition, lightning is the primary cause of fires which require activation of Oregon’s Conflagration Act.

Equipment use: This source ranges from small weed eaters to large logging equipment; many different types of equipment may readily ignite a wildfire, especially if used improperly or illegally. Although fire agencies commonly limit or ban certain uses of fire-prone equipment, the frequency of fires caused by equipment has been trending upward in recent years. This increase may be related to the expansion of the wildland interface, which results in more people and equipment being in close proximity to forest fuels.

Railroad: Wildfires caused by railroad activity are relatively infrequent. In the early twentieth century, this had been a major cause of fires, but has been decreasing for many years. Over the past 10-year period, the number of railroad-caused fires has leveled out. In the past few decades, Oregon has responded to railroad-caused fires with aggressive fire investigation and cost recovery efforts. Oregon Department of Forestry works with the railroad on hazard abatement along tracks and requires water cars and chase vehicles during high fire danger. The resulting quick return to normal fire incidence showed that railroad fires are preventable.

Recreation: The trend in fires caused by people recreating in and near Oregon's forests has been rising over the past 10 years. This trend may reflect the state's growing population and as well as a greater interest in outdoor recreation opportunities.

Debris burning: Historically, debris burning activities have been a leading source of human-caused wildfires. Aggressive prevention activities coupled with increasing local burning bans during the wildfire season have begun to show positive results. Many debris burning fires occur outside of fire season, resulting in increased awareness during the spring and fall months.

Juvenile: The trend in the incidence of juveniles starting wildland fires is downward in recent years. This is attributed to concerted effort by local fire prevention cooperatives to deliver fire prevention messages directly to school classrooms and the Office of the State Fire Marshal's (OSFM's) aggressive youth intervention program. In 1999, according to the ODF, juveniles were reported to have started 60 wildland fires. Conversely, juveniles accounted for just 17 fires in 2013 and, on average, have only accounted for 25 fires per year over the last 10 years. Additionally, parents or guardians, under Oregon Law, are responsible for damages done by fires started by their children. ORS 30.765 covers the liability of parents; ORS 163.577 holds parents or guardians accountable for child supervision, ORS 477.745 makes parents liable for wildfire suppression costs of a fire by a minor child, and ORS 480.158 holds a parent liable for fireworks-caused fires. Additionally, parents may be assessed civil penalties.

Arson: Oregon experienced a rapid rise in the frequency of arson caused fires in the early '90s. 1992 was the worst fire season for arson with 96 fires attributed to the category. In response, the state instituted aggressive arson prevention activities with solid working relationships with local law enforcement and the arson division of the Oregon State Police. The result has seen the 10-year average slightly decline with just 41 fires occurring annually since 2004.

Smoking: Fires caused by smoking and improperly discarded cigarettes is down. It is not known if this is due to fewer people smoking, recent modifications producing fire standard compliant cigarettes, or better investigation of fire causes.

Miscellaneous: Wildfires resulting from a wide array of causes: automobile accidents, burning homes, pest control measures, shooting tracer ammunition and exploding targets, and electric fence use are a few of the causes in this category. The frequency of such fires has been rising in recent years.

Historic Wildfire Events

Table 2-23. Historic Wildfires in Oregon

Date	Location	Description
1933, 1939, 1945, 1951	Tillamook County	the Tillamook Burn included four fires occurring every 6 years over an 18-year period that burned 355,000 acres and killed one person
1936	Bandon	the fire destroyed the town of Bandon, burned 400 structures, and killed 11 people
1951	Douglas County	the Hubbard Creek Fire burned 15,774 acres and destroyed 18 homes; the Russell Creek Fire burned 350 acres and killed one person
1966	Douglas County	the Oxbow Fire burned 43,368 acres and killed one person
1987	Douglas County	the Bland Mountain Fire burned 10,300 acres and 14 homes and killed two people
1990	Deschutes County	the Awbrey Hall Fire burned 3,353 acres and destroyed 22 homes
1992	Klamath County	the Lone Pine Fire burned 30,320 acres and destroyed three structures
1994	Jackson County	the Hull Mountain Fire burned 8,000 acres, destroyed 44 structures, and killed one person
1996	Deschutes County	the Skeleton Fire burned 17,776 acres and destroyed 19 homes
2002	Coos, Josephine, Jefferson, and Deschutes Counties	the Biscuit Fire burned 500,000 acres and destroyed 13 structures; the Eyerly Fire burned 23,573 acres and destroyed 37 structures; the Cache Mountain Fire burned 4,200 acres and destroyed 2 structures
2010	Jackson County	the Oak Knoll Fire in Ashland destroyed 11 homes in less than 45 minutes
2011	Wasco County	the High Cascade Complex burned on the east side of Mount Hood into Warm Springs, consuming 101,292 acres
2012	Malheur and Harney Counties	the Long Draw Fire consumed 557,648 acres
2013	Douglas, Josephine, Wasco, and Grant Counties	more than 100,000 acres burned — the most acres burned in the last 50-plus years; four homes destroyed; three firefighter deaths attributed to the fires

Source: Oregon Department of Forestry, 2013

Probability

Fire is a natural component of forest and rangeland ecosystems found in all portions of the state. Many of these ecosystems are dependent upon frequent fires or a viable substitute for their continued existence. Even western Oregon forests, in the "wet" northwestern portion of the state, depend upon fire. It is a common myth that an unbroken carpet of old growth timber blanketed western Oregon prior to the beginning of European American settlement. In fact, fire and other natural forces had created a mosaic of different aged timber stands across the region. Factors now influencing the occurrence and severity of wildfires include poor forest health, invasive plant and tree species, great amounts of vegetation from long-term fire exclusion, changes in weather patterns, and the presence of humans and human development.

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 an intensity and rate of spread that surprises many people.

During a typical year, in excess of 2,500 wildland fires are ignited on protected forestlands in Oregon. On lands protected by ODF, the 10-year trend in both the incidence of human-caused fires and the acres they burn across is rising. When compared to Oregon's rapidly increasing population, the trend in the number of human-caused wildland fires has also been trending upward.

The Oregon Department of Forestry (ODF), on behalf of the Council of Western State Foresters and the Western Forestry Leadership Coalition, conducted the West Wide Wildfire Regional Risk Assessment (WWRA) for 17 western states and select U.S.-affiliated Pacific Islands. This assessment was funded by the U.S. Forest Service.

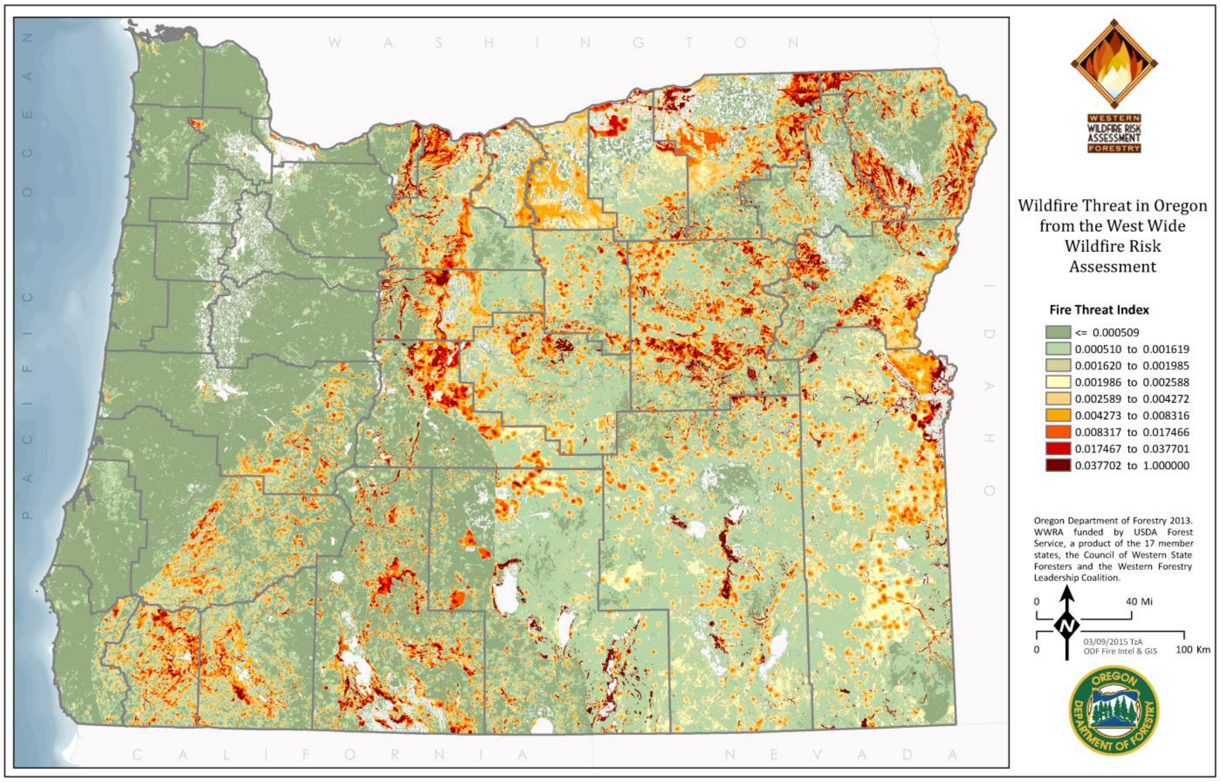
The WWRA resulted in a comprehensive data library that describes types of wildfire behavior and wildfire risk. Local users will have a chance to evaluate this new data for their localities. The distribution of the WWRA data is currently underway in 2015.

The WWRA is intended to support strategic planning at regional, state, and landscape scales. It was conducted at the larger multi-state level, but delivered as a regional multi-state product and state product. It represents findings as of 2008, however key data used in the assessment varies with respect to accuracy and date of compilation. The WWRA can be used to compare fire probability in different areas throughout the Western U.S. and state-leveled data.

The WWRA contains fire model outputs that describe the types of wildfire behavior that can be expected given different fuels, weather, and topography throughout the states. A sample of the Oregon data is presented in context for this NHMP update. Model methods are identical to the regional 17-state WWRA, except that calibration was done at a state level using Fire Occurrence Area class breaks based on state.

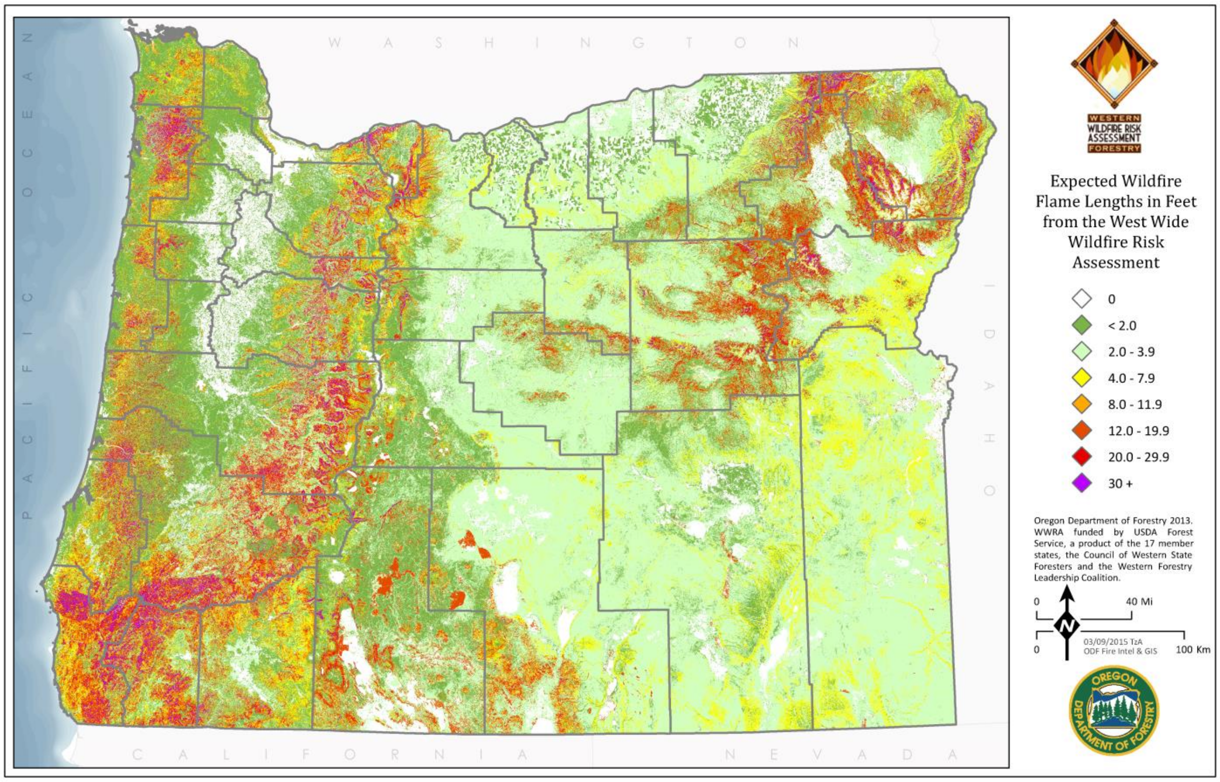
Among the modeled outputs is a Fire Threat Index. The Fire Threat Index, shown in **Figure 2-52** measures wildfire threat related to the likelihood of an acre burning. It integrates the probability of an acre igniting and the expected final fire size, based on the rate of spread in four weather percentile categories.

Figure 2-52. Wildfire Threat in Oregon from the West Wide Wildfire Risk Assessment



The WWRA also provides fire behavior data so that local planners can better understand the potential wildfire characteristics in their communities, from least severe to most severe fire weather conditions. [Figure 2-53](#) shows potential flame lengths given "normal" conditions, although there is data in the WWRA showing these kinds of outputs in more severe weather conditions that may occur. It is evident that the southwest and northeast portions of the state may experience more severe fire behavior in terms of flame lengths, but local fuel accumulations due to historical fire suppression and local topographic conditions will influence local fire behavior.

Figure 2-53. Expected Flame Lengths of Wildfires under "Normal" Conditions

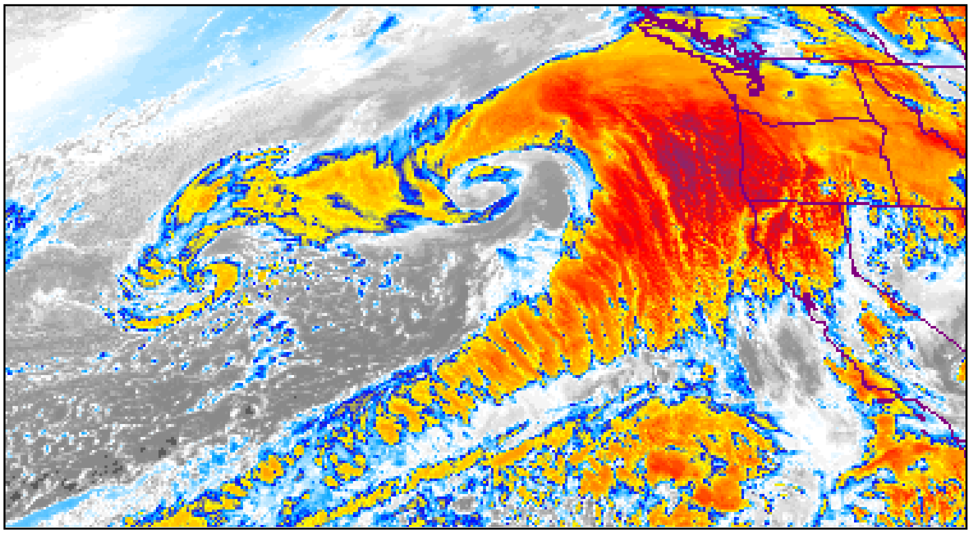


Climate Change

All eight regions in Oregon are projected to be affected by an increased incidence of drought and wildfire. Moreover, areas that have historically been both hotter and drier than the statewide average — southwest Oregon counties and central and eastern Oregon — are at somewhat higher risk of increased wildfire activity than the state overall.

Windstorms

Figure 2-54. Satellite Image of the Type of Severe Pacific Storm that Can Bring High Winds to Western Oregon



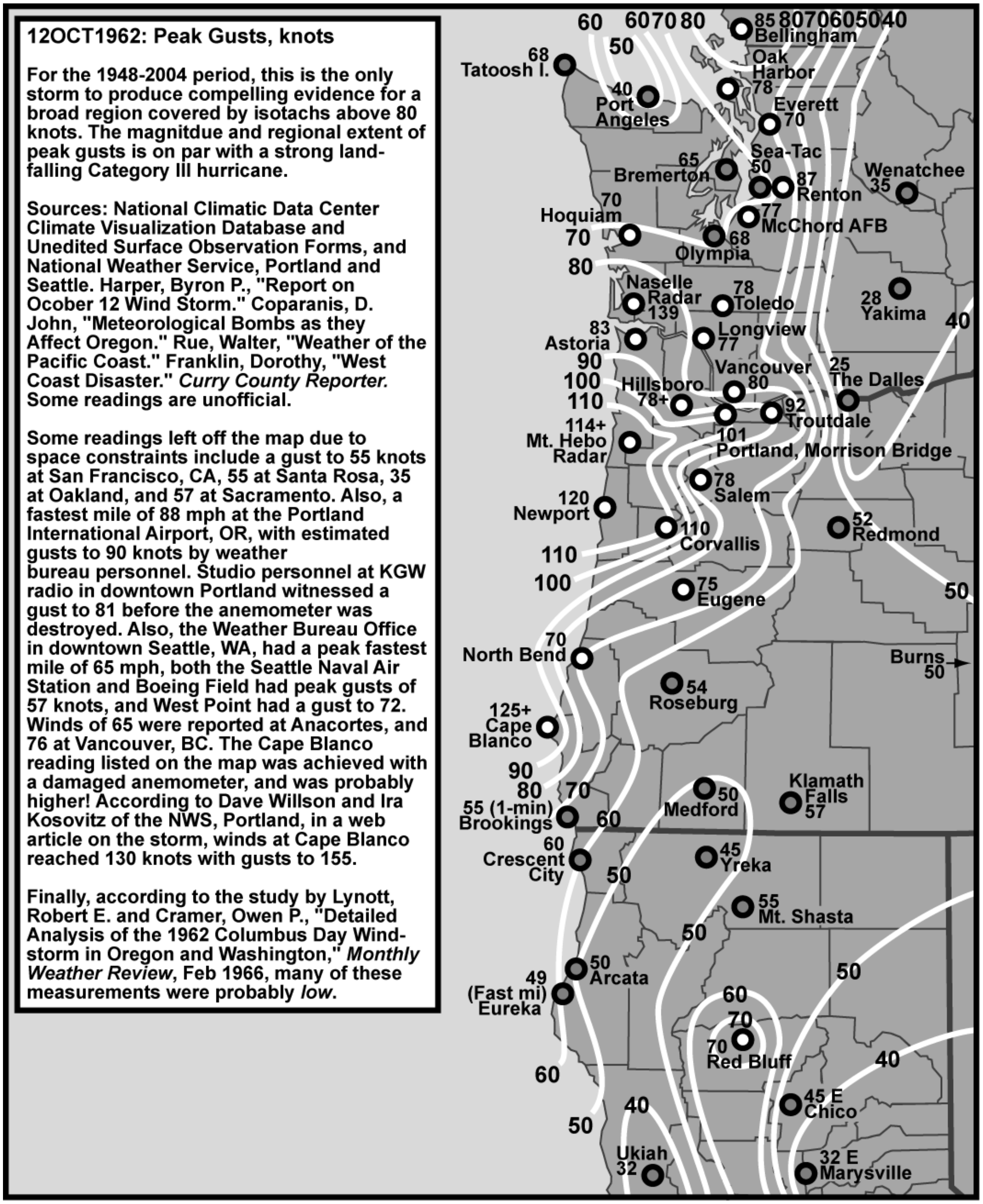
Source: NOAA

This section covers most kinds of windstorm events in Oregon, including the wind aspects of Pacific storm events. The precipitation aspects of Pacific storm events are covered earlier in the **Flood** section. Winds specifically associated with blizzards and ice storms are covered in the **Winter Storm** section.

Analysis and Characterization

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

Figure 2-55. Peak Gusts for Windstorm on October 12, 1962



Source: Wolf Read, Climatologist, Oregon Climate Center, Oregon State University

Pacific storms can produce high winds and often are accompanied by significant precipitation and low barometric pressure. These storms usually produce the highest winds in Western Oregon, especially in the coastal zone. These storms are most common from October through March. The impacts of these storms on the state are influenced by storm location, intensity, and local terrain.

Figure 2-56. Unstable Trees Near Electric Lines Left after a Logging Operation

Note: Unstable trees near electric lines left after a logging operation near electric lines pose a serious threat of personal injury, forest fire, and outages should high winds develop. Forest owners and workers need to coordinate their "leave trees" with electric utilities to prevent dangerous conditions as depicted here.

Photo source: Randy Miller, PacifiCorp

The historian Lancaster Pollard documented exceptional storms that occurred in 1880, 1888, 1920, 1931, and 1962. On January 29, 1920 a hurricane off the mouth of the Columbia River had winds estimated at 160 miles per hour (Pitzer, 1988).

One easterly windstorm that affected much of Oregon, particularly northern Oregon, was the northeasterly gale of April 21-22, 1931. This storm proved to be very destructive. Dust was reported by ships 600 miles out to sea. "While officially recorded wind speeds were not extreme, sustained wind speeds observed were 36 mph at Medford, 32 mph at Portland, 28 mph at Baker, and 27 mph at Roseburg. Unofficial wind measuring equipment reported winds of up to 78 mph. Damage was heavy to standing timber and fruit orchards." (http://www.wrh.noaa.gov/Portland/windstorm.html; for more information on this 1931 storm, see **Appendix 9.1.6**.)

Effects

The damaging effects of windstorms may extend for distances of 100 to 300 miles from the center of storm activity. Isolated wind phenomena in the mountainous regions have more localized effects. Near-surface winds and associated pressure effects exert loads on walls, doors, windows, and roofs, sometimes causing structural components to fail.

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 high-velocity 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.

Debris carried along by extreme winds can directly contribute to loss of life and indirectly to the failure of protective building envelope components. Upon impact, wind-driven debris can rupture a building, allowing more significant positive and internal pressures. When severe windstorms strike a community, downed trees, power lines, and damaged property are major hindrances to response and recovery.

The most destructive winds are those which blow from the south, parallel to the major mountain ranges. The Columbus Day Storm of 1962 was a classic example of a south windstorm. The storm developed from Typhoon Freda remnants in the Gulf of Alaska, deepened off the coast of California and moved from the southwest, then turned, coming into Oregon directly from the south. This was the most damaging windstorm in Oregon of the last century. Winds in the Willamette Valley topped 100 mph, while in the Coast Range they exceeded 140 mph. The Columbus Day Storm was the equivalent of a Category IV hurricane in terms of central pressure and wind speeds.

In terms of damage, "throughout the Willamette Valley, undamaged homes were the exception, not the rule. In 1962 dollars, the Columbus Day Storm caused an estimated $230-280 million in damage to property in California, Oregon, Washington and British Columbia combined, with $170-200 million happening in Oregon alone. This damage figure is comparable to eastern hurricanes that made landfall in the 1957–1961 time period... The Columbus Day Storm was declared the worst natural disaster of 1962 by the Metropolitan Life Insurance Company. In terms of timber loss, about 11.2 billion board feet was felled... in Oregon and Washington combined" (http://www.climate.washington.edu/stormking/) "The storm claimed 46 lives, injured hundreds more, and knocked power out for several million people" (http://www.wrh.noaa.gov/pqr/info/pdf/pacwindstorms.pdf).

Other Issues

The Hazard Mitigation Survey Team (HMST) Report developed in response to the February 7, 2002 windstorm the recommended that "differences in definitions of easements and allowable practices within them ('easement language') for private versus public, and urban forests vs. rural forests should be resolved." The State IHMT agencies agree that this issue continues to exist, but neither the resources nor the political will exist at this time to attempt to fix this complicated issue with many vested stakeholders.

Two other issues identified in that report also continue to exist, but cannot be solved at this time:

- "Land use actions being proposed by agencies with non-utility interests, which would affect land for which utilities have an interest, should be coordinated and should address vegetation management as it affects utility system operations."
- "Agencies and organizations should be identified to work with federal and state landowners to streamline processes by which electric utilities conduct hazard mitigation work on those lands..." Currently, ODOT issues permits for right-of-way work and ODF issues permits for the use of power equipment in forested areas.

Other areas of ongoing concern from this HMST Report are:

- Under Coordination — Utility providers should receive notification, from property owners, of planned tree-harvesting operations near utility lines.
- Under Vegetation Management — Diseased, damaged, and hazard trees near power lines that could fall or hit utility lines should be removed. Some "leave trees" remaining after new building developments and tree harvesting operations pose a threat to utility line safety and reliability. See **Appendix** 9.1.7, *How to Recognize and Prevent Tree Hazards*, for progress that has been made toward vegetation management issues.
- Under Engineering, Construction, and Compliance — "During initial planning and design of utility lines, identify types of geographic areas already known to pose hazards during windstorms. Inventory and analyze areas of repetitive failures to determine alternate designs and construction methods that will mitigate future damages... Consider selective undergrounding of lines where repetitive tree damage occurs, keeping in mind excavations can undermine tree root zones and create new hazards."

Historic Windstorm Events

Table 2-24. Historic Windstorms in Oregon

Date	Location	Comments
Oct. 1962	W. Oregon and locations east of Cascades, Oregon	Columbus Day Storm: Oregon's most famous and most destructive windstorm; barometric pressure low of 960 mb*
Mar. 1963	W. Oregon	second strongest windstorm in the Willamette Valley since 1950
Oct. 1967	most of western and central Oregon	an intense 977 mb low produced a sudden, destructive blow (*)
Nov. 1981	Oregon coast and N. Willamette Valley, Oregon	back-to-back storms on Nov. 13 and 15
Jan. 1993	North Coast Range, Oregon	Inauguration Day Storm; major disaster declaration in Washington State
Dec. 1995	NW Oregon	FEMA-1107-DR-Oregon (*); strongest windstorm since Nov. 1981; barometric pressure of 966.1 mb (Astoria), and Oregon record low 953 mb (off the coast)
Feb. 2002	south and central coast, Southern Willamette Valley, Oregon	FEMA-1405-DR-Oregon; surprise windstorm
Feb. 2007	NW and central coast and north central Oregon	FEMA-1683-DR-Oregon; severe winter storm with a wind component
Dec. 2007	Oregon coast and Willamette Valley, Oregon	FEMA-1733-DR-Oregon; severe winter storm, including flood and landslide events

*For comparison, surface barometric pressures associated with Atlantic hurricanes are often in the range of 910 to 960 mb. The all-time record low sea level barometric pressure recorded was associated with Typhoon Tip in the Northwest Pacific Ocean on October 12, 1979 at 870 mb.

Sources: Oregon Climate Service, http://www.ocs.oregonstate.edu/; Pitzer (1988)

Probability

Extreme weather events are experienced in all regions of Oregon. Areas experiencing the highest wind speeds are the Central and North Coast under the influence of winter low-pressure systems in the Gulf of Alaska and North Pacific Ocean, and the Columbia River Gorge, when cold air masses funnel down through the canyon in an easterly direction. For example, at Crown Point, located about 20 miles east of Portland, easterly winds with a 24-hour average of more than 53 mph and gusts in excess of 120 mph were recorded.

Table 2-25. Probability of Severe Wind Events by State of Oregon Natural Hazard Region (One-Minute Average, 30 Feet above the Ground)

Location	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 - Northern 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 Public Utilities Commission

Additional wind hazards occur on a very localized level, due to several down-slope windstorms along mountainous terrain. These regional phenomena known as foehn-type winds, result in winds exceeding 100 mph, but they are of short duration and affect relatively small geographic areas. A majority of the destructive surface winds in Oregon are from the southwest. Under certain conditions, very strong east winds may occur, but these are usually limited to small areas in the vicinity of the Columbia River Gorge or in mountain passes.

The much more frequent and widespread strong winds from the southwest are associated with storms moving onto the coast from the Pacific Ocean. If winds are from the west, they are often stronger on the coast than in interior valleys due to the north-south orientations of the Coast Range and Cascades. These mountain ranges obstruct and slow the westerly surface winds.

High winds occur frequently in Oregon, and they are especially common in coastal regions and in the mountains of the Coast Range between October and March. From unofficial but reliable observations, it is reasonable to assume that gusts well above 100 mph occur several times each year across the higher ridges of the Coast and Cascades Ranges. At the most exposed Coast Range ridges, it is estimated that wind gusts of up to 150 mph and sustained speeds of 110 mph will occur every 5 to 10 years. The Willamette Valley may face 40 to 60 mile per hour winds from a 100 mph+ storm on the coast. Also, the Columbia River Gorge funnels very strong winds, often from east to west.

Climate Change

There is insufficient research on changes in the likelihood of wind storms in the Pacific Northwest as a result of climate change.

Winter Storms

Winter storms are among nature's most impressive spectacles. Their combination of heavy snow, ice accumulation, and extreme cold can totally disrupt modern civilization, closing down roads and airports, creating power outages, and downing telephone lines. Winter storms remind us how vulnerable we are to nature's awesome powers.

For the most part, the wind aspects of winter storms are covered in the **Windstorm** section. Heavy precipitation aspects associated with winter storms in some parts of the state, which sometimes lead to flooding, are covered in the **Flood** section. This winter storms section instead generally addresses snow and ice hazards, and extreme cold.

Analysis and Characterization

According to the National Weather Service (2003) —

"Most snowstorms need two ingredients: cold air and moisture. Rarely do the two ingredients occur at the same time over western Oregon, except in the higher elevations of the Coast Range and especially in the Cascades. But snowstorms do occur over eastern Oregon regularly during December through February. Cold arctic air sinks south along the Columbia River Basin, filling the valleys with cold air. Storms moving across the area drop precipitation, and if conditions are right, snow will occur.

However, it is not that easy of a recipe for western Oregon. Cold air rarely moves west of the Cascades Range. The Cascades act as a natural barrier, damming cold air east of the range. The only spigot is the Columbia River Gorge, which funnels the cold air into the Portland area. Cold air then begins deepening in the Columbia River valley, eventually becoming deep enough to sink southward into the Willamette valley. If the cold air east of the Cascades is deep, it will spill through the gaps of the Cascades and flow into the western valleys via the many river drainage areas along the western slope. The cold air in western Oregon is now in place. The trick is to get a storm to move near or over the cold air, which will use the cold air and produce freezing rain, sleet, and/or snow. Sometimes, copious amounts of snow are produced. Nearly every year, minor snowfalls of up to six inches occur in the western interior valleys. However, it is a rare occurrence for snowfalls of over a foot in accumulations [*sic*]."

Figure 2-57. Troutdale Area—December 1996

Photo source: National Weather Service

Snow is relatively rare along the coast in Oregon. There is, however, a noticeable relationship between latitude and snowfall. **Appendix 9.1.8** shows average annual snowfall at various Oregon stations. Notice, in particular, Crater Lake, one of the snowiest measurement stations in the United States, which once reported nearly 900 inches of snow in one season (Taylor & Hannan, 1999).

Figure 2-58. Shielded Snow Gauge Used in the Pacific Northwest to Register Snowfall, 1917

Source: National Weather Service

Ice storms and freezing rain can cause severe problems when they occur. The most common freezing rain events occur in the proximity of the Columbia Gorge. The Gorge is the most significant east-west air passage through the Cascades. In winter, cold air from the interior commonly flows westward through the Gorge, bringing very cold air to the Portland area. Rain arriving from the west falls on frozen streets, cars, and other sub-freezing surfaces, creating severe problems. As one moves away from the Gorge, temperatures moderate as the marine influence becomes greater and cold interior air mixes with milder west-side air. Thus freezing rain is often confined to areas in the immediate vicinity of the Gorge: Corbett, Troutdale, perhaps as far west as Portland Airport. Downtown Portland and the western and southern suburbs often escape with no ice accumulation (Taylor & Hannan, 1999).

Freezing rain (also known as an ice storm) is rain that falls onto a surface with a temperature below freezing. The cold surface causes the rain to freeze so the surfaces, such as trees, utilities, and roads, become glazed with ice. Even small accumulations of ice can cause a significant hazard to property, pedestrians, and motorists.

Sleet is rain that freezes into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects; however, it can accumulate like snow and cause roads and walkways to become hazardous.

Black ice can fool drivers into thinking water is on the road. What they may not realize is that condensation, such as dew, freezes when temperatures reach 32 ˚F or below, forming a thin layer of ice. This shiny ice surface is one of the most dangerous road conditions. Black ice is likely to form under bridges and overpasses, in shady spots and at intersections.

Meteorologists define *heavy snow* as six inches or more falling in less than twelve hours, or snowfall of eight inches or more in twenty-four hours. A *blizzard* is a severe winter weather condition characterized by low temperatures and strong winds blowing a great deal of snow. The National Weather Service defines a blizzard as having wind speeds of 35 mph or more, with a visibility of less than a quarter mile. Sometimes a condition known as a *whiteout* can occur during a blizzard. This is when the visibility drops to zero because of the amount of blowing snow.

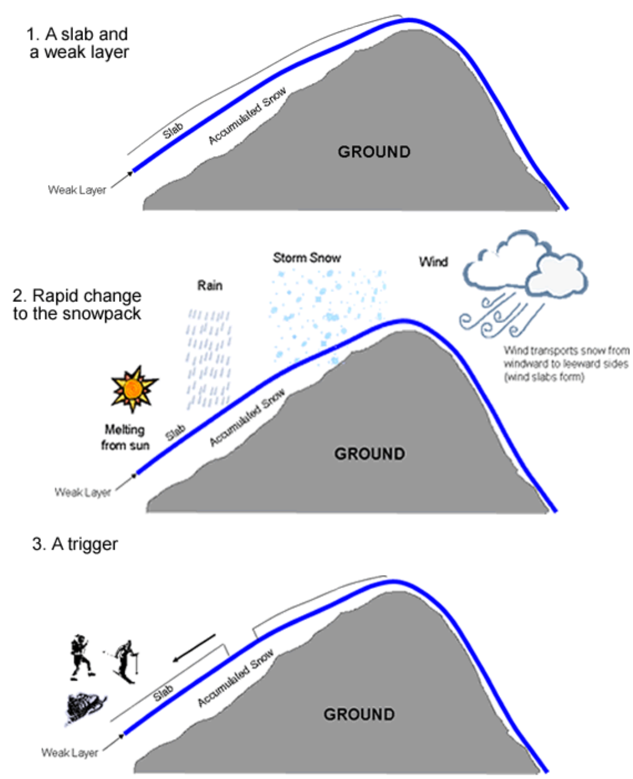
Wind blowing across your body makes you feel colder. The *wind chill* factor is a measure of how cold the combination of temperature and wind makes you feel. Wind chill of 50 °F or lower can be very dangerous: exposed skin can develop frostbite in less than a minute, and a person or animal could freeze to death after just 30 minutes of exposure.

A snow avalanche is a mass of snow falling down a mountain or incline. Three variables interact to determine whether an avalanche is possible:

- *Terrain:* the slope must be steep enough to avalanche,
- *Snowpack:* the snow must be unstable enough to avalanche, and
- *Weather:* changing weather can quickly increase instability.

According to the Northwest Weather and Avalanche Center, avalanches don't happen by accident and most human involvement is a matter of choice, not chance. Most avalanche accidents are caused by slab avalanches that are triggered by the victim or a member of the victim's party. However, any avalanche may cause injury or death and even small slides may be dangerous.

Figure 2-59. Ingredients for a Slab Avalanche



Source: Northwest Weather and Avalanche

On average, about 30 people in the United States are killed in avalanches each year. For the 21 years between 1985 and 2006. With five fatalities, Oregon ranks 10th among the states for avalanche fatalities. This is based on statistics from the Colorado Avalanche Information Center. Avalanche victims are almost exclusively backcountry recreationists — snowmobilers, climbers, snowboarders, snowshoers, skiers, and hikers. Nationally snowmobilers lead the list with twice as many fatalities as any other activity.

According to Portland Mountain Rescue, most avalanche victims triggered the very avalanche that caught them. The group advises people to be aware of the constantly changing conditions in the backcountry and take a certified avalanche class to increase their avalanche awareness.

Ski areas are different from the backcountry. It is very rare for someone to get caught in an avalanche within a ski area. Professional snow safety crews rely on explosives and ski compaction to stabilize ski area snowpack.

Historic Winter Storm Events

Table 2-26. Historic Winter Storms in Oregon

Date	Location	Description
Dec. 16–18, 1884	Linn, Marion, Washington, Multnomah, Hood River and Wasco Counties	heavy snow in the Columbia River Basin from Portland to The Dalles and along the Cascades foothills in the Willamette Valley; 1-day snow totals: Albany, 16.0 inches; The Dalles, 29.5 inches; Portland, 12.4 inches
Dec. 20–23, 1892	Linn, Marion, Washington, Multnomah, and Umatilla Counties	substantial snow across most of northern Oregon; greatest snowfall in the northwest part of the state; totals from 15 to 30 inches with Albany, 15.0 inches; Corvallis, 14.0 inches; Portland, 27.5 inches; Forest Grove, 28.0 inches; Pendleton, 8.0 inches
Jan. 5–10, 1909	Josephine, Jackson, Douglas Lane, Linn, Marion, Clackamas, Hood River, and Waco Counties	heavy snowfall in mountainous areas; 34.5 inches at Siskiyou Summit; many locations, particularly in western Oregon, received more snow in this 6-day period than they normally would receive in an entire year; snow totals: Ashland, 9.1 inches; Eugene, 15.1 inches; Forest Grove, 29.0 inches; Lakeview, 17.0 inches; Portland, 19.3 inches; The Dalles, 14.5 inches
Jan. 11–15, 1916	Josephine, Jackson, Douglas Lane, Linn, Marion, Clackamas, Hood River, and Waco Counties	5-8 inches of snow in western Oregon, except for the southwestern interior and the coastal areas; McMinnville had the most snow in one day, with 11 inches falling on January 12; another 24 inches at Siskiyou Summit; higher elevations in the Cascades received very heavy snowfall
Jan. 30–Feb. 3, 1916	Hood River, Clackamas, Marion, Wasco, Jefferson, and Multnomah Counties	snow and ice storm along the northern Oregon border; heaviest snowfall in the Hood River Valley with 29.5 inches in one day at Parkdale, and 81.5 inches total; heavy snow especially in the higher Cascades with Government Camp 41.0 inches in a day and storm total of 87.5 inches; the ice inflicted severe damage to electric light, telephone and telegraph companies, fruits and ornamental trees; many locations, earlier snow had not melted, resulting in substantial snow depths
Dec. 9–11, 1919	statewide	one of three heaviest snowfall-producing storms to hit Oregon on record; lowest statewide average temperature since record keeping began in 1890; the Columbia River froze over, closing the river to navigation from the confluence with the Willamette River upstream; nearly every part of the state affected; snow totals (inches): Albany, 25.5; Bend, 49.0; Cascade Locks, 21.5; Eugene, 8.5; Heppner, 16.0; Parkdale, 63.0; Pendleton, 15.0; Siskiyou Summit, 50.0
Feb. 10, 1933	statewide	cold outbreak across state; the city of Seneca, in northeast Oregon, recorded the state's all-time record low temperature of -54 °F; the next day high was nearly 100 degrees warmer at 45 °F
Jan. 31–Feb. 4, 1937	statewide	heavy snowfalls in the western slopes of the Cascades and the Willamette Valley; deep snowdrifts blocked major highways and most minor roads in northern Oregon and passes of the Cascade Mountains for several days
Jan. 5–7, 1942	Columbia, Clackamas, Multnomah, Washington, Marion, Linn, Yamhill, and Polk Counties	considerable sleet, followed by freezing rain in some areas; freezing rain, resulting in heavy accumulations of ice in upper and middle Willamette Valley; roads and streets dangerous for travel, orchard and shade trees damaged, and telephone, telegraph, and power wires and poles broken down.
Mid Jan.–Feb, 1950	statewide	extremely low temperatures injured a large number of orchard and ornamental trees and shrubs, and harmed many power and telephone lines and outdoor structures; severe blizzard conditions and a heavy sleet and ice storm together caused several hundred thousand dollars damage and virtually halted traffic for two to three days; Columbia River Highway closed between Troutdale and The Dalles leaving large numbers of motorists stranded, removed to safety only by railway; damage to orchard crops, timber, and power services, costing thousands in damages.

Date	Location	Description
Jan. 9–20, 1950	Columbia, Washington, Multnomah, Hood River, Wasco, Clackamas, Yamhill, Marion, Polk, Linn, Benton, and Lane Counties	frequent snowstorms throughout January; snow heavier during this January than ever before on record; snow plus high winds created widespread blowing and drifting of snow; deep snowdrifts closed all highways west of the Cascades and through the Columbia River Gorge; sleet 4-5 inches in northwestern Oregon; sleet turned to freezing rain, creating havoc on highways, trees, and power lines; hundreds of motorists stranded in the Columbia River Gorge, only rescued by train; hundreds of thousands of dollars of damage occurred; winds reached 60–70 mph in gusts along the coast and excess of 40 mph in Portland and Grants Pass; outdoor work and school halted due to impeded traffic, down power lines, and community isolation; in Portland 32.9 inches of snow fell (5.8 inches was the January average)
Dec. 5–7, 1950	Washington, Multnomah, Hood River, Wasco, Sherman, Gilliam, Morrow, and Umatilla Counties	severe ice storm with light freezing rain over the Columbia Basin east of the Cascades; heavy ice accretions on trees, highways, power and telephone lines causing accidents due to broken limbs, slippery pavements, and down power lines; heavy snowfall across Oregon; Crater Lake reported 93 inches of snow for December
Jan. 18, 1956	Washington, Multnomah, Hood River, Wasco, Sherman, Gilliam, Morrow, and Umatilla Counties	freezing rain mixed with snow. Ice coated trees, highways, and utility lines; traffic accidents due to slick surfaces; trees heavy with ice broke, sometimes on top of houses
Jan. 11–12, 1960	Columbia, Clackamas, Multnomah, Washington, Marion, Linn, Yamhill, and Polk Counties	light to moderate snows and freezing rain produced dangerous highway conditions; automobile accidents, but no known fatalities; accidents blocked arterial highways, creating serious traffic jams
Jan. 30–31, 1963	Columbia, Clackamas, Multnomah, Washington, Marion, Linn, Yamhill, Polk, Hood River, Waco, Jefferson, and Deschutes Counties	substantial snowfall amplified by moderate to severe icing created hazardous conditions on highways; power lines downed due to ice or felled trees; injuries, one reported death, and statewide school closures due to the icy streets and highways
Jan. 25–31, 1969	Douglas, Coos, Josephine, Jackson, Columbia, Clackamas, Multnomah, Washington, Marion, Linn, Yamhill, and Polk Counties	snowfall records throughout Lane, Douglas, and Coos Counties were surpassed by incredible numbers; 2-3 feet on the valley floors; heavier amounts at higher elevations; at Eugene, a snow depth of 34 inches. Total January snowfall was 47 inches, nearly 7 times the normal monthly snowfall. Roseburg reported 27 inches and monthly snowfall of 35.2 inches; along the coast, where the average snowfall is generally less than 2 inches, January snowfall totals ranged 2-3 feet, with snow depths of 10–20 inches reported; hundreds of farm buildings and several large industrial buildings collapsed under the weight of the heavy wet snow; heavy losses in livestock; entire communities completely isolated for nearly a week; traffic on major highways west of the Cascades and central Oregon halted; total losses estimated $3 to $4 million
Jan. 17–19, 1970	Washington, Multnomah, Hood River, Wasco, Sherman, Gilliam, Morrow, and Umatilla Counties	Stagnant and cold air in the Columbia River Basin east of the Cascades had surface temperatures well below freezing for a week. Ice accumulated on tree branches up to 1.5 inches. Damage was mostly destroyed orchards and utilities.
Nov. 22-23, 1970	Columbia, Washington, Multnomah, Hood River, Wasco, Clackamas, Yamhill, Marion, Polk, Linn, Benton, and Lane Counties	freezing rain across western Oregon, especially in Corvallis, Albany, Salem, Independence, and Dallas; ice accumulations up to 0.5 inches broke thousands of tree limbs and telephone lines; hazardous traffic conditions, power and phone outages, and felled trees
Feb. 4–6, 1972	Columbia, Clackamas, Multnomah, Washington, Marion, Linn, Yamhill, and Polk Counties	several days of sub-freezing temperatures across Oregon followed by warm moist air across northwestern Oregon; glazed roads were hazardous; 140 persons in Portland treated for sprains, fractures or head injuries; some ambulance services doing twice their normal business

Date	Location	Description
Jan. 11–12, 1973	Columbia, Clackamas, Multnomah, Washington, Marion, Linn, Yamhill, and Polk Counties	rains beginning in the Willamette Valley glazed streets and highways in the Portland area and into the Gorge; auto, bus and truck accidents and persons injured in falls; hospitals reported "full house" conditions; glaze of 0.25–0.75 inches in the Portland area
Jan. 1978	Columbia Gorge, Willamette Valley, Portland, Oregon and Vancouver, Washington	over an inch of rain froze, covering everything with ice; power outages (some for more than 10 days); areas east of Portland hit hardest
Jan. 9–10, 1979	Portland and Multnomah Counties	severe ice storm in Portland area as a Pacific storm moved across the state; temperatures ranged from low teens to 33 °F; half inch of rain turned to ice
Jan. 5, 1986	Multnomah, Hood River, Waco Counties	roads covered with ice and caused power outages to several thousand houses
Feb. 1–8, 1989	statewide	heavy snow across state; up to 6–12 inches of snow at the coast, 9 inches in Salem, more than a foot over the state; numerous record temperatures set; wind chill temperatures 30–60 degrees below 0 °F; power failures throughout state, with home and business damage resulting from frozen plumbing; several moored boats sank on the Columbia River because of ice accumulation; five weather-related deaths (three auto accidents caused by ice and snow, and two women froze to death); damage estimates exceeded one million dollars
Feb. 14–16, 1990	Columbia, Clackamas, Multnomah, Washington, Hood River, Wasco, Marion, Linn, Yamhill, and Polk Counties	24–35 inches of snow in Cascade Locks and Hood River; up to 28 inches in the North Coast Range, 16 inches at Timberline Lodge; the Willamette Valley had 2–4 inches with up to 1 foot in higher hills around Portland; 10-15 inches of snow in the North Coast Range, 20–35 inches in the North Cascades, 1-2 feet in the South Cascades; snow in south-central areas included 9 inches at Chemult, 6–8 in Klamath Falls and Lakeview; 6 inches at Tipton Summit in the northeast mountains and Juntura in the southeast.
Jan. 6-7, 1991	all of eastern Oregon	constant precipitation all over Oregon; freezing rain in Willamette Valley made transportation difficult; two auto fatalities; 1–6 inches of new snow in high ground of eastern Oregon; 12 inches of snow in the Columbia Gorge
Jan. 16–18, 1996	Columbia Gorge, Willamette Valley, Portland, Oregon Columbia, Clackamas, Multnomah, Washington, Hood River, Wasco, Marion, Linn, Yamhill, and Polk Counties	freezing rain with heavy accumulations of glaze ice in the Gorge, Northern Cascades and extreme eastern Portland Metro area; numerous minor traffic accidents due to power outages; freezing rain in the Willamette Valley as far south as Eugene
Feb. 2–4, 1996	Columbia Gorge, Willamette Valley, Portland, Oregon Columbia, Clackamas, Multnomah, Washington, Hood River, Wasco, Marion, Linn, Yamhill, and Polk Counties	ice storm caused disruption of traffic and power outages in the Willamette Valley and Coast Range valleys; freezing rain in the Willamette Valley; traffic accidents, including a 100 car pileup near Salem; one traffic fatality near Lincoln City
Dec. 26–30, 1996	Columbia Gorge, Willamette Valley, Portland, Oregon Columbia, Clackamas, Multnomah, Washington, Hood River, Wasco, Marion, Linn, Yamhill, and Polk Counties	ice storm paralyzed the Portland Metro area and the Columbia Gorge; ice accumulations of 4-5 inches in the Columbia Gorge; I-84 through the Gorge closed for 4 days; widespread electricity outages and hundreds of downed trees and power lines in the Portland area

Date	Location	Description
Dec.28, 2003–Jan. 9, 2004	statewide storm	

The most significant winter storm in several years brought snowfall to most of Oregon. The largest snowstorm to hit the Siskiyou Pass in Jackson County in a quarter century. I-5 shut down for nearly a day as ODOT maintenance crews and Oregon State Police troopers dug stranded motorists out of snowdrifts reaching 5-6 feet. Two feet of snow in the Blue Mountains in eastern Oregon. Roadside snow levels exceeded six feet along the Tollgate Highway, OR-204. The eastbound lanes of I-84 closed at Ladd Canyon east of La Grande. Additional segments of I-84 eastbound at Pendleton closed as stranded motorists filled truck stops, motels and restaurants in the La Grande area.

Wet snow on highways in the Willamette Valley, toppled power lines and trees. Oregon 34 east of Philomath closed for 30 hours while crews removed trees. Snow on the Siskiyou Pass made national news and was a top story on the CNN website. 150 miles of I-5 from Ashland to south of Redding, California closed, leaving 100 to 200 vehicles stranded on the Siskiyou Pass overnight. The American Red Cross opened a shelter on the Southern Oregon University campus, and reports out of cities from Redding to Medford confirmed that all motels were full. Emergency service delivered gasoline, food, and water to stranded motorists and hard-to-reach areas. One fatality related to the storm. (Heart attack after helping a stranded motorist.)

I-5 North on the Siskiyou Pass closed for 19 hours. The snow event turned into a major ice storm. Icy roads made driving hazardous. Trees damaged or destroyed by ice adhering to the branches. Downed power lines, often due to falling trees, caused power outages. Businesses, school districts, and government offices closed or hours shortened. Several hundred flights cancelled at the Portland International Airport. Thousands of passengers stranded at the airport. The MAX light rail system also was shut down by the storm. ODOT closed I-84 through the Columbia Gorge twice, for almost 70 hours total. Freight trucks and passenger cars had to detour over Mount Hood where, ironically, road conditions were better than they were in downtown Portland where all vehicles were required to chain up. ODOT closed US-101 over the Astoria Megler Bridge for about 14 hours as large chunks of ice fell off the bridge's superstructure. Many other highways in the state were closed. Freezing rain also in eastern Oregon. Minus 30 degrees reported in Meacham. 60 mph wind gusts in Union County created whiteout conditions, prompting the closure of I-84 between La Grande and Baker City. 2 fatalities.

President Bush issued a major disaster declaration for 26 Oregon counties affected by the winter storm, later extended to 30 of Oregon's 36 counties.

Estimated the cost of damages to public property at $16 million. A frigid arctic air mass, heavy snow, sleet and freezing rain, strong east winds and blizzard conditions through and near the Columbia River Gorge snarled travel, forced school and business closures, and resulted in widespread power outages and properly damage in Northwestern Oregon. 2-6 inches of snow along the North Oregon Coast, 2–8 inches in the Willamette Valley, 5–8 inches in the Portland Metro area, and up to 27 inches in the Cascade Mountains. Up to 2 inches of sleet and freezing rain followed the snowfall.

In Portland this winter storm:

- limited or halted most forms of travel
- resulted in the cancellation of over 1,300 flights at Portland International Airport, stranding 90,000 passengers
- shut down Portland's light rail train system
- closed most businesses and schools

Blizzard conditions in the Columbia River Gorge:

- closed I-84 between Troutdale and Hood River
- closed Washington State Route 14 between Washougal, and White Salmon, Washington
- Halted east-west travel through the Gorge and stranded hundreds of trucks at both ends of the Gorge

Weight from snow and ice buildup:

- downed trees and power lines, leaving 46,000 customers without power, and collapsed roofs at Portland's Gunderson Steel and Rail, Fred Meyer stores in Gateway and Clackamas, and a barn in Forest Grove that killed 4 horses
- collapsed a Scappoose marina roof, sinking 4 boats and damaging many others
- snowfall in the Cascades ranged from 8 inches at Blue Box Pass and Bennett Pass to 27 inches at Timberline Lodge and White River

Date	Location	Description
Mar. 8–10, 2006	Lane, Linn, Benton, Marion, Jefferson, Polk, Yamhill, Clackamas Counties	snow fell up to a few inches at the coast and through the Willamette Valley; 2–4 feet in the Coast Range, Cascades, and Cascade Foothills; many school closures
Jan. 2–Feb. 9, 2008	Hood River, Waco, Sherman, Gilliam, Morrow, Umatilla, Union, Grant, Baker, Wheeler, Jefferson Deschutes, Crook Counties	heavy snow and freezing rain across eastern Oregon; 5–13 inches of snow; a multi-vehicle accident closed I-84, 15 miles west of Arlington, for 5 hours; 36 Oregon National Guard personnel helped with snow removal in Detroit and Idanha with over 12 feet of record snow. Inmate crews removed snow that cracked walls and collapsed roofs
Dec. 9–11, 2009	Marion, Linn, Lane Counties	freezing rain covered the central valley with a coating of ice; south of Salem, numerous road closures due to accidents caused by icy roadway; I-84 from Troutdale to Hood River closed for 22 hours
Nov. 29-30, 2010	Hood River, Multnomah, Wasco Counties	4-5 inches of snow reported in Cascade Locks and Hood River; 1/2 inch of ice in Corbett
Jan. 12–18, 2012	Hood River, Wasco Counties	4.5 inches of new snow reported in Hood River; I-84 closed due to ice and snow east of Troutdale
Feb. 6–10, 2014	Lane, Benton, Polk, Yamhill, Columbia, Clackamas, Multnomah, Washington, Linn, Marion, Hood River, Lincoln, Tillamook and Clatsop Counties	a strong winter storm system affected the Pacific Northwest during the February 6–10, 2014 time period bringing a mixture of arctic air, strong east winds, significant snowfall and freezing rain to several counties in northwest Oregon; a much warmer and moisture-laden storm moved across northwest Oregon after the snow and ice storm (Feb. 11-14), which produced heavy rainfall and significant rises on area rivers from rain and snowmelt runoff; during the 5-day period Feb. 6–10, 5 to 16 inches of snow fell in many valley locations and 2 to10 inches in the coastal region of northwest Oregon; freezing rain accumulations generally were 0.25 to 0.75 inches; the snowfall combined with the freezing rain had a tremendous impact on the region
Feb. 11–14, 2014	Lane, Benton, Polk, Yamhill, Columbia, Clackamas, Multnomah, Washington, Linn, Marion, Hood River, Lincoln, Tillamook and Clatsop Counties	another weather system moved across northwest Oregon during the February 11–14 time frame; this storm was distinctly different from the storm that produced the snow and ice the week prior and brought abundant moisture and warm air from the sub-tropics into the region; as this storm moved across the area, 2 to 7 inches of rain fell across many counties in western Oregon; the heavy rainfall combined with warm temperatures led to snowmelt and rainfall runoff that produced rapid rises on several rivers, which included flooding on three rivers in northwest Oregon

Source: The National Weather Service

Figure 2-60. Rescuing Snowbound Vehicles, Old Oregon Trail Highway between Kamela and Meacham, 1923

Source: ODOT

Figure 2-61. Stranded Motorists on I-5 Southbound at Siskiyou Pass, Late December 2003

Note: Vehicles being towed out the "wrong way."
Source: ODOT

Figure 2-62. Detroit, Oregon, February 2, 2008, Buried from the 12 Feet of Snow

Source: ODOT

Figure 2-63. Trees Collapse from Weight of the Snow on Oregon 62 near Prospect, February 2, 2008

Source: ODOT

Probability

Winter storms occur annually in Oregon bringing snow to Oregon's mountains and much of Eastern Oregon. These winter storms are welcomed by Oregon's skiers and the ski industry and are tolerated by people traveling the numerous mountain passes and Eastern Oregon highways kept open during the winter by the Oregon Department of Transportation. Approximately every 4 years, winter storms bring extreme cold temperatures, snow, sleet and ice to Oregon's western valley floors. Because these storms are infrequent and tend to last only a few days, residents in western Oregon are often unprepared for such events.

One issue concerns the fact that there is not a statewide effort regarding winter storm impacts, either historical or for future planning. There are only limited snowfall sensors distributed mainly through the mountain ranges of the state and there is not an annual tracking system in place for snowfall statewide. A program of statewide snowfall sensors would allow us to better understand the impact of winter storms on Oregon and have a better means of predicting potential impacts in the future.

The American Society of Civil Engineers has developed a 50-year recurrence interval map of Oregon showing probabilities for ice thickness caused by freezing rain (ASCE-7-02, 2003a), found at: http://www.americanlifelinesalliance.com/pdf/PipecommFinalPosted061705.pdf

According to the Northwest Weather and Avalanche Center (NWAC), experts on the subject aren't able to predict, nor do they completely understand each and every avalanche occurrence. Regional avalanche centers across the country do have the technology to forecast avalanche danger. These forecasts are valuable tools in reducing danger to people. However, no matter what forecasts indicate even the smallest avalanche can be injurious or life threatening!

Avalanche danger ratings levels have been adopted within North America (with slight changes in Canada) and are generally accepted internationally. These levels are:

Low Avalanche Danger (green): Natural avalanches very unlikely. Human triggered avalanches unlikely. Generally stable snow. Isolated areas of instability. Travel is generally safe. Normal caution advised.

Moderate Avalanche Danger (yellow): Natural avalanches unlikely. Human triggered avalanches possible. Unstable slabs possible on steep terrain. Use caution in steeper terrain on certain aspects.

Considerable Avalanche Danger (orange): Natural avalanches possible. Human triggered avalanches probable. Unstable slabs probable on steep terrain. Be increasingly cautious in steeper terrain.

High Avalanche Danger (red): Natural and human triggered avalanches likely. Unstable slabs likely on a variety of aspects and slope angles. Travel in avalanche terrain is not recommended. Safest travel on windward ridges of lower-angle slopes without steeper terrain above.

Extreme Avalanche Danger (red with black border): Widespread natural or human triggered avalanches certain. Extremely unstable slabs certain on most aspects and slope angles. Large destructive avalanches possible. Travel in avalanche terrain should be avoided and travel confined to low-angle terrain well away from avalanche path runouts.

Climate Change

There is no current research available about changes in the incidence of winter storms in Oregon due to changing climate conditions.

2.2.2 Oregon Vulnerabilities

2.2.2.1 Overview

Requirement: 44 CFR §201.4(c)(2)(ii): The risk assessment shall include… (ii) (a)n overview and analysis of the State's vulnerability to the hazards described... based on estimates provided in local risk assessments as well as the State risk assessment. The State shall describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events…

The vulnerability assessment provides an overview and analysis of the state's vulnerabilities to each of Oregon's 11 hazards addressed in this Plan. Both local and state risk assessments are referenced to identify vulnerabilities, most vulnerable jurisdictions, and potential impacts from each hazard. In addition, a side-by-side comparison of local and state vulnerability "rankings" for each county show similarities and differences that the state will be addressing over the course of the next Plan update cycle.

Requirement: 44 CFR §201.4(c)(2)(ii): The risk assessment shall include… (ii)…State owned or operated critical facilities located in the identified hazard areas shall also be addressed.

Requirement: 44 CFR §201.4(c)(2)(iii): The risk assessment shall include… (iii) An overview and analysis of potential losses to the identified vulnerable structures, based on estimates provided in local risk assessments as well as the State risk assessment. The State shall estimate the potential dollar losses to State owned or operated buildings, infrastructure, and critical facilities located in the identified hazard areas.

The exposure analysis and estimate of potential losses to state-owned/leased facilities and critical/essential facilities (both state-owned/leased and non-state-owned/leased) located within hazard zones performed by the Department of Geology and Mineral Industries (DOGAMI) for the 2012 Oregon NHMP was updated by DOGAMI in 2014. Loss data are not available in local plans. Therefore, this Plan only includes the most recent estimates provided by DOGAMI.

An overview of seismic lifeline vulnerabilities is a new addition to the 2015 Oregon NHMP. This includes a summary of the Oregon Department of Transportation's (ODOT's) 2012 Oregon Seismic Lifeline Report (OSLR) findings, including identification of system vulnerabilities, loss estimates and recommended next steps. Both the facilities and lifeline report findings are further discussed in the **Regional Risk Assessments**.

2.2.2.2 Local Vulnerability Assessments

Requirement: 44 CFR §201.4(c)(2)(ii): The risk assessment shall include… (ii) (a)n overview and analysis of the State's vulnerability to the hazards described... based on estimates provided in local risk assessments …. The State shall describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events…

The Oregon Military Department's Office of Emergency Management (OEM) periodically collects hazard vulnerability information from each of the 36 counties in the state. The information is generated at the local government level to meet OEM required activities under the State's Emergency Management Grant Program (EMPG) and in many cases to inform Local NHMPs.

The OEM Hazard Analysis Methodology was first developed by FEMA in 1983, and has been gradually refined by OEM over the years. There are two key components to this methodology: vulnerability and probability. Vulnerability examines both typical and maximum credible events, and probability reflects how physical changes in the jurisdiction and scientific research modify the historical record for each hazard.

This analysis is conducted by county or city emergency program managers, usually with the assistance of a team of local public safety officials. The assessment team initially identifies which hazards are relevant in that community. Then, the team scores each hazard in four categories: history, probability, vulnerability, and maximum threat. Following is the definition and ranking method for each category:

- History = the record of previous occurrences:
  - Low 0–1 event past 100 years,
  - Moderate 2–3 events past 100 years, and
  - High 4+ events past 100 years.
- Probability = the likelihood of future occurrence within a specified period of time:
  - Low one incident likely within 75–100 years,
  - Moderate one incident likely within 35–75 years, and
  - High one incident likely within 10–35 years.
- Vulnerability = the percentage of population and property likely to be affected under an "average" occurrence of the hazard:
  - Low < 1% affected,
  - Moderate 1–10% affected, and
  - High > 10% affected.
- Maximum Threat = the highest percentage of population and property that could be impacted under a worst-case scenario:
  - Low < 5% affected,
  - Moderate 5–25% affected, and
  - High > 25% affected.

Each county in Oregon is required to periodically update its hazard analysis. As part of this analysis, each county develops risk scores for natural hazards that affect its communities. These scores range from 24 (low) to 240 (high), and reflect risk for each particular hazard, as determined by a team process facilitated by the Emergency Manager. This method provides local jurisdictions with a sense of hazard priorities, or relative risk. It does not predict the occurrence of a particular hazard in a community, but it does "quantify" the risk of one hazard compared with another. By doing this analysis, local planning can first be focused where the risk is greatest. This analysis is also intended to provide comparison of the same hazard across various local jurisdictions.

Among other things, the hazard analysis can:

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

Although this methodology is consistent statewide, the reported raw scores for each county are based on partially subjective rankings for each hazard. Because the rankings are used to describe the "relative risk" of a hazard within a county, and because each county conducted the analysis with a different team of people working with slightly different assumptions, comparing scores between counties must be treated with caution.

For the purposes of the Oregon NHMP, the State Vulnerability Assessment focuses only on county vulnerability rankings (H, M, L) taken from LNHMP Hazard Analysis scores. These rankings provide the state an understanding of local hazard concerns and priorities. **Table 2-27** presents the local vulnerability rankings for each of Oregon's 11 hazards by county. In the **Regional Risk Assessments**, both county vulnerability and probability rankings are identified for each Oregon NHMP Natural Hazards Region.

Table 2-27. Local Vulnerability Rankings by County

County	Coastal Erosion	Tsunami	Drought	Dust Storm	Earthquake	Volcanic	Landslide	Wildfire	Flood	Wind Storm	Winter Storm
Baker			H	M	M	L	M	H	M	H	H
Benton			L		H	L	L	M	M	M	M
Clackamas			L		H	H	L	M	M	L	M
Clatsop	H	H	M		H	M	H	H	H	H	H
Columbia			L		M	M	M	M	H	H	H
Coos	M	H	M		H	M	M	M	H	H	H
Crook			H	L	L	H	L	M	H	M	M
Curry		H			H	H	L	H	H	H	
Deschutes			L		M	H		M	L	L	H
Douglas - central					M		M	H	H	M	H
Douglas - coastal	L	H			H		M	M	M	M	M
Gilliam			H		M	M	M	M	M	L	H
Grant			H		M	H	M	H	H	H	H
Harney			M		L	L	L	H	M	L	M
Hood River			H		M	L	M	M	M	H	H
Jackson			M		H	L	L	M	M	H	H
Jefferson			H		L	H	L	H	M		H
Josephine					H			M	M	H	H
Klamath			M		M	L		L	M		M
Lake			H		H	H	L	M	M	M	H
Lane - central			M		M	M	L	M	H	M	H
Lane - coastal		H			H		M	L	H	H	L
Lincoln		M	L		M	L		M	L	H	
Linn					H	H		M	H	M	H
Malheur			H	L	M	M	M	H	H	M	M
Marion					H	M		M	M	H	H
Morrow				M	H		M	M	H	M	H
Multnomah					H	H	M	M	H	H	H
Polk					H	M		M	H	H	
Sherman			M		L	L	M	M	M	M	M
Tillamook		H	L	L	H	M	H	H	H	H	H
Umatilla			H	H	M			H	M	H	H
Union			M	L	H	L	L	H	H	H	H
Wallowa			H		L	L	L	H	M	M	M
Wasco			H		M	L	M	M	L	H	H
Washington			M		H	H	L	M	H	H	H
Wheeler			H		H	M	H	H	H	M	H
Yamhill			M		H		M	L	H	M	H

Source: OEM, November 2013

Oregon's Natural Hazards Viewer

Oregon's Natural Hazards Viewer is an online interface that visually describes natural hazard risk throughout the State of Oregon. Information displayed in the Viewer is taken from the OEM Hazard Analysis Methodology findings. By moving the cursor over each county, individual hazard scores are displayed on the right-hand side of the screen. Up to four hazard maps can be displayed at one time. The Natural Hazards Viewer can be found at the following web link: http://oregonem.com/hazardsviewer/hazardsViewer_content.html

Data in the Natural Hazards Viewer is current through March 2015. OEM plans to require most Oregon counties to update their analyses for the local fiscal year that ends on June 30, 2016. Therefore, the Hazards Viewer will be updated to reflect these county updates during the summer of 2016.

Note: The Natural Hazards Viewer addresses all hazards in the plan except Coastal Erosion.

2.2.2.3 State Vulnerability Assessment

Requirement: 44 CFR §201.4(c)(2)(ii): The risk assessment shall include… (ii) (a)n overview and analysis of the State's vulnerability to the hazards described... based on estimates provided in … the State risk assessment. The State shall describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events…

Oregon does not have one standard method to assess risk across all hazards statewide. For each of the 11 hazards addressed in this Plan, a state agency has been identified as the lead over that hazard (**Table 2-28**). All hazards have at least one lead and most have a support hazard expert who compiled and analyzed hazard data for this state risk assessment. In some instances both experts are from the same agency. For other hazards two agencies worked together to perform the analysis. Due to the wide range of data available for each hazard, the method used to assess risk varies from hazard to hazard. For example, there is a wealth of data available to assess risk to earthquakes, but data on dust is difficult to locate. In response, the State relies on hazard lead and support experts to determine the best method, or combination of methods, to identify vulnerability and potential impacts for this Plan. In general, each hazard is assessed by using a combination of exposure, historical, and scenario analyses. Hazards for which more data exist — earthquake, flood, tsunami, wildfire and, to a lesser degree, volcanic events (primarily related to Mount Hood) — have undergone a more robust analysis.

Table 2-28. Oregon NHMP Hazard Lead Agencies

Hazard	Lead Agency	Support Agency
Coastal Hazards	Department of Geology and Mineral Industries	Department of Geology and Mineral Industries
Droughts	Oregon Water Resources Department	Oregon Water Resources Department
Dust Storms	Oregon Office of Emergency Management	Oregon Department of Transportation
Earthquakes	Oregon Office of Emergency Management	Department of Geology and Mineral Industries
Floods	Department of Land Conservation and Development	Department of Geology and Mineral Industries
Landslides	Department of Geology and Mineral Industries	Department of Geology and Mineral Industries
Tsunamis	Department of Geology and Mineral Industries	Department of Geology and Mineral Industries
Volcanoes	Department of Geology and Mineral Industries	Department of Geology and Mineral Industries
Wildfires	Oregon Department of Forestry	Oregon Department of Forestry
Windstorms	Oregon Climate Change Resource Institute	Oregon Public Utility Commission
Winter Storms	Oregon Department of Transportation	

Coastal Hazards

Chronic hazards are clearly evident along Oregon's shores, including beach, dune, and bluff erosion, landslides, slumps, gradual weathering of sea cliffs, and flooding of low-lying coastal lands during major storms. The damage caused by chronic hazards is usually gradual and cumulative. The regional, oceanic, and climatic environments that result in intense winter storms determine the severity of chronic hazards along the coast. These hazards threaten property and, in extreme events, human life.

Most Vulnerable Communities

The Department of Geology and Mineral Industries is the agency with primary oversight of the coastal erosion hazard. Based on agency staff review of the available hazard data, DOGAMI ranks Tillamook, Lincoln, Clatsop, and Curry Counties one through four respectively as the counties most vulnerable to coastal erosion in the state.

Coastal hazards in Coos, Lane, and Douglas Counties are considered to be generally negligible. This is because the bulk of these coastlines have little population base and hence are largely unmodified. In Coos County, coastal hazards can be found in a few discrete communities such as adjacent to the Coquille River south jetty in Bandon and along Lighthouse Beach near Cape Arago. Similarly, coastal hazards in Lane County are confined almost entirely to the Heceta Beach community and adjacent to the Siuslaw River mouth, particularly adjacent to the lower estuary mouth where development lines coastal bluffs that are gradually being eroded by riverine processes.

The most vulnerable counties and communities on the Oregon coast include:

Tillamook County (ranked #1):

- Neskowin (erosion and flooding),
- Pacific City (erosion),
- Tierra del Mar (erosion and flooding),
- Cape Meares (flooding),
- Twin Rocks (erosion and flooding), and
- Rockaway Beach(erosion and flooding);

Lincoln County (ranked #2):

- Yachats to Alsea Spit (erosion),
- Waldport (erosion and flooding),
- Alsea Spit (erosion),
- Seal Rock (erosion and landsliding),
- Ona Beach to Southbeach (erosion and landsliding),
- Newport (landsliding),
- Beverly Beach (erosion and landsliding),
- Gleneden Beach to Siletz Spit (erosion, landsliding, and flooding), and
- Lincoln City (erosion and landsliding);

Clatsop County (ranked #3):

- Falcon Cove (erosion and landsliding),
- Arch Cape (erosion and flooding),
- Tolovana to Cannon Beach (erosion and flooding), and
- Seaside (flooding);

Curry County (ranked #4):

- Nesika Beach (erosion and landsliding), and
- Port Orford (flooding at Garrison Lake);

Coos County (ranked #5):

- North Coos Spit (erosion),
- Lighthouse Beach (bluff erosion), and
- Bandon (erosion and flooding, particularly adjacent to the Coquille River south jetty);

Lane County (ranked #6):

- Heceta Beach (erosion and flooding).

Knowledge derived from field experience, discussions with scientists, scientific publications, agency reports, and thesis dissertations were used to determine which communities are the most vulnerable to coastal hazards within Oregon.

Droughts

There is a tendency to associate drought conditions with the arid sections of the state, principally east of the Cascade Mountains. However, this perception is not entirely accurate. During the winter of 2002-03, Coos and Curry Counties on the southwestern coast experienced drought conditions.

When a drought occurs, it may affect all regions of the state. However, most of Oregon's urban areas usually fare much better during a drought than rural, less populated regions of the state. By encouraging or invoking water conservation measures during a drought, a public municipal water system can reduce residential and industrial demand for water.

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 and in the southern portions of the state are more prone to drought-related impacts.

Most Vulnerable Communities

The Water Resources Department (WRD) is the state agency with primary oversight of drought conditions and mitigation activities. Based on the frequency of drought declarations issued by the Governor issued since 1992, Klamath and Baker Counties are the most vulnerable to drought. Klamath County has been under a Governor-declared drought on 11 occasions since 1992, while Baker County has received nine declarations during this same time period. Lake, Malheur, Sherman, Gilliam, and Morrow Counties are vulnerable as well.

These communities were identified as most vulnerable based on only one indicator: the frequency of drought declarations. A broader, more detailed assessment that considers other factors, such as past economic or environmental drought-related impacts for each community, would help the state better prioritize its mitigation and response-related activities.

Dust Storms

Dust storms primarily occur in the arid regions of Central and Eastern Oregon. They are generally produced by the interaction of strong winds, fine-grained surface material, and landscapes with little vegetation. The winds involved can be as small as "dust devils" or as large as fast moving regional air masses.

Most Vulnerable Communities

Based on research conducted by OEM, the counties in Oregon most vulnerable to dust storms are Morrow and Umatilla. These two counties are most vulnerable because historically in locations close to their county lines, a combination of soil types, past agricultural practices, and high winds have led to motor vehicle accidents that have resulted in many deaths and injuries. The following counties are also vulnerable: Baker, Deschutes, Harney, Jefferson, Klamath, Lake, Malheur, Union, and Wasco.

Poor visibility leading to motor vehicle crashes is the worst potential impact of these storms; often these crashes result in fatalities and major injuries. Other impacts include poor air quality, including dust infiltration of equipment and engines, loss of productive soil, and an increase in fine sediment loading of creeks and rivers.

Communities most vulnerable to dust storms have been identified on the basis of historic occurrence, including the impacts of those occurrences.

Earthquakes

Oregon has a long history of earthquakes (and tsunamis, which often accompany major off-shore seismic events) because of the state's proximity to the Cascadia Subduction Zone (CSZ) just off the Pacific Coast, and also from crustal faults that run under or near populated areas. Oregon is vulnerable to damage because of its topography and geology; many of its local soil profiles are prone to liquefaction during the shaking that would occur during a Cascadia event. Depending on the size of the fault rupture, areas receiving major damage from a magnitude 8.0–9.0 earthquake would include most of the counties in western Oregon; the heavily populated metropolitan areas of Portland, Salem, and Eugene would certainly experience major damage.

A major Cascadia earthquake (>M_W 8.5) or a local crustal earthquake (>M_W 5.0) would be devastating to the Portland Metro area. The Northern Willamette Valley/Portland Metro Region is the most densely populated region with a total population of almost 1.5 million people. A major earthquake would likely do extensive damage to many of the region's 1382 bridges and overpasses as few bridges have been retrofitted to withstand this type of event. In addition, many structures are located on soils likely to experience liquefaction from the shaking that would occur. Most of the state's major critical infrastructure such as energy sector lifelines, transportation hubs, and medical facilities is particularly vulnerable to damage from liquefaction and long periods of shaking. The Northern Willamette Valley/Portland Metro Region also has 49 dams that could be affected by a major earthquake.

Depending on the size of the fault rupture, this magnitude of earthquake would likely cause extensive damage to structures and infrastructure in the Mid/Southern Willamette Valley Region as well. The city of Salem, Oregon's state capital, is only 46 miles south of Portland. To gain a perspective of the potential damage from a major earthquake, 169 of the state's facilities are located in or near Salem. To replace these state facilities would cost over $850 million dollars. Marion County, where Salem is located, has over 20 dams and 400 bridges that could also be affected. For more information on state facilities located in earthquake hazard zones, see the **Earthquake Hazard Facility Summary** section.

The long-term effects from a major earthquake would be felt for years. Major damage would likely occur to most of western Oregon's public and private buildings, its vast road network, to its rail lines and power transmission lines, and to the state's most important employment centers.

A major earthquake that occurs in the southern, central, or eastern areas of Oregon would be catastrophic to that region. It may also be catastrophic to the state economically if key facilities and infrastructure (i.e., highways, bridges, rail lines, power transmission lines, and dams) are damaged to the degree that links with the Portland Metro region and the rest of the state could not quickly be repaired. However, the length of time for the state to recover from such a disaster occurring in an area away from the Portland Metro area should be much shorter than if the same event occurred near Portland. For more information about the seismic vulnerability lifelines, see the **Seismic Transportation Lifeline Vulnerabilities** section, summarizing the Oregon Department of Transportation's Seismic Lifeline Report.

In the late 1990s, DOGAMI developed two earthquake loss models for Oregon: (a) a magnitude 8.5 Cascadia Subduction Zone (CSZ), and (b) a 500-yr probabilistic ground motion model, which combines CSZ, intraplate and crustal events. Both models are based on Hazus, a computer program developed 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 500-yr model incorporates earthquake ground motions with 10% chance of exceedance in the next 50 years, which was used by the building code. It does not look at a single earthquake (as in the CSZ model) but encompasses many faults.

Neither model takes into account damage and losses from unreinforced masonry buildings or tsunamis. Due to the limitations of Hazus with respect to modeling damage from unreinforced masonry buildings and tsunamis at that time, DOGAMI estimated fatalities outside of the Hazus model. DOGAMI developed lower bound estimates on the order of 5,000 fatalities.

DOGAMI investigators caution that the models contain a high degree of uncertainty and should be used only for general planning and policy purposes. Despite the model limitations, valuable estimates of damage, functionality and relationships between county estimates are made available for each region within Oregon. Results for each State of Oregon Natural Hazard Region are found in the **Regional Risk Assessments** section.

In 2000, DOGAMI co-organized an important conference convening scientists to discuss the Cascadia fault. At this Geological Society of America Penrose conference, which was held in Seaside, Oregon, there was scientific consensus that the most recent Cascadia earthquake occurred in 1700, that it was a magnitude 9 earthquake, and the Cascadia fault would produce future magnitude 9 earthquakes and damaging tsunamis (DOGAMI Special Paper 33, found at: http://www.naturenw.org/qs3/products.php?sku=001227).

Also in 2000, the Oregon Seismic Safety Policy Advisory Commission (OSSPAC) developed a report called "Oregon at Risk" which addressed the many cross-cutting effects that earthquakes have on our communities, including the basic services provided by infrastructure. Five objectives were outlined: (a) earthquake awareness and education, (b) earthquake risk information, (c) earthquake safety of buildings and lifelines, (d) geoscience and technical information, and (e) emergency pre-disaster planning, response, and recovery. The report is available on the following the Oregon Office of Emergency Management webpage: http://www.oregon.gov/omd/oem/pages/osspac/osspac.aspx.

In 2007, DOGAMI (Lewis, 2007) 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 developed 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 a total of 3,349 buildings, giving each 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 (Lewis, 2007). The RVS study can help prioritize which buildings require additional studies and which do not. To fully assess a building’s potential of collapse, a more detailed engineering study completed by a qualified professional is required. Details of this study for each State of Oregon Natural Hazard Region can be found in the **Regional Risk Assessments** section.

In 2012 the USGS published Professional Paper 1661-F, *Turbidite Event History — Methods and Implications for Holocene Paleoseismicity of the Cascadia Subduction Zone* (Goldfinger et al., 2012), which provides the most comprehensive catalog of prehistoric Cascadia Subduction earthquakes to date, including a 10,000 year chronology (Table 2-29) of as many as 40 subduction earthquakes ranging from about M8.1 to about M9.3. This study forms the basis for efforts to evaluate the consequences and likelihood of future Cascadia earthquakes, and has been particularly useful in DOGAMI's program to map tsunami inundation zones along the Oregon coast.

Table 2-29. Turbidite Event History Methods and Implications for Holocene Paleoseismicity of the Cascadia Subduction Zone

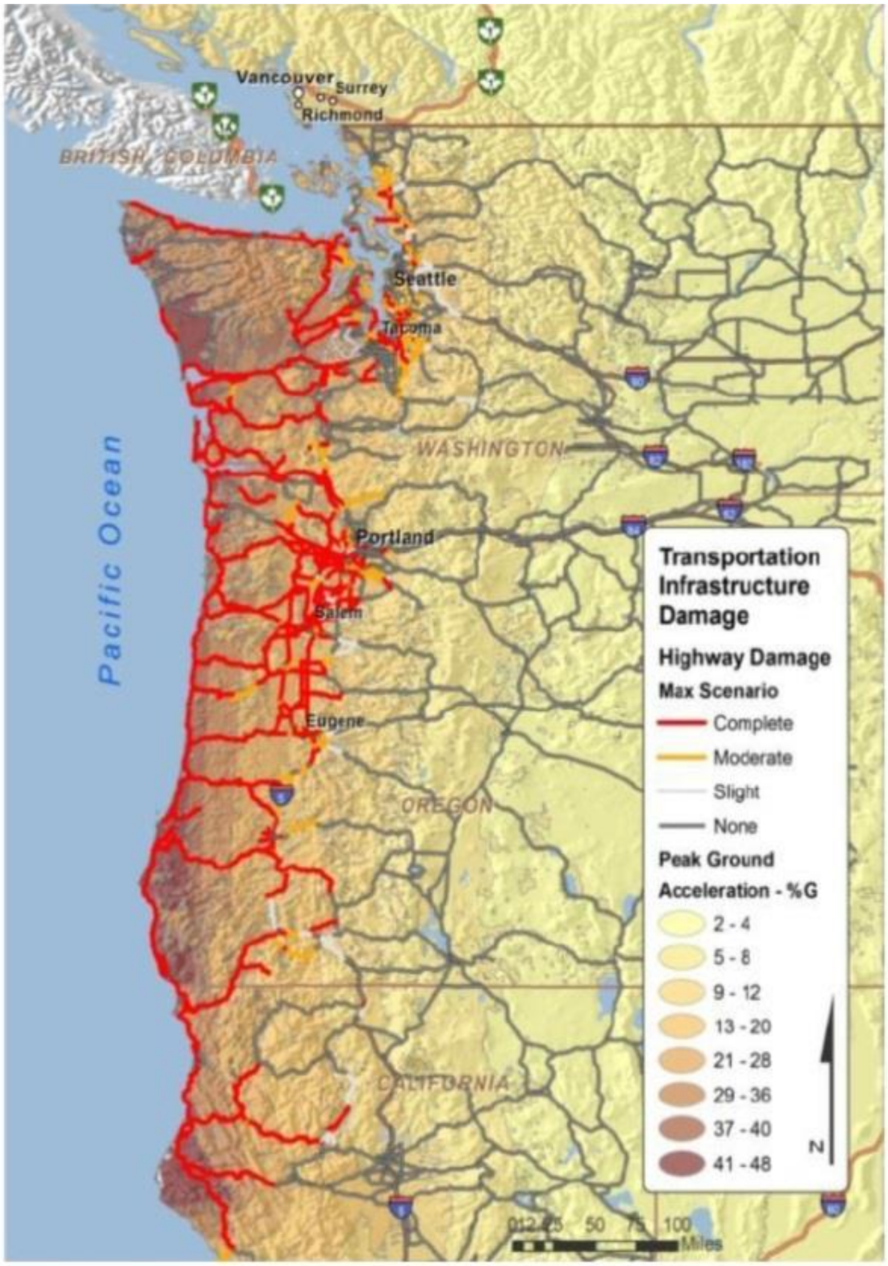
Turbidite number	Mean age	Northern margin following interval, in years	Northern margin slip from following time, in meters	Southern margin interval, in years	Southern margin slip from time, in meters	Average northern and southern slip, in meters	Segment name	Rupture length, in kilometers	Rupture width, in kilometers	Mw	Seismic moment
1	250					16.0	A	1,000	83	9.00	398.4E+27
2	482	232	8.9	232	8.3	8.4	A	1,000	55	8.70	138.3E+27
2a	550			57	2.1	2.1	D	222	40	8.19	23.8E+27
3	798	305	11.2	248	8.9	10.0	A	1,000	83	8.87	250.2E+27
3a	1,077			279	10.0	10.0	C	444	50	8.34	40.1E+27
4	1,243	446	16.3	167	6.0	11.2	A	1,000	83	8.90	277.9E+27
4a	1,429			186	6.7	6.7	C	444	50	8.25	29.9E+27
5	1,554	311	11.4	125	4.5	7.9	A	1,000	83	8.80	197.4E+27
5a	1,820			266	9.6	9.6	C	444	50	8.41	51.9E+27
5b	2,036			216	7.8	7.8	B	660	60	8.66	122.5E+27
5c	2,323			286	10.3	10.3	C	444	50	8.41	51.1E+27
6	2,536	982	35.9	213	7.7	21.8	A	1,000	83	9.09	542.7E+27
6a	2,730			194	7.0	7.0	D	222	40	8.24	28.7E+27
7	3,028	492	18.0	298	10.7	14.4	A	1,000	83	8.97	358.2E+27
7a	3,157			129	4.6	4.6	D	222	40	8.23	27.5E+27
8	3,443	415	15.2	286	10.3	12.7	A	1,000	83	8.94	317.2E+27
8a	3,599			442	5.6	0.0	B	660	60	8.67	124.4E+27
8b	3,890			447	10.5	10.5	D	222	40	8.15	21.0E+27
9	4,108	665	24.4	218	7.9	16.1	A	1,000	83	9.01	401.1E+27
9a	4,438			548	11.9	0.0	B	660	60	8.35	41.4E+27
9b	4,535			426	3.5	3.5	D	222	40	8.17	22.5E+27
10	4,770	661	24.2	235	8.5	16.3	A	1,000	83	9.01	406.6E+27
10a	5,062			292	10.5	10.5	C	444	50	8.39	47.6E+27
10b	5,260			198	7.1	7.1	B	660	60	8.43	55.7E+27
10c	5,390			130	4.7	4.7	C	444	50	8.55	82.7E+27
10d	5,735			344	12.4	12.4	C	444	50	7.90	9.0E+27
10f	5,772			37	1.3	1.3	C	444	50	8.37	44.8E+27
11	5,959	1189	43.5	187	6.7	25.1	A	1,000	83	9.13	625.5E+27
12	6,466	508	18.6	508	18.3	18.4	A	1,000	55	8.93	304.0E+27
12a	6,903			437	15.7	15.7	D	222	40	8.22	26.7E+27
13	7,182	715	26.2	278	10.0	18.1	A	1,000	83	9.04	450.7E+27
14*	7,625	443	16.2	443	16.0	16.1	A	1,000	83	9.01	400.7E+27
14a	7,943			318	11.4	11.4	D	222	40	8.17	22.1E+27
15	8,173	548	20.1	230	8.3	14.2	A	1,000	83	8.97	353.0E+27
15a	8,459			286	10.3	10.3	D	222	40	8.36	42.9E+27
16	8,906	733	26.8	447	16.1	21.4	A	1,000	83	9.09	534.1E+27
16a	9,074			169	6.1	6.1	D	222	40	7.54	2.6E+27
17	9,101	195	7.2	27	1.0	4.1	A	1,000	55	8.49	67.0E+27
17a	9,218	117	4.3	117	4.2	4.2	A	1,000	55	8.50	70.1E+27
18	9,795	577	21.1	577	20.8	20.9	A	1,000	83	9.08	521.2E+27

Source: Goldfinger et al. (2012)

In 2013, DOGAMI published Open-File Report O-13-09, *Earthquake Risk Study for Oregon's Critical Energy Infrastructure Hub* (Wang et al., 2013). This report highlights the concentration of critical energy facilities in the Portland Harbor area of the lower Willamette River, and the seismic risk posed by a combination of liquefiable soils and the age and poor condition of many facilities in the area. The report also points out how dependent Oregon is on this concentration of facilities for virtually all petroleum products used in the State, and the potential impacts on post-earthquake recovery if these facilities are damaged.

Also in 2013, the Cascadia Region Earthquake Workgroup (CREW) issued a Cascadia magnitude 9 scenario, which provided a narrative on the expected effects throughout the region including northern California, Oregon, Washington, and British Columbia (www.crew.org). Some of the CREW scenario was obtained from the 2011 Federal Emergency Management Agency (FEMA) regional planning scenario for the Pacific Northwest (Draft Analytical Baseline Study for the Cascadia Earthquake and Tsunami, September 12, 2011) based on a magnitude 9 megathrust earthquake. Using the most current version of Hazus, FEMA's disaster loss modeling software, they have prepared the most comprehensive and realistic Cascadia scenario to date). In addition to Hazus analysis, FEMA evaluated likely tsunami effects for several Oregon coastal communities. Data like this provides a critical tool for planning emergency response and for designing a resiliency plan, as it highlights areas of infrastructure damage that affect the entire system. State and local government agencies have been working with FEMA to provide local knowledge to inform the scenario, and the final document and associated databases should be adopted as the basis for planning. In general the scenario results predict severe damage in coastal areas, particularly in tsunami inundation zones with widespread but moderate damage along the I-5 corridor (**Figure 2-64**). For more information about tsunamis in Oregon, see the **Tsunami** section. For more information about seismic lifeline vulnerability see the **Seismic Transportation Lifeline Vulnerabilities** section.

Figure 2-64. Draft Hazus Results from the 2011 FEMA Analytical Baseline Study for the Cascadia Earthquake and Tsunami



Source: FEMA

The Oregon Seismic Safety Policy Advisory Commission (OSSPAC) developed a report in 2013 entitled "The Oregon Resilience Plan: Reducing Risk and Improving Recovery for the Next Cascadia Earthquake and Tsunami." The report (**Appendix** 9.2.5), which was commissioned by a legislative resolution, estimated the impacts of an M9.0 Cascadia subduction earthquake on the State's population, buildings, and infrastructure with a focus on seven sectors:

- Businesses,
- Coastal communities,
- Energy,
- Transportation,
- Communication,
- Critical buildings, and
- Water and wastewater.

For each of these sectors the Plan sets a desired level of performance (time to recover a given level of service) and estimates performance under current conditions in each of four earthquake impact zones:

- **Tsunami**, where damage will be complete and saving lives through evacuation is the main focus;
- **Coastal**, where damage will be severe and the focus will be on managing a displaced population with little functioning infrastructure;
- **Valley**, where moderate damage will be widespread, and the focus will be on restoring services quickly to re-start the economy; and
- **Eastern**, where damage will be light and the focus will be on staging recovery efforts for the rest of the state.

For the first three zones, times for restoration of services (**Table 2-30**) are typically several months, and in some cases several years, a clearly unacceptable level of performance, and far short of the general performance goal of two weeks to restore most services to functional, if not original conditions. These results are particularly sobering in the face of the report's finding that where services are not restored within 2 to 4 weeks, businesses will either fail or leave.

The report includes extensive recommendations for actions that if implemented over the next 50 years, should greatly improve the performance of Oregon's buildings and infrastructure in the next great earthquake. These include:

- Undertaking comprehensive assessments of key structures and systems,
- Launching a sustained program of investment in retrofit of Oregon's public buildings,
- Creating a package of incentives to help Oregon's private sector improve its resilience, and
- Updating public policies to streamline recovery and to increase public preparedness

Upon consideration of the Plan, the 2013 Oregon Legislature passed Senate Bill 33 establishing an Oregon Resilience Task Force to facilitate a comprehensive and robust plan to implement the Oregon Resilience Plan. The Task Force will report to the Oregon Legislature during the 2015 session.

The report and an executive summary are available at:

- http://www.oregon.gov/OMD/OEM/osspac/docs/Oregon_Resilience_Plan_Final.pdf, and
- http://www.oregon.gov/OMD/OEM/osspac/docs/Oregon_Resilience_Plan_Executive_Summary_Final.pdf.

Table 2-30. Estimated Times for Restoration Services Post CSZ and Tsunami Event

Critical Service	Zone	Estimated Time to Restore Service
Electricity	Valley	1 to 3 months
Electricity	Coast	3 to 6 months
Police and fire stations	Valley	2 to 4 months
Drinking water and sewer	Valley	1 month to 1 year
Drinking water and sewer	Coast	1 to 3 years
Top-priority highways (partial restoration)	Valley	6 to 12 months
Healthcare facilities	Valley	18 months
Healthcare facilities	Coast	3 years

Source: Oregon Resilience Plan, OSSPAC (2013)

Most Vulnerable Communities

The Department of Geology and Mineral Industries (DOGAMI) is the agency with primary oversight of the earthquake hazard identification and risk evaluation and also has responsibilities for earthquake risk mitigation. DOGAMI has developed two earthquake loss models for Oregon based on the two most likely sources of seismic events: (a) the Cascadia Subduction Zone (CSZ), and (b) combined crustal events (500-year model). Both models are based on Hazus, a computerized program, currently used by the FEMA as a means of determining potential losses from earthquakes.

The CSZ event is based on a potential magnitude 8.5 earthquake generated off the Oregon coast. The model does not take into account a tsunami, which probably would develop from the event. 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 buildings 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.

Table 2-31 lists all counties in the state in the order of projected losses and damages (highest to lowest) based on the two models mentioned above. See DOGAMI Special Paper 29 (Wang and Clark, 1999; http://www.oregongeology.org/pubs/sp/SP-29.pdf) for more information on these earthquake loss models.

Table 2-31. Projected Loss and Damage Rankings by County from Two Earthquake Loss Models

Counties listed from highest to lowest based on projected losses and damages due to a *Cascadia Subduction Zone (CSZ) earthquake*	
1. Multnomah	19. Klamath
2. Lane	20. Deschutes
3. Coos	21. Hood River
4. Washington	22. Jefferson
5. Marion	23. Grant
6. Benton	24. Gilliam
7. Lincoln	25. Harney
8. Josephine	26. Lake
9. Clatsop	27. Umatilla
10. Jackson	28. Baker
11. Linn	29. Crook
12. Curry	30. Malheur
13. Clackamas	31. Morrow
14. Douglas	32. Sherman
15. Yamhill	33. Union
16. Polk	34. Wallowa
17. Tillamook	35. Wasco
18. Columbia	36. Wheeler

Counties listed from highest to lowest based on projected losses and damages due to *combined crustal events using a 500-year model*	
1. Multnomah	19. Columbia
3. Lane	21. Umatilla
3. Lane	21. Umatilla
4. Marion	22. Hood River
5. Clackamas	23. Malheur
6. Coos	24. Lake
7. Jackson	25. Wasco
8. Benton	26. Jefferson
9. Linn	27. Baker
10. Klamath	28. Morrow
11. Josephine	29. Union
12. Lincoln	30. Wallowa
13. Clatsop	31. Crook
14. Yamhill	32. Grant
15. Douglas	33. Harney
16. Polk	34. Sherman
17. Curry	35. Wheeler
18. Tillamook	36. Gilliam

Source: Wang and Clark (1999)

It should be emphasized that in the original 1999 DOGAMI study, estimated statewide losses did not include tsunami-related losses. In the future, an updated Hazus study should include the current population and infrastructure as well as losses from a tsunami. If tsunami losses are included, rankings might shift.

Floods

Flooding is a natural phenomenon. Damage and loss of life occur when flood waters come into contact with the built environment or where people congregate. Flood can have secondary effects of causing stream bank erosion and channel migration, or precipitating landslides.

Every Oregon County has suffered flood losses at one time or another. Some counties are more susceptible to both flood events and damages. To capture these differences in susceptibility DLCD created a countywide flood vulnerability index by compiling data from NOAA's Storm Events Database and from FEMA National Flood Insurance Program. Data were calculated statewide for the period 1978 through 2013 for five input datasets: number of events, structure and crop damage estimates in dollars and NFIP claims number and dollar amounts. The mean and standard deviation were calculated for each input. Then, each county was assigned a score ranging from 0 to 3 for each of these inputs according to **Table 2-32**.

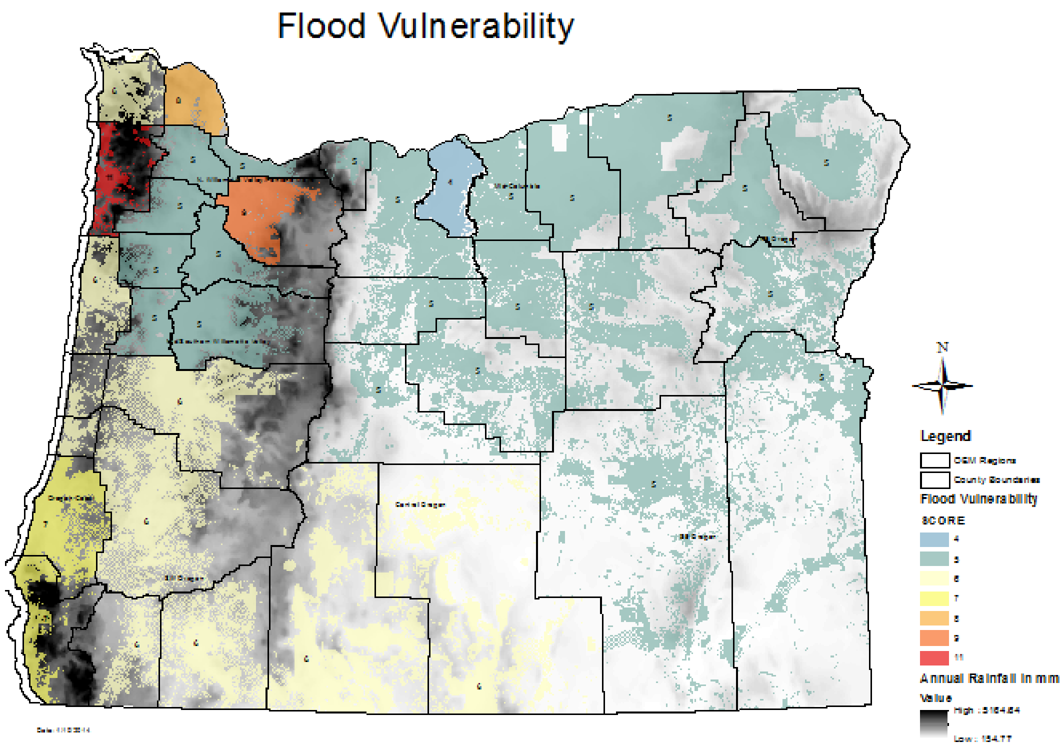
Table 2-32. Scoring for Vulnerability Index

Score	Description
3	county data point is greater than 2.5 times standard deviation for the input data set
2	county data point is greater than 1.5 times standard deviation for the input data set
1	county data point is within standard deviation
0	no data reported

DLCD summed the scores for each of the five inputs to create a county-by-county vulnerability index. Since there were five input datasets, with a maximum score of three each, the maximum countywide score could be 15. The theoretical minimum score could be zero, but in fact all but one county had complete datasets, so the actual minimum score was four.

A vulnerability index value over 5 indicates that one or more input variables exceeded 1.5 times the confidence limit for that input, meaning that the value exceeds the average value for that input. A score over 6 indicates that at least one variable significantly exceeds average values. Tillamook, Clackamas, and Columbia Counties received flood vulnerability scores of 11, 9 and 8, respectively, indicating that two or more input variables in those counties significantly exceeded average values for the State, making these the most vulnerable to flood losses. **Figure 2-65** shows results overlaid onto annual rainfall amounts to convey the relationship between rainfall amounts and flood vulnerability. Public land areas were removed to show distribution of potential damage to the built environment, although analyses were conducted countywide. Not surprisingly, areas of, or downstream from, areas of high annual rainfall tend to be most vulnerable to flood damage. This appears to more true in the northern rather than southern Oregon coast, possibly because of higher intensity land use in the north.

Figure 2-65. Annual Rainfall Relationship to Flood Vulnerability



Source: DLCD

Most Vulnerable Communities

DLCD supplemented the countywide assessment of vulnerability by looking at cities that received the most NFIP claims by dollar amount and count. We also identified cities with a large proportion of their land area identified as Special Flood Hazard Area. Eight of the 10 cities with highest number and dollar amount of NFIP paid claims are within the three most vulnerable counties (Clackamas, Columbia, and Tillamook).

Table 2-33. Top 10 Oregon Counties Vulnerable to Flooding as Measured by NFIP Claims

County	NFIP Claims Paid ($)	Population (2011)	Claim $ Per Capita	Unmitigated Repetitive Loss Buildings	Vulnerability Score
Clackamas	23,282,552	378,480	62	70	9
Columbia	19,925,386	49,625	402	17	8
Tillamook	12,989,179	25,255	514	163	11
Marion	5,664,119	318,150	18	22	5
Lincoln	5,439,319	46,155	118	108	6
Lane	3,736,028	353,155	11	71	6
Washington	3,305,600	536,370	6	121	5
Coos	2,408,653	62,960	38	28	7
Jackson	2,334,687	203,950	11	16	6
Clatsop	1,824,264	37,145	49	18	6

Sources: PSU Population Center 2012; FEMA Community Information System, 2014

The top 10 vulnerable cities, as measured by dollar amount paid on NFIP flood insurance claims, are shown in Table 2-34. The most vulnerable counties and cities within them are shown in boldface type.

Table 2-34. Top 10 Oregon Cities Vulnerable to Flooding as Measured by Dollar ($) Amount Paid on NFIP Claims

City	County	NFIP Claims Paid ($)	Population	$ Per Capita	Unmitigated Repetitive Loss Buildings
Vernonia	**Columbia**	$13,733,794	2,080	6,603	2
Tillamook	**Tillamook**	$7,551,192	4,880	1,547	17
Lake Oswego	Multnomah/**Clackamas**	$3,583,026	36,760	97	0
Salem	Marion	$3,390,250	156,455	22	3
Portland	Multnomah/**Clackamas**	$2,581,748	586,307	4	9
Milwaukie	**Clackamas**	$1,904,200	20,435	93	6
West Linn	**Clackamas**	$1,886,683	25,370	74	2
Oregon City	**Clackamas**	$1,467,600	32,500	45	1
Tualatin	Washington/**Clackamas**	$1,390,381	26,120	53	5
Coos Bay	Coos	$1,355,071	16,060	84	6

Note: The most vulnerable counties and cities within the group are shown in boldface type.

Sources: PSU Population Center 2012; FEMA Community Information System, 2014

The top 10 vulnerable cities, as measured by number of paid NFIP flood insurance claims, are shown in **Table 2-35**.

Table 2-35. Top 10 Oregon Cities Vulnerable to Flooding as Measured by Total Number of Paid NFIP Claims

City	County	Number of NFIP Paid Claims	Population	Per Capita	Unmitigated Repetitive Loss Buildings
Vernonia	**Columbia**	223	2,080	11%	2
Portland	Multnomah/**Clackamas**	198	586,307	<1%	9
Salem	Marion	190	156,455	<1%	3
Tillamook	**Tillamook**	180	4,880	1%	17
Lake Oswego	**Clackamas**	64	36,760	<1%	0
Milwaukie	**Clackamas**	57	20,435	<1%	6
Sheridan	Yamhill	57	6,180	<1%	1
Coos Bay	Coos	56	16,060	<1%	6
Lincoln City	Lincoln	53	7,965	1%	5
West Linn	**Clackamas**	52	25,370	<1%	1

Note: The most vulnerable counties and cities within them are shown in boldface type.

Sources: PSU Population Center 2012; FEMA Community Information System, 2014

Cities with a high proportion of FEMA-defined Special Flood Hazard area within their city boundaries are shown in **Table 2-35**. The area of Special Flood Hazard Area within city limits for each NFIP city was estimated by calculating the area of the Special Flood Hazard Area minus bodies of water to estimate normally dry Special Flood Hazard Area within city limits. We assumed that highest population densities are in cities due to Oregon's requirement to site most residential development inside Urban Growth Boundaries. All of the cities identified in this analysis have small populations, however, and therefore don't help identify a significant proportion of the population at risk from flooding. Only one of these cities is located in one of the three most vulnerable counties.

Table 2-36. Top 10 Cities by Percent Land Area in 1% Annual Flood Zone

City	County	Percent Normally Dry Land Area Within 1% Flood Zone	Population *Portland State University, 2012 Annual Population Report Tables*
Helix	Umatilla	70	190
Scio	Linn	62	830
Burns	Harney	52	2,835
Warrenton	Clatsop	47	5,090
Seaside	Clatsop	38	6,550
Vernonia	Columbia	36	2,080
Sheridan	Yamhill	36	6,180
Ione	Morrow	34	330
Adams	Umatilla	33	365
Athena	Umatilla	33	1,125

Note: Estimated using area of Special Flood Hazard Area, excluding area below ordinary high water divided by area within city limits.

Source: DLCD (2014)

Repetitive Losses

FEMA has identified 302 buildings in Oregon as repetitive loss (RL) properties. The NFIP defines an RL property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period since 1978. At least two of the claims must be more than 10 days apart but within 10 years of each other. Or, the property has incurred flood-related damage on 2 occasions, in which the cost of the repair, on the average, equaled or exceeded 25% of the market value of the structure at the time of each such flood event.

In Oregon, RL properties represent about 1% of all insured properties, and account for about 14% of all claims paid (21% of the dollar amount paid). RL properties in Oregon have suffered on average less than 3 losses each. Most (80%) of Oregon's repetitive loss properties were built in floodplains before FEMA FIRMs became available (FEMA NFIP BureauNet, http://bsa.nfipstat.fema.gov/, accessed 7/11/2014). The majority of Oregon's 302 repetitive loss buildings appear to be residential structures, but the State has yet to verify all of the repetitive loss buildings. Building type will be assigned to each RL property as part of the annual review described below.

Beyond identifying vulnerable buildings, the RL list provided by FEMA has value for hazard mitigation planning because the location of these buildings may indicate areas of persistent flood or drainage problems.

FEMA reports RL counts for unincorporated Clackamas (26), Lane (22), Lincoln (37), Tillamook (37), and Washington (28) in the double digits (FEMA NFIP BureauNet, http://bsa.nfipstat.fema.gov/, accessed 7/11/2014). Each of these counties also shows at least one severe repetitive loss (defined below). Of the cities, only the City of Tillamook shows RL buildings in the double digits. Together these counties and the one city account for over half of Oregon's repetitive losses. All of these counties and the one city are located all or part in Oregon's coastal region (Region 1), suggesting where the State should focus future mitigation planning and project development. Any mitigation of repetitive loss buildings along the coast also should address exposure to tsunami hazards.

Severe Repetitive Losses

Severe repetitive loss (SRL) properties are a subset of RL properties. SRL properties:

1. Are covered under a contract for flood insurance made available under the NFIP; and

2. Have incurred flood related damage:

   a. for which four or more separate claims payments have been made under flood insurance coverage with the amount of each such claim exceeding $5,000, and with the cumulative amount of such claims payments exceeding $20,000; or

   b. for which at least two separate claims payments have been made under such coverage, with the cumulative amount of such claims exceeding the market value of the insured structure.

Oregon is fortunate to have fewer than a dozen (11) SRL properties. Four of the SRL buildings are located in a county identified as most vulnerable to flood damages.

RL and SRL Mitigation Strategy

The State's strategy for selecting properties for flood hazard mitigation projects is four-fold. Priority projects are (a) are geographically balanced; (b) in communities with a FEMA-approved local hazard mitigation plan; (c) on buildings that have sustained substantial damages or repetitive losses, (d) located in jurisdictions capable of managing Federal grants. Buy-outs are the preferred mitigation action in areas affected by tsunami and in floodways.

The state, working with local jurisdictions, will verify the FEMA-provided repetitive flood loss information at least once during this Plan's term and establish a priority ranking for properties that would benefit most from hazard mitigation by means of acquisition, relocation, elevation, or demolition. Verification of properties is needed because the State has found that FEMA's RL list contains many address and geolocation errors, and in some cases the building has already been mitigated. The state will maintain and review the verified list annually as a basis for selecting and funding hazard mitigation projects.

DLCD and OEM will analyze and summarize the verified information in a geographic information system to discover spatial patterns associated with repetitive losses. Results will be shared with jurisdictions in which repetitive loss structures are located, with the recommendation that the loss areas be addressed as potential mitigation action items in local hazard mitigation plans (in concept but not by specific property address). DLCD will provide communities with RL property addresses so that they may determine whether these potential mitigation projects are cost-effective, environmentally sound, and technically feasible. Cost-effectiveness of mitigation must be proven for RL properties and unfortunately the dollar losses suffered by many properties in Oregon may not allow mitigation to be funded using the Federal mitigation grant programs. Even FEMA's Greatest-Savings-to-the-Fund (GSTF) calculation may not provide sufficient benefits to mitigate many properties.

OEM will then work with these communities to turn qualified potential projects into sub-grant applications. In addition to this routine work, Notice of Funding Availability letters will be sent directly to jurisdictions with validated RL and SRL properties whenever funding opportunities become available.

In 2013, the Oregon Department of Land Conservation and Development visited each of the FEMA- identified severe repetitive loss properties and assessed their mitigation potential. Local emergency management agencies have contacted owners of homes located in Lane, Linn and Marion Counties, and one in Clackamas County. The Linn County home was acquired in 2014. The State will continue to encourage owners of SRL properties to participate in FEMA mitigation programs.

Channel Migration

Channel migration vulnerability is not well understood at the state or regional level because no systematic identification of the hazard has been performed in Oregon.

Landslides

Landslides occur statewide in Oregon, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. In general, the coast and Coast Range Mountains and the Cascade Mountains have the most landslides. On occasion, major landslides sever major transportation routes such as U.S. or state highways and rail lines, causing temporary but significant economic damage to the state. Less commonly, landslides and debris flows in this area cause loss of life.

Most Vulnerable Communities

The Department of Geology and Mineral Industries is the agency with primary oversight of the landslide hazard. After agency staff review of available hazard data, DOGAMI lists Clackamas, Linn, Douglas, Coos, Lane, Tillamook, Multnomah, Benton, Jackson, Clatsop, Lincoln, Marion, Washington, Curry, Columbia, Hood River, and Yamhill Counties as having the highest hazard and risk to landslide in the state. Because of their importance to the state’s economy, landslides occurring in Multnomah, Clackamas, and Washington Counties present the greatest danger from this type of disaster. Landslides that close US-101 or any of the many highways connecting the I-5 corridor to the coast have a significant effect on commerce in the Oregon Coast Region.

Currently, there is no method to evaluate statewide vulnerability to landslides. The communities listed above are primarily based on existing landslide inventory data in SLIDO-2. DOGAMI has performed landslide risk analysis of some individual communities in Oregon including Astoria, part of the US-30 transportation corridor, the Mount Hood region, and parts of the Portland Metro area. The Mount Hood multi-hazard risk study provides details on the methods used to evaluate landslide and other hazard risk.

Tsunamis

The entire coastal zone is highly vulnerable to tsunami impact. Distant tsunamis caused by earthquakes on the Pacific Rim strike the Oregon coast frequently but only a few of them have caused significant damage or loss of life. Local tsunamis caused by earthquakes on the Cascadia Subduction Zone (CSZ) happen much less frequently but will cause catastrophic damage and, without effective mitigation actions, great loss of life.

Because tsunamis in Oregon typically occur as a result of earthquakes, the unknown time and magnitude of such events adds to the difficulty in adequately preparing for such disasters. If a major earthquake occurs along the CSZ, a local tsunami could follow within 5 to 30 minutes. Although tsunami evacuation routes have been posted all along the Oregon Coast, damage to bridges and roadways from an earthquake could make evacuation quite difficult even if a tsunami warning were given. In addition, if a major earthquake and tsunami occur during the "tourist season," causalities and fatalities from these disasters would be far greater than if the same events occurred during the winter months.

It is also important to consider where the impact of a tsunami would be the greatest. Owing to relatively large resident and visitor populations located at very low elevations, cities facing the Pacific Ocean on the northern Oregon Coast are more vulnerable to inundation and have the greater potential for loss of life than coastal cities in central and southern Oregon. USGS (Wood, 2007) estimated vulnerable populations using a tsunami inundation zone similar to the Medium CSZ event, which is the most likely event to occur. That study found that:

1. 22,201 residents and 10,201 households are in the zone, with the largest numbers in the northern coast;
2. the City of Seaside had the highest number of residents in the zone (4,790); and
3. 7,912 residents (36% of all residents in the zone) are in unincorporated communities, the balance in 26 incorporated communities.

Similar inventories are not yet available for the currently mapped DOGAMI tsunami inundation zones, but the lower probability L, XL, and XXL CSZ inundation zones will impact more residents. Distant tsunamis, except for the most extreme events, will not affect significant numbers of residents, since they flood principally beaches and immediate waterfront areas. Loss of life from distant tsunamis will also be far less than for local tsunamis, because there will be at least four hours to evacuate prior to wave arrival rather than 15–20 minutes.

That said, visitors are more vulnerable than residents to both distant and locally generated tsunamis, because they are more likely to be at beaches and shoreline parks and are generally less aware of hazard response and preparedness. During the summer and holidays, visitors can greatly outnumber residents in the small coastal towns. While intensive education and outreach programs led by DOGAMI and OEM have greatly increased awareness and preparedness, residents are much more likely to have received this education than visitors.

The Oregon Resilience Plan (ORP) uses the impact of a "Medium" or "M" CSZ earthquake and tsunami for planning purposes, because this was judged the most likely CSZ event (see DOGAMI Special Paper 43 [Witter et al., 2011] for explanation). The current regulatory tsunami inundation used by the Oregon Building Code to limit new construction of critical, essential, large occupancy, and hazardous facilities also uses a scenario similar to the "Medium" case. The ORP describes the "M" impact as follows:

> *Following the Cascadia event, the coastal communities will be cut off from the rest of the state and from each other. The coastal area's transportation system, electrical power transmission and distribution grid, and natural gas service will be fragmented and offline, with long-term setbacks to water and wastewater services. Reliable communications will be similarly affected. Because so many of these connecting systems are single lines with little or no redundancy, any break or damage requiring repair or replacement will compromise the service capacity of the entire line.*
>
> *The loss of roads and bridges that run north and south will make travel up and down the coast and into the valley difficult, if not impossible, due to the lack of alternate routes in many areas. Reestablishing the roads and utility infrastructure will be a challenge, and the difficulties will be exacerbated in the tsunami inundation area by its more complete destruction. Even businesses outside of the tsunami inundation may not recover from the likely collapse of a tourist-based economy during the phased and complicated recovery and reconstruction period.*
>
> *Based on the resilience targets provided by the Transportation, Energy, Communications, and Water/Wastewater task groups, current timelines for the restoration of services up to 90-percent operational levels will take a minimum of one to three years, and often over three years in the earthquake-only zone. Restoration in the tsunami zone will take even longer than that... The most critical infrastructure is the road and highway system. Without functioning road systems, none of the infrastructure can be accessed to begin repairs.*
>
> *The tsunami will also create an enormous amount of debris that needs to be gathered, sorted, and managed. The recent experience of Japan, with a similar mountainous coastline, has shown that debris management competes with shelter and reconstruction needs for the same flat land that is often in the inundation zone.*

The ORP estimates that times for recovery of the coastal infrastructure for a Medium CSZ event will be as follows: electricity and natural gas, 3–6 months; drinking water and sewer systems, 1–3 years; and Healthcare facilities, 3 years. The ORP gives no estimate for times to recover police and fire stations or the coastal transportation system, but times for the latter would no doubt be measured in years. Economic recovery would also be many years, since much of the coast is dependent on tourism that is directly dependent on the transportation system. According to the ORP:

> *Even if a business had sufficient capital to relocate, it is unlikely that the tourist industry will recover rapidly enough to support business start-up. Local authorities may need to keep tourists out of the inundation zones, for safety reasons, for months or years after a tsunami.*

Most Vulnerable Communities

The entire coastal region is highly vulnerable to tsunamis, but some areas are more vulnerable owing to geographic and demographic factors. The Oregon Office of Emergency Management (OEM) is the agency with primary oversight of emergency response to the tsunami hazard. A 1990 revision of DOGAMI's enabling statutes added geologic hazard mitigation to its responsibilities, but other state agencies such as OEM and local governments share this responsibility. Based on agency staff review of the available hazard data, particularly estimates of Wood (2007), OEM lists Clatsop and Tillamook Counties as having the greatest hazard to tsunami in the state. As previously mentioned, Seaside is the town most vulnerable to tsunamis on the coast, but Gearhart, Cannon Beach, Rockaway Beach, Pacific City, Neskowin, Salishan Spit, Cutler City in Lincoln City, South Beach in Newport, and downtown Waldport are all extremely difficult to evacuate owing to local geographic factors (marshes or lakes limiting evacuation, long distances to evacuation routes, and limited high ground for evacuees) and significant percentages of retirees with limited mobility.

Vulnerability of communities is based primarily on difficulty of evacuation in the 15-20 minutes between a CSZ earthquake and arrival of the tsunami. A community is considered highly vulnerable if the population is large with high ground located a long distance away accessible by only a few routes that could be compromised by earthquake damage.

Volcanoes

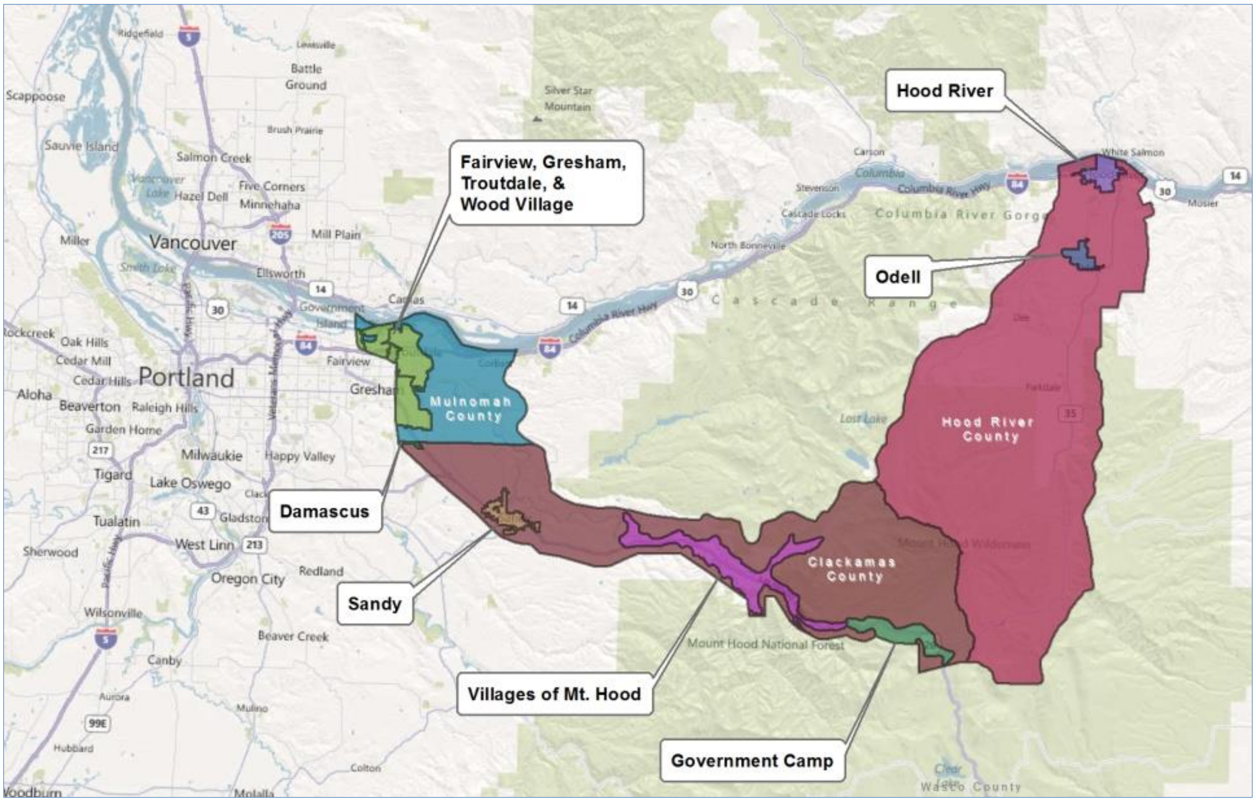
Oregon's vulnerability to volcanic events varies statewide. The Cascade Mountains, which separate Western Oregon from Central Oregon, pose the greatest threat for volcanic activity. Oregon NHMP Natural Hazard Regions that include the Cascade Mountains are most vulnerable to the effects of a volcanic event. Within the State of Oregon, there are several volcanoes that may pose a threat of future eruption. These include Mount Hood, which most recently erupted about 200 years ago, Newberry Volcano with recent eruptions about 1300 years ago, and the Three Sisters and Mount Jefferson with eruptions about 15,000 years ago. Eruptions from volcanoes in Washington State, like the Mount St. Helens eruption in 1980, can also significantly impact Oregon.

Most Vulnerable Communities

The Oregon Department of Geology and Mineral Industries (DOGAMI) is the agency with primary oversight of the Volcano hazard. After agency staff review of the available hazard data, DOGAMI lists Clackamas, Douglas, Deschutes, Hood River, Jackson, Jefferson, Klamath, Lane, Linn, Marion, Multnomah, and Wasco Counties as having the highest volcanic hazard in the state. Deschutes County is most vulnerable in the Central Oregon Region because the region's most populous city, Bend, is located here and the greatest numbers of "composite" volcanic mountains are located near the county's population centers. Klamath and Jefferson Counties are also vulnerable within this region. Other regions are also vulnerable to damage from volcanic eruptions. If Mount Hood erupted, the Northern Willamette Valley/Portland Metro Region and the Mid-Columbia Region would both be impacted. Because of Mount Hood's proximity to Portland, the Columbia River, the I-84 freeway, and major dams on the Columbia River, the potential for a large disaster exists.

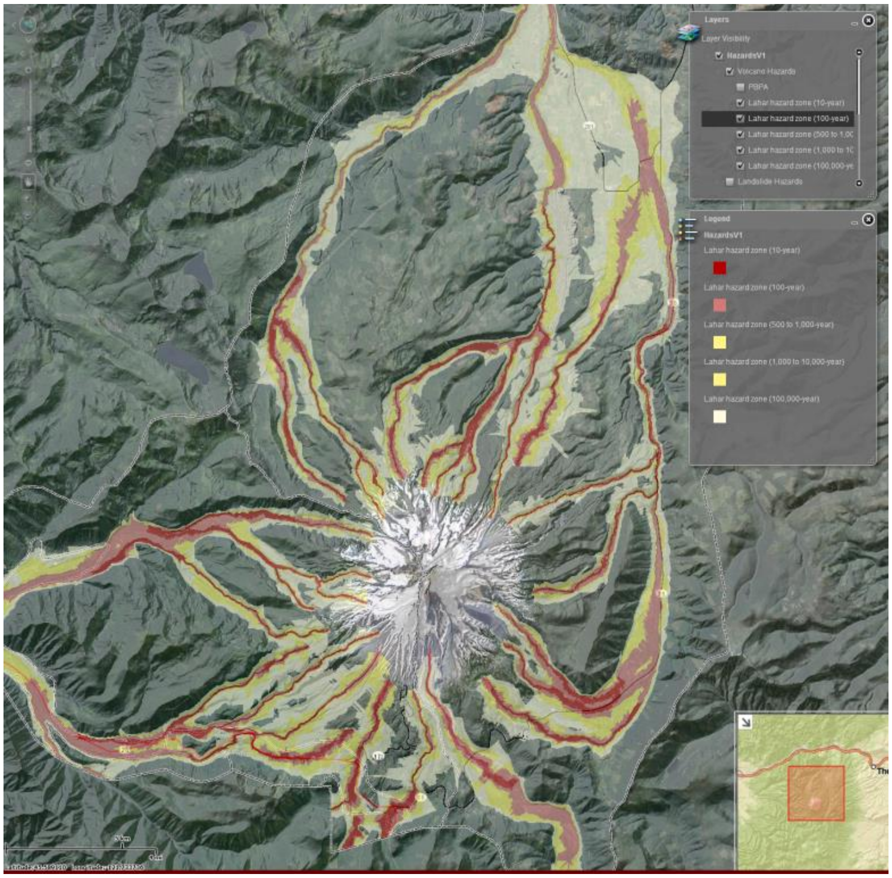
Little has been done to evaluate risk to volcanoes. One of the first studies to evaluate risk for the Mount Hood region was by Burns et al. (2011b) (**Figure 2-66**, **Figure 2-67**, and **Table 2-37**). The main purpose of this study was to help communities on or near Mount Hood become more resilient to geologic hazards by providing accurate, detailed, and up-to-date information about the hazards and the community assets at risk. A second purpose was to explore hazard and risk analysis methodologies that would be applicable to other volcanic areas. The study examined volcano, landslide, flood, channel migration, and earthquake hazards on Mount Hood, along US-26 and the Sandy River Corridor, and along OR-35 and the Hood River Corridor (**Figure 2-66**). Two types of risk analysis were performed: (a) hazard and asset exposure, and (b) Hazus-MH (FEMA, 2005). **Figure 2-67** and **Table 2-37** are a summary of volcano and community asset exposure for the study area.

Figure 2-66. Mount Hood Risk Study Project Area



Source: Burns et al. (2011b)

Figure 2-67. Interactive Web Map for Mount Hood Risk Study



Source: DOGAMI. Map generated at Hazards and Assets Viewer for Mount Hood website: http://www.oregongeology.org/MtHood/

This study also found approximately 5,000 people are located in the 500-year volcano hazard zones, which is a large amount of people to evacuate in an event. Although the report estimated 6% to 22% of the total study area community assets will be damaged or lost, this percentage is significantly more within some individual communities, especially The Villages at Mount Hood. Both risk methods resulted in ranges of percent damage and losses that appear reasonable. For example, we found 11% to 34% loss ratios for the volcano exposure method and 5% to 35% loss ratios for the Hazus-MH volcano analyses are all in the same approximate range of 10% to 35%. The report estimates the loss ratio for the 500-year volcano hazard to be approximately 18% for the study area from these ranges of percent loss from the various portions of the two risk analyses.

Table 2-37. Summary of Community Asset Exposure to Volcano Hazards for Mount Hood

Hazard	Population	Buildings		Generalized Land Use / Zoning Parcels		Critical Facilities	Primary Infrastructure—Roads (miles)
		Count	$Value	Count	$Value		
Proximal	2,129	1,604	$242 million	2,995	$208 million	8	287
Lahar, 10-year	163	120	$32 million	520	$19 million	0	22
Lahar, 100-year	473	531	$92 million	1,633	$71 million	0	91
Lahar, 500- to 10,000 year	3,843	3,731	$663 million	7,120	$402 million	7	271
Lahar, 100,000-year	14,635	9,897	$1,510 million	13,082	$1,364 million	21	525

Source: Burns et al. (2011b)

Wildfires

Wildfires are a common and widespread natural hazard in Oregon. Fire is a critical component of the forest and rangeland ecosystems found in all portions of the state. Over 41 million acres of forest and rangeland in Oregon are susceptible to wildfire, which may occur during any month of the year, but usually occur between July and October. On average, 96% of the fires are suppressed at 10 acres or less. Unfortunately, the remaining 4% of the fires tend to be damaging and very difficult to suppress.

The principal type of wildfire affecting Oregon communities is a wildland-urban interface (WUI) fire, which occurs where wildland and developed areas intermingle with both vegetation and structures combining to provide fuel. As more people have moved into WUI areas, the number of large wildfires impacting homes has escalated dramatically. In addition to WUI fires, Oregon experiences wildland fires that do not threaten structures, and also occasionally has prescribed fires.

The general factors that contribute to a higher risk from wildfire are as follows:

Ignition Risk: A high risk rating was given when fire occurrence exceeded 1 fire per 1,000 acres over 10 years.

Suppression capability: Areas at high risk have no organized fire suppression response capability. Areas at moderate risk have wildland forest suppression response, but structural response within 10 minutes is limited.

Values at risk: High values at risk were defined by population and dwelling densities (urban and highly urbanized), forests containing municipal watersheds and forests managed for wood production.

Fuel loading and hazard: A high risk rating is a composite, based on the following factors (percentages indicate the weight of each factor):

- *Weather:* The weather risk rating is based on the number of days per season that forest fuels were capable of producing a significant wildfire event as determined by an analysis of daily fire danger rating indices for regulated use areas across Oregon. All of eastern Oregon and interior southwest Oregon are high weather risk.
- *Slope, Aspect and Elevation:* Slopes greater than 40% with south facing aspects at elevations at or below 3,500 feet all contribute to high risk.
- *Fuels:* Forest fuels that result in the following fire behaviors: flame lengths exceeding 8 feet; frequent spotting, torching, or crowning such that fire severity is stand-replacing. Example fuel conditions include flammable grasses, heavy/flammable brush, and mature timber with slash.
- *Insect and Disease Damage:* A high risk rating was given for forested areas exhibiting at least three dead trees per acre from insect and disease, or at least three consecutive years of defoliation from the spruce budworm, as determined by the statewide Aerial Insect and Disease Survey.

Fire regime condition class: Fire regime condition class is a measure of forest conditions that are outside the range of natural variability in fuel conditions as result of increased tree stocking and fuel build-up after fire suppression. Lodgepole pine forests are the exception as they can exhibit a high Fire Regime Condition Class rating even though the fuel conditions are within their range of natural variability. Forests with the high risk Fire Regime Condition Class rating exhibit excessive surface fuels, brush, live and dead mid-canopy or ladder fuels as well as canopy fuels in standing dead and overstocked mature trees. Under these forest conditions wildfires are likely to develop into severe crown fires.

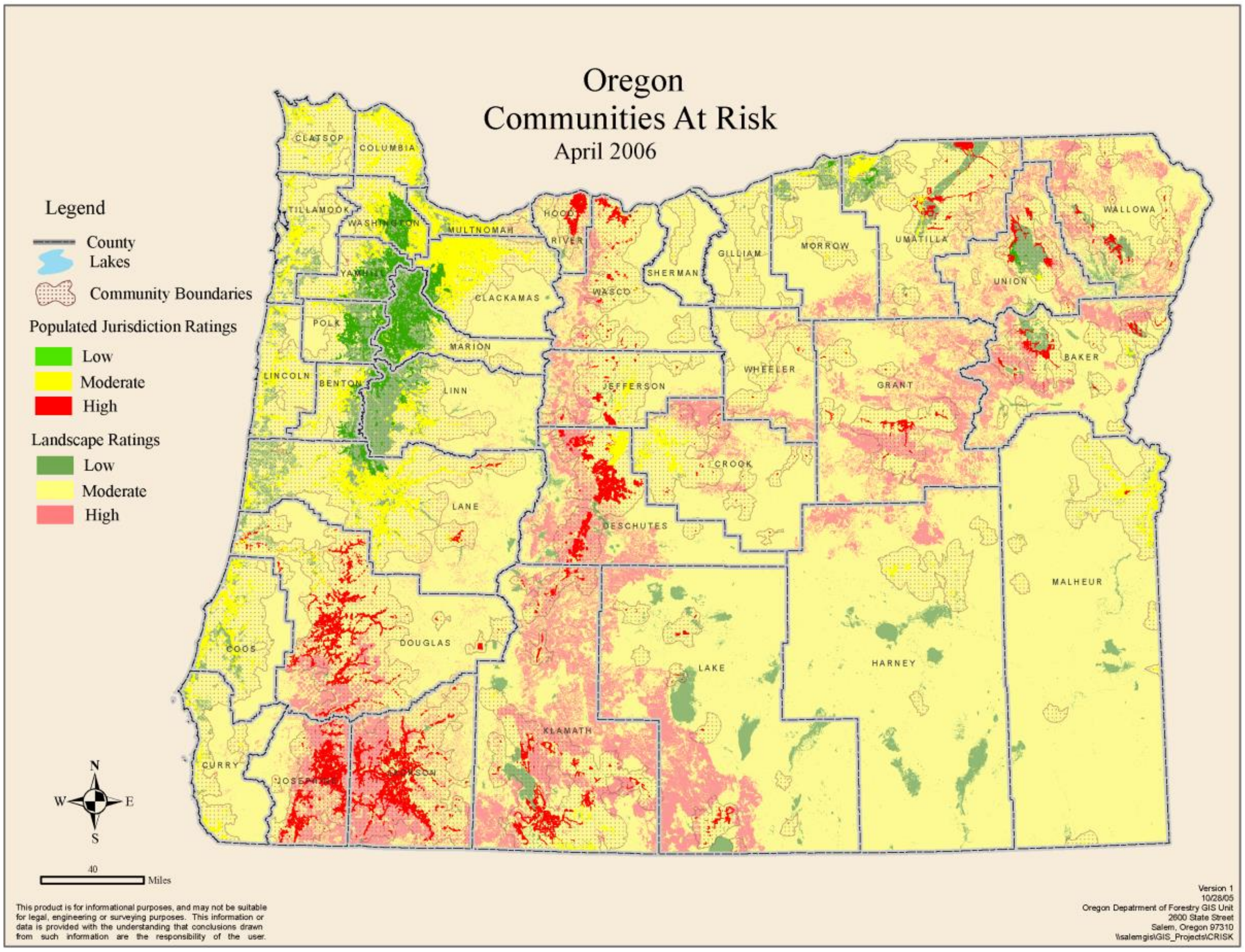
Most Vulnerable Communities

In 2006, the Oregon Department of Forestry conducted a Statewide Forest Assessment of the communities at risk to wildfire to determine priorities for delivering landowner assistance. The parameters of this assessment included high-priority fish and wildlife habitat, potential for forest conversion, and communities at risk to wildfire. With local evaluation and adoption, the 2006 assessment can be superseded with the 2013 West Wide Wildfire Risk Assessment (WWRA) to characterize Oregon wildfire risk and vulnerabilities.

Much like the 2006 assessment, the WWRA defined a community at risk as a geographic area within and surrounding permanent dwellings 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. The 2006 assessment evaluated landscape wildfire risk based on ignition risk, fuel loading and hazard, suppression capability, and values at risk (population, municipal watersheds, commercial timber), and then evaluated risk as a function of the surrounding landscape risk ratings. The WWRA used updated data, added a Riparian value component, and used a more comprehensive fire behavior modeling process. For identifying communities, the WWRA determined “where people live” by using “night-light” satellite imagery coupled with 2010 U.S. Census data to detect actual dwellings and structures, especially those in wildland-urban interface areas.

In the still widely cited 2006 assessment, of the 595 identified community areas in Oregon, 159 (27%) face a HIGH risk from wildfire and 331 (56%) faced a moderate threat. Although the majority of Oregon NHMP Natural Hazard Regions have at least one high-risk community, the majority of these communities are concentrated in Regions 4 and 6. In Region 4, Douglas County had the highest absolute number of high-risk communities with 33, and Jackson County had the highest percent of communities facing high risk (all 22 identified communities). In Region 6, Deschutes County recorded the second highest percentage with 10 out of 12 identified communities facing high risk of wildfire (**Figure 2-68**).

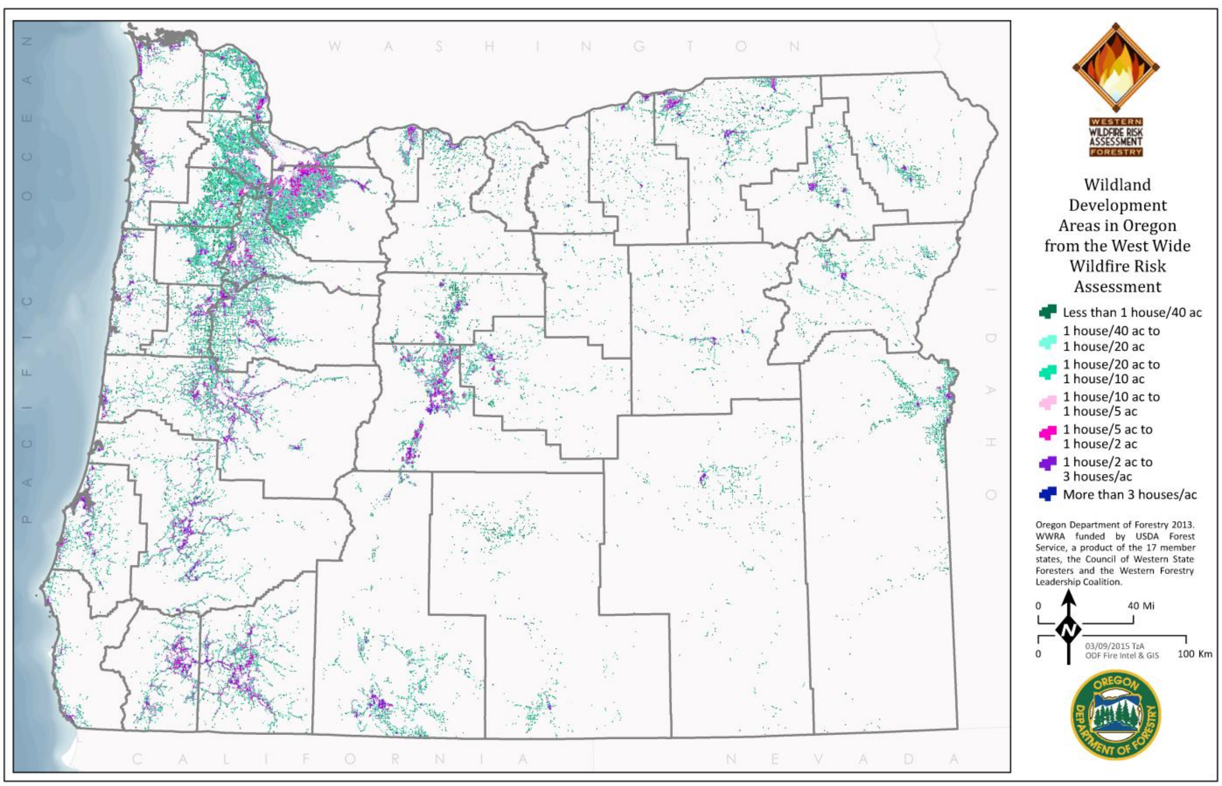
Figure 2-68. Communities at Risk, Overall Landscape Wildfire Risk Map



The WWRA identified that of 56 million total burnable acres across the state (90% of all lands), 22% are subject to moderate to high wildfire risk. 22 counties each have over 1 million wildland acres subject to a moderate to high risk. There are about 636,000 acres of wildland development areas at moderate to high fire risk, and 751,672 people are living at risk to wildfire within these areas. 27.6 million acres of forest assets are at risk to wildfire, 6.5 million of which are subject to a moderate to high risk. 2.9 million acres of riparian area are subject to moderate to high wildfire risk. As shown in **Wildfire: West Wide Wildfire Risk Assessment Project Summary Statistics of Published Results by State: Oregon** and **Wildfire: West Wide Wildfire Risk Assessment Final Report–Addendum VI, County Risk Summaries: Oregon**, the WWRA provided summary statewide and county level statistics showing acreages for fire risk categories which could be a useful first glance at overall risk at the statewide and county level.

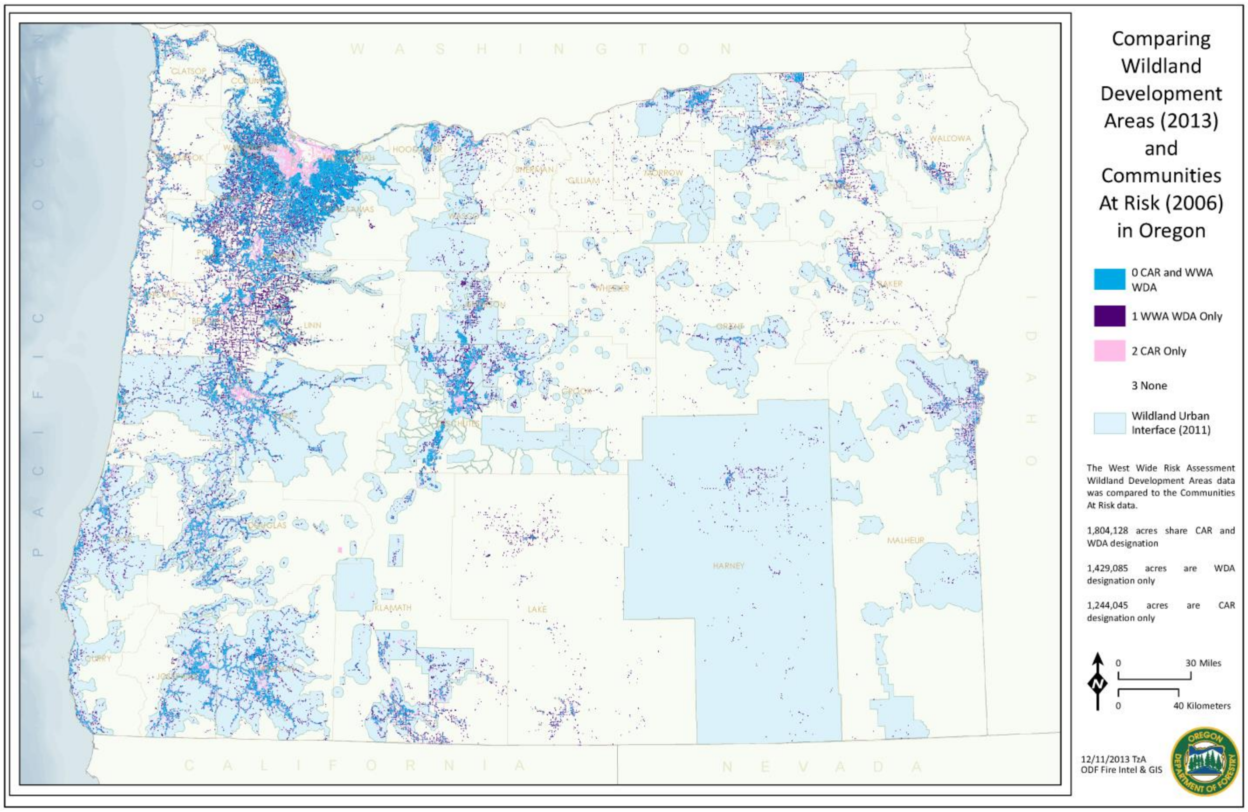
With respect to structures and population density, communities that were evaluated for wildfire risk in the WWRA as shown in **Figure 2-69** were either rural (consisting of 1 to 3.9 dwellings per 40 acres and a population density of 28 to 111 people per square mile), suburban (consisting of 4 to 19.9 dwellings per 40 acres and a population density of 112 to 559 people per square mile) or urban (consisting of 20 to 99 dwellings per 40 acres and 560 to 1,371 people per square mile). Highly urbanized areas (100 or more dwellings per square mile and 1,372 or more people per square mile) were excluded.

Figure 2-69. Wildfire Risk for Wildland Development Areas, Based on Night-Light Satellite Imagery and Census Data



A preliminary comparison of the WWRA Wildland Development Areas and the 2006 Communities At Risk (CAR) in **Figure 2-70** shows a similarity in geography and extent, but the WWRA may capture some isolated homes that are not necessarily within a CAR or wildland-urban interface area. Local communities may be able to refine CARs with supplemental data from WWRA WDAs.

Figure 2-70. Preliminary Comparison of 2013 WWRA Wildland Development Areas and 2006 Communities at Risk (CARs)



In addition, forest assets, riparian assets, and drinking water areas were evaluated for their economic, habitat, and drinking water importance with consultations with resource experts in the multi-state effort of the WWRA. **Figure 2-71** shows the potential response of forest assets to fire, whether sensitive, adaptive, or resilient. Forested lands were categorized by height, cover and susceptibility (response to wildfire). About 6.6 million acres of forest assets are at moderate to high fire risk. **Figure 2-72** shows the importance of riparian assets in terms of terrestrial and aquatic habitat values, water quality and quantity, and other ecological functions. Nearly 3 million acres of riparian areas are classified as moderate to high risk, and nearly all were classified as most important riparian areas. **Figure 2-73** shows areas that present crucial contributions to sustaining the quality of drinking water by incorporating data on water supply, surface drinking water consumers at the point of intake, and the flow patterns to the surface water intakes. Approximately 18.7 million acres of drinking water sources are at moderate to high fire risk.

Figure 2-71. Forest Assets Response to Wildfire: Whether the Forests are Resilient, Adaptive, or Sensitive to Wildfire

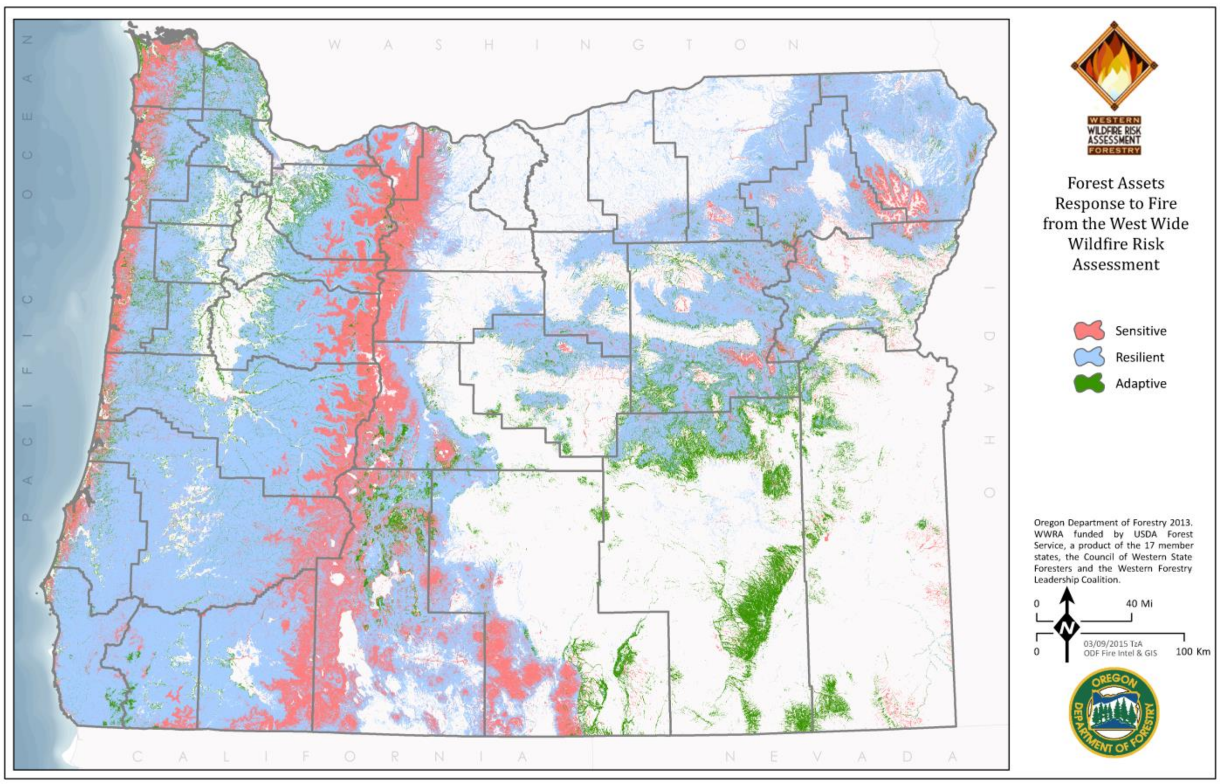


Figure 2-72. Riparian Importance in Terms of Terrestrial and Aquatic Habitat Values, Water Quality and Quantity, and Other Ecological Functions

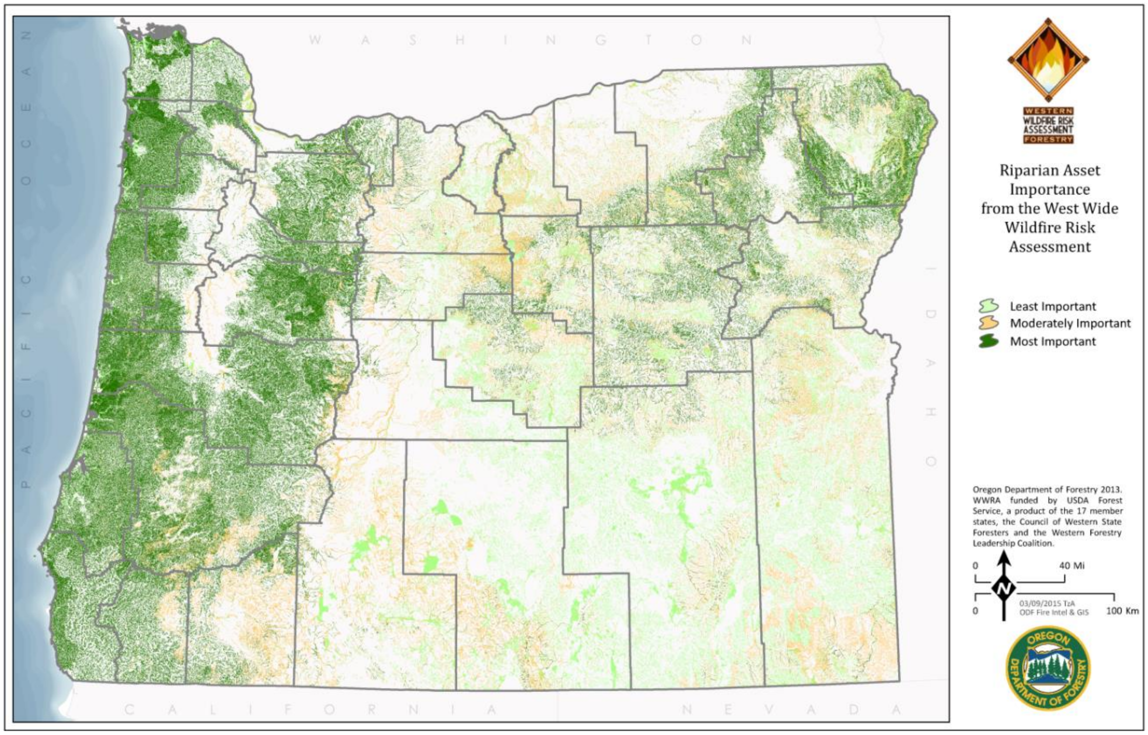
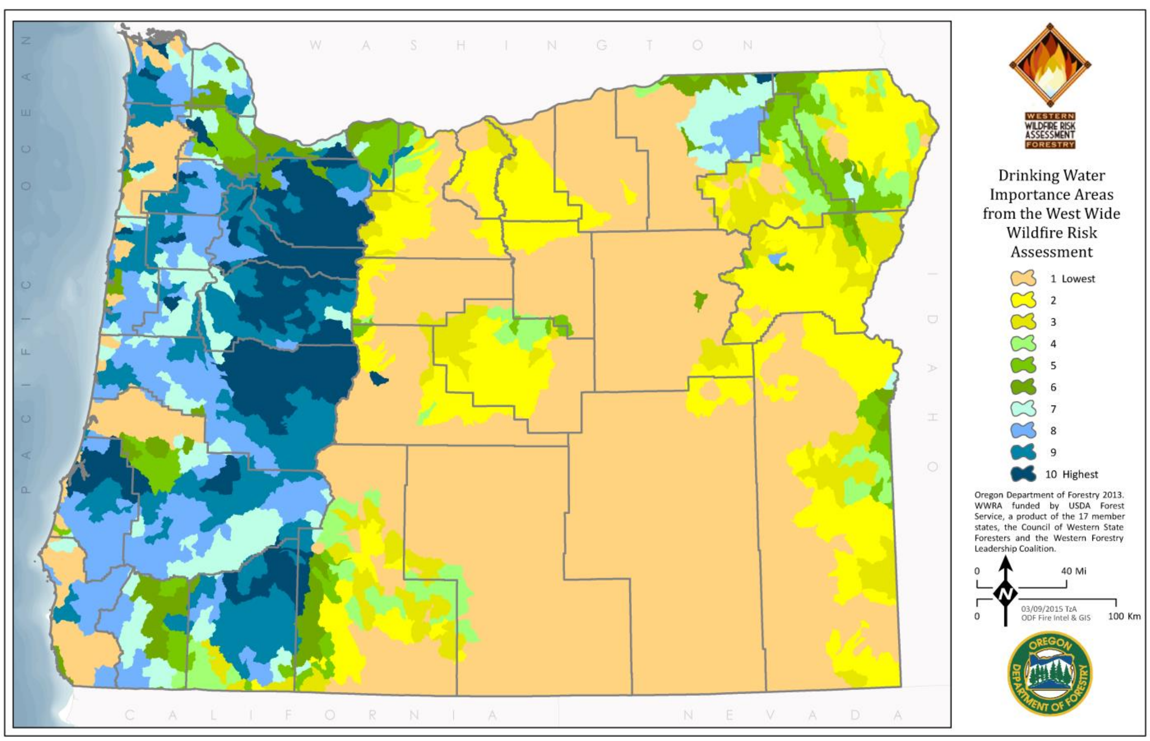
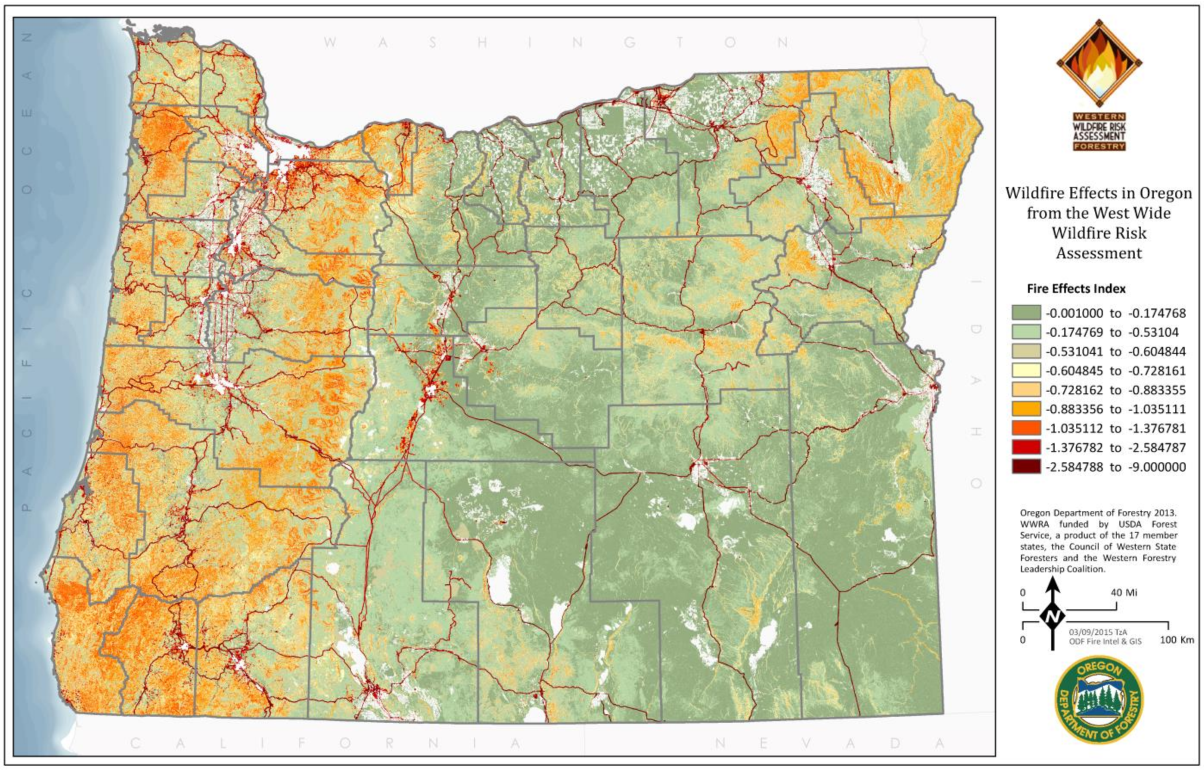


Figure 2-73. Drinking Water Importance Areas



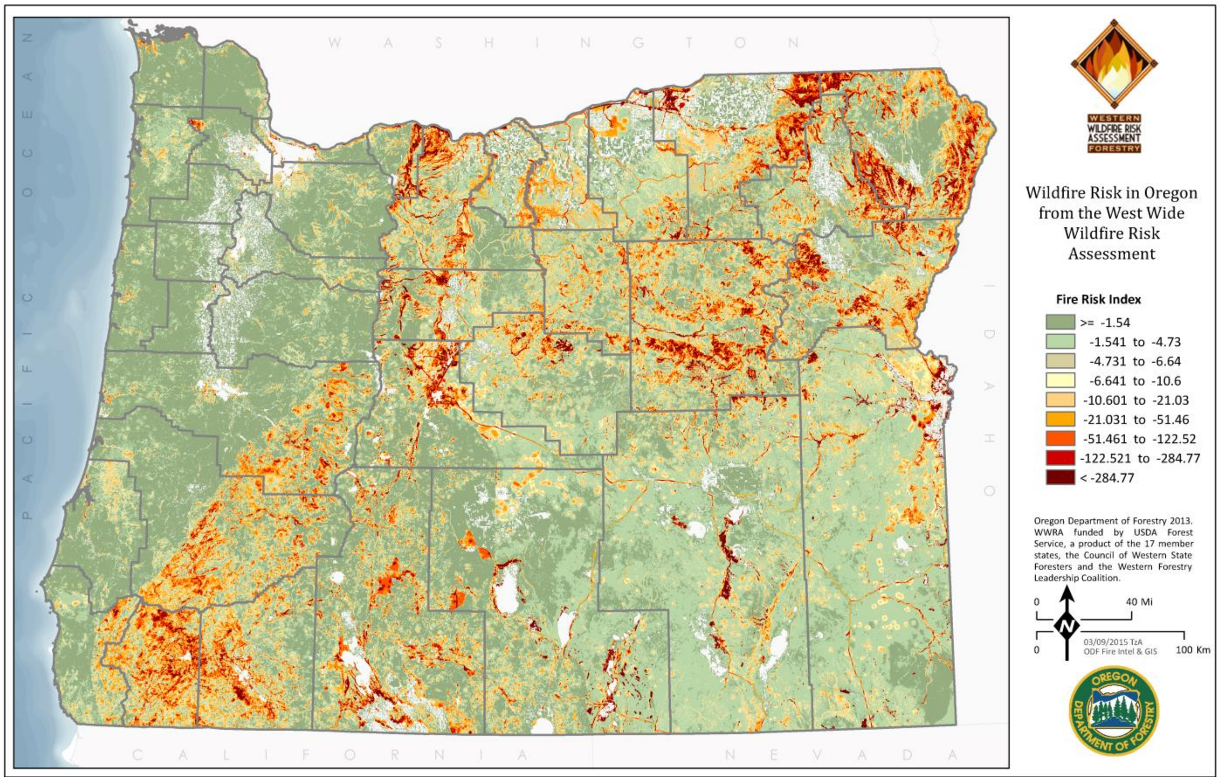
The Fire Effects Index combines areas that have important values at risk to wildfire, including the values discussed above — where people live adjacent to burnable wild lands, forest and riparian assets, and drinking water. The Fire Effects Index also considers the cost to suppress a fire. The final product, the Fire Effects Index is shown classified into categories and displayed based upon a cumulative percent of acres by class. One can generally interpret the greener the color, the lesser the overall impact, the redder the color the larger the impact. **Figure 2-74** shows the Fire Effects Index as a measure of the overall impact on important values, and takes into account the difficulty in fire suppression.

Figure 2-74. Fire Effects Index



The Fire Risk Index, shown in **Figure 2-75**, is a measure of the overall wildfire risk. It is calculated from the Fire Threat Index and the Fire Effects Index. It shows that the warmer, redder areas of the state experience more frequent wildfire activity historically and have a greater likelihood of fires igniting and spreading. It also reflects Fire Effects to a lesser degree, meaning the greater weight on this output is regarding wild fire occurrence and spread. This data set will continue to be evaluated for fitness for use.

Figure 2-75. Fire Risk Index



Overall, although both the Fire Risk and Fire Threat maps may suggest a “lesser risk” in western Oregon, the Fire Effects are much greater as there are more sensitive forest, riparian, and human values at risk. The Fire Risk does agree with our understanding of historic fire regimes: that although large fires are less frequent in coastal forests, more severe effects occur when conditions are right to allow for large fire spread and that in drier regions of the state, fires historically occur more frequently but have more variable severities and effects.

The Oregon Department of Forestry (ODF) is the agency with primary oversight of the Wildfire hazard. Based on agency staff review of the available hazard data, every county in Oregon has wildland areas and some level of vulnerability to wildfire.

Table 2-38 lists counties that have a high percentage of wildland acres that are subject to one or more of these WWRA categories: Fire Risk, Wildland Development Areas, Fire Effects, and Fire Threat. Counties with a high percentage of acres in three or more categories are considered most vulnerable. All other counties in the state are considered vulnerable to some extent.

Table 2-38. Counties with High Percentages of Acres Affected by Wildfire

Counties with Greater than 20% of Their Wildland Acres Subject to Moderate to High Overall Fire Risk	Counties with Greater than 10% of Their Wildland Acres in Wildland Development Areas	Counties with Greater than 20% of Their Wildland Acres Subject to Moderate to High Fire Effects	Counties with Greater than 20% of Their Wildland Acres Subject to Moderate to High Fire Threat
Baker		Baker	Baker
	Benton	Benton	
	Clackamas	Clackamas	
		Clatsop	
	Columbia	Columbia	
Crook			Crook
		Coos	
		Curry	
Deschutes	**Deschutes**	**Deschutes**	**Deschutes**
Douglas	**Douglas**	**Douglas**	
Gilliam			Gilliam
Grant		**Grant**	**Grant**
Hood River		Hood River	
Jackson	**Jackson**	**Jackson**	**Jackson**
Jefferson		**Jefferson**	**Jefferson**
Josephine	**Josephine**	**Josephine**	**Josephine**
Klamath	**Klamath**	**Klamath**	**Klamath**
	Lane	Lane	
	Lincoln	Lincoln	
	Linn	Linn	
	Marion	Marion	
Morrow			Morrow
	Multnomah	Multnomah	
	Polk	Polk	
Sherman			Sherman
		Tillamook	
Umatilla	**Umatilla**	**Umatilla**	**Umatilla**
Union		**Union**	**Union**
Wallowa		**Wallowa**	**Wallowa**
Wasco		**Wasco**	**Wasco**
	Washington	Washington	
Wheeler			Wheeler
	Yamhill	Yamhill	

Boldface text indicates those counties with a high percentage of acres in three or more categories, and which are considered most vulnerable.

Source: Oregon Department of Forestry

In late 2015 the WWRA will be incorporated into Oregon State University's Oregon Explorer online mapping application as a primary data source in the Wildfire Explorer module. Community Wildfire Protection Planning tools and outreach programs will be developed as part of the Explorer application for Oregon's community Wildfire Planners so local users can evaluate the data and supplement their local knowledge.

Windstorms

The damaging effects of windstorms may extend for distances of 100 to 300 miles from the center of storm activity. Isolated wind phenomena in the mountainous regions have more localized effects. Near-surface winds and associated pressure effects exert loads on walls, doors, windows, and roofs, sometimes causing considerable damage. When severe windstorms strike a community, downed trees, power lines, and damaged property are major hindrances to response and recovery.

Most Vulnerable Communities

The Oregon Coast has several relatively harsh storms during the winter months. Although major damage from these storms is infrequent, the Oregon Coast Region of the state is the most vulnerable to windstorms. The seven coastal counties in the Oregon Coast Region often face 60 to 100 mile an hour winds sometime during the year. While the coast is experiencing severe winds, the Willamette Valley may also face 40 to 60 mile per hour winds from the same storm. Also, the Columbia River Gorge funnels very strong winds, often from east to west. The Northern Willamette Valley/Portland Metro and Mid-Columbia Regions are most vulnerable to this type of wind event.

Major windstorms that can impact large areas of the state, like the Columbus Day windstorm of 1962, are relatively rare. These storms can cause major damage to many areas of the state with the Oregon coastal counties typically suffering the most damage from this type of hazardous event.

Historically, the Oregon communities most vulnerable to windstorm damage and loss are Benton, Clatsop, Coos, Columbia, Curry, Douglas, Gilliam, Hood River, Lane, Lincoln, Linn, Marion, Morrow, Multnomah, Polk, Sherman, Tillamook, and Washington. The identification of communities most vulnerable to windstorms is based on PUC agency staff and OCCRI/OCS staff review.

Winter Storms

A major winter storm can last for days and can include high winds, freezing rain or sleet, heavy snowfall, and cold temperatures. People can become marooned at home without utilities or other services. Severe cold can cause much harm. It can damage crops and other vegetation and freeze pipes, causing them to burst. Unusually cold temperatures are especially dangerous in areas not accustomed to them because residents are generally unprepared and may not realize the dangers severe cold presents.

Figure 2-76. Trucks Wait Out Winter Storm

Note: Trucks wait at a truck stop in Troutdale after ice, wind, and snow caused ODOT to close I-84 through the Columbia River Gorge – January 2004

Photo source: William Hamilton, *The Oregonian*

Heavy snowfall and blizzards can trap motorists in their vehicles and make walking to find help a deadly mistake. Heavy snow can immobilize a region and paralyze a city, stranding commuters, closing airports, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow can cause roofs to collapse and knock down trees and power lines. Homes and farms may be isolated for days. In rural areas, unprotected livestock can be lost. In urban areas, the cost of snow removal, damage repair, and lost business can have severe economic impacts.

When an ice storm strikes, some landscape trees seem to be able to come through with only minor damage, while others suffer the loss of large limbs or sizable parts of their branching structure. In the worst cases, trees may be completely split in two or may have nothing left standing but a trunk. If a tree has been weakened by disease, there may be little that can be done to prevent major breakage or loss when the stresses of a storm occur. However, there are preventive measures that cities and property owners can take to help their trees be stronger and more resistant to storm damage. For more information, see **Appendix 9.1.9**, *Reducing Ice Storm Damage to Trees*.

Heavy accumulations of ice can bring down trees and topple utility poles and communication towers. Ice can disrupt power and communication for days while utility companies repair extensive damage. Even small accumulations of ice can be dangerous to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces.

Exposure to cold can cause frostbite and life-threatening hypothermia. Frostbite is the freezing of body tissue. It most frequently affects fingers, toes, earlobes, and the tip of the nose. Hypothermia begins to occur when a person's body temperature drops three degrees below normal temperature. On average, a person begins to suffer hypothermia if his or her temperature drops to 96 °F (35.6 °C). Cold temperatures can cause hypothermia in anyone who is not adequately clothed or sheltered in a place with adequate heat. Hypothermia can kill people, and those who survive hypothermia are likely to suffer lasting ill effects. Infants and elderly people are the most susceptible. Elderly people account for the largest percentage of hypothermia victims, many of whom freeze to death in their own homes. Most of these victims are alone and their heating systems are working improperly or not at all. People who take certain medications, who have certain medical conditions, or who have been drinking alcohol also are at increased risk for hypothermia.

Driving can be tricky in the snow, but once a storm has passed, there is another danger: flying snow from trucks and cars. When snow is warmed by the vehicle, it will begin to melt. Wind and motion cause sections to break off and hit other vehicles. The snow can also fall on the road, melt, and later turn into ice.

Winter storms are considered deceptive killers because most winter storm deaths are related only indirectly to the storms. Overall, most winter storm deaths result from vehicle or other transportation accidents caused by ice and snow. Exhaustion and heart attacks brought on by overexertion are two other common causes of deaths related to winter storms. Tasks such as shoveling snow, pushing a vehicle, or even walking in heavy snow can cause a heart attack, particularly in people who are older or who are not used to high levels of physical activity. Home fires occur more frequently in the winter because people do not take the proper safety precautions when using alternative heat sources. Fires during winter storms present a great danger because water supplies may freeze and it may be difficult for firefighting equipment to get to the fire. In addition, people can be killed by carbon monoxide emitted by fuels such as charcoal briquettes improperly used to heat homes (National Disaster Education Coalition, 2004).

One issue is the lack of a statewide effort regarding winter storm impacts, either historical or for future planning. There are only a few snowfall sensors distributed mainly through the mountain ranges of the state and there is not an annual tracking system in place for snowfall statewide. A program to install snowfall sensors and track snowfall statewide would allow us to better understand the impact of winter storms on Oregon and have a better means of predicting potential impacts in the future.

Most Vulnerable Communities

The Oregon Department of Transportation (ODOT) is the agency with primary oversight of the winter storm hazard. Based on agency staff review of the available hazard data, ODOT lists the Northern Willamette Valley (Linn, Benton, Marion, Polk, and Yamhill Counties), the Portland Metro Region (Columbia, Washington, Multnomah, and Clackamas Counties), and the Mid/Southern Willamette Region (Lane, Douglas, Josephine, and Jackson Counties) as the most vulnerable to damage and loss associated with winter storms because Oregon's most densely populated cities are located within these regions.

The Portland Metro area is the most vulnerable not only because it is the most densely populated but also because of its proximity to the Columbia River Gorge. It is not uncommon to have severe ice and sleet storms occurring as cold artic winds blow down the Gorge over east Multnomah County and Portland. These storms have delayed air traffic and even closed the Portland International Airport in the past, thus negatively affecting Oregon's economy. Winter storms often bring ice and sleet that makes driving extremely dangerous. Ice and sleet storms can cripple the movement of goods and services, thus negatively impacting Oregon's economy.

National Weather Service winter storm reports were used as the basis for determining community vulnerabilities. Unfortunately there is only the NWS storm information available for analysis. There is no statewide winter storm program to study the impacts of these storms statewide. There is no program to identify annual average snowfalls across the state either historical or for planning purposes. Hydrological precipitation information is available but not winter storm and snowfall information.

2.2.2.4 Local and State Vulnerability Assessment Comparison

Vulnerability rankings guide local and state mitigation goals and actions that inform mitigation priorities at the local and state scale. Past iterations of the Oregon NHMP stated local and state vulnerability rankings separately. No comparison or analysis of similarities and differences among the rankings of risk assessment methods was conducted. For this update, the state placed local and state vulnerability rankings side-by-side to identify if and where similarities and differences occur.

As stated earlier in this Plan, in most cases, local governments use the OEM Hazard Analysis to assess risk, and each state hazard lead determines the best risk assessment method for each respective hazard. Nonetheless, there are similarities among these methods. First, in all of these assessments historical events are identified and are the basis upon which the likelihood of future hazard events occurring is determined. Second, based on best available data, all of these methods identify a community's vulnerability to each hazard at either the local or state scale.

On the other hand, *how* local and state risk assessments identify vulnerability varies greatly from local to state, as well as across all hazards at the state level. The OEM Hazard Analysis Methodology ranks vulnerability to each hazard based on the estimated percentage of population and property likely to be affected. The ranking of vulnerability is based on best data retrieved from the local level — often including objective data, studies, Hazus, etc. as well as local knowledge — and is therefore somewhat subjective. This methodology identifies which hazards are priorities at the local level.

For the State Risk Assessment, each hazard lead is an expert on that particular hazard. Hazard lead knowledge with some combination of research, literature and agency knowledge form the factual basis for each hazard risk assessment accompanied by some level of subjectivity. For some hazards — such as flood, earthquake and tsunami — a significant amount of data is available and supports detailed damage and loss projections. Damage and loss estimates help the state identify which communities are most vulnerable to each hazard. Hazards for which there is limited data — such as dust storms — undergo a less rigorous assessment, and identifying which communities are most vulnerable to those hazards may be more challenging.

Table 2-39 shows a side-by-side comparison of local and state vulnerability rankings.

Table 2-39. Local and State Vulnerability Ranking by County

Symbols in this table are defined as:

Local	**State**
H = High Vulnerability	MV = Most Vulnerable Community (as identified by all hazard leads)
M = Moderate Vulnerability	V = Vulnerable Community (as identified by *some* hazard leads)
L = Low Vulnerability	

	Coastal Erosion		Tsunami		Drought		Dust Storm		Earthquake		Volcanic		Landslide		Wildfire		Flood		Wind Storm		Winter Storm	
County	**Local**	**State**	**Local**	**State**	**Local**	**State**	**Local**	**State**	**Local**	**State**	**Local**	**State**	**Local**	**State**	**Local**	**State**	**Local**	**State**	**Local**	**State**	**Local**	**State**
Baker					H	MV	M	V	M	V	L		M	MV	H	V	M		H	V	H	
Benton					L				H	MV	L		L	MV	M	V	M		M	MV	M	MV
Clackamas					L				H	MV	H	MV	L	MV	M	V	M	MV	L	V	M	MV
Clatsop	H	MV	H	MV	M				H	MV	M		H	MV	H	V	H	V	H	MV	H	
Columbia					L				M	V	M		M	MV	M	V	H	MV	H	MV	H	MV
Coos	M	V	H	MV	M				H	MV	M		M	MV	M	V	H	V	H	MV	H	
Crook					H		L		L	V	H		L	MV	M	V	H		M	V	M	
Curry		MV	H	MV					H	MV	H		L	MV	H	V	H	V	H	MV		
Deschutes					L			V	M	V	H	MV			M	MV	L		L	V	H	
Douglas - central									M	MV		MV	M	MV	H	MV	H		M	MV	H	MV
Douglas - coastal	L		H						H	MV			M	MV	M	MV	M		M	V	M	
Gilliam					H	MV			M	V	M		M		M	V	M		L	MV	H	
Grant					H				M	V	H		M	MV	H	MV	H		H	V	H	
Harney					M			V	L	V	L		L	MV	H	V	M	V	L	V	M	
Hood River					H				M	V	L	MV	M	MV	M	V	M		H	MV	H	
Jackson					M				H	MV	L	MV	L	MV	M	MV	M		H	V	H	MV
Jefferson					H			V	L	V	H	MV	L		H	MV	M			V	H	
Josephine									H	MV				MV	M	MV	M		H	V	H	MV
Klamath					M	MV		V	M	MV	L	MV		MV	L	MV	M			V	M	
Lake					H			V	H	V	H		L		M	V	M		M	V	H	
Lane - central					M				M	MV	M	MV	L	MV	M	V	H		M	MV	H	MV
Lane - coastal		V	H	MV					H	MV			M	MV	L	V	H		H	V	L	
Lincoln		MV	M	MV	L				M	MV	L			MV	M	V	L	V	H	MV		
Linn									H	MV	H	MV		MV	M	V	H	V	M	MV	H	MV
Malheur					H	MV	L	V	M	V	M		M	MV	H	V	H		M	V	M	
Marion									H	MV	M	MV		MV	M	V	M	V	H	MV	H	MV
Morrow						MV	M	MV	H	V			M		M	V	H	V	M	MV	H	
Multnomah									H	MV	H	MV	M	MV	M	V	H	V	H	MV	H	MV
Polk									H	V	M				M	V	H		H	MV		MV
Sherman					M	MV			L	V	L		M		M	V	M		M	MV	M	
Tillamook		MV	H	MV	L		L		H	V	M		H	MV	H	V	H	MV	H	MV	H	
Umatilla					H		H	MV	M	V					H	MV	M	V	H	V	H	
Union					M		L	V	H	V	L		L	MV	H	MV	H		H	V	H	
Wallowa					H				L	V	L		L		H	MV	M		M	V	M	
Wasco					H			V	M	V	L	MV	M	MV	M	MV	L		H	V	H	
Washington					M				H	MV	H		L	MV	M	V	H	V	H	MV	H	MV
Wheeler					H				H	V	M		H	MV	H	V	H		M	V	H	
Yamhill					M				H	MV			M	MV	L	V	H	V	M	V	H	MV

Sources: Oregon NHMP 2015 hazard leads and the Oregon Office of Emergency Management

This comparison indicates similarities and differences between local and state vulnerability rankings. For some counties, local and state assessments agree there is a high level of vulnerability to a hazard, as indicated by both an "H" (high vulnerability) and a "MV" (most vulnerable) ranking. In other instances, local and state rankings are not in sync. For example, in several instances a county did not score itself for a hazard (indicating it is not at risk to that hazard), or scored itself "L" (as having low vulnerability) to a hazard, while the state ranked that county as one of the "MV" (most vulnerable) counties to that hazard.

It would be instructive to both local communities and to the State to understand where agreement and differences occur in vulnerability prioritization. Therefore, the State is dedicated to analyzing why differences in vulnerability rankings occur between local and state risk assessments, and how to enhance risk assessment methods so vulnerability rankings are more closely aligned.

Time did not permit an analysis of **Table 2-39** to be conducted during this Plan update cycle. For the purposes of this update, a side-by-side comparison is the extent to which the State is able to address these inconsistencies. However, the State is in the process of exploring what these findings mean and how Oregon can better align local and state risk assessments to identify its most vulnerable communities.

In April 3014, the Department of Land Conservation and Development (DLCD) presented a version of **Table 2-39** at the Oregon Prepared Conference to emergency managers and others involved with LNHMP updates. This presentation initiated a local-state discussion about risk assessments in Oregon; how to enhance the Plan update process at the local level; and how state hazard experts can better inform local jurisdictions on hazard data available at state or local scales.

In May 2014, **Table 2-39** was also presented to the State Interagency Hazard Mitigation Team (IHMT) for feedback on how to best initiate a two-way information sharing dialogue between local and state entities that perform risk assessment updates for NHMPs. At that meeting the IHMT identified these discussions as a State priority. Therefore, between the 2015 and the next Oregon NHMP update, the State will facilitate three local-state discussions on risk assessment methods and vulnerability rankings at venues such as statewide conferences and trainings.

2.2.2.5 State-Owned/Leased Facilities and Critical/Essential Facilities Exposure Assessment

Requirement: 44 CFR §201.4(c)(2)(ii): The risk assessment shall include… (ii) State owned or operated critical facilities located in the identified hazard areas shall also be addressed.

Requirement: 44 CFR §201.4(c)(2)(iii): The risk assessment shall include… (iii) An overview and analysis of potential losses to the identified vulnerable structures, based on estimates provided in local risk assessments as well as the State risk assessment. The State shall estimate the potential dollar losses to State owned or operated buildings, infrastructure, and critical facilities located in the identified hazard areas.

According to the Oregon Department of Administrative Services (DAS), the State of Oregon owns or leases buildings having a total value of over $7.3 billion. Because of this investment it is important the State assess the vulnerability of these structures to Oregon's natural hazards, including landslides, floods, volcanic hazards, tsunamis, earthquakes, wildfires, and coastal erosion. The Oregon Department of Geology and Mineral Industries (DOGAMI) assembled the best-available statewide natural hazard data and assessed which state-owned/leased buildings are exposed to each hazard. Data to support this level of analysis were available for the follow hazards: coastal erosion, earthquake, flood, landslide, tsunami, volcano, and wildfire.

Most building data were carried forward from the 2012 Oregon NHMP assessment of state-owned/leased buildings. For the 2015 assessment, this building data (originally digitized by DOGAMI from DAS-supplied spreadsheets) was updated with DAS deletions and additions current as of 2013. Because of imprecise, incomplete, or ambiguous addresses, 205 lower-value entries in the "additions" spreadsheets were not digitized in this study. This amounts to nearly $28 million worth of property, though only about $17 million is within Oregon state boundaries; at least $11 million of that total is located in Utah, Texas, or Washington and therefore outside the bounds of this analysis.

Notably, the DAS building data does not identify "critical/essential" facilities. So, DOGAMI identified indicative descriptors found within building names and usage descriptions (e.g., armory, hazmat storage, hospital, communication tower, etc.) and identified those facilities critical/essential. It is also important to note this assessment is based on limited data. The DAS buildings list is of variable quality and completeness. Facilities for which there were missing or incomplete address/location information, uncertain matches to older building data, missing or vague names, or locations outside of the State of Oregon were not used in this update.

The DAS database lists 5,693 state facilities owned or leased by 122 State agencies. DOGAMI used the DAS list to locate facilities using Geographic Information Systems (GIS). Figure 2-77 shows the distribution of these 5,693 state-owned/leased facilities within Oregon NHMP Natural Hazard Regions.

Critical and essential facilities not owned or leased by the state are in each map developed for this analysis. These facilities were carried forward from an earlier DOGAMI project to locate critical/essential facilities such as military facilities, schools, communication towers, police and fire stations, hospitals, etc. These facilities were located and digitized by DOGAMI. Critical and/or essential facilities were defined using criteria developed by FEMA and the International Building Council. Facilities were located and digitized from a variety of sources including FEMA, the U.S. Department of Transportation, DAS, the Oregon Office of Emergency Management, the Oregon Department of Transportation, and others.

However, since no property values are included in these data, and they are not owned or leased by the state, they are not included in property value.

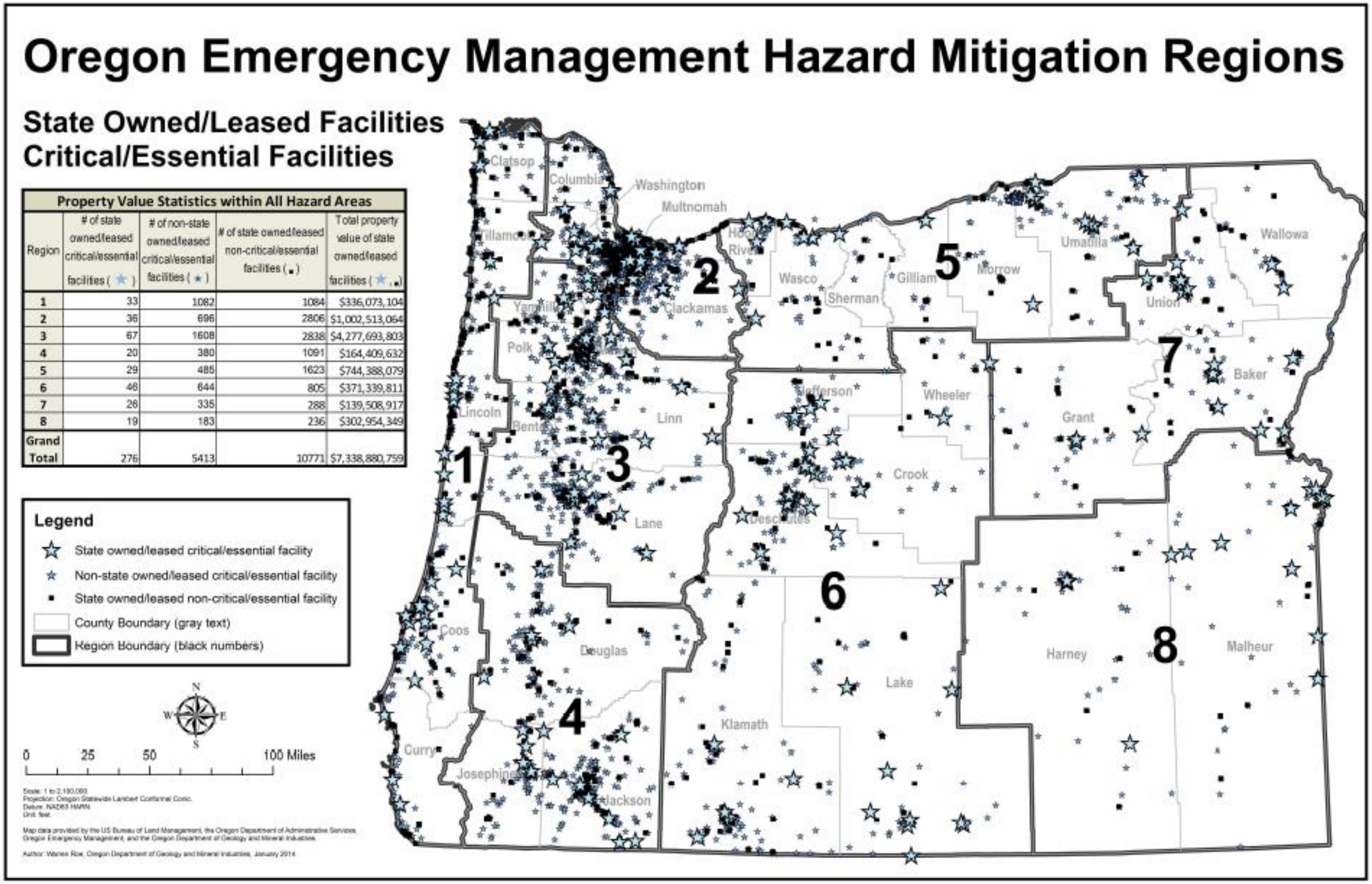
Hazard Data Limitations

This assessment evaluates each hazard individually; there are no comprehensive or multi-hazard assessments. In order to prioritize facilities most vulnerable facilities to natural hazards, DOGAMI categorized most hazards with simple classification schemes (most commonly "High", "Moderate", "Low", or "Other"). For each hazard "Other" is used to describe very low hazard areas, unmapped and/or unstudied areas, or zero hazard zones (this is further defined in each of the hazard descriptions below).

Statewide natural hazard data are generalized in several ways and provide a gross view of their distribution and magnitude across the state. They are often combined or derived from other data sources that themselves can have widely different quality, accuracy, attribution, or currency. Future investigations or actual hazard events may substantially modify our understanding of where and when natural hazards might occur.

Last, it is worth noting that building-specific information can make an enormous difference when evaluating the actual damaging effects of natural hazards. For example, a modern seismically-reinforced building may receive far less or no earthquake damage relative to older un-reinforced buildings next door. This study evaluates which facilities are *exposed* to certain natural hazards and, due to data and time limitations, makes no attempt to account for site-specific characteristics.

Figure 2-77. Statewide Distribution of State-Owned/Leased Facilities and Critical/Essential Facilities



Property Value Statistics within All Hazard Areas				
Region	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
1	33	1082	1084	$336,073,104
2	36	696	2806	$1,002,513,064
3	67	1608	2838	$4,277,693,803
4	20	380	1091	$164,409,632
5	29	485	1623	$744,388,079
6	46	644	805	$371,339,811
7	26	335	288	$139,508,917
8	19	183	236	$302,954,349
Grand Total	276	5413	10771	$7,338,880,759

Source: DOGAMI

Facilities within Hazard Areas

The spatial distribution of the facilities within hazard zones is not easily viewed on a statewide map. Therefore, maps depicting hazard zones and facilities within those zones have only been created at the regional scale. Those maps can be found in the **Regional Risk Assessments**.

Coastal Erosion

DOGAMI used the results from several of their coastal erosion studies to develop a coastal erosion hazard zone for this analysis. However, these data do not cover the entire Oregon coastline: coastal erosion hazard zones have not been created for Lane, Douglas, and Coos Counties, and only partial data coverage exists for Curry County. To address these data gaps, DOGAMI excluded those portions of the coast from the analysis, using a 0.5km buffer of the coastline to delineate an “other” value. In areas where mapping exists, the hazard is mapped as Active, High, Moderate, or Low Hazard Zones which, for the purposes of this analysis, were simplified to “High” (encompassing Active and High), “Moderate”, and “Other” (encompassing Low hazards and unmapped areas). The “Low” hazard zones incorporate hypothetical landslide block failures assumed to fail in the event of a M9 Cascadia earthquake and were placed under “Other” due to their very low probability. All other areas of the state received a “None” attribute.

Coastal Erosion Hazard Facility Summary

Of the 5,693 facilities evaluated, 28 are currently located within a coastal erosion zone and represent a value of approximately $7 million. Of those, one (ODOT Cape Perpetua Radio building) is identified as a critical or essential facility.

Coastal Erosion Data Limitations

1. Erosion rates used to estimate widths of hazard zones are based on interpretation of a relatively short historical series of aerial photography (1939 to present) and very limited lidar data acquired before 2008. Photos were georeferenced but not necessarily orthorectified and spatial locations may have considerable error.
2. Coastal erosion hazard zones have not been created for Lane, Douglas, and Coos Counties, and only partial data coverage exists for Curry County. Therefore, state-owned facilities along the coastline in these areas are not accounted for in this study.

Recommended Data Improvements

As previously stated, the coastal erosion hazard data set used the best available data from detailed studies conducted by DOGAMI. However, these data do not cover the entire coastline and outside of very small, specific areas, the overall coastal erosion hazard in Lane, Douglas, Coos and Curry Counties is undetermined. Therefore, DOGAMI recommends conducting detailed coastal erosion studies on a case-by-case basis within these counties.

Table 2-40. State-Owned/Leased Facilities and Critical/Essential Facilities in a Coastal Erosion Hazard Zone

Region	# of State Owned/Leased Critical/Essential Facilities	# of Non-State Owned/Leased Critical/Essential Facilities	# of State Owned/ Leased Non-Critical/Essential Facilities	Total Property Value of State Facilities
1	1	5	27	$7,020,077
2	0	0	0	$0
3	0	0	0	$0
4	0	0	0	$0
5	0	0	0	$0
6	0	0	0	$0
7	0	0	0	$0
8	0	0	0	$0
Totals	**1**	**5**	**27**	**$7,020,077**

Source: DOGAMI

Earthquake

This assessment used a combination of datasets that represent key geologic factors that contribute to earthquake hazard damage. Two statewide earthquake hazard datasets created by DOGAMI were used to assess the exposure of state-owned facilities to these hazards: liquefaction susceptibility and ground shaking intensity (estimated peak ground motions over a 2500 year forecast period). Where they overlapped, ground shaking and liquefaction were combined. The greater hazard of the two at any given location was determined and the higher hazard category assigned.

Ground Shaking

Earthquakes produce various types of seismic waves which can be felt as ground shaking. Ground shaking is stronger close to earthquake sources and weakens with distance. Stronger earthquakes result in more ground shaking, though how it is felt partly depends on the underlying geology at any location. For example, some geologic units can amplify ground shaking while others can lessen it. One simple way to classify ground shaking is to use the Modified Mercalli Index (MMI), which ties how an earthquake is measured to how it is felt as ground shaking.

Table 2-41. Modified Mercalli Index

INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
Shaking	Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme
Damage	None	None	None	Very slight	Light	Moderate	Moderate/ heavy	Heavy	Very heavy
Peak Acc	<0.17	0.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
Peak Vel	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16 -31	31-60	60-116	>116

Peak Acc = Peak ground acceleration (g), Peak Vel = Peak ground velocity (cm/s)

Source: DOGAMI

For the purposes this analysis, DOGAMI created data layers representing the likelihood of maximum ground acceleration and velocity for all earthquake scenarios (crustal and subduction zone) over a 2500 year forecast period. This forecast period was used because it follows the standard used in building codes for the state of Oregon. A Modified Mercalli Index was created from these data and anything receiving a MMI value of VII or greater was divided in to “Low” (VII), “Moderate” (VIII), or “High” (IX and above) earthquake hazard zones. Areas with modeled MMI values less than VII were given an attribute of “Other”. It is important to note that these areas can still sustain damage from earthquakes, particularly if buildings are poorly built.

Liquefaction Susceptibility

Deposits of loose sand or silt that are saturated with water commonly liquefy when shaken strongly or repeatedly by an earthquake. The liquefied materials lose most of their ability to support overlying soil layers and structures: buildings and bridges can sink and tilt, while riverbanks may slump and flow into a river channel. In many large earthquakes, liquefaction results in considerable damage. However, it only occurs in certain types of geologic settings and soil types. As part of the Oregon Resilience Plan, DOGAMI created a data layer depicting liquefaction susceptibility that generally represents where certain geologic formations may liquefy in earthquakes. These liquefiable geologic units are derived from the geologic units within the Oregon Geologic Data Compilation (OGDC v5). The liquefaction data layer from the Oregon Resilience Plan was categorized as Very Low, Low, Moderate, High, and Very High. For the purposes of this analysis, Very Low and Low were combined into “Low”, “Moderate” remained the same, and High and Very High were combined into the “High” category. Areas with no known liquefiable geology were given the attribute “Other.” Future geologic mapping, particularly maps that emphasize shallow geology, may change our understanding of where liquefiable deposits occur in Oregon.

Earthquake Hazard Facility Summary

Almost all the state facilities evaluated are within an earthquake hazard zone, comprise over $7 billion worth of state property. Among those, 1,141 are critical/essential state facilities (**Table 2-42**).

Data Limitations

It is important to note that the methodology used for this vulnerability study is a very broad-scaled approach and does not assess the ability of a building to withstand the earthquake hazard. For a given amount of ground motion, two buildings with different construction types may receive very different types and amounts of damage. The data provided by DAS does not have adequate structure information within its inventory of state-owned facilities to conduct a more accurate earthquake vulnerability assessment. All state-owned facilities should have a site-specific study performed in order to more accurately assess hazard vulnerability. Last, future geologic mapping will likely further define liquefiable soils and geologic units as well as faulting style and rates. These could change our understanding of the earthquake hazard in Oregon.

Table 2-42. State-Owned/Leased Facilities and Critical/Essential Facilities in an Earthquake Hazard Zone

Region	# of State Owned/Leased Critical/Essential Facilities	# of Non-State Owned/Leased Critical/Essential Facilities	# of State Owned/ Leased Non-Critical/Essential Facilities	Total Property Value of State Facilities
1	186	913	1,114	$336,012,474
2	120	2,675	729	$1,002,278,664
3	455	2,413	1,679	$4,277,900,069
4	34	1,069	400	$164,409,632
5	76	1,446	335	$527,780,360
6	100	721	60	$365,685,290
7	47	168	297	$130,162,468
8	53	153	158	$284,568,313
Totals	**1,071**	**9,558**	**4,772**	**$7,088,797,270**

Source: DOGAMI

Flood

DOGAMI used a combination of Federal Emergency Management Agency (FEMA) effective and preliminary flood zone data, state digitized flood zone data, and FEMA Q3 data to develop a statewide flood hazard zone for this analysis. DOGAMI indicated a flood hazard if a building fell within floodways, 100 year floodplains, or 500 year floodplains. The flood hazard was not divided in to High, Moderate, or Low categories due to the wide variety of flood data, its variable absolute and relative accuracy, and its variable geographic coverage and completeness. In particular, rural or sparsely-populated areas tend to have poorly-mapped or nonexistent flood hazard data. For these reasons, buildings were simply classified as “Hazard Zone” or “Other”. “Hazard Zone” indicates a building falls within one of the floodway, 100 year, or 500 year flood hazard zones. “Other” indicates there is insufficient information to determine whether a flood hazard exists for a given site. Buildings with “Other” designations could conceivably face relatively high flood hazards or no flood hazard at all.

Flood Hazard Facility Summary

There are 788 state facilities located within a flood hazard zone, with an estimated total value of nearly $900 million. Of these, 41 are identified as a critical or essential facility.

Recommended Data Improvements

The flood hazard data set used multiple data layers in order to fully cover the state of Oregon. FEMA is currently updating flood data for several counties. The effective FEMA data is the most recently updated data for the state. Both the state digitized flood data and the FEMA Q3 data layers need revision and update because of inaccuracy (created on poor topography source data) and the overall age of the data. These findings demonstrate the need for enhanced flood data in certain areas of the state.

Table 2-43. State-Owned/Leased Facilities and Critical/Essential Facilities in a Flood Hazard Zone

Region	# of State Owned/Leased Critical/Essential Facilities	# of Non-State Owned /Leased Critical/Essential Facilities	# of State Owned/ Leased Non-Critical/Essential Facilities	Total Property Value of State Facilities
1	5	85	146	$22,823,803
2	2	56	49	$25,422,551
3	1	90	27	$13,110,987
4	4	80	98	$45,443,883
5	3	35	262	$6,205,342
6	6	71	60	$9,103,740
7	14	28	75	$40,965,936
8	6	48	30	$14,656,711
Totals	**41**	**493**	**747**	**$177,732,953**

Source: DOGAMI

Landslides and Debris Flow

DOGAMI used their recent landslide inventory publication SLIDO-3 (Statewide Landslide Information Database for Oregon, release 3) and a statewide landslide susceptibility model from the Oregon Resilience Plan to determine which state-owned facilities are vulnerable to the landslide hazard. The statewide landslide susceptibility model was originally published with susceptibility values of 1 through 10 using FEMA Hazus-MH classifications; for this analysis these were reclassified into “Low” (values 1–3), “Moderate” (values 4–6), and “High” (values 7–10). Atop this, existing landslide outlines from SLIDO-3 were overlain as “High” hazards to emphasize that pre-existing landslides are relatively more likely to reactivate in rainstorms or during earthquake shaking.

Landslide Hazard Facility Summary

Of the 5,693 facilities evaluated, 5,146 (amounting to nearly $7 billion) are located within “High” and “Moderate” landslide hazard areas. These include 1,038 critical or essential facilities (**Table 2-44**).

Data Limitations and Recommended Improvements

The statewide landslide susceptibility map generalizes geology and topography at a statewide level using FEMA Hazus guidelines and indicates large portions of the state are susceptible to landslides. Future geologic mapping may change our understanding of which geologic units are more or less prone to landslides and where they occur. Additionally, site-specific information, if available, would likely supersede the statewide susceptibility data and accurately portray the actual risk to buildings posed by landslides. Although DOGAMI used the most data available in SLIDO, the database is a combination of landslide inventories of varying scale, coverage, and quality. Future studies will likely change the extent and quality of data in SLIDO.

Table 2-44. State-Owned/Leased Facilities and Critical/Essential Facilities in a Landslide Hazard Zone

Region	# of State Owned/Leased Critical/Essential Facilities	# of Non-State Owned /Leased Critical/Essential Facilities	# of State Owned/ Leased Non-Critical/Essential Facilities	Total Property Value of State Facilities
1	186	913	1,114	$336,012,474
2	120	2,675	728	$1,002,258,406
3	455	2,413	1,679	$4,277,900,069
4	34	1,069	400	$164,409,632
5	121	1,541	510	$744,312,579
6	103	744	682	$370,945,511
7	58	237	361	$139,508,917
8	64	192	202	$302,954,349
Totals	**1,141**	**9,784**	**5,676**	**$7,338,301,937**

Source: DOGAMI

Tsunami

DOGAMI used recently-published tsunami inundation model results for the entire coast to determine the tsunami hazard zone for this analysis. The coast-wide inundation models divide tsunami scenarios by whether an earthquake source is local or distant. These in turn are graded into various inundation zones depending on the size of the earthquake. For the purposes of this exposure analysis, all of these zones are described as the “Tsunami Hazard Zone,” with the remainder of the state receiving an “Other” designation to encompass very-low probability events or no tsunami hazard.

Tsunami Hazard Facility Summary

There are currently 676 state facilities located within the tsunami hazard zone and have an estimated total value of $134 million. These facilities are shown on **Table 2-45**. Of these, 105 are identified as critical or essential facilities.

Data

Detailed tsunami modeling for the entire Oregon coastline was completed in 2013.

Table 2-45. State-Owned/Leased Facilities and Critical/Essential Facilities in a Tsunami Hazard Zone

Region	# of State Owned/Leased Critical/Essential Facilities	# of Non-State Owned /Leased Critical/Essential Facilities	# of State Owned/ Leased Non-Critical/Essential Facilities	Total Property Value of State Facilities
1	105	243	571	$134,347,494
2	0	0	0	$0
3	0	0	0	$0
4	0	0	0	$0
5	0	0	0	$0
6	0	0	0	$0
7	0	0	0	$0
8	0	0	0	$0
Totals	**105**	**243**	**571**	**$134,347,494**

Source: DOGAMI

Volcanic Hazards

DOGAMI used data from the U.S. Geological Survey (USGS) Cascades Volcano Observatory (CVO) to develop the statewide volcanic hazard layer for this analysis. CVO maintains hazard zone data for five volcanic areas in the Cascade Mountains of Oregon: Mount Hood, Crater Lake, Newberry Crater, Mount Jefferson, and the Three Sisters. This assessment scores each facility based on whether it is located within a proximal hazard zone (translating to "High") or distal hazard zone (translating to "Moderate" or "Low"). The maximum credible lahar scenario for each volcano was classified as "Low" because it has a very low probability of occurring, while the others were placed into a "Moderate" category. DOGAMI added its own unpublished lahar data for Mount Hood which resulted in a slight expansion of "Low" hazard areas for the maximum credible lahar scenario. Additionally, DOGAMI included an airfall ash hazard area in the "Low" category to capture USGS depictions of areas with a 1 in 2500 to 1 in 5000 annual chance of receiving 4 inches or more of volcanic ash. Any facility located within these hazard zones is considered vulnerable to volcanic hazards. Outside these hazard zones, the volcanic hazard is undetermined and categorized as "Other."

Volcanic Hazard Facility Summary

There are 601 state facilities located within a volcanic hazard area representing an approximate value of $358 million (**Table 2-46**). Of those, 55 are located in the "Moderate" or "High" volcanic hazard zones. One critical/essential facility falls in a "High" hazard zone, while the remaining 76 critical/essential facilities fall in to the "Low" volcanic hazard zone.

Table 2-46. State-Owned/Leased Facilities and Critical/Essential Facilities in a Volcano Hazard Zone

Region	# of State Owned/Leased Critical/Essential Facilities	# of Non-State Owned /Leased Critical/Essential Facilities	# of State Owned/ Leased Non-Critical/Essential Facilities	Total Property Value of State Facilities
1	0	0	0	$0
2	17	601	203	$73,677,661
3	1	90	27	$13,110,987
4	0	0	0	$0
5	59	1377	262	$259,126,313
6	0	22	32	$11,593,171
7	0	0	0	$0
8	0	0	0	$0
Totals	**77**	**2,090**	**524**	**$357,508,132**

Source: DOGAMI

Wildfire

The Oregon Department of Forestry (ODF) participated in a statewide fire hazard and risk assessment in 2012 and 2013 as part of the West Wide Wildfire Risk Assessment for states in the western United States. Following ODF guidance, DOGAMI evaluated building exposure to wildfire using the Fire Risk Index which was classified by ODF in "High", "Moderate", and "Low" categories. Urban areas, lake surfaces, and areas bare of vegetation do not have fire risk classifications in the data and are represented here as "other". For more detailed information regarding this data set, refer to the West Wide Wildfire Risk Assessment or contact an ODF representative.

Fire Hazard Facility Summary

Roughly half of the state facilities evaluated are within a wildfire hazard zone and total about $1.05 billion in value. Notably, about half of these are in a "High" or "Moderate" wildfire zone. There are a total of 330 state-owned critical/essential facilities all the wildfire hazard zones. (**Table 2-47**).

Data Limitations

As with several other natural hazards described here, it is important to note that the type of vulnerability study performed for the wildfire hazard is very broad-scaled analysis. All state facilities should have a site-specific study performed because structure risk for fire hazard can be better determined by analyzing the ignition zone surrounding the specific structure and identifying details of the structure type (roof type, construction materials, etc.). Building data provided by DAS does not have adequate structure information within its inventory of state-owned facilities to conduct a more accurate fire hazard vulnerability assessment.

Table 2-47. State-Owned/Leased Facilities and Critical/Essential Facilities in a Wildfire Hazard Zone

Region	Number of State-Owned/Leased Critical/Essential Facilities	Number of Non-State-Owned/Leased Critical/Essential Facilities	Number of State-Owned/Leased Non-Critical/Essential Facilities	Total Property Value of State Facilities
1	98	408	698	$186,184,049
2	18	380	216	$114,809,329
3	70	587	540	$314,818,225
4	11	450	187	$44,078,123
5	23	1,072	216	$81,561,189
6	59	350	445	$187,857,811
7	32	141	197	$84,199,026
8	19	135	98	$41,075,335
Totals	**330**	**3523**	**2,597**	**$1,054,583,087**

Source: DOGAMI

2.2.2.6 Seismic Transportation Lifeline Vulnerabilities

Requirement: 44 CFR §201.4(c)(2)(iii): The risk assessment shall include… (iii) …The State shall estimate the potential dollar losses to … infrastructure…located in the identified hazard areas.

In 2012 the Oregon Department of Transportation (ODOT) conducted the Oregon Seismic Lifeline Routes (OSLR) identification project. The purpose of the OSLR project was twofold:

- Support emergency response and recovery efforts by identifying the best connecting highways between service providers, incident areas and essential supply lines to allow emergency service providers to do their jobs with minimum disruption; and
- Support community and regional economic recovery after a disaster event.

The focus of the OSLR project is on state highway right of way, with the assumption that other transportation modes and facilities are part of an integrated lifelines system. The Oregon Seismic Resilience Plan furthers the discussion of the roles of the different modes and facilities in the aftermath of a CSZ event.

The OSLR project study recommends a specific list of highways and bridges that comprise the seismic lifeline network; and establishes a three-tiered system of seismic lifelines to help prioritize investment in seismic retrofits on state-owned highways and bridges.

A Cascadia Subduction Zone event has the potential to simultaneously affect all of western Oregon, potentially crippling the statewide transportation network.

This project was conducted by the ODOT Transportation Development Division (TDD) from September 2011 through April 2012, in coordination and consultation with Bridge, Maintenance, Geotechnical, and other impacted divisions within the agency, as well as with other state agencies including the Oregon Department of Geological and Mineral Industries (DOGAMI) and the Public Utility Commission (PUC) through a Project Management Team (PMT) and Steering Committee (SC). The full report is located in **9.1.13, Statewide Loss Estimates: Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification**.

Methodology

The OSLR project management team used the following five-step process to conduct the OSLR analysis.

Step 1: Identify Study Corridors

State highways west of US-97 were selected as study corridors that met one or more of the following characteristics (**Table 2-48**):

- Likely ability to promote safety and survival through connections to major population centers with survival resources;
- Current use as a strategic freight and commerce route; and
- Connection to one or more of the following key destinations of statewide significance:
  - I-84 east of Biggs Junction,
  - US-20 east of Bend,
  - The California border on I-5,
  - The California border on US-97,
  - A crossing of the Columbia River into southwest Washington,
  - A port on the Columbia or Willamette River,
  - A port on the coast,
  - Portland International Airport, and
  - Redmond Municipal Airport.

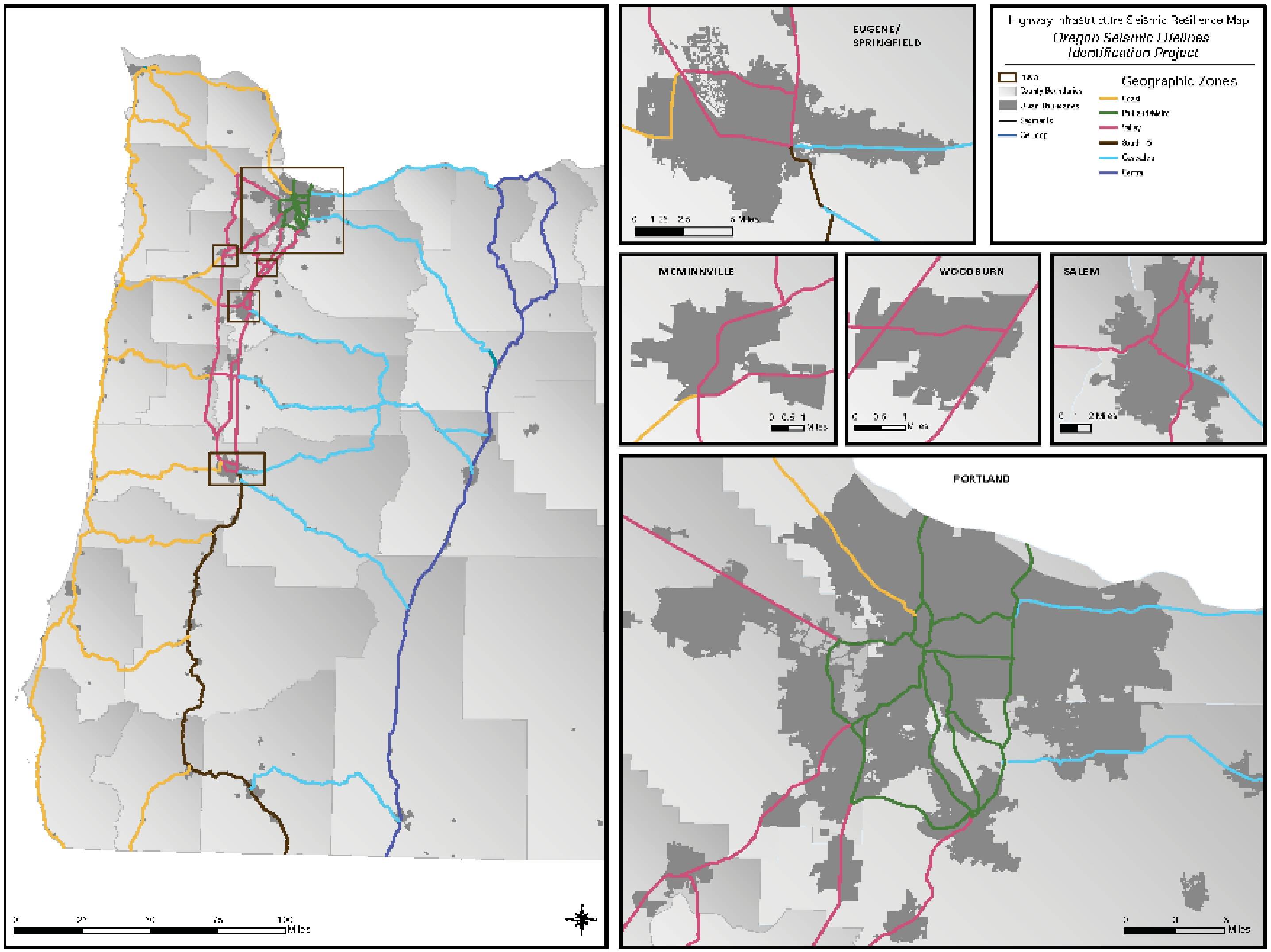
The study corridors were grouped geographically into the following six distinct zones within the western half of the state (**Figure 2-78**):

- Coast (US-101 and connections to US-101 from the I-5 corridor),
- Portland Metro (highways within the Portland Metro region),
- Valley (circulation between the Portland metro area and other major population centers in the Willamette Valley),
- South I-5 (the section of I-5 south of Eugene-Springfield),
- Cascades (highways crossing the Cascades Mountains),
- Central (the US-97/US-197 corridor from Washington to California), and
- Central (the US-97/US-197 corridor from Washington to California).

Step 2: Develop Evaluation Framework

The PMT established an evaluation framework that consists of the following four main elements: goals, objectives, criteria, and parameters (**Table 2-48**).

Figure 2-78. OSLR Geographic Zones



Source: ODOT

Table 2-48. OSLR Evaluation Framework

Goals	Objectives	Criteria
Support survivability and emergency response efforts immediately following the event *(immediate and short-term needs)*	1A. Retain routes necessary to bring emergency responders to emergency locations	bridge seismic resilience roadway seismic resilience dam safety roadway width route provides critical non-redundant access to major area access to fire stations access to hospitals access to ports and airports access to population centers access to ODOT maintenance facilities ability to control use of the highway
	1B. Retain routes necessary to (a) transport injured people from the damaged area to hospitals and other critical care facilities and (b) transport emergency response personnel (police, firefighters, and medical responders), equipment and materials to damaged areas	route provides critical non-redundant access to a major area bridge seismic resilience dam safety roadway seismic resilience access to hospitals access to emergency response staging areas
Provide transportation facilities critical to life support for an interim period following the event *(midterm needs)*	2A. Retain the routes critical to bring life support resources (food, water, sanitation, communications, energy, and personnel) to the emergency location	access to ports and airports bridge seismic resilience after short term repair dam safety roadway seismic resilience access to critical utility components access to ODOT maintenance facilities Freight access
	2B. Retain regional routes to hospitals	access to hospitals
	2C. Retain evacuation routes out of the affected region	access to Central Oregon access to ports and airports Importance of route to freight movement
Support statewide economic recovery *(long-term needs)*	3A. Retain designated critical freight corridors	Freight access bridge seismic resilience after short-term repair roadway seismic resilience after short-term repair route provides critical non-redundant access to a major area access to ports and airports access to railroads
	3B. Support statewide mobility for connections outside the affected region	access to Central Oregon access to ports and airports access to railroads
	3C. Retain transportation facilities that allow travel between large metro areas	route provides critical non-redundant access to a major area connection to centers of commerce

Source: ODOT

The criteria in the evaluation framework fell into three categories:

1. **Connections:** criteria relating to proximity to key resources and geographic areas likely to be essential after a seismic event,
2. **Capacity:** measure the characteristics of the roadway itself, and
3. **Resilience:** assess the likely capability that a corridor will function in the aftermath of a major seismic event, with or without a short term repair.

Criteria within each category are listed in **Table 2-49**.

Table 2-49. OSLR Criteria by Group

Connections	Capacity	Resilience
Access to fire stations	width of roadway	bridge seismic resilience
Access to hospitals	ability to control use of highway	roadway seismic resilience
Access to ports and airports	freight access	bridge seismic resilience after short-term repair
Access to railroads		roadway seismic resilience after short-term repair
Access to ODOT maintenance facilities		
Access to population centers		
Access to emergency response staging areas		
Access to critical utilities		
Access to central Oregon		

Source: ODOT

Step 3: Analyze Selected Highways

Each of the criteria were weighted and ranked (high, moderate, low performance) for each study segment.

Step 4: Solicit Feedback from Steering Committee

The OSLR project team used the results of the evaluation to identify a three-tiered seismic lifeline system — Tier 1 being the highest priority roadway segment, Tier 2 being the next highest, and Tier 3 being the third highest priority grouping to functions as follows:

- Tier 1: A system that provides access to and through the study area from Central Oregon, Washington, and California, and provides access to each region within the study area;
- Tier 2: Additional roadway segments that extend the reach of the Tier 1 system throughout seismically vulnerable areas of the state and that provide lifeline route redundancy in the Portland Metro Area and Willamette Valley; and
- Tier 3: Roadway segments that, together with Tier 1 and Tier 2, provide an interconnected network (with redundant paths) to serve all of the study area.

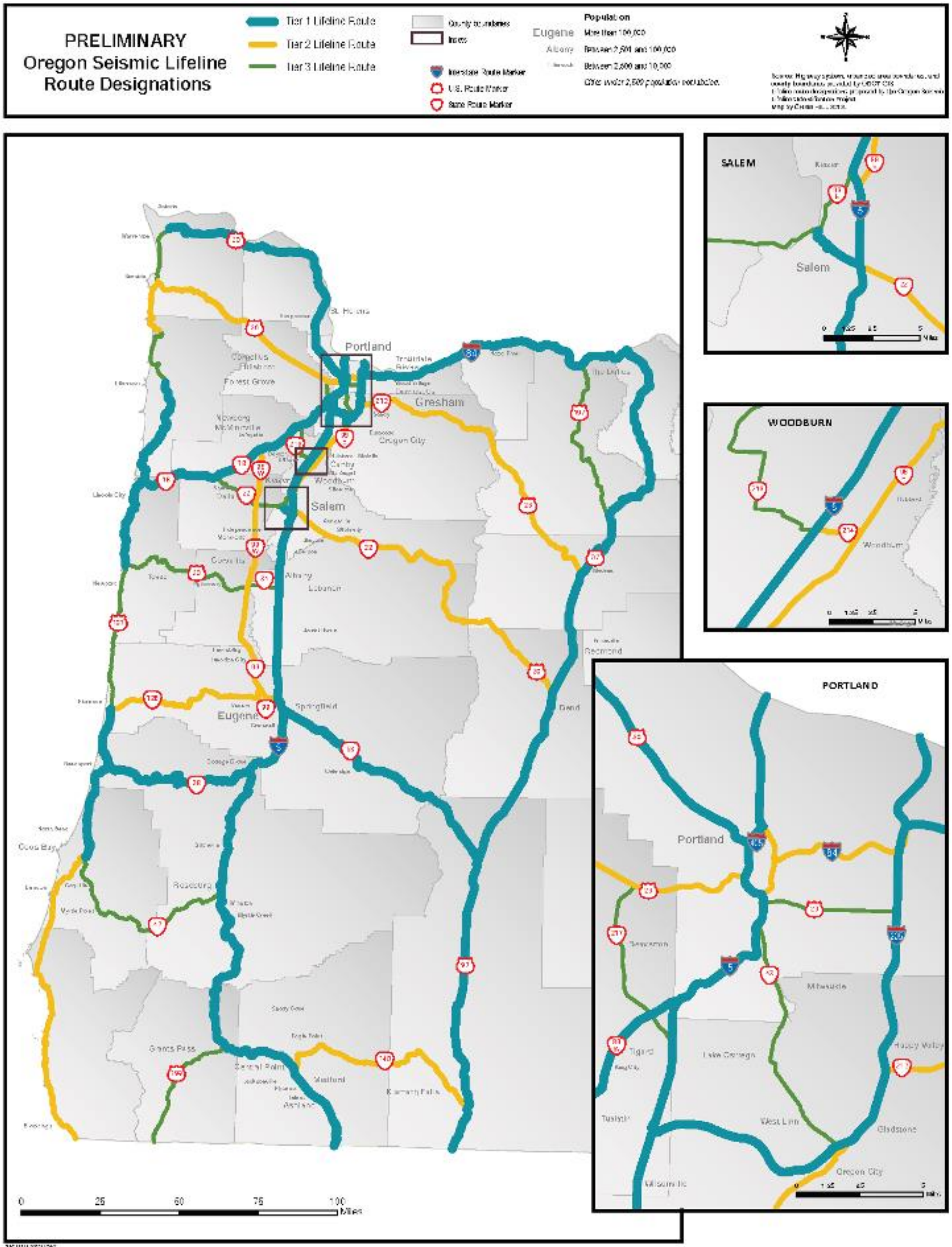
Step 5: Propose a System of Lifeline Routes

The proposed Tier 1 lifeline network shown provides roadway access to within about 50 miles of all locations in western Oregon. Total roadway miles for each tier are as follows:

- Tier 1: 1,146 miles,
- Tier 2: 705 miles, and
- Tier 3: 422 miles.

This provides a total of 2,273 miles of designated lifeline route. Study routes not identified as seismic lifelines total 298 miles. Figure 2-79 shows the proposed seismic lifeline routes with tier designations.

Figure 2-79. Preliminary Oregon Seismic Lifeline Routes, by Tier



Source: ODOT

Seismic Hazards Affecting Lifeline Routes

The following seismic hazards have the potential to affect the seismic vulnerability of structures (such as bridges, retaining walls, culverts, and tunnels) and roadway grades along the lifeline routes during a CSZ event:

Ground shaking. Ground shaking is a function of the distance to the earthquake epicenter, the magnitude of the earthquake, regional bedrock properties, and the stiffness of the site-specific soils. It includes the potential for ground amplification because of soft soil deposits. The effects of ground shaking, including the intensity, frequency content, and duration of the shaking, can physically damage structures (such as bridges, culverts, retaining walls, and tunnels), as well as trigger other seismic hazards (such as liquefaction and landslides).

Coseismic deformation. During a subduction zone earthquake, the tectonic plates undergo elastic deformation on a regional scale, resulting in the potential for several meters of permanent uplift or subsidence that could occur along the entire rupture zone, as expected along the entire Oregon Coast for the CSZ magnitude 9.0 event. Coseismic subsidence can affect tsunami wave heights and runup. If the ground subsides during the seismic event, the effective tsunami wave and associated runup are increased by the amount of subsidence. In addition, coseismic deformation can reduce ground elevations along low-elevation roadway grades to the extent that the elevations end up below design sea level following coseismic subsidence.

Liquefaction. Soil liquefaction is a phenomenon by which loose, saturated, and sandy/silty soils undergo almost a complete loss of strength and stiffness because of seismic shaking. Its occurrence along highway corridors is likely most significant at bridge sites (which are often near bodies of water) or along roadways that are adjacent to bodies of water (such as estuaries, rivers, and lakes). Liquefaction may cause failure of retaining walls from excessive earth pressure, movement of abutments and slopes caused by lateral spreading (liquefaction-induced slope instability), and loss of bearing or pile capacity for bridge abutments and pile caps.

Landslides. Landslide hazards are most likely to occur at locations of steeply sloping ground within the Coast Range and Cascade Mountains, or near alluvial channels. Landslides located above a roadway may lead to the blockage of a road from debris buildup. Landslides located below a roadway may cause undermining and loss of road grade. Landslides can occur at locations with recognized slope instabilities, but they can also occur in areas without a historic record of landslide activity.

However, the thoroughness of current mapping of faults for the State of Oregon is uncertain and very few of the observed earthquakes in Oregon are associated with mapped crustal faults. It is anticipated that, given the heavy vegetative cover for a lot of Oregon and the short period of time for which records have been kept, not all active faults have been identified.

Tsunamis. Tsunamis may affect lifeline routes near and adjacent to the coastline. The resulting water forces can damage structures within the tsunami runup zone, and can also cause debris buildup or inundation and the washing away of roadway grades.

State Vulnerability

Given the current conditions of the state highway system, the western half of Oregon will be profoundly impacted by a CSZ that will fragment major highways by damaging and destroying bridges, triggering landslides that obstruct and/or undermine roadways, other geological hazards such as soil liquefaction and the potential for tsunami that could overwhelm low-lying transportation facilities.

Significant loss of life is likely in tsunami prone areas. Additional loss of life from untreated injuries and disease due to a fragmented response network could also be significant. Loss of life due to structural collapse could be widespread, exacerbating by the duration of ground shaking and the size of the event at the coast, in the Coast Range, along the Lower Columbia, in the Metro area and in the central valleys.

The long-term economic impacts would be profound. Many residential, commercial, and industrial buildings would collapse or suffer significant damage. Supply lines for reconstruction materials would be disrupted and the transportation system capacity to move goods is likely to be usurped for a period of weeks for response/survival supplies and materials and personnel needed to re-establish essential services. The ability of employees and customers to get to businesses could be disrupted for weeks if not longer. Smaller and locally based businesses cannot typically survive long periods of closure.

A program to immediately (within the next few years) retrofit all seismic lifeline routes in western Oregon to current design standards is not possible with current budget limitations. Even if the State were able to embark on a program of rapid seismic strengthening of the entire highway system, let alone other regional and private transportation assets, it would be prudent to begin where the most benefit is accomplished in the least time for the least cost. That is a key premise of the development of the OSLR project and the Seismic Options Report that was, in part, based upon it.

Statewide Loss Estimates

The OSLR project includes consideration of the costs of retrofitting bridges and other highway facilities to support the tiering decisions and a preliminary work for revenue requests for implementation. Cost estimates were made for construction projects to mitigate or correct vulnerabilities on the recommended Seismic Lifelines system. Details can be found in Appendix E of the Seismic Options Report (**Appendix 9.1.12**).

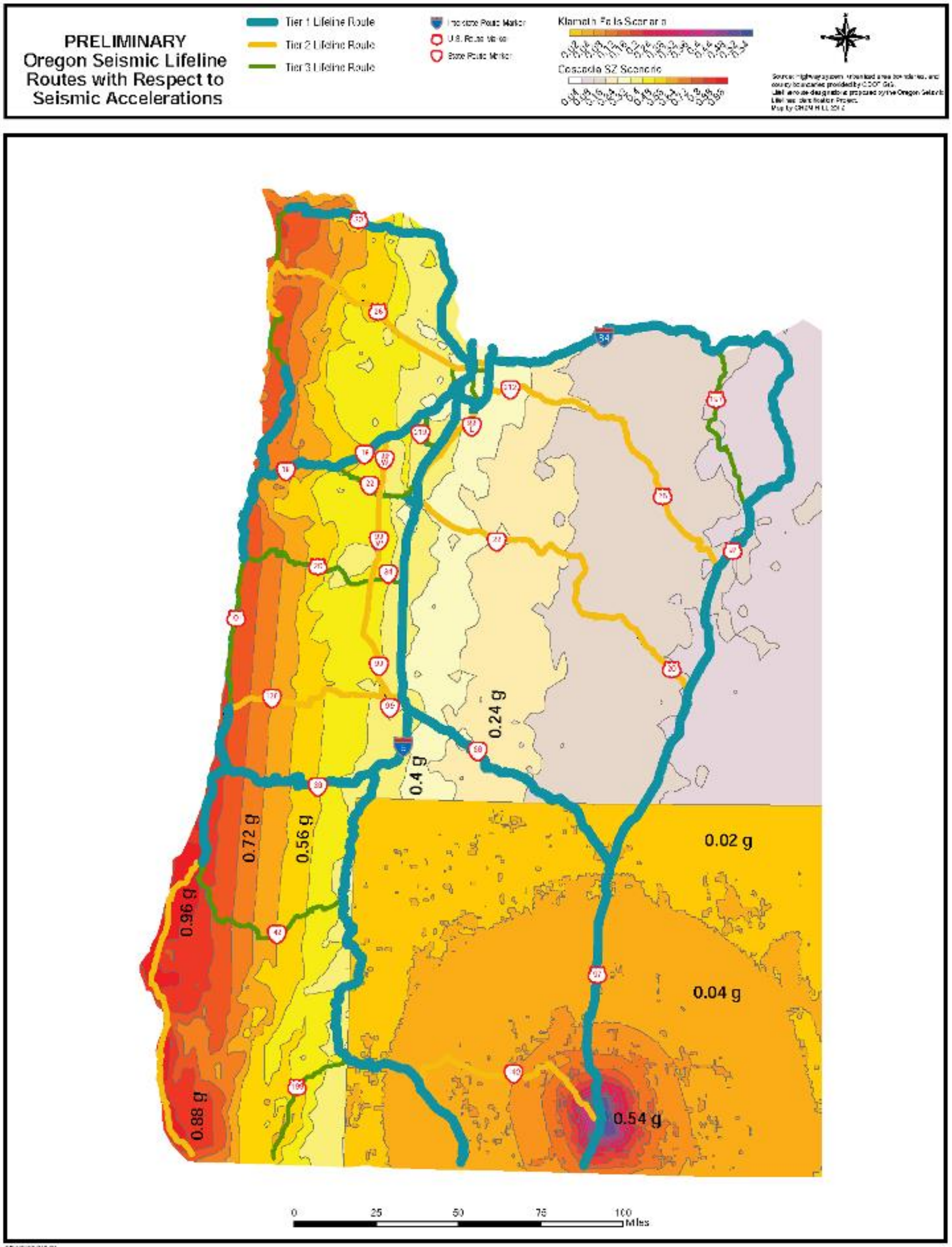
Appendix F of that report (**Appendix 9.1.12**) considers the **Estimated Economic Impact Due to Failure of Transportation Infrastructure.** This analysis was done to answer a slightly different question: what is the value of making the recommended improvements to the identified lifeline routes?

> *"Significant economic losses in production activity can be avoided by preparing for a major earthquake ahead of time. With no preparation ahead of time, Oregon could lose up to $355 billion in gross state product in the 8 to 10 year period after the event. Proactive investment in bridge strengthening and landslide mitigation reduces this loss between 10% and 24% over the course of the eight years simulated for this analysis."*

It is important to note that the losses considered in the economic analysis only considered impacts directly related to transportation system failures. It did not account for impacts outside of the transportation economic impacts such as the collapse of industrial or commercial buildings or basic service failures. Even so, the benefit to cost ratio of making needed improvements to the Seismic Lifelines system is 46:1.

Figure 2-80 shows seismic vulnerability of proposed lifeline routes relative to projected ground shaking from a CSZ event. These lifelines, including bridges on these roadways, are the most significant vulnerabilities of the state highway system.

Figure 2-80. Preliminary Seismic Lifeline Routes and Seismic Acceleration



Source: OSLR, ODOT

Bridges: Bridges are the most significant vulnerabilities of the state highway system. They are primarily vulnerable to the following seismic hazards:

- Ground shaking, which can results in structural damage of the bridge elements;
- Liquefaction, which can result in movement or failure of the abutments and/or the bridge piers;
- Tsunamis that can scour or result in large loads on bridge piers and abutments and, if high enough, can damage the bridge superstructure; and
- Landslides that can undermine a bridge.

Road grade vulnerabilities: Roadway grades are vulnerable to the following seismic hazards:

- Ground shaking, which can result in structural damage of roadway elements, including culverts, retaining walls, and abutments;
- Liquefaction, which can result in movement or failure of the slopes and ground under and adjacent to the roadway;
- Landslides, which can results in failure of the slope above the roadway (which may lead to the blockage of a road from debris buildup) and/or failure of the slope below the roadway (which may result in loss or complete failure of road grade). Landslides may be known, new, or ancient slides reactivated by ground shaking. Landslide potential is most prominent in the Coast Range and Cascade Mountains.
- Tsunamis, which can scour or deposit debris on the roadways making them inaccessible; and
- Coseismic deformation, which can result in the roadway grade being below design sea level.

Tunnels: Tunnels generally perform well in seismic events; however, some amount of rock fall and structural damage is likely, particularly at portals. The length of tunnels along each segment was tabulated.

Dams: Dams can pose significant risk to roadways because of releases of large volumes of water that can wash out roadway grades and scour out bridge foundations. This sudden release of water could be due to a dam failure, intentional rapid drawdown in response to structural damage, or overtopping due to a landslide into the upstream pool. Furthermore, rapid drawdown of water levels can also cause slope failures upstream of the dam along the edge of the reservoir. The dams identified in this study are those that have a potential to pose a risk to a state highway. Only one segment was noted to be at risk per dam, in spite of the fact that a dam failure may cause damage on multiple downstream segments. In general, segments farther downstream are at lower risk due to attenuation of the flood wave and the fact that further downstream waterways and crossings generally have a larger capacity.

Data

The main sources of data used to analyze the seismic vulnerability of each highway segment include:

- ODOT GIS database;
- DOGAMI references;
- U.S. Geological Survey (USGS) seismic hazard references;
- Risks from Earthquake Damage to Roadway Systems (REDARS2) data;
- DOGAMI and the Federal Emergency Management Agency evaluations of the potential impacts of a major seismic event in Oregon;
- Local knowledge of CH2M HILL staff who have lived and worked in these regions;
- Interviews with key maintenance and technical staff at ODOT;
- Interviews of technical and field staff at DOGAMI; and
- Public mapping databases, including aerial photographs, digital terrain models (DTMs), and transportation GIS databases.

During the last 15 years ODOT Bridge Section has compiled statewide hazard and vulnerability data including data on bridge seismic vulnerabilities and existing landslides, while other state and federal agencies have compiled geographic and other data defining seismic risks including predicted tsunami inundation zones. That work is the foundation of this study. Most of the earlier studies have been either comprehensive (statewide) but imprecise, or precise but not comprehensive.

Some statewide information used in the OSLR analysis (for example, the landslide data) was compiled from various sources and is based on varied data-gathering technologies and data-evaluation methods. Therefore, the data are highly variable and are not precise or consistent as a whole. Some older statewide or region-wide data were used in this project in place of more recent site-specific information to provide a platform to make relative comparisons (rather than absolute measures) of seismic risks along various candidate lifeline routes.

Recommended Next Steps

The OSLR provides ODOT with guidance about which roadways are most important for response and recovery following a major earthquake and which roadways are most easily prepared for, and repaired after, a major seismic event. Tier 1 lifeline routes are the most critical highways identified to provide statewide coverage; Tiers 2 and 3 lifeline routes would increase the usability of the system and add access to other areas. The Tier 1 routes have been divided into two phases for planning purposes. Phase one engineering and site evaluations are under way.

The next steps in the process of planning for a seismic event are to do engineering and site evaluations of the recommended routes to inform prioritizing specific mitigation and retrofit projects on these lifelines. Although this study has provided comparative results for seismic vulnerability on roadways, it does not provide sufficient detail to actually prioritize bridge and roadway seismic retrofits on a given highway facility. The engineering and site evaluations will determine the actual needs for and costs of bridge and roadway seismic retrofit projects.

Identifying funding and implementing seismic lifelines priorities will be an ongoing part of the Highway Division’s work for many years to come. The OSLR enables an approach that can be expedited or done incrementally over time. The Seismic Options Report addresses general questions about the kinds of work that need to be done and the economic value of doing that work. It is the intent of this combined effort to position the state to develop an increasingly resilient highway system in an efficient and strategic manner.

2.2.3 Future Enhancements to the State Risk Assessment

2.2.3.1 Climate Change

Oregon is committed to planning and understanding how climate change will impact its citizens, and natural resources. Climate change will exacerbate certain natural hazards such as drought and wildfire in the State of Oregon. Climate change planning is not only for the future; it is occurring and affecting Oregon now.

Oregon sits at the forefront of climate change research in the United States. In 2007, the Oregon State Legislature established the Oregon Climate Change Research Institute (OCCRI) at Oregon State University. OCCRI has provided extensive support to Oregon State agencies over the past 5 years. OCCRI has been successful at winning two large federal climate change centers: one funded through the National Oceanic and Atmospheric Administration, and the second through the Department of Interior. Both centers specifically focus on how climate change impacts the Pacific Northwest, with an interest in natural hazards. The NHMP will once again draw from the research at OCCRI in the 2020 plan.

Climate science is rapidly evolving, and it is impossible to predict where the state of the science will be in 5 years. From 2010 to the present, a suite of new climate information and knowledge was made available. A new round of global climate model outputs was produced to support the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). The IPCC Fifth Assessment was released in late 2013. Additionally, the Third U.S. National Climate Assessment was issued in May of 2014. The legislation that created OCCRI requires an assessment of the state of the science as it impacts Oregon. The NHMP drew heavily from the two existing reports (2010 and 2013), and will draw from future reports for the 2020 update.

Regional climate impacts and the extent to which human activities contributed to a specific change is one of the hottest topics in climate change science in 2014. We will, with confidence, understand more about regional climate impacts by 2020.

Oregon commits to addressing climate change in each climate-related hazard, statewide and by OEM hazard mitigation region, in the 2020 plan to the extent that the science can support inclusion into each section. We addressed the uncertainty of the state of the science, and maintain that we will only draw from peer-reviewed literature to support the plan. The U.S. National Climate Assessment is now undergoing a sustained assessment, or continued examination of climate change impacts as they affect the United States. OCCRI is involved in the sustained assessment, and we will draw from this work in the 2020 plan. With some confidence, we feel that we will be able to improve information about climate change impacts to drought, flood, wildfire, and coastal hazards in the 2020 report.

2.2.3.2 New Risk Assessment Methodology

During the 2012 Oregon NHMP update process it was realized by the State that no standardized statewide risk assessment methodology is being used across all hazards — each state hazard lead uses a different method to assess risk. This is due in part to the fact that "many state agencies do not have the tools and/or resources to conduct a full risk assessment. Likewise, most agencies do not maintain existing statewide risk assessment data" as identified in Task 5 of the Mid-Planning Alterations to the 2012 work plan. In response, the State allocated remaining federal funds from DR-1733 to support initial stages of the development of a standardized risk assessment model.

Beginning in March 2013, Oregon's Interagency Hazard Mitigation Team (IHMT) established a Risk Assessment Sub-Committee (RAS-C) that worked in partnership with faculty and staff from the University of Oregon's Department of Geography InfoGraphics Lab and Oregon Partnership for Disaster Resilience (OPDR) to develop a new risk assessment model concept. When fully developed and implemented, the model will provide a standardized way to assess vulnerability to natural hazards in Oregon at the state level thereby allowing the State to better identify where to strategically target mitigation resources. This initiative was facilitated by the Department of Land Conservation and Development (DLCD).

The RAS-C convened a total of five times from March to August to develop a risk assessment methodology that (a) meets federal requirements, (b) draws from the strengths of existing methods, and (c) addresses Oregon's unique priorities. The committee took a four-pronged approach to developing a new risk assessment model. Phase One involved review of natural hazard risk assessment methodologies found in academic literature and in other state Natural Hazards Mitigation Plans. In Phase Two, the UO team developed a proposed risk assessment model concept drawing from the strongest elements of the literature review and other research. While this phase focused heavily on adapting Susan Cutter's Social Vulnerability Index (SoVI), a key driver was the development of a framework tailored toward Oregon that could address key shortcomings identified in the SoVI and other models. In addition, the model incorporates state priorities identified by the RAS-C. Phase Three involved testing the feasibility of the proposed model. Finally, in Phase Four, the UO team developed a timeline, work plan and budget in an effort to identify the resources needed to fully develop the risk assessment model and interface. The proposed 3-year budget is roughly $600,000, which includes UO staff and resources.

This budget does not consider state time and resource needs, including, but not limited to, a high level of interagency collaboration to identify and classify hazard and vulnerability data, testing, and implementing the model. Notably, state resource needs will ultimately have to be identified and supported through funding and technical support to fully realize this model.

At this time, further development of the new model is pending funding. The RAS-C continues to meet to discuss potential funding opportunities. Due to the considerable amount of funding and other resources needed to fully develop and implement the new risk assessment methodology, it is likely that its development will take place in phases over the course of the next few iterations of the Oregon NHMP.

2.2.3.3 Cultural Resources

Overview

Every day, in countless ways, Oregonians experience their cultural heritage. They drive roads following routes first created by pioneers or Native Americans. They buy food from century-old farms. They shop at businesses in historic commercial areas. They visit parks created years ago by Oregonians with visions of healthy communities.

Oregonians attend schools and work in buildings built by and named for historic people, whose fortitude and dreams created the businesses and communities they live in. An Oregonian's engineering or medical discovery decades ago may have been the breakthrough that enabled today's medical treatment.

An Oregonian's dress, food, language, material goods and music are the tangible remnants of heritages transmitted to them from previous generations of Oregonians and from those new to Oregon. This means heritage is found in the closet, the workplace, the auditorium, the historic barn and elsewhere. In short, Oregon heritage is everywhere.

Our diverse Oregon cultural heritage attracts visitors to Oregon, who in turn help our economy. Eighty-three percent of the leisure tourists responding to a Mandala Research study in 2012 said they are cultural and heritage tourists for whom heritage activities and places were important to their decision to vacation in Oregon. Cultural and heritage activities are especially popular with "well-rounded, active" tourists. These active tourists are the most common variety of tourist in Oregon and they spend on average 39% more on their visits than the average tourist.

Oregon recognizes the importance of protecting and preserving the natural, cultural, and historic resources found throughout the state. Additionally, the economic impact that these resources have on local, regional, and statewide tourism is documented and significant. The important connection to our history and our future economic growth is tied to the deliberate efforts to preserve these resources. OEM intends to continue to partner with Oregon's recognized experts — Oregon Parks and Recreation Department, the State Historic Preservation Office, and the Oregon Heritage Commission — in the identification, protection, and preservation of Natural, Cultural, and Historical Resources (NCHR) on mitigation projects. Through agency partnership, and at all levels of government, we share responsibility to develop plans of action that ensure these important resources are preserved for future generations to connect with, experience, and enjoy.

Existing Efforts

The State's success in preserving Oregon's resources through intentional planning and mitigation efforts through collaborative partnerships and creative approaches is an ongoing process. This work is accomplished by working with local, tribal, state, and national partners to increase the awareness of Natural, Cultural, and Historical Resources (NCHRs) and identifying opportunities to protect them through existing site specific plans and actions. OEM is committed to requiring local jurisdictions to follow all applicable laws, rules, and regulations related to resource protection in mitigation projects administered by the State Hazard Mitigation Officer.

An example of this commitment through action includes the agency's recent efforts to increase the availability of NCHR related information and to encourage the consideration of NCHRs in disaster planning. Within the past year, OEM has worked with strategic partners to develop a single source of information related to NCHR topics in the form of a web page on the agency's website. This page includes local, regional, and national level information related to NCHR protection requirements, best management practices, as well as primers for caretakers of these resources. This information site is designed to assist emergency managers, organizations, and agencies charged with protecting and preserving collections, sites, and artifacts in making informed decisions related to NCHR. The page has also been promoted and distributed by the Oregon Heritage Commission through the posting of the site on a list serve that is focused on connecting with collection curators and historic site managers. By sharing this information, OEM intends to promote awareness, Best Management Practices, and dialog within the emergency management community and the professionals that maintain these important resources.

OEM is in the early stages of working with Oregon Parks and Recreation Department (OPRD), the State Historic Preservation Office, and the Heritage Commission in identifying and publishing NCHR inventories and resource specific information in a Geographic Information System (GIS). This GIS system is called RAPTOR which stands for Real-Time Assessment and Planning Tool for Oregon. This tool is managed by OEM for use by emergency managers before, during, and after disasters in staying informed of developing situations and maintaining an awareness of issues or resources at risk. The inclusion of NCHR information in RAPTOR will ensure an awareness of resources at risk and will allow for consideration in the development of mitigation, response, and recovery actions that can help protect them. Making this information available in an accessible format that is simple to use should lead to a higher level of awareness and consideration of these resources in all phases of the disaster planning cycle. Today, NCHRs are included in the RAPTOR training being delivered to emergency managers to ensure they are aware of existing data sets that can assist them in their decision making process.

Future Strategic Opportunities

For the upcoming budget cycle, OEM has proposed the addition of two Full-Time Equivalent (FTE) positions in the 2015-17 budget to augment the existing dedicated staff currently working on mitigation and recovery projects throughout the State of Oregon. These mitigation specialist positions, if approved, would be dedicated to providing assistance in the development of onsite, tailored project proposals that include the consideration NCHRs. The specialists would provide specific guidance on project application development considering NCHR presence, known risk potential, and mitigation opportunities throughout the development of any local project proposal. These focused efforts would result in consistent compliance with FEMA's Environmental Planning and Historic Preservation Program (EHP) requirements as well as in elevating the importance of the consideration and inclusion of NCHRs in the mitigation and recovery program at all levels of government. These positions would enable OEM to develop an implementation strategy including formal planning processes, mitigation project standard operating procedures, and mechanisms that ensure NCHRs are considered in comprehensive mitigation planning efforts. This is a significant request for the agency, as the proposed creation of additional FTE's is rigorously reviewed by the Executive Branch and the Oregon Legislature, and it speaks to the commitment OEM is making in addressing mitigation and recovery planning and project management. Existing barriers to statewide and local mitigation efforts include limited dedicated staff time at all levels of government, currency and validity of existing state and local NCHR data sets, multiple data sets that need to be referenced, and competing priorities — i.e., life safety and home/business property damage. The addition of these two FTEs would help alleviate some of these issues.

If OEM is successful in securing the additional FTE positions, and if OPRD is successful in funding limited duration or temporary positions that can be directed to work on resource inventory databases, then many of the actions listed below would be feasible for the 2020 NHMP risk assessment. The following information discusses the potential paths forward for OEM's efforts directed at protection and preservation of NCHRs.

First, the following are specific actions that OEM and OPRD believe could be taken to assess the potential risk to the significant natural, cultural, and historical resources. Second, as part of the risk assessment process, the two agencies can work together to identify methods to determine potential collection losses in monetary value as well as methods to assess potential tourism loss as a result of collection damage or destruction. This is followed by possible mitigation strategies that the two agencies can work on together to protect cultural and historical resources. Additionally, some strategies are offered as ways to provide technical assistance to local governments and nonprofit organizations to ensure cultural and historic resources of local significance are included in risk assessment and mitigation strategies.

1. Possible actions to assess risk to cultural and historic resources of statewide significance in the 2020 Oregon NHMP <u>risk assessment:</u>
    a. Actions related to assessing exposure of cultural and historic resources of statewide significance to potential damage from natural disaster events —
        - Continue to update historical resource surveys to maintain an accurate inventory of resources at both the state and local levels.
        - Survey and re-survey historic repositories and ensure resource catalog information is current.
        - Continue to develop a GIS inventory of resources that has current, verified information which can then be used in concert with hazard specific GIS information to identify resources at risk and the level of hazard potential exposure to which they are subject.
        - Prioritize combining resource data layers and known hazard data layers to identify resources at risk and prioritize mitigation efforts to protect and preserve them.
        - Continue to provide emergency preparedness training to museums, libraries, and archivists to assist them in understanding the risks to their collections and steps they can take to minimize damage.
        - Work toward compatibility of historic site databases so they can be integrated into a single mapping system.
        - Create and promote local incentives to inventory, designate, and rehabilitate historic properties.
    b. Actions related to assessing potential damage to cultural and historic resources of statewide significance and resulting dollar losses from natural disaster events —
        - Survey existing federal, state, and local jurisdictions' potential damage assessment tools for natural, historical, and cultural resources. Identify models or modify models that are feasible for use in Oregon.

- Survey existing federal, state, and local methodologies currently in use for valuation of resources. Identify multiple methods that are peer group or nationally accepted forms of valuation.
- Develop and deliver training to emergency managers and resource curators on valuation methods. Encourage emergency managers and resource curators to estimate potential losses in both collection damage/loss as well as economic impacts due to a loss of tourism and visitors.
- Encourage emergency managers to include these estimated potential losses in their planning and prioritization of mitigation projects to ensure resource protection and preservation.
- Identify existing data sets and develop assessment tools to estimate the economic loss potential to the state economy from impacts to historic buildings, organizations, and businesses located in historic buildings, and tourism.

2. Possible actions to include cultural and historic resources of statewide significance in the 2020 Oregon NHMP mitigation strategy —
    a. Actions related to identifying how to protect cultural and historic resources of statewide significance from potential damage from natural disaster events
        - As natural, cultural, and historic resource data sets are updated and become available in GIS data layers, this information can be combined with existing natural hazard information to assess existing risk potential and possible mitigation opportunities.
        - Provide training to state and local decision makers on the availability of these data sets and how the information can be used to identify resources at risk.
        - Provide guidance on methods of assessment for the potential economic impacts as a result of resource damage or loss.
        - Continue to add resource inventories into GIS layers for access to the information in RAPTOR by emergency managers for planning, response, recovery, and mitigation activities.
    b. Actions related to providing funding or technical assistance to local governments for including cultural and historic resources of local significance in local NHMP risk assessments and mitigation strategies —
        - With the addition of OEM staff dedicated to mitigation and recovery, specific efforts would be focused on providing technical assistance to local governments related to the identification, risk assessment, valuation, and mitigation options and opportunities to ensure resource protection and preservation.
        - With additional seasonal or limited duration staff, OPRD would continue to update resource inventory databases and work toward the consolidation of this information into a single location that can be used by emergency managers for awareness and consideration in local NHMPs.
        - Work toward developing and providing resource identification and preservation training opportunities targeting emergency managers, historic site owners, and collection curators to promote collaborative planning efforts.

- Assess national, state, and local programs to identify best management practices related to emergency management and resource protection efforts. Include the results of this work in training courses delivered to emergency managers, historic site owners, and collection curators.
- Identify opportunities to include volunteers and collection curators in the mitigation, notification, response, and recovery phases of disaster management to ensure resource protection.
- Continue to assist local representatives in resource identification and recordation.
- Compile “Connecting to Collections” disaster plans and engage organizations in sharing them with emergency managers for inclusion in local NHMPs. Use the collection to promote the development of additional plans through awareness and technical assistance.

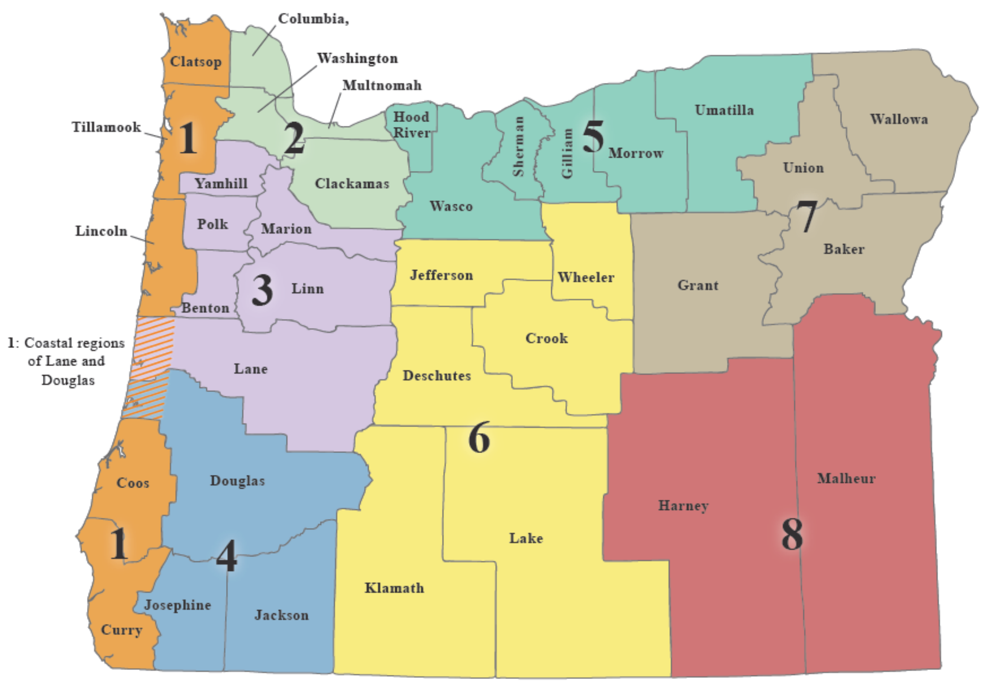
Summary

OEM will continue to incorporate natural, cultural, and historical resource consideration and compliance in all mitigation and recovery projects. As additional information related to these resources becomes more accessible through the use of current and new technology, decision makers at all levels will have the opportunity to make more informed decisions that ensure protection and preservation. These resources are important for the historical significance as well as the economic impacts to the community of Oregon. Assuming additional FTEs are approved, the agency intends to increase the level of consideration and prioritization of NCHRs in mitigation work and pre-disaster planning. These FTEs would enable OEM to provide a higher level of service to local partners in all phases of disaster management including assistance focused on NCHRs. Finally, as OEM moves forward with its partners in identifying and capitalizing on opportunities to increase NCHR information availability, NCHR specific training, and risk assessment and mitigation efforts, the state will ensure that it meets the commitment to compliance while protecting and promoting Oregon’s historical treasures.

2.3 Regional Risk Assessments

The purpose of the Regional Risk Assessment is to assess risks at a regional scale by profiling the characteristics, natural hazards, and vulnerabilities within the eight Oregon NHMP Natural Hazard Regions (Figure 2-81). Each region has its own Risk Assessment. Together, the eight Regional Risk Assessments combine to describe the State's overall risk to natural hazards.

Figure 2-81. Oregon NHMP Natural Hazards Regions



Each Regional Risk Assessment includes three sections:

1. The **Summary** provides a general overview of (a) the Regional Profile, (b) the Regional Hazards and Vulnerability, and (c) how climate change models predict hazards in the region will be impacted based on statewide data.
2. The **Profile** section provides an overview of the region's unique characteristics including profiles of the natural environment, social and demographic situation, economic environment, infrastructure, and built environment.

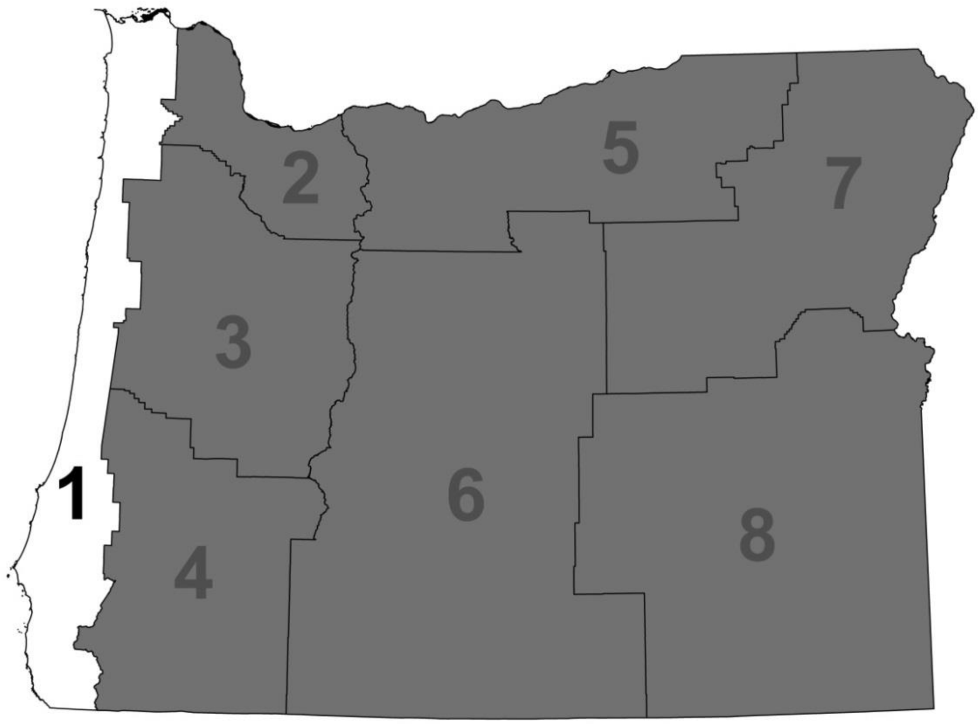
   The research of Susan Cutter, Professor of Geography at the University of South Carolina, Columbia, on vulnerability and environmental hazards provides the framework for discussion of vulnerability in the Regional Profile section. Cutter's framework helps to illustrate the geographic variability of vulnerability and allows policy makers to better understand how to prepare for, mitigate, and reduce vulnerability (Cutter et al., 2003; Cutter, 2006).

3. The **Hazards and Vulnerability** section first identifies each hazard and its characteristics in the region. Then, the historical events that have impacted the region are listed. Lastly, probabilities and vulnerabilities are discussed as identified by local and state risk assessments. Vulnerabilities to and potential impacts from each hazard in the region are described including the identification and analysis of the region's State owned/leased facilities and critical/essential facilities located within hazard zones and seismic lifeline vulnerabilities.

Regional Risk Assessments add to the current body of literature and technical resource guides available to Oregon communities. The three levels of government — federal, state, and local — will find the Regional Risk Assessments useful when assessing natural hazards and vulnerabilities and when planning mitigation activities. Local governments can use the Regional Risk Assessments in the development of their jurisdiction's natural hazards mitigation plan. Information from these assessments is intended to be used as a springboard for more detailed community profiles. Likewise, information from local plans helps to inform the Oregon NHMP risk assessment overall.

2.3.1 Region 1: Oregon Coast

Clatsop, Coos, Curry, Lincoln, and Tillamook Counties and coastal areas of *Douglas and *Lane Counties



*Note: Where data specific to the coastal areas of Douglas and Lane Counties are available, the data are used in the Region 1 Risk Assessment. Where data are available only for the county as a whole, the data are reported in the Region 3 (Lane County) and Region 4 (Douglas County) Risk Assessments.

2.3.1.1 Summary

Profile

The region's demographic, economic, infrastructure, and development patterns indicate that some populations, structures, and places may be more vulnerable to certain natural hazards than others. Mitigation efforts directed toward these vulnerabilities may help boost the area's ability to bounce back after a natural disaster.

Social vulnerability in Region 1 is driven in part by a high percentage of tourists, homeless persons, seniors, and disabled populations. In addition, education levels and median household incomes across the region are below statewide numbers. Conversely, communities along the coast have high levels of homeownership, indicating an ability to better withstand economic hardship during natural disaster events.

Coastal communities were hit particularly hard by the financial crisis that began in 2007 and continue to suffer from low job recovery rates, especially in Curry, Coos, and Lincoln Counties. There are relatively few key industries and employment sectors in the region, and wages are lower than the state average. Coastal economies are becoming more reliant upon tourism, which peaks in the spring and summer months. Consequently, the area is particularly vulnerable during winter months when fewer employment opportunities exist.

A Cascadia Subduction Zone (CSZ) earthquake will be catastrophic to infrastructure along the coast. Following a CSZ event, access to and from coastal communities will be limited along US-101, major roadways, and bridges. Railroads that support transport of freight and cargo and access to the Southwest Regional Airport will also be compromised and will have implications statewide.

Currently, there are no power plants or major dams in the region, requiring energy to be transmitted long distances from other states and Canada. These energy conveyance systems are vulnerable to severe but infrequent natural hazards, such as a Cascadia Subduction Zone (CSZ) event. The proposed Jordan Cove Liquid Natural Gas facility will provide a local energy supply. Older, centralized storm and wastewater infrastructure is also vulnerable to flood events.

Most of the region's drinking water is sourced from surface water that is vulnerable to flooding, erosion, and landslides. These hazard events could result in pollution entering waterways that supply the region with drinking water.

Region 1 is developing at a slower pace than the rest of the state. Growth that is occurring is primarily in Tillamook and Curry Counties. The region has a high number of mobile home units. Almost half of all housing in Clatsop and Curry Counties was built before current seismic and floodplain management standards, creating a greater risk to damage to loss. Due to the coast's geology and geomorphology, development is limited to low-lying areas often subject to coastal hazards. New tsunami risk information and development guidance developed by the State are available to help communities develop land use planning strategies to reduce tsunami hazard risk.

Hazards and Vulnerability

Region 1 is affected by nine of the 11 natural hazards that affect Oregon communities. Dust storms and volcanoes do not directly impact the area.

Coastal Hazards: The Oregon coast is increasingly threatened by wave-induced erosion, wave runup and overtopping, wind-blown sand, and coastal landslides. Clatsop, Tillamook, Lincoln, and Curry Counties are principally vulnerable to these hazards. Development in low-lying areas subject to erosion or adjacent to estuaries is of particular concern. There are 28 state facilities in the region's coastal erosion zone, valued at approximately $7 million. Of these, one is a critical/essential facility. An additional five non-state critical/essential facilities are also located in this hazard zone.

Droughts: The region is affected by droughts to a lesser extent than other areas in the state. While uncommon, when they do occur they can be problematic — impacting community water supplies and creating forest conditions conducive to wildfires.

Earthquakes and Tsunamis: Three types of earthquakes affect Region 1: (a) shallow crustal events, (b) deep intra-plate events within the subducting Juan de Fuca plate, and (c) the offshore Cascadia fault. The CSZ is the chief earthquake hazard for coastal communities. The return rate for this type of catastrophic event is 530 years. The probability of such an event occurring in the next 50 years is 7–12%.

Tsunamis may take the form of distant or local events. The CSZ earthquake and local tsunami event have the potential to affect the entire coastline through severe ground shaking, liquefaction of fine-grained soils, landslides, and flooding. In addition to causing significant loss of lives and development, a CSZ earthquake and local tsunami would dramatically affect the region's critical infrastructure, including principal roads and highways, bridges, tunnels, dams, and coastal ports. The region has the most seismically vulnerable highway system in the state. Seismic lifelines will be fragmented along US-101 and along east-west routes that connect the region to the rest of the state.

There are 1,300 state facilities in Region 1. Of these, the following are in earthquake or tsunami zones:

- All 1,300 state-owned/leased facilities, valued at over $336 million, are in the earthquake zone. Of these, 186 are critical/essential facilities.
- 676 state-owned/leased facilities, valued at approximately $134 million, are in the tsunami hazard zone. Of these, 98 are critical/essential facilities.
- In addition, there are 913 non-state-owned critical/essential facilities in the earthquake hazard zone. Of these, 243 are in the tsunami zone.

Floods: Coastal communities are impacted by riverine flooding, tsunami flooding, and ocean flooding from high tides and wind-driven waves. Low lying areas adjacent to bays or the ocean are more susceptible to flooding, which can be intensified by high tides. Northern counties are considered highly vulnerable to riverine flood damage because the area is more densely populated and has more of the region's infrastructure. Local highways are susceptible to wave action because of their location and geology. There are 151 state facilities, valued at approximately $23 million, located in the region's flood hazard zone. Of these, five are critical/essential facilities. An additional 85 non-state critical/essential facilities are located in this hazard zone.

Landslides: Landslides can occur throughout the region, though more tend to occur in areas with steeper slopes, weaker geology, and higher annual precipitation. Many landslides occur along the coast and Coast Range Mountains. Rain-induced landslides can occur during winter months, and earthquakes can trigger landslides at any time. US-101, principal roadways, and rail lines are exposed to landslides. Landslides have the potential to cause injuries and fatalities along these transportation systems. Landslides can also sever transportation systems, causing temporary but significant economic damage regionally and beyond. There are 1,300 state facilities in Region 1 in this hazard zone. These facilities have an estimated value of over $336 million. Of these, 186 are critical/essential facilities. An additional 913 non-state critical/essential facilities are also located within this hazard zone.

Volcanoes: Though the volcanic Cascade Range is outside the region, there is some risk that volcanic ashfall, lahars, and mud flows may impact communities within Region 1 following a volcanic event.

Wildfires: Though cool moist weather makes the region less susceptible to wildfire than some other areas in the state, some of the largest fires have occurred in Region 1. Wildfire events typically take place in late summer. Areas with high levels of dry vegetation (gorse, timber, etc.) are most susceptible to wildfire. Based on data from the 2013 West Wide Wildfire Risk Assessment, in Region 1, Douglas County has a high percentage of wildland acres subject to Fire Risk, Wildland Development Areas, and Fire Effects, making it especially vulnerable. Other vulnerable areas are located within wildland-urban interface communities. There are 796 state facilities located in Region 1's wildfire hazard zone with a value of approximately $186 million. Of these, 98 are critical/essential facilities. An additional 408 non-state critical/essential facilities are also located in the wildfire hazard zone.

Windstorms: In general, winds generated offshore and traveling inland in a northeasterly direction can create windstorms in all counties along the coast. Windstorms affect the region annually, especially between October and March. They can impact the region's buildings, utilities, tree-lined roads, transmission lines, residential parcels, and transportation systems along open areas such as the coastline, grasslands, and farmland.

Winter Storms: Colder weather, snow, ice, sleet, higher precipitation, and high winds can impact the Oregon Coast annually. Heavy ice can down trees causing widespread power outages and road closures that can isolate communities. Communities that are particularly susceptible to winter storms include Astoria, Canon Beach, Rockaway Beach, Oceanside, Lincoln City, Depot Bay, and Newport.

Climate Change

The most reliable information on climate change to date is at the state level. The state information indicates that hazards projected to be impacted by climate change in Region 1 include coastal hazards, drought, wildfire, flooding, and landslides. Research shows that sea levels and wave heights along the Oregon Coast are rising and are expected to increase coastal erosion and coastal flooding. In addition, climate models project warmer drier summers and a decline in mean summer precipitation for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, all eight regions are expected to be affected by an increased incidence of drought and wildfire. Furthermore, flooding and landslides are projected to occur more frequently throughout western Oregon. An increase in extreme precipitation is projected for some areas in Region 1 and can result in a greater risk of flooding in certain basins, including an increased incidence of magnitude and return intervals. Landslides in Oregon are strongly correlated with rainfall, so increased rainfall — particularly extreme events — will likely trigger more landslides. While winter storms and windstorms affect Region 1, there is little research on how climate change influences these hazards in the Pacific Northwest. For more information on climate drivers and the projected impacts of climate change in Oregon, see the section **Introduction to Climate Change**.

2.3.1.2 Profile

Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

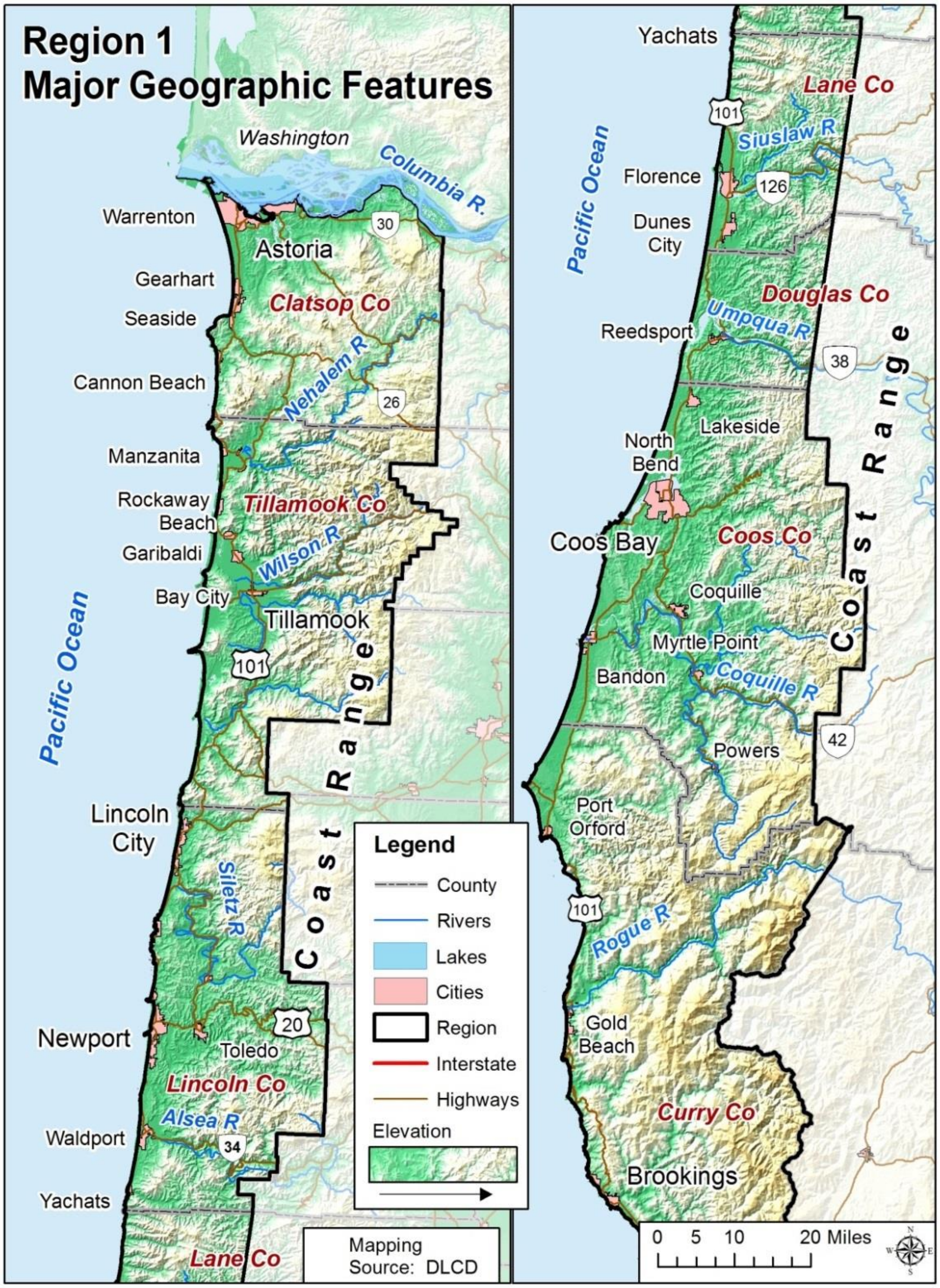
Natural Environment

Geography

The Oregon Coast is approximately 17,063 square miles in size, and includes Clatsop, Coos, Curry, Lincoln and Tillamook Counties, and coastal areas of Douglas and Lane Counties. The Coast Range mountains and waterways shape the region's topography. Region 1 begins at the Pacific Ocean on the west side and continues eastward beyond the Coast Range to the major valleys in the east. It extends from Washington State in the North to the California border in the south. Major rivers in the region include the Siuslaw, Umpqua, Nehalem, Rogue, Yaquina, Siletz, Nestucca, Trask, Wilson, Coos, and Coquille. **Figure 2-82** shows the dominant mountain ranges, major watersheds, and political boundaries of Region 1.

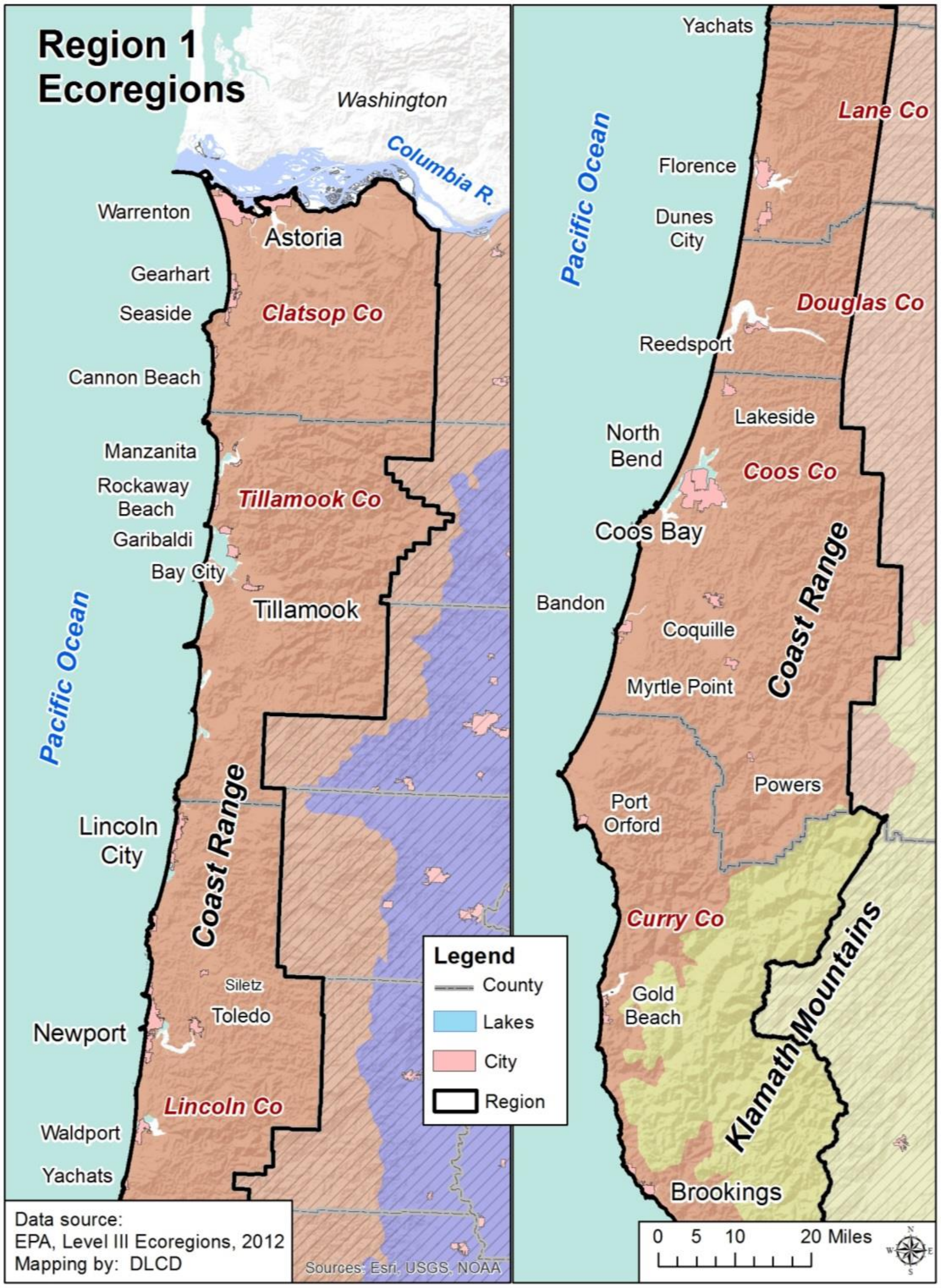
The U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Region 1 is comprises two ecoregions: the Coast Range and a smaller area of the Klamath Mountains (**Figure 2-83**).

Figure 2-82. Region 1 Major Geographic Features



Source: USGS, NGA, NASA, CGIAR

Figure 2-83. Region 1 Ecoregions



Coast Range: The Coast Range is Region 1’s dominant ecoregion. Mountains in the Coast Range are low in elevation and high in precipitation, creating lush evergreen forests. Naturally occurring diverse forests have given way to monocrop plantings for timber harvest. The Oregon Coast Range is volcanic in origin and is drained by hundreds of creeks, streams, rivers, and lakes. Sedimentary soils are more prone to failure following clear cuts and road building than are areas with volcanic soils, which may be of concern as commercial Douglas fir forests are highly productive commercial logging areas. Landslides can impact the safety of nearby infrastructure and health of the region’s waterways. Sedimentary soils create more concerns for stream sedimentation than areas with volcanic soils. Low lands include beaches, dunes, forests, lakes, marshes, and streams. Many wetlands in the ecoregion have been converted to dairy pastures (Thorson et al., 2003).

Klamath Mountains: The majority of the Klamath Mountains found in Region 1 are classified as the Coastal Siskiyous. This area has a wet, mild maritime climate. Land cover is a mix of hard- and soft-wood forests, which is far more diverse than the predominantly coniferous forests of the Coast Range. Logging, recreation, rural residential development, and mining activities are common in this ecoregion (Thorson et al., 2003).

Climate

This section covers historic climate information. For estimated future climate conditions and possible statewide impacts refer to the **State Risk Assessment**.

The Oregon Coast has a predominantly mild climate with localized variation in precipitation levels. Precipitation occurs predominantly in the winter months, mostly in the form of rain due to the region's low elevation. Wet winters and dry summers impact risk to drought, floods, landslides, and wildfires. Winter storms are often accompanied by high winds. Variations in temperature and precipitation vary widely by sub-ecoregion and microclimates. For more detailed and locally relevant climate data refer to the Oregon Climate Service.

Table 2-50. Average Precipitation and Temperature Ranges in Region 1 Ecoregions

Ecoregion	Mean Annual Precipitation Range (inches)	Mean Temperature Range (°F) January min/max	Mean Temperature Range (°F) July min/max
Klamath Mountains*	45–130	32/50	49/82
Coast Range*	50–200	30/52	48/78

*Data have been generalized from all the sub-ecoregions of the ecoregion in Region 1.

Source: Thorson et al. (2003)

Demography

Population

Population forecasts are an indicator of future development needs and trends. Community demographics may indicate where specific vulnerabilities may be present in the aftermath of a natural hazard (Cutter et al., 2003). If a population is forecast to increase substantially, a community's capacity to provide adequate housing stock, services, or resources for all populations post disaster may be stressed or compromised.

Between 2000 and 2013 the region's growth lagged behind the state by 11%. Growth in Coos County, the region's largest county, has been flat, while Curry County had the region's greatest percentage increase in population. Coastal communities are projected to continue to grow at a slower rate than the state, with Lincoln County expected to experience the greatest growth in the region and Coos County to experience the least.

Table 2-51. Population Estimate and Forecast for Region 1

	2000	2013	Percent Change (2000 to 2013)	2020 Projected	Percent Change (2013 to 2020)
Oregon	3,421,399	3,919,020	14.5%	4,252,100	8.5%
Region 1	188,287	194,365	3.2%	201,941	3.9%
Clatsop	35,630	37,270	4.6%	38,461	3.2%
Coos	62,779	62,860	0.1%	64,098	2.0%
Curry	21,137	22,300	5.5%	23,087	3.5%
Lincoln	44,479	46,560	4.7%	49,535	6.4%
Tillamook	24,262	25,375	4.6%	26,760	5.5%

Sources: Population Research Center, Portland State University, 2013; U.S. Census Bureau, 2010 Decennial Census. Table DP-1; Office of Economic Analysis, Long-Term Oregon State's County Population Forecast, 2010-2050, 2013

Tourists

Tourists are not counted in population statistics and are therefore considered separately in this analysis. More than 14,000 tourists visited and stayed at least one night at the Oregon Coast in 2013. The average travel party along the Oregon Coast contained three people, and the majority of these trips originated from Oregon or California. Communities in the northern and central coast attracted more tourists than the southern communities, and Lincoln County received the largest single-county share of tourists. Between 2011 and 2013, visitors in Region 1 mostly lodged in hotels, motels, campgrounds, or vacation homes rather than in private homes (Dean Runyan Associates, 2014).

Difficulty locating or accounting for travelers increases their vulnerability in the event of a natural disaster. Furthermore, tourists are often unfamiliar with evacuation routes, communication outlets, or even the type of hazard that may occur (MDC Consultants, n.d.). Targeting natural hazard mitigation outreach efforts to places where tourists lodge can help increase awareness and minimize the vulnerability of this population.

Table 2-52. Annual Visitor Estimates in Person Nights in Region 1

	2011		2012		2013	
	Number	Percent	Number	Percent	Number	Percent
Region 1	14,368	—	14,669	—	15,388	—
North Coast	5,362	100%	5,537	100%	5,857	100%
Hotel/Motel	2,278	42.5%	2,394	43.2%	2,686	45.9%
Private Home	714	13.3%	738	13.3%	746	12.7%
Other	2,370	44.2%	2,405	43.4%	2,425	41.4%
Clatsop	3,082	100%	3,180	100%	3,410	100%
Hotel/Motel	1,671	54.2%	1,742	54.8%	1,954	57.3%
Private Home	467	15.2%	481	15.1%	487	14.3%
Other	944	30.6%	957	30.1%	969	28.4%
Tillamook	2,280	100%	2,357	100%	2,448	100%
Hotel/Motel	607	26.6%	652	27.7%	733	29.9%
Private Home	247	10.8%	257	10.9%	259	10.6%
Other	1,426	62.5%	1,448	61.4%	1,456	59.5%
Central Coast*	5,350	100%	5,392	100%	5,626	100%
Hotel/Motel	2,146	40.1%	2,134	39.6%	2,315	41.1%
Private Home	761	14.2%	780	14.5%	801	14.2%
Other	2,443	45.7%	2,478	46.0%	2,510	44.6%
Lincoln	4,004	100%	4,045	100%	4,233	100%
Hotel/Motel	1,857	46.4%	1,853	45.8%	2,004	47.3%
Private Home	573	14.3%	589	14.6%	604	14.3%
Other	1,574	39.3%	1,604	39.7%	1,626	38.4%
South Coast	3,656	100%	3,740	100%	3,905	100%
Hotel/Motel	1,230	33.6%	1,261	33.7%	1,389	35.6%
Private Home	1,015	27.8%	1,028	27.5%	1,042	26.7%
Other	1,411	38.6%	1,451	38.8%	1,474	37.7%
Coos	2,235	100%	2,296	100%	2,406	100%
Hotel/Motel	843	37.7%	875	38.1%	970	40.3%
Private Home	796	35.6%	806	35.1%	815	33.9%
Other	596	26.7%	615	26.8%	621	25.8%
Curry	1,421	100%	1,444	100%	1,500	100%
Hotel/Motel	387	27.2%	386	26.7%	420	28.0%
Private Home	219	15.4%	222	15.4%	227	15.1%
Other	815	57.4%	836	57.9%	853	56.9%

*Central Coast also includes the coastal portions of Douglas and Lane Counties; data is not aggregated for coastal portions of these counties within the report. See Region 3 (Lane) and Region 4 (Douglas) profiles for the entire county tourism data.

Source: Oregon Travel Impacts: 1991–2013, April 2014. Dean Runyan Associates, http://www.deanrunyan.com/doc_library/ORImp.pdf

Persons with Disabilities

Disabilities appear in many forms. While some disabilities may be easily identified, others may be less perceptible. Disabled populations, while difficult to identify and measure, are disproportionately affected during disasters (Cutter et al., 2003). In Region 1, roughly 7% more people identify as having a disability than do people throughout the state. Over one third of all disabled persons in the region reside in Coos County. A quarter of the people in Curry County have a disability. Local natural hazard mitigation plans should specifically target outreach programs toward helping disabled residents better prepare for and recover from hazard events.

Table 2-53. People with a Disability by Age Groups in Region 1, 2012

	Total Population*	With a Disability (Total Population)		Under 18 Years with a Disability		65 Years and Over with a Disability	
	Estimate	Estimate	Percent	Estimate	Percent**	Estimate	Percent**
Oregon	3,796,881	511,297	13.5%	39,439	4.6%	200,374	37.8%
Region 1	190,678	38,347	20.1%	2,200	6.1%	16,126	39.2%
Clatsop	36,381	6,447	17.7%	540	7.1%	2,335	37.3%
Coos	62,026	14,000	22.6%	824	6.9%	5,911	43.9%
Curry	22,180	5,547	25.0%	221	6.2%	2,629	42.5%
Lincoln	45,632	8,746	19.2%	409	5.1%	3,679	36.8%
Tillamook	24,459	3,607	14.7%	206	4.1%	1,572	30.4%

*Total population does not include institutionalized population.

**Percent of age group.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Homeless Population

Population estimates of the homeless in Oregon are performed each January. These are rough estimates and can fluctuate with many factors, including the economy or season. The overwhelming majority of the homeless population in Region 1 is either single adult males or families with children. Communities located along major transportation corridors tend to have higher concentrations of homeless people. Between 2009 and 2011, the number of homeless people more than doubled in Coos County and almost tripled in Clatsop County. The greatest percent increase in the region, though, was in Tillamook County, with more than a 22% rise in number of homeless persons.

Extra attention is needed to care for and serve homeless communities. Some homeless people choose to remain hidden or anonymous, making it especially difficult to mitigate harm to them from natural hazard events. Accessible shelter and social services are key emergency considerations for the homeless community.

Table 2-54. Homeless Population Estimate for Region 1

	2009	2010	2011	3-Year Average
Oregon	17,122	19,208	22,116	19,482
Region 1	696	1,504	1,892	1,364
Clatsop	137	184	407	243
Coos	390	821	991	734
Curry	105	133	93	110
Lincoln	48	82	41	57
Tillamook	16	284	360	220

Source: Oregon Point in Time Homeless Count, Oregon Housing and Community Services. http://www.oregon.gov/ohcs/pages/ra_point_in_time_homeless_count.aspx

Gender

The gender breakdown in Region 1 is similar to that of the state, roughly 50:50 (U.S. Census Bureau, 2010). 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 (U.S. Census Bureau, 2010).

Age

Region 1 has 7% more seniors than the state average. This is likely due to a high number of retirees in the region. A higher percentage of seniors requires special consideration due to sensitivity to heat and cold, reliance upon transportation to obtain medication, and comparative difficulty in making home modifications that reduce risk to hazards. In addition, the elderly may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to the elderly (Morrow, 1999).

Children also represent a vulnerable segment of the population. Though the share of children in Region 1 is less than the share of children statewide, at least 16% of all people in each coastal county are under 18 years old. Almost one third of all children in the region live in Coos County. Special considerations should be given to young children, schools, and parents during the natural hazard mitigation process. Young children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities. In addition, parents may lose time and money when their children’s childcare facilities and schools are impacted by disasters.

Table 2-55. Population by Vulnerable Age Groups, in Region 1, 2012

	Total Population	Under 18 Years Old		65 Years and Older	
	Estimate	**Estimate**	**Percent**	**Estimate**	**Percent**
Oregon	3,836,628	864,243	22.5%	540,527	14.1%
Region 1	193,595	36,181	18.7%	41,648	21.5%
Clatsop	37,068	7,583	20.5%	6,368	17.2%
Coos	62,937	11,932	19.0%	13,674	21.7%
Curry	22,344	3,592	16.1%	6,240	27.9%
Lincoln	45,992	8,040	17.5%	10,090	21.9%
Tillamook	25,254	5,034	19.9%	5,276	20.9%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP05

Language

Special consideration in hazard mitigation should be given to populations who do not speak English as their primary language. These populations are less likely to be prepared for a natural disaster if special attention is not given to language and culturally appropriate outreach materials. In the Oregon Coast Region, most residents speak English as their primary language. However, in every county along the Coast, 1–3% of the total population does not speak English “very well.” Communities creating outreach materials used to communicate with and plan for populations who do not speak English very well should take into consideration the language needs of these populations.

Table 2-56. English Usage in Region 1, 2012

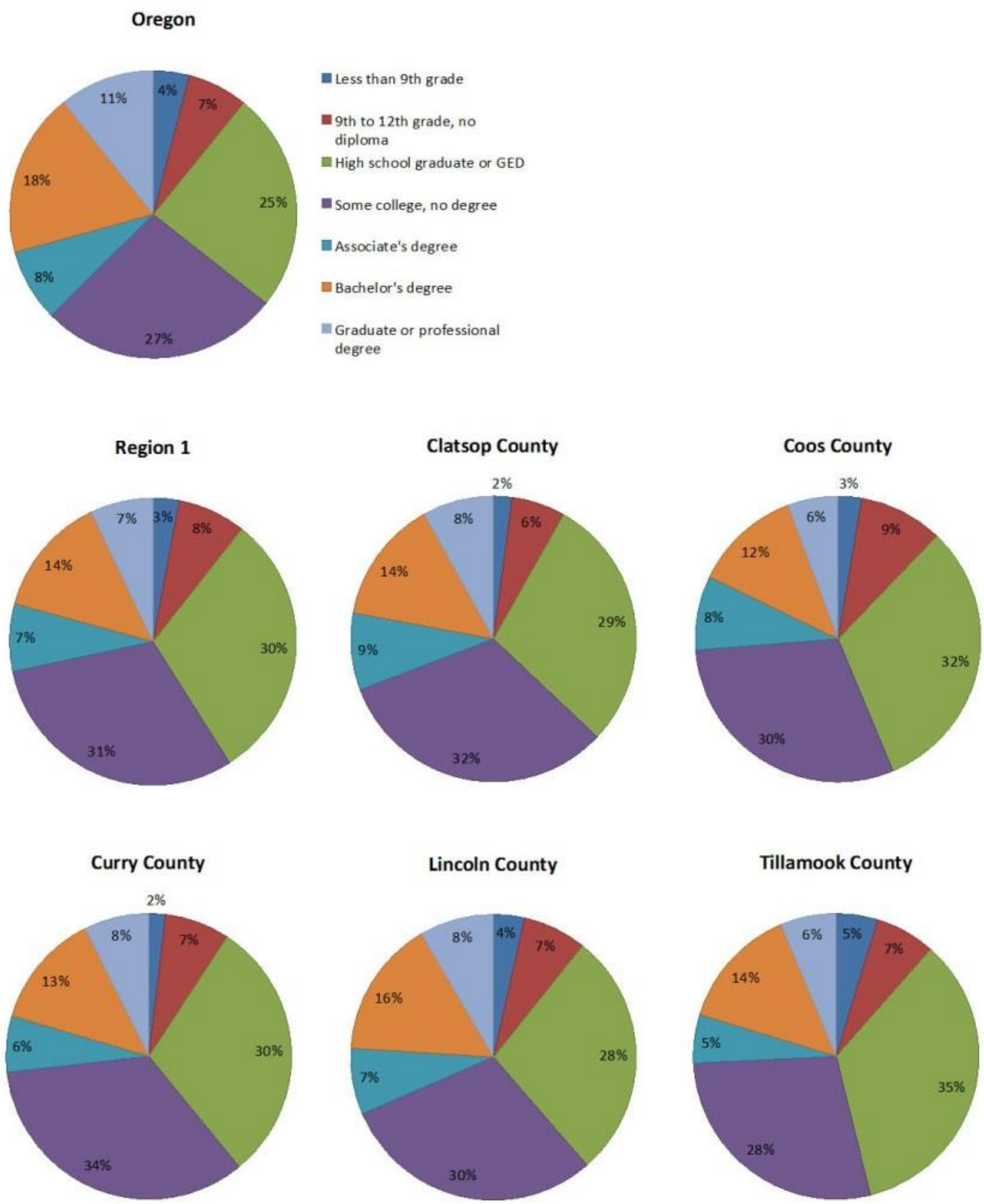
	Speak English "Very Well"		Speak English Less Than "Very Well"	
	Estimate	**Percent**	**Estimate**	**Percent**
Oregon	3,376,744	93.8%	224,905	6.2%
Region 1	179,730	97.7%	4,281	2.3%
Clatsop	34,027	97.0%	1,070	3.0%
Coos	58,969	98.7%	798	1.3%
Curry	21,227	98.9%	230	1.1%
Lincoln	42,374	96.9%	1365	3.1%
Tillamook	23,133	96.6%	818	3.4%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Education Level

Studies (e.g., Cutter et al., 2003) show that education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings. Furthermore, education can influence a person’s and community’s ability to understand warning information and to access resources before and after a natural disaster. Region 1 has a greater percentage of people with a high school or General Education Development (GED) degree and a lower percentage of people with a bachelors or master’s degree than statewide numbers. About one third of the population in each of the coastal counties has some college education. Clatsop and Lincoln Counties have the highest percentage of people with an associate’s degree or more in the region.

Figure 2-84. Educational Attainment in Region 1, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Income

The impact of a disaster in terms of loss and the ability to recover varies among population groups. “The causes of social vulnerability are explained by the underlying social conditions that are often quite remote from the initiating hazard or disaster event” (Cutter, 2006, p. 76). Historically, 80% of the disaster burden falls on the public. Of this number, a disproportionate burden is placed upon those living in poverty. People living in poverty are more likely to be isolated, are less likely to have the savings to rebuild after a disaster, and less likely to have access to transportation and medical care.

In Region 1, the greatest impacts from the financial crisis that began in 2007 occurred in southern counties (Coos, Curry, and Douglas) that were already affected by high levels of joblessness and less diverse economies. Median household incomes remain $6,000 to $12,000 lower than the statewide numbers. Coos and Curry Counties continue to have the lowest median household incomes in the region.

Table 2-57. Median Household Income in Region 1

	2009	2012	Percent Change
Oregon	$52,474	$50,036	-4.6%
Region 1	N/A	N/A	N/A
Clatsop	$43,263	$44,330	2.5%
Coos	$39,334	$37,853	-3.8%
Curry	$38,714	$38,401	-0.8%
Lincoln	$40,849	$41,996	2.8%
Tillamook	$41,578	$41,869	0.7%

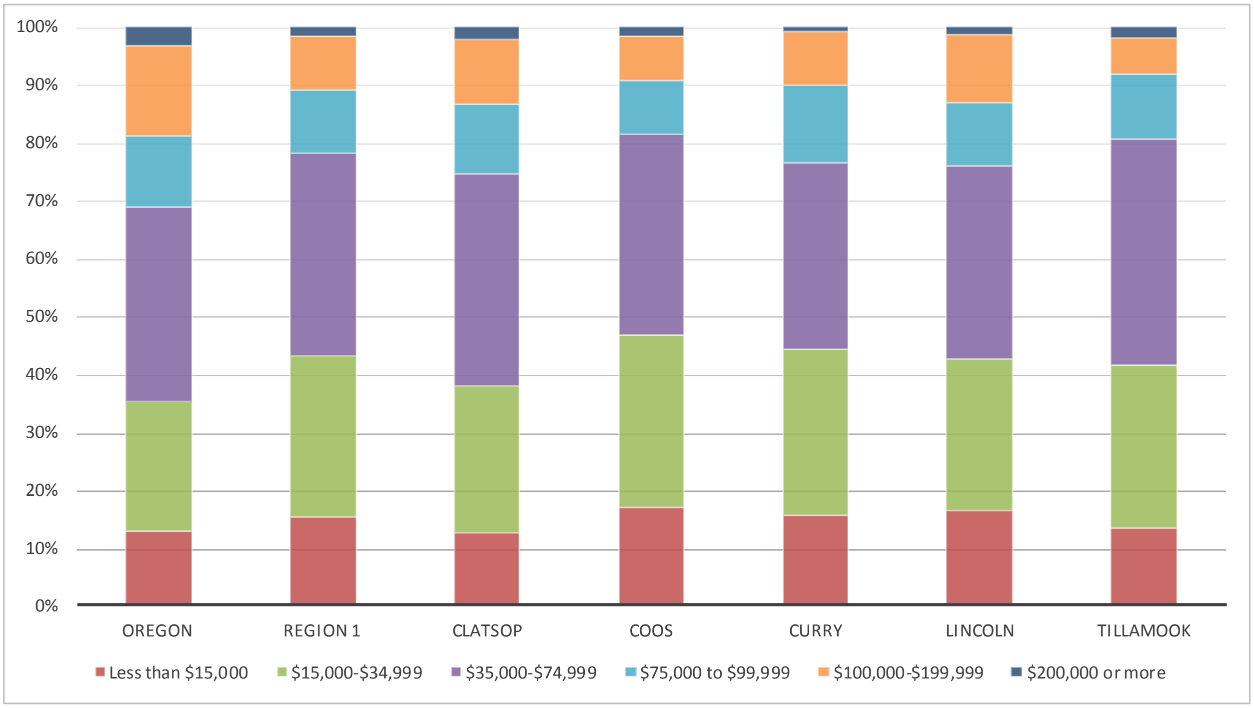
Note: 2009 dollars are adjusted for 2012 using Bureau of Labor Statistics’ Consumer Price Index Inflation Calculator.

N/A = data not aggregated at the regional level.

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates. Table DP03.

Compared to statewide numbers, a higher percentage of households earn less than $35,000 per year in Oregon’s coastal communities. Clatsop and Lincoln Counties have the highest percentage of households in upper income brackets. Nonetheless, compared to the state, 9% fewer households in coastal communities are in the top income brackets earning $75,000 or more.

Figure 2-85. Median Household Income Distribution in Region 1, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP03

There are 5% more individuals and children in coastal communities living in poverty than across the state. Clatsop County has had by far had the greatest increase in poverty — at least 15% more than other counties in the region and almost 10% more than the state. Poverty has decreased in Lincoln and Curry Counties.

Table 2-58. Poverty Rates in Region 1, 2012

	Total Population in Poverty			Children Under 18 in Poverty		
	Number	Percent	Percent Change*	Number	Percent	Percent Change*
Oregon	584,059	15.5%	17.7%	175,303	20.6%	17.6%
Region 1	30,893	16.3%	5.5%	7,958	22.6%	4.5%
Clatsop	5,725	15.8%	27.1%	1,829	25.0%	37.3%
Coos	10,661	17.3%	3.6%	2,659	23.1%	0.3%
Curry	3,048	13.7%	3.9%	531	14.8%	-8.4%
Lincoln	7,262	16.0%	-6.9%	1,618	20.5%	-14.8%
Tillamook	4,197	17.2%	12.2%	1,321	26.7%	14.9%

*Percent change since 2009.

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates, Table S1701

Low-income populations require special consideration when mitigating loss to a natural hazard. Often, those who earn less have little to no savings and other assets to withstand economic setbacks. When a natural disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the natural disaster. To reduce the compounded loss incurred by low-income populations post-disaster, mitigation actions need to be specially tailored to ensure safety nets are in place to provide further support to those with fewer personal resources.

Housing Tenure

Wealth can increase the ability to recover following a natural disaster and homeownership, versus renting, is often linked to having more wealth (Cutter et al., 2003). Renters often do not have personal financial resources or insurance to help recover post-disaster. On the other hand, renters tend to be more mobile and have fewer assets at risk. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable due to natural disaster events.

Homeownership is higher among Oregon Coastal communities, compared to the state average. Almost one fifth of the housing stock are second or seasonal homes or used recreationally by tourists. Clatsop County has the highest percentage of renters in the region. Coos and Curry Counties have the highest vacancy rates. Homeownership being an indicator of resiliency, coastal communities are doing quite well as they have a strong homeowner base.

Table 2-59. Housing Tenure in Region 1, 2012

	Total Occupied Units	Owner Occupied		Renter Occupied		Vacant*	
		Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	945,824	62.5%	566,894	37.5%	105,417	6.3%
Region 1	84,526	56,191	66.5%	28,335	33.5%	8,346	7.3%
Clatsop	15,757	9,814	62.3%	5,943	37.7%	1,647	7.6%
Coos	26,567	17,672	66.5%	8,895	33.5%	2,750	9.0%
Curry	10,320	7,162	69.4%	3,158	30.6%	1,517	12.1%
Lincoln	21,039	13,945	66.3%	7,094	33.7%	1,738	5.7%
Tillamook	10,843	7,598	70.1%	3,245	29.9%	694	3.8%

*Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04 and Table B25004.

Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households. Region 1 is predominantly composed of family households. The region's percentage of single-parent households is slightly lower than the state average but still equates to 7% of households (roughly 6,000 people).

Table 2-60. Family vs. Non-family Households in Region 1, 2012

	Total Households	Family Households		Nonfamily Households		Householder Living Alone	
	Estimate	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	964,274	63.7%	548,444	36.3%	421,620	27.9%
Region 1	84,526	52,009	61.5%	32,517	38.5%	26,443	31.3%
Clatsop	15,757	9,825	62.4%	5,932	37.6%	4,893	31.1%
Coos	26,567	16,171	60.9%	10,396	39.1%	8,215	30.9%
Curry	10,320	6,298	61.0%	4,022	39.0%	3,317	32.1%
Lincoln	21,039	12,725	60.5%	8,314	39.5%	6,802	32.3%
Tillamook	10,843	6,990	64.5%	3,853	35.5%	3,216	29.7%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Table 2-61. Family Households with Children by Head of Household in Region 1, 2012

	Family Households with Children		Single Parent (Male)		Single Parent (Female)		Married Couple with Children	
	Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	415,538	27.5%	35,855	2.4%	93,575	6.2%	286,108	18.9%
Region 1	17,303	20.5%	1,914	2.3%	4,124	4.9%	11,265	13.3%
Clatsop	3,873	24.6%	393	2.5%	1,035	6.6%	2,445	15.5%
Coos	5,205	19.6%	543	2.0%	1,230	4.6%	3,432	12.9%
Curry	1,763	17.1%	271	2.6%	331	3.2%	1,161	11.3%
Lincoln	3,969	18.9%	381	1.8%	947	4.5%	2,641	12.6%
Tillamook	2,493	23.0%	326	3.0%	581	5.4%	1,586	14.6%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Social and Demographic Trends

The demographic analysis shows Region 1 is particularly vulnerable to a hazard event in the following ways:

- Many tourists visit the central and north coast, especially Lincoln County.
- Region 1 has a significantly higher proportion of disabled residents than the state overall, particularly Coos and Curry Counties.
- The homeless population in Coos and Clatsop Counties has risen dramatically in recent years.
- Region 1 has a higher percentage of seniors in its counties than the state overall.
- Region 1 higher percentages of people with less education and lower percentages of people with higher education than the state as a whole.
- Median incomes are below the state average in all coastal counties.
- Clatsop County has seen a significant increase in the number of households living in poverty.

Economy

Employment

The Oregon Coast Region enjoys some economic advantages due to its coastal location. In addition, the region's close proximity to the Coast Range, California, Washington, and the beach itself provides year-round sporting and tourism activities.

Since the financial crisis that began in 2007, job recovery in Region 1 has lagged behind statewide numbers. However, unemployment rates in Region 1 have been steadily declining since 2009 and there has been significant job growth since 2012. Curry County has the highest unemployment rate in the region. Coos County has the largest labor force and the second highest unemployment rate. Despite its slowly growing economy, the region's average salary remains 25% to 29% lower than the state average.

"The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster" (Cutter et al., 2003). Spring and summer months bring more jobs to the region, as the weather improves and tourism, construction, fishing, and retail trade increases. Therefore, Oregon's coastal economy is more vulnerable during winter months when tourism drops and in turn employment opportunities that support those industries decreases.

Table 2-62. Employment and Unemployment Rates in Region 1, 2013

	Civilian Labor Force	Employed Workers		Unemployed	
	Total	Total	Percent	Total	Percent
Oregon	1,924,604	1,775,890	92.3%	148,714	7.7%
Region 1	90,368	82,699	91.5%	7,669	8.5%
Clatsop	19,984	18,621	93.2%	1,363	6.8%
Coos	27,479	24,772	90.1%	2,707	9.9%
Curry	8,689	7,770	89.4%	919	10.6%
Lincoln	21,916	20,121	91.8%	1,795	8.2%
Tillamook	12,300	11,415	92.8%	885	7.2%

Source: Oregon Employment Department, 2014

Table 2-63. Unemployment Rates in Region 1, 2009-2013

	2009	2010	2011	2012	2013	Change (2009–2013)
Oregon	11.1%	10.8%	9.7%	8.8%	7.7%	-3.4%
Region 1	11.0%	11.1%	10.3%	9.6%	8.5%	-2.5%
Clatsop	9.0%	9.3%	8.7%	7.8%	6.8%	-2.2%
Coos	12.8%	12.6%	11.5%	10.8%	9.9%	-3.0%
Curry	13.0%	12.8%	12.2%	11.7%	10.6%	-2.4%
Lincoln	10.5%	10.7%	10.1%	9.4%	8.2%	-2.3%
Tillamook	9.4%	9.7%	9.1%	8.6%	7.2%	-2.2%

Source: Oregon Employment Department, 2014

Table 2-64. Employment and Payroll in Region 1, 2013

	Employees	Average Pay	Percent State Average
Oregon	1,679,364	$45,010	100%
Region 1	70,445	$32,971	73.3%
Clatsop	16,888	$33,680	74.8%
Coos	21,579	$33,332	74.1%
Curry	6,180	$31,801	70.7%
Lincoln	17,329	$32,387	72.0%
Tillamook	8,469	$32,685	72.6%

Source: Oregon Employment Department, 2014

Employment Sectors and Key Industries

In 2012 the five major employment sectors in Region 1 were: (a) Government; (b) Trade, Transportation, and Utilities; (c) Leisure and Hospitality; (d) Education and Health Services; and (e) Manufacturing. Natural-Resources industries (wood products, fishing, etc.) remain key industries of in Region 1. However, of growing importance are industries that rely upon the emerging retirement and seasonal tourist populations (the leisure and hospitality sector).

Table 2-65. Covered Employment by Sector in Region 1, 2013

		Clatsop County		Coos County		Curry County		Lincoln County		Tillamook County	
Industry	**Region 1**	**Employment**	**Percent**	**Employment**	**Percent**	**Employment**	**Percent**	**Employment**	**Percent**	**Employment**	**Percent**
Total All Ownerships	70,445	16,888	100%	21,579	100%	6,180	100%	17,329	100%	8,469	100%
Total Private Coverage	78.7%	14,241	84.3%	16,017	74.2%	5,031	81.4%	13,497	77.9%	6,684	78.9%
Natural Resources & Mining	3.8%	441	2.6%	979	4.5%	298	4.8%	310	1.8%	661	7.8%
Construction	3.7%	658	3.9%	674	3.1%	332	5.4%	652	3.8%	300	3.5%
Manufacturing	9.3%	2,149	12.7%	1,657	7.7%	564	9.1%	1,080	6.2%	1,133	13.4%
Trade, Transportation & Utilities	18.2%	2,925	17.3%	4,085	18.9%	1,187	19.2%	3,332	19.2%	1,289	15.2%
Information	0.9%	151	0.9%	187	0.9%	65	1.1%	174	1.0%	43	0.5%
Financial Activities	3.2%	526	3.1%	669	3.1%	238	3.9%	561	3.2%	257	3.0%
Professional & Business Services	6.8%	711	4.2%	2,266	10.5%	428	6.9%	989	5.7%	405	4.8%
Education & Health Services	11.1%	2,116	12.5%	2,502	11.6%	671	10.9%	1,667	9.6%	898	10.6%
Leisure & Hospitality	18.0%	3,915	23.2%	2,352	10.9%	1,028	16.6%	4,096	23.6%	1,315	15.5%
Other Services	3.6%	651	3.9%	646	3.0%	218	3.5%	631	3.6%	381	4.5%
Private Non-Classified	0.0%	(c)	—	(c)	—	(c)	—	6	0.0%	(c)	—
Total All Government	21.3%	2,647	15.7%	5,562	25.8%	1,150	18.6%	3,833	22.1%	1,785	21.1%
Federal Government	1.5%	206	1.2%	323	1.5%	84	1.4%	352	2.0%	107	1.3%
State Government	3.8%	450	2.7%	963	4.5%	174	2.8%	694	4.0%	386	4.6%
Local Government	16.0%	1,990	11.8%	4,276	19.8%	892	14.4%	2,788	16.1%	1,292	15.3%

Note: (c) = confidential, information not provided by Oregon Employment Department to prevent identifying specific businesses.

Source: Oregon Employment Department, 2013.

Each industry faces distinct vulnerabilities to natural hazards. Identifying key industries in the region enables communities to target mitigation activities toward those industries' specific sensitivities. Each of the primary private employment sectors has sensitivity to natural hazards, as follows.

Trade, Transportation, and Utilities: Retail Trade is the largest employment subsector within the Trade, Transportation, and Utilities sector. Retail Trade is vulnerable to disruptions in the disposable income of regional residents and to disruptions in the transportation system. Residents' discretionary spending diminishes after natural disasters as spending priorities tend to focus on essential items. Retail businesses are concentrated in the larger cities of the region and disruption of the transportation system could sever the connectivity between people living throughout the region and these retail hubs.

Leisure and Hospitality: This sector primarily serves regional residents with disposable income and tourists. Following a natural disaster, residents may have less disposable income and tourists may choose not to visit a region with unstable infrastructure.

Education and Health Services: The importance of Health and Social Assistance industries is underscored in Region 1 because of the increasing number of retirees and individuals with a disability. Health care is a relatively stable revenue sector regionally with an abundant distribution of businesses primarily serving a local population. Following a disaster, Health and Social Assistance industries will play important roles in emergency response and recovery.

Manufacturing: This sector is highly dependent upon transportation networks in order to access supplies and send finished products to outside markets. For these reasons the manufacturing sector may be susceptible to disruptions in transportation infrastructure. However, manufacturers are not dependent on local markets for sales, which may contribute to the economic resilience of this sector. Within the region, manufacturers are primarily based in Clatsop and Tillamook Counties.

Revenue by Sector

In 2007, Manufacturing, Trade (Retail and Wholesale), and Healthcare and Social Assistance were the highest revenue grossing industries in Region 1. Combined, these three industries generated 84% of the region's total revenue, nearly $5.9 billion. Manufacturing represented nearly 60% of revenue within Tillamook County. Trade accounted for approximately 40% of all revenue within the region. Interruptions to these sectors, such as those likely to occur following a natural disaster, would result in significant revenue loss for the region.

According to the Oregon Employment Department, between 2012 and 2022, the largest job growth in Region 1 is expected to occur in the following sectors: (a) Education and Health services; (b) Government; (c) Trade, Transportation, and Utilities (including retail trade); (d) Leisure and Hospitality; and (e) Professional and Business Services. Of growing importance are industries that support the growing retirement and seasonal tourist populations in coastal communities, i.e., health, leisure, and hospitality industries.

Table 2-66. Revenue of Top Industries (in Thousands of Dollars) in Region 1, 2007

	Total Revenue (in Thousands)	Trade (Retail and Wholesale)	Manufacturing	Health Care and Social Assistance
Oregon	$277,017,733	44.4%	24.1%	7.3%
Region 1	$6,987,691	39.3%	33.9%	11.0%
Clatsop	$1,800,769	37.8%	38.0%	8.0%
Coos	$1,859,888	52.5%	15.0%	17.7%
Curry	$586,151	38.7%	32.5%	10.5%
Lincoln	$1,675,051	36.3%	34.8%	9.3%
Tillamook	$1,065,832	24.0%	59.5%	6.9%

Source: U.S. Census, Economic Census. 2007, Table ECO700A1

Identifying sectors with a large number of businesses, and targeting mitigation strategies to support those sectors, can help the region's resiliency. The Trade, Transportation, and Utilities sector includes the most businesses in Region 1, 19% of all businesses. Retail Trade is the largest sub-category within this sector, with 14% of all businesses. The Leisure and Hospitality sector has the second largest number of business units. Other Services, Professional and Business, and Construction round off the top five sectors in the region. Many of these are small businesses employing fewer than 20 employees. Due to their small size, these businesses are particularly sensitive to temporary decreases in demand that may occur following a natural hazard event. Collectively these businesses represent two thirds of the business units in the region, so a negative impact on them will have a multiplied ripple effect through the region.

Economic Trends and Issues

Because a strong and diverse economic base increases the ability of individuals, families, and communities to absorb impacts of a disaster and recover more quickly, current and anticipated financial conditions of a community are strong determinants of community resilience. The economic analysis of the region shows the following situations increase Oregon Coastal communities' level of vulnerability to natural hazard events:

- Higher unemployment than the state average in Curry, Coos, and Lincoln Counties;
- Low average salaries across the region; and
- A regional economy heavily dependent on seasonal employment and few key industries.

Supporting the growth of dominant industries and employment sectors, as well as emerging sectors identified in this analysis, can help the region become more resilient to economic downturns that often follow a hazard event (Stahl et al., 2000).

Infrastructure

Transportation

There are two primary modes of transportation in the region: highways and railroad. There are also many small airports scattered throughout the region that are used for passenger and freight service.

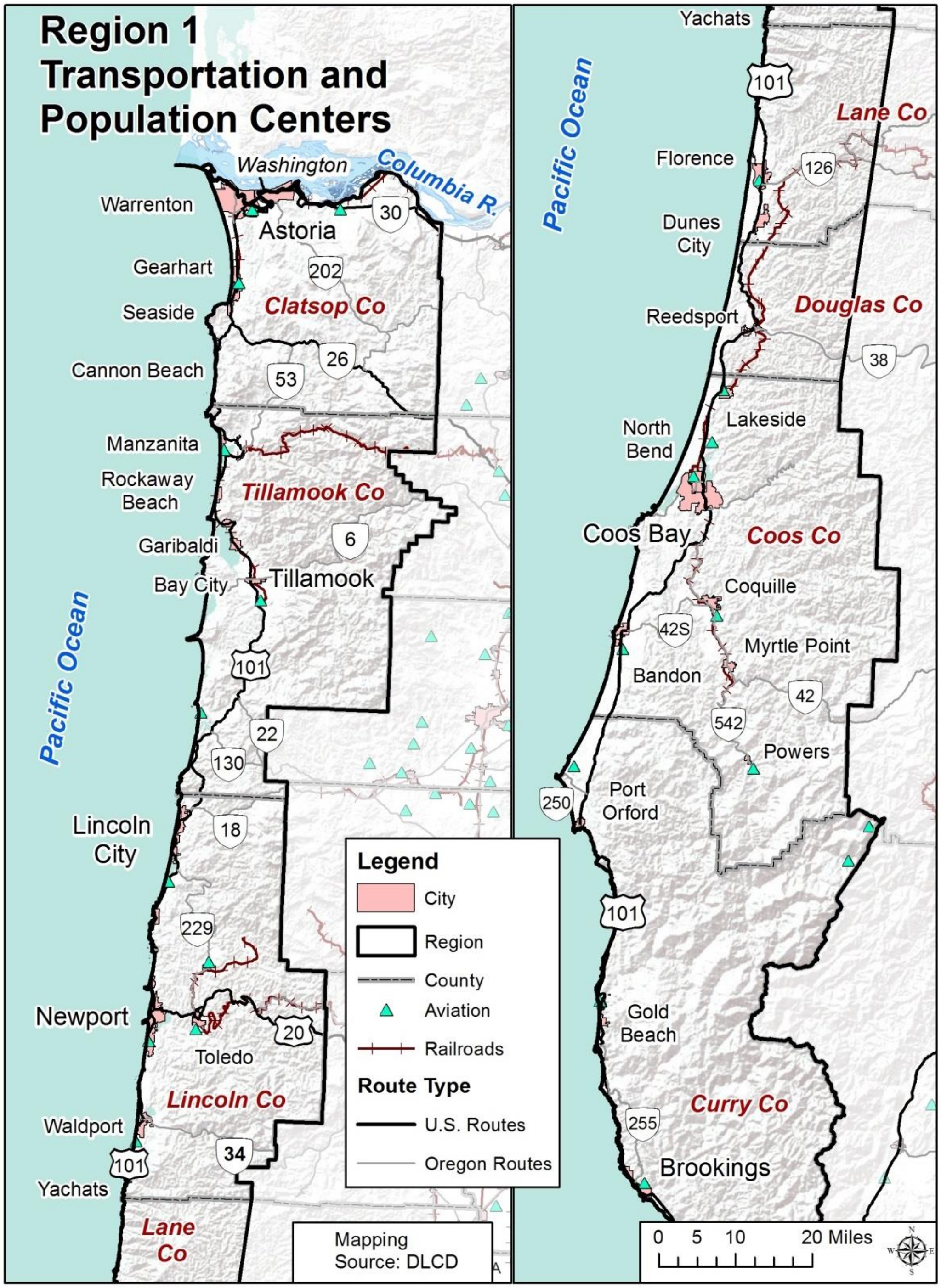
Roads

Most of the population bases in Region 1 are located along the region's major freeway, US-101. US-101 runs north-south and is the only continuous passage for automobiles and trucks traveling along the Oregon Coast. Coastal communities are connected to the interior of the state by many routes.

Natural hazards and emergency events disrupt automobile traffic, create gridlock, and shut down local transit systems, making evacuations and other emergency operations difficult. Localized flooding can render roads unusable. A severe winter storm or tsunami has the potential to disrupt the daily driving routine of thousands of people.

According to the Oregon Department of Transportation's (ODOT's) Seismic Lifeline Report (**Appendix 9.1.13**), the region has high exposure to earthquakes, especially a Cascadia Subduction Zone event. Therefore, the seismic vulnerability of the region's lifelines, including roadways and bridges, is an important issue. For information on ODOT's Seismic Lifeline Report findings for Region 1, see **Seismic Lifelines**.

Figure 2-86. Region 1 Transportation and Population Centers



Source: Department of Land Conservation and Development, 2014

Bridges

As mentioned, the region's bridges are highly vulnerable to seismic activity. Non-functional bridges disrupt local and freight traffic, emergency operations, and sever lifelines. These disruptions exacerbate local economic losses if industries are unable to transport goods. The region's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or that are part of regional and local systems maintained by the region's counties and cities.

Table 2-67 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 (ODOT, 2012, 2013). 29% of the region's bridges are distressed or deficient. About 42% of the region's ODOT bridges are distressed.

Table 2-67. Bridge Inventory for Region 1

	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 1	125	299	42%	64	361	18%	16	24	67%	11	37	30%	216	749	29%	57
Clatsop	27	68	38%	9	51	18%	13	19	68%	2	8	25%	51	150	34%	19
Coos	18	58	30%	10	113	9%	1	2	50%	3	11	27%	32	186	17%	6
Curry	14	29	41%	6	31	19%	0	0	—	0	0	—	20	65	31%	7
Lincoln	21	68	31%	20	85	24%	2	2	100%	2	3	67%	45	158	28%	10
Tillamook	45	76	48%	19	81	23%	0	1	0%	4	15	27%	68	190	36%	15

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 of 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.

Source: ODOT (2012, 2013)

Railroads

Railroads that run throughout Region 1 support cargo and trade flows. All of the region's rail lines are short lines and freight routes, connecting the coast to larger rail lines and inland metropolitan areas. Curry County is the only coastal community without rail service. The region's rail providers are the Portland & Western Railroad (PNWR), Port of Tillamook Bay Railroad (POTB), and the Coos Bay Rail Link (CBRL). The PNWR lines in Clatsop County connect Astoria and the Portland Metro Area. The POTB line connects Tillamook to inland railways operated by PNWR. Oregon's rail system is critical to the state's economy, energy, and food systems. Rail systems export lumber and wood products, pulp and paper, and other goods produced in Oregon and products from other states that are shipped to and through Oregon by rail (Cambridge Systematics, 2014). Though there is no commuter rail line in the region, there is a local passenger line.

Rails are sensitive to storms. Disruptions in the rail system can result in economic losses. The potential for harm from rail accidents can also have serious implications for local communities, particularly if hazardous materials are involved.

Airports

Southwest Oregon Regional Airport is the only commercial airport in the region and is the fifth busiest airport in Oregon (Federal Aviation Administration, 2012). The airport is owned, operated and administered by Coos County Airport District. It serves two hubs and two air carriers (Southwest Regional Airport, n.d.).

In the event of a natural disaster, public and private airports are important staging areas for emergency response activities. Public airport closures will impact the region's tourism industries, as well as the ability for people to leave the region by air. Businesses relying on air freight may also be impacted by airport closures.

Table 2-68. Public and Private Airports in Region 1

	Number of Airports by FAA Designation				
	Public Airport	Private Airport	Public Heliport	Private Heliport	Total
Region 1	16	6	0	10	32
Clatsop	2	1	0	4	7
Coos	4	2	0	2	8
Curry	3	2	0	1	6
Lincoln	4	1	0	2	7
Tillamook	3	0	0	1	4

Source: FAA Airport Master Record (Form 5010), 2014

Ports

Ports in the Oregon Coast Region are a major contributor to the local, regional, and national economies. Oregon's ports have historically been used for timber transport and commercial and recreational fishing. With the decline in the timber industry, ports have evolved to embrace economic development and tourism by offering industrial land and infrastructure (river, rail, road, and air) and by promoting fresh seafood, fishing trips, and ecotourism. Oregon's coastal ports are divided by region: north, central and south (Coastal Oregon Marine Experiment Station, n.d.). The North Coast ports include: Astoria, Nehalem, and Garibaldi (including Tillamook Bay). The Astoria

Port includes facilities for cruise ships while the Port of Garibaldi/Tillamook Bay encompass more than 1,600 acres of industrial zoned land. The central coast ports include: Newport, Toledo, Alsea, and Siuslaw. The Newport and Siuslaw are active fishing ports that also provide an array of businesses catering to tourists. South coast ports include Umpqua, Coos Bay, Bandon, Port Orford, Gold Beach, and Brookings-Harbor. The Port of Coos Bay is Oregon's largest coastal deep-draft harbor and supports cargo ships that link to the Coos Bay Rail Link (Coastal Oregon Marine Experiment Station, n.d.). The Port of Brookings-Harbor is the busiest recreational port in Oregon with more than 31,000 visitor trips for more than 95,000 recreational boaters (Port of Brookings-Harbor, http://www.port-brookings-harbor.com).

Energy

Electricity

There are no power plants in Region 1. The region is served by several investor-owned, public, cooperative, and municipal utilities. The Bonneville Power Administration is the area's wholesale electricity distributor. Pacific Power and Light (Pacific Power) is the largest investor-owned utility company serving the region. The Blachly-Lane Electric Cooperative, Coos-Curry Electric Cooperative, and Western Oregon Electric Cooperative serve portions of the region. The Bandon Municipal Utility District serves an area around the City of Bandon in Coos County. In addition, the Tillamook People's Utility District, Central Lincoln People's Utility District, and Consumers Power Inc. provide electricity for portions of Region 1.

Hydropower

There are no major dams in the Oregon Coast region, but just east of the region, in the Cascades, there are several major dams — Bonneville, Round Butte, Lookout Point, Carmen-Smith, Detroit, and Pelton dams — that combined have maximum generating capacities of over 100 megawatts of electricity that service the state (Loy, 2001).

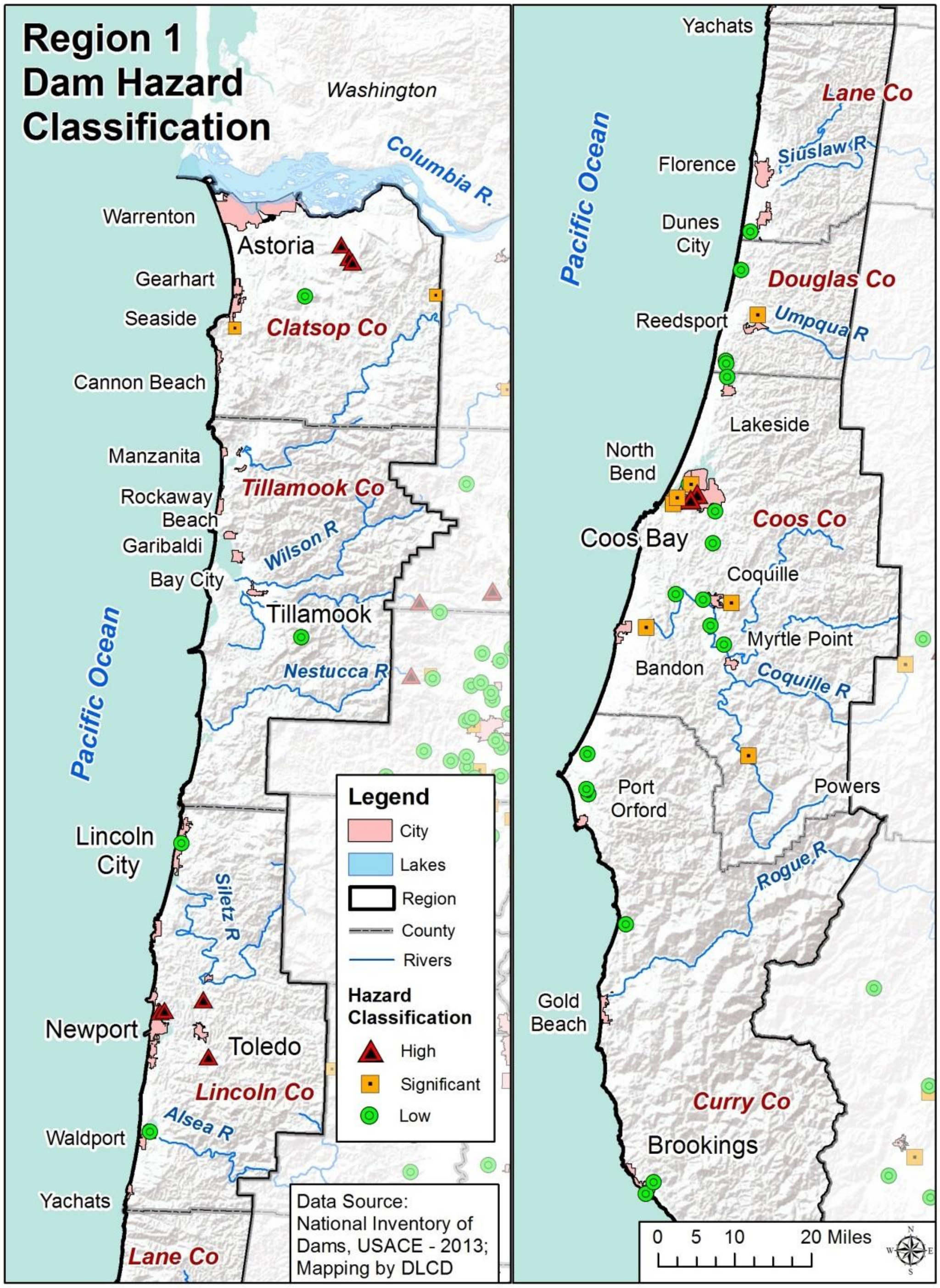
Minor dam failures can occur at any time. Most dam failures result in minor damage to structures and pose little or no risk to life safety. However, the potential for severe damage and fatalities does exist. Most recently, major dam failures have occurred near Hermiston in 2005 and in Klamath Lake in 2006 (Association of Dam Safety Officials, n.d.). The Oregon Water Resources Department uses the National Inventory of Dams (NID) threat potential methodology to inventory all large dams located in Oregon. The majority of dams along the Oregon Coast are located in Coos County (26). There are 11 High Threat Potential dams and 9 Significant Threat Potential dams in the region.

Table 2-69. Threat Potential of Dams in Region 1

	Threat Potential			Total Dams
	High	Significant	Low	
Region 1	11	9	35	55
Clatsop	4	1	1	6
Coos	2	8	16	26
Curry	0	0	8	8
Lincoln	5	0	2	7
Tillamook	0	0	8	8

Source: Oregon Water Resources Department, Dam Inventory Query, 2014

Figure 2-87. Region 1 Dam Hazard Classification



Source: National Inventory of Dams, 2013

Natural Gas

Natural gas provides about 12% of the region's energy. Liquefied natural gas (LNG) is transported via pipelines throughout the United States. The Jordan Cove Energy Project is a proposed liquefied natural gas (LNG) storage facility and power plant within the Port of Coos Bay. If built, this facility would provide LNG storage (320,000 cubic meters), liquefaction capacity (6 million metric tons per year), and sendout capacity (1,000,000 decatherms per day) via the Pacific Connector Gas Pipeline. It would include marine facilities — a single LNG marine berth and a dedicated tractor tug dock — and the South Dunes Power Plant capable of providing energy for the facility and the local grid (Jordan Cove Energy Project, L.P., n.d.). If developed, the pipeline would extend 235 miles through both public and private lands. **Figure 2-88** shows existing LNG pipelines (in blue) and the proposed Pacific Connector Gas Pipeline (in red) (Oregon Department of Environmental Quality, 2014). LNG pipelines, like other buried pipe infrastructure, are vulnerable to earthquakes and can cause danger to human life, safety, and environmental impacts in the case of a spill.

Figure 2-88. Liquefied Natural Gas Pipelines in Region

Source: Retrieved from http://gs-press.com.au/images/news_articles/cache/Pacific_Connector_Gas_Pipeline_Route-0x600.jpg

Utility Lifelines

Most of the Oregon Coast's oil and gas pipelines are connected to main lines that run through the Willamette Valley. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy, and is therefore crucial to consider during the natural hazard planning process. A network of electrical transmission lines, owned by Bonneville Power Administration and Pacific Power, runs through the region. Most of the natural gas Oregon uses originates in Alberta, Canada. Northwest Natural Gas serves the central portion of the Oregon Coast (Loy, 2001). These electric, oil, and gas lines may be vulnerable to severe, but infrequent, natural hazards such as earthquakes. If these lines fail or are disrupted, the essential functions of the community can become severely impaired.

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio). Parts of Region 1 are included in the Southern Oregon, the South Valley, and the North Coast Operational Areas under The Oregon State Emergency Alert System Plan (OEM, 2013), which also includes parts Jackson, Josephine and Klamath Counties. There is a memorandum of understanding between these counties that facilitates the launching of emergency messages for counties by Jackson County. Counties in this area can launch emergency messages by contacting the Oregon Emergency Response System (OERS) that in turn creates emergency messages to communities statewide.

Beyond day-to-day operations, maintaining communications capabilities during disaster events and other emergency situations helps to keep citizens safe by keeping them informed of the situation's status, areas to avoid, and other procedural information. Additionally, responders depend on telecommunications infrastructure to be routed to sites where they are needed.

Television

Television serves as a major provider for local, regional, and national news and weather information and can play a vital role in emergency communications. The local primary stations identified as emergency messengers by the Oregon State Emergency Alert System Plan are:

- KOBI-TV Channel 36, Coos Bay;
- KOBI-TV Channel 8, Coos Bay;
- KOBI-TV Channel 25, Coos Bay; and
- KOBI-TV Channel 7, Coos Bay.

Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband providers serve Region 1. Broadband technology including mobile wireless is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless, and mobile wireless. Internet service is becoming more readily available in the region with a greater number of providers and service types available within major communities and along major transportation corridors such as I-5, US-199, etc. (NTIA, n.d.). Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

Wireless providers sometimes offer free emergency mobile phones to those impacted by disasters, which can aid in communication when landlines and broadband service are unavailable.

Radio

Radio is readily available to those who live within Region 1 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Radio transmitters for Region 1 are (Oregon OEM, 2013):

- KIX-37, 162.550 MHZ, Brookings;
- WIX-32, 162.400 MHZ, Coos Bay;
- WNG-596, 162.425 MHZ, Port Orford;
- WNG-674, 162.525 MHZ, Florence;

- WZ-2509, 162.525 MHZ, Reedsport;
- KIH-33, 162.550 MHZ, Newport;
- WWF-95, 162.475 MHZ, Tillamook;
- KOGL, 89.3 MHZ, Gleneden Beach;
- KTMK, 91.1 MHZ, Tillamook; and
- KWAX-FM, 91.3 MHZ, Toledo.

Ham Radio

Amateur radio, or ham radio, is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). Region 1 is served by Amateur Radio Emergency Service (ARES) District 5. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (Oregon Office of Emergency Management, n.d.). The official ham emergency station calls for Region 1 include (American Relay Radio League Oregon Chapter, www.arrloregon.org):

- Clatsop County: WA7FIV, KD7IBA;
- Tillamook County: KF7ARK;
- Lincoln County: none available at this time;
- West Lane County: K7BHB;
- Douglas County: K7AZW;
- Coos County: KE7EIB; and
- Curry County: W7VN.

Water

Drinking water, stormwater, and wastewater systems all possess some level of vulnerability to natural hazards that can have repercussions on human health, ecosystems, and industry.

Drinking Water

In Region 1 the majority of the municipal drinking water supply is primarily obtained from surface water. Each county's water is drawn from several major waterways, including the Youngs, Nehalem, Wilson, Nestucca, Siletz, Yaquina, Alsea, Siuslaw, Umpqua, Coos, Coquille, and Rogue Rivers. Most urbanized areas also have infrastructure for groundwater wells in case of a surface water shortage. Because of high levels of turbidity in streams during heavy rain events, many communities are investing in new well fields. However, groundwater drawn within the floodplain is often heavy in iron, causing undesirable odor and taste, although no health risks have been associated with heavy iron levels. Earthquakes pose a major threat to the region's water supply because of the risk of dam failure at the region's reservoirs.

Rural residents may get water primarily from groundwater wells. These wells generally have low flow levels due to the region's predominantly volcanic soils. Areas with sedimentary and volcanic soils may be subject to high levels of arsenic, hydrogen sulfide, and fecal coliform bacteria, which can impact the safety of groundwater sources, although the coast is less subject to concerns about arsenic than inland areas of Oregon.

Water rights for rivers and streams in the region have reached a tipping point due to low summer water flows. New water rights cannot be purchased in Region 1. However, conservation approaches now allow landowners to share or sell a portion of their water rights to downstream users. To supplement high demand during summer irrigation, many farmers in the region are turning to above-ground water storage gathered from streams in the winter.

Surface sources for drinking water are vulnerable to pollutants caused by non-point sources and natural hazards. Non-point source pollution is a major threat to surface water quality, and may include stormwater runoff from roadways, agricultural operations, timber harvest, erosion, and sedimentation. Landslides, flood events, and earthquakes and resulting liquefaction can cause increased erosion and sedimentation in waterways.

Underground water supplies and aging or outdated infrastructure — such as reservoirs, treatment facilities, and pump stations — can be severed during a seismic event. Rigid materials such as cast iron may snap under the pressure of liquefaction. More flexible materials such as polyvinyl chloride (PVC) and ductile iron may pull apart at joints under the same stresses. These types of infrastructure damages could result in a loss of water pressure in municipal water supply systems, thus limiting access to potable water. This can lead to unsanitary conditions that may threaten human health. Lack of water can also impact industry, such as the manufacturing sector. Moreover, if transportation infrastructure is impacted by a disaster event, repairs to water infrastructure will be delayed.

Stormwater and Wastewater

In urbanized areas severe precipitation events may cause flooding that leads to stormwater runoff. A non-point source of water pollution, stormwater runoff can adversely impact drinking water quality. It can also lead to environmental issues such as increasing surface water temperatures that can adversely affect habitat health. Furthermore, large volumes of fast-moving stormwater that enters surface waterways can cause erosion issues.

Stormwater can also impact water infrastructure. Leaves and other debris can be carried into storm drains and pipes, which can clog stormwater systems. In areas where stormwater systems are combined with wastewater systems (combined sewers) flooding events can lead to combined sewer overflows (CSOs). CSOs present a heightened health threat as sewage can flood urban areas and waterways. Underground stormwater and wastewater pipes are also vulnerable to damage by seismic events.

In Region 1, most local building codes and stormwater management plans emphasize use of centralized storm sewer systems to manage stormwater. Low impact development (LID) mitigation strategies can alleviate or lighten the burden to a jurisdiction's storm sewer system by allowing water to percolate through soil onsite or detaining water so water enters the storm sewer system at lower volumes, lower speeds, and lower temperatures. No jurisdictions in Region 1 refer to LID techniques in their stormwater management plans. Requiring decentralized LID stormwater management strategies could help reduce the burden of new development on storm sewer systems, and increase a community's resilience to flooding and seismic events, among other hazards.

Infrastructure Trends and Issues

Physical infrastructure is critical for everyday operations and is essential following a disaster. Lack, or poor condition, of infrastructure can negatively affect a community's ability to cope with, respond to, and recover from a hazard event. Diversity, redundancy, and consistent maintenance in infrastructure systems help create system resiliency (Meadows, 2008).

The effects of road, bridge, rail, and airport failures on the economy and residents could be devastating. Of special concern is the impact to US-101 and bridges following a Cascadia earthquake event and resulting tsunami. This infrastructure is at risk of damage, collapse, and blockage by landslides, flooding, and debris.

The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards. Transmission lines extend long distances to provide the region with power, making the system and region more vulnerable to possible disruptions and infrastructure damage during a disaster event. The proposed Jordan Cove LNG facility, if developed, would provide a local energy supply.

Multiple telecommunication systems can help boost the area's ability to communicate before, during, and after a disaster event. It is important to note that broadband and mobile telephone services do not cover many rural areas of the region that are distant from the region's major transportation corridor along US-101. This may present a communication challenge in the wake of a disaster. Encouraging residents to keep AM/FM radios available for emergency situations could aid in communicating important messages throughout the region.

Older centralized water systems are particularly vulnerable to hazard events. The region is also at risk of pollutants entering waterways through stormwater runoff and combined sewer overflows (CSOs) during high-water events. The implementation of decentralized LID stormwater systems can increase the region's capacity to better manage high-precipitation events.

Built Environment

Development Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's program is the 19 land use goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards (Department of Land Conservation and Development, http://www.oregon.gov/LCD/docs/goals/goal7.pdf).

Settlement Patterns

The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people or an "urban cluster" of at least 2,500 people (but less than 50,000). Wheeler County does not meet either definition; therefore all of its population is considered rural even though the county has incorporated cities.

Over the 10 year period between 2000 and 2010, growth in urban areas in Region 1 was only half that of the state. However, two counties — Curry and Tillamook — experienced more than 30% urban growth. Rural development in the coastal communities decreased by 3% overall, growing only slightly in Lincoln and Coos Counties. Notably, rural populations declined by 22% in Curry County.

The percent growth of housing units in urban areas was twice that in rural areas. Curry and Tillamook Counties experienced at least 3 times more urban growth than other counties in the region. Lincoln and Tillamook Counties experienced the most growth in rural housing units.

Unsurprisingly, populations tend to cluster around major road corridors and waterways. Population centers include the Cities of Astoria, Tillamook, Newport, Florence, Coos Bay, Brookings, and some unincorporated areas.

Table 2-70. Urban and Rural Populations in Region 1

	Urban			Rural		
	2000	**2010**	**Percent Change**	**2000**	**2010**	**Percent Change**
Oregon	2,694,144	3,104,382	15.2%	727,255	726,692	-0.1%
Region 1	103,534	111,575	7.8%	84,753	82,155	-3.1%
Clatsop	20,976	22,604	7.8%	14,654	14,435	-1.5%
Coos	38,999	38,864	-0.3%	23,780	24,179	1.7%
Curry	10,030	13,702	36.6%	11,107	8,662	-22.0%
Lincoln	27,640	28,730	3.9%	16,839	17,304	2.8%
Tillamook	5,889	7,675	30.3%	18,373	17,575	-4.3%

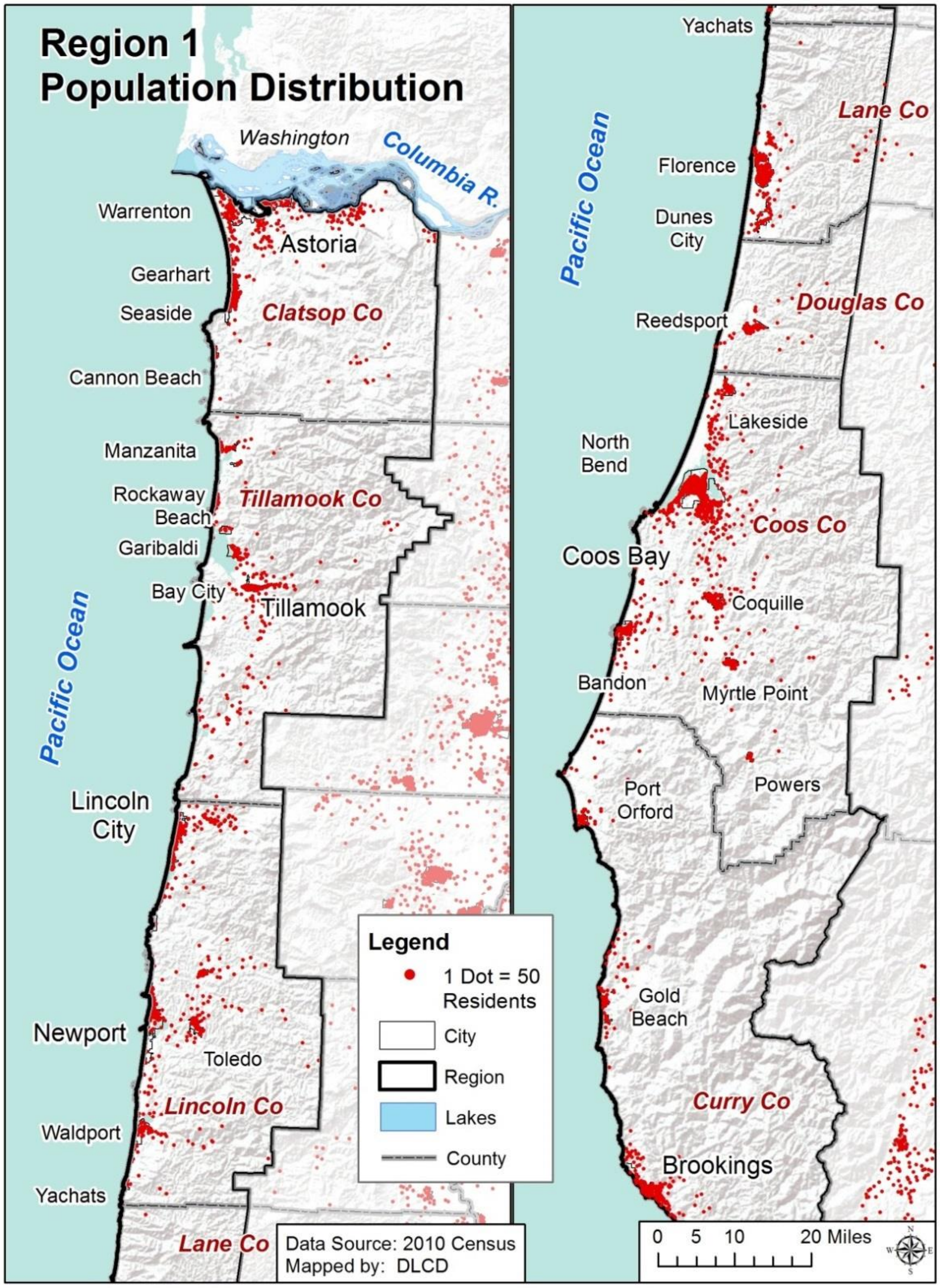
Source: U.S. Census Bureau. 2000 Decennial Census, Table P002, and 2010 Decennial Census, Table P2

Table 2-71. Urban and Rural Housing Units in Region 1

	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 1	54,599	61,938	13.4%	48,534	51,783	6.7%
Clatsop	11,639	12,866	10.5%	8,046	8,680	7.9%
Coos	17,957	18,578	3.5%	11,290	12,015	6.4%
Curry	5,331	7,428	39.3%	6,075	5,185	-14.7%
Lincoln	17,152	19,534	13.9%	9,737	11,076	13.8%
Tillamook	2,520	3,532	40.2%	13,386	14,827	10.8%

Source: U.S. Census Bureau. 2000 Decennial Census, Table H002, and 2010 Decennial Census, Table H2

Figure 2-89. Region 1 Population Distribution



Source: U.S. Census, 2012

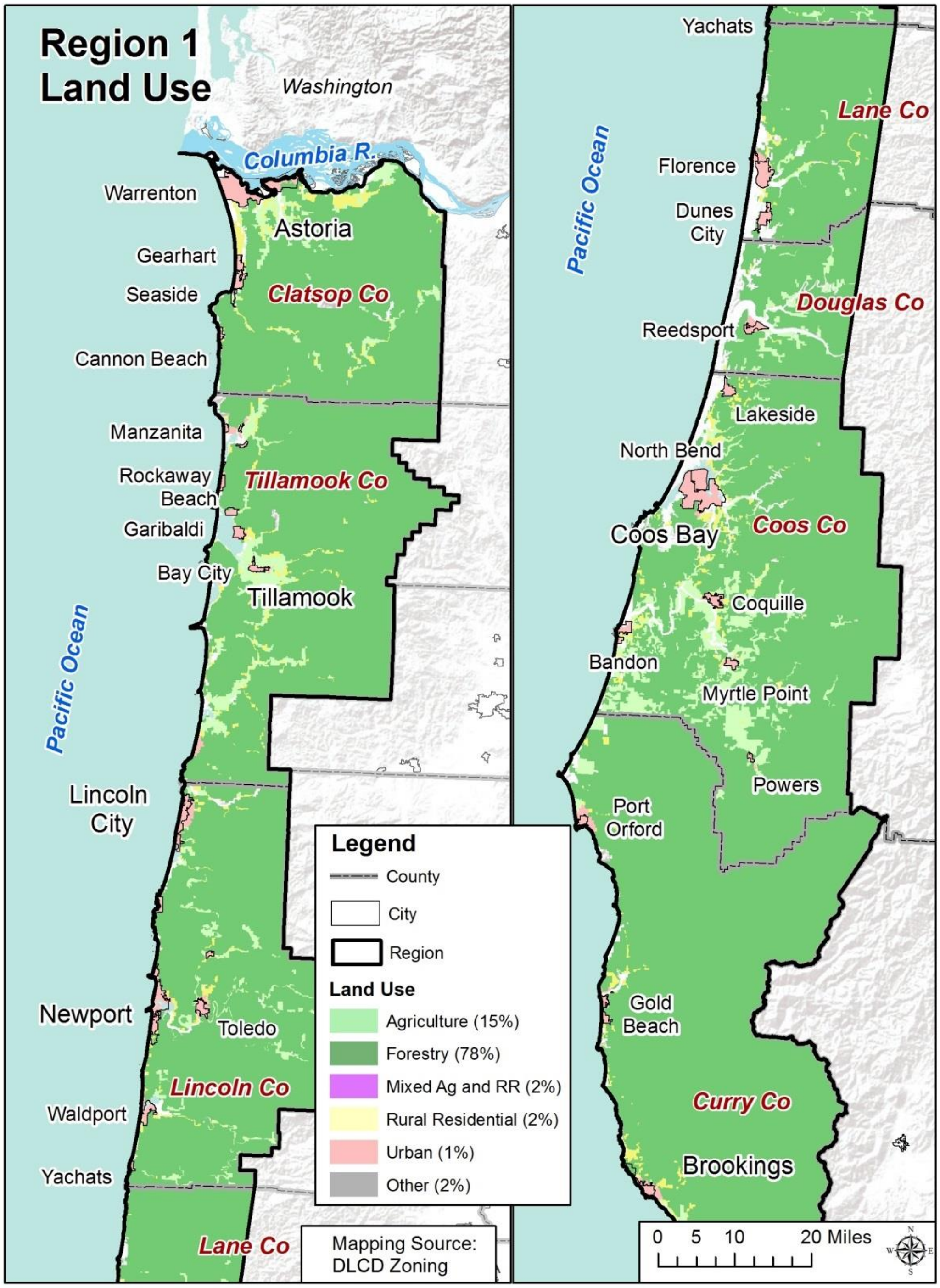
Land Use Patterns

Just over half of the land ownership of the Coast Region is private, with an additional 35% in federal ownership. The vast majority of this land is dedicated to forestry. From the period of 1974 to 2009 the north coast area has had the lowest conversion rate of private land from resource land uses to low-density residential and urban uses (Lettman, 2011). Overall, the coastal communities have experienced little development in the past 5 years, although recently building permitting has increased, mostly for infill of existing subdivisions (DLCD, internal communication, 2014).

The first liquefied natural gas export terminals on the Oregon Coast are proposed in Warrenton and Coos Bay. The Coos Bay project would also support the first power generation plant on the Coast. These projects are the focus of several State, Federal, and local permitting issues, including whether they are consistent with the Coastal Zone Management Act.

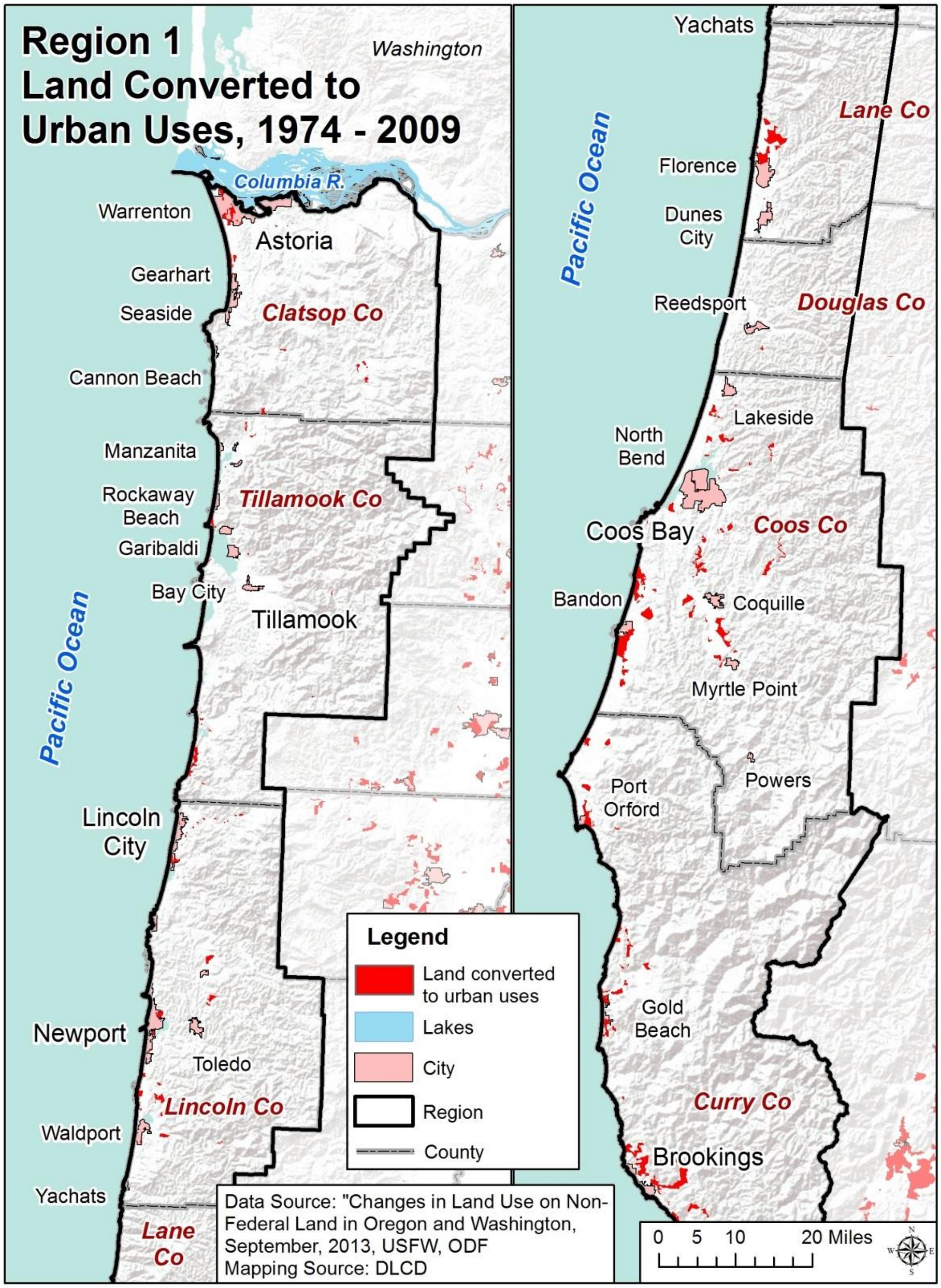
During 2012-2013, the Department of Geology and Mineral Industries released new tsunami inundation maps displaying five scenarios of a potential impact of a Cascadia Subduction Zone tsunami, reflecting the full range of what was experienced in the past and is projected for the future. Then in January, 2014, the Department of Land Conservation and Development distributed *Preparing for a Cascadia Subduction Zone Tsunami: A Land Use Guide for Oregon Coastal Communities* (http://www.oregon.gov/lcd/ocmp/docs/publications/tsunamiguide20140108.pdf). This guide is intended to help communities develop land use planning strategies to reduce tsunami hazard risk.

Figure 2-90. Region 1 Land Use



Source: Department of Land Conservation and Development, 2014

Figure 2-91. Region 1 Land Converted to Urban Uses, 1974–2009



Source: Lettman (2013), http://www.oregon.gov/odf/RESOURCE_PLANNING/land_use_in_OR_WA_web_edited.pdf

Housing

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. Over 71% of the region's housing stock is single-family homes. There are roughly the same share of multi-family units and mobile units across the region, 14%. Fifty-eight percent of all mobile homes are located in Coos and Lincoln Counties. In Curry County almost a quarter of all homes are mobile units. In natural hazard events such as earthquakes and floods, mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of OES, 1997).

Table 2-72. Housing Profile for Region 1, 2012

	Total Housing Units	Single Family		Multi-Family		Mobile Homes	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	1,140,319	68.1%	460,852	27.5%	139,768	8.4%
Region 1	113,554	81,174	71.5%	16,310	14.4%	15,440	13.6%
Clatsop	21,563	15,669	72.7%	4,586	21.3%	1,282	5.9%
Coos	30,569	22,105	72.3%	3,867	12.7%	4,468	14.6%
Curry	12,569	7,980	63.5%	1,439	11.4%	2,971	23.6%
Lincoln	30,516	20,998	68.8%	4,777	15.7%	4,490	14.7%
Tillamook	18,337	14,422	78.6%	1,641	8.9%	2,229	12.2%

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25024

Aside from location and type of housing, the year structures were built (Table 2-73) has implications for level of vulnerability to natural hazards. Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for a Cascadia Subduction Zone (CSZ) catastrophic earthquake event (Judson, 2012). Therefore, homes built before 1994 within an earthquake hazard zone are more vulnerable to damage and loss caused by seismic events. Less than one third of the region's housing stock was built after 1990 and the codification of seismic building standards. Note: This does not reflect the number of structures that are exposed to seismic activity.

Also in the 1970s, FEMA began assisting communities with floodplain mapping as part of administering 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. Almost 40% of the region's housing stock was built prior to 1970, before the implementation of floodplain management ordinances. More than 47% of homes in Clatsop and Coos Counties were built prior to 1970. Note: This does not reflect the number of structures that are built within special flood hazard areas.

Table 2-73. Age of Housing Stock in Region 1, 2012

	Total Housing Units	Pre 1970		1970 to 1989		1990 or later	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	609,062	36.4%	518,569	31.0%	545,962	32.6%
Region 1	113,554	44,465	39.2%	37,214	32.8%	31,875	28.1%
Clatsop	21,563	10,236	47.5%	5,474	25.4%	5,853	27.1%
Coos	30,569	14,448	47.3%	9,547	31.2%	6,574	21.5%
Curry	12,569	3,423	27.2%	5,228	41.6%	3,918	31.2%
Lincoln	30,516	10,072	33.0%	11,106	36.4%	9,338	30.6%
Tillamook	18,337	6,286	34.3%	5,859	32.0%	6,192	33.8%

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25034

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. **Table 2-74** shows the initial and current FIRM effective dates for Region 1 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, **Flood** section.

Table 2-74. Community Flood Map History in Region 1

	Initial FIRM	Current FIRM
Clatsop County	July 3, 1978	Sept. 17, 2010
Astoria	Aug. 1, 1978	Sept. 17, 2010
Cannon Beach	Sept. 1, 1978	Sept. 17, 2010
Gearhart	May 15, 1978	Sept. 17, 2010
Seaside	Sept. 5, 1979	Sept. 17, 2010
Warrenton	May 15, 1978	Sept. 17, 2010
Coos County	Nov. 15, 1984	Mar. 17, 2014
Bandon	Aug. 15, 1984	Mar. 17, 2014
Coos Bay	Aug. 1, 1984	Mar. 17, 2014
Coquille	Sep. 28, 1984	Mar. 17, 2014
Lakeside	Aug. 1, 1984	Mar. 17, 2014
Myrtle Point	July 16, 1984	Mar. 17, 2014
North Bend	Aug. 1, 1984	Mar. 17, 2014
Curry County	Apr. 3, 1978	Sep. 25, 2009
Brookings	Sep. 18, 1985	Sep. 25, 2009
Gold Beach	Nov. 15, 1985	Sep. 25, 2009
Port Orford	Jan. 29, 1980	Sep. 25, 2009
Douglas County	Dec. 15, 1978	Feb. 17, 2010
Reedsport	Apr. 3, 1984	Feb.17, 2010
Lane County	Dec. 18, 1985	June 2, 1999
Dunes City	Mar. 24, 1981	June 2, 1999 (M)
Florence	May 17, 1982	June 2, 1999
Lincoln	Sep. 30, 1980	Dec. 18, 2009
Depoe Bay	Oct. 15, 1980	Dec. 18, 2009
Lincoln City	Apr. 17, 1978	Dec. 18, 2009
Newport	Apr. 15, 1980	Dec. 18, 2009
Siletz	Mar. 1, 1979	Dec. 18, 2009
Toledo	Mar. 1, 1979	Dec. 18, 2009
Waldport	Mar. 15, 1979	Dec. 18, 2009
Yachats	Mar. 1, 1979	Dec. 18, 2009
Tillamook County	Aug. 1, 1978	Aug. 20, 2002
Bay City	Aug. 1, 1978	Aug. 1, 1978
Garibaldi	Apr. 17, 1978	Apr. 17, 1978
Manzanita	May 1, 1978	Jan. 12, 1982
Nehalem	Apr. 3, 1978	Dec. 7, 1982
Rockaway	Sep. 29, 1978	Oct. 12, 1982
Tillamook, City	May 1, 1978	Apr. 16, 2004
Wheeler	Nov. 16, 1977	Nov. 16, 1977

Note: M means no base flood elevation.

Source: Federal Emergency Management Agency, Community Status Book Report

State-Owned/Leased and Critical/Essential Facilities

In 2014 the Department of Geology and Mineral Industries updated the 2012 Oregon NHMP inventory and analysis of state-owned/leased facilities and critical/essential facilities. Results from this report relative to Region 1 can be found in **Table 2-75**. The region contains 4.6% of the total value of state-owned/leased critical/essential facilities, valued at over $336 million. A third of these facilities are located in Clatsop County.

Table 2-75. Value of State-Owned/Leased Critical and Essential Facilities in Region 1

	Total Property Value (State Facilities)	Percent of State Total
Oregon	$7,339,087,023	100%
Region 1	$336,073,104	4.6%
Clatsop	$116,767,199	1.6%
Coos	$59,977,786	0.8%
Curry	$13,782,834	0.2%
Douglas	$3,063,701	0.0%
Lane	$43,742,674	0.6%
Lincoln	$38,634,005	0.5%
Tillamook	$60,104,905	0.8%

Source: DOGAMI

Built Environment Trends and Issues

Trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. Most counties in Region 1 experienced little development over the last 5 years. The exceptions are Tillamook and Curry Counties, where population increased by roughly 30% and the number of housing units increased by 40%.

New tsunami inundation maps created by DOGAMI provide coastal communities new tsunami risk information. In response, DLCD's publication *Preparing for a Cascadia Subduction Zone Tsunami: A Land Use Guide for Oregon Coastal Communities* (http://www.oregon.gov/lcd/ocmp/docs/publications/tsunamiguide20140108.pdf) was developed to help communities develop land use planning strategies to reduce tsunami hazard risk.

The region has nearly double the state's percentage of mobile homes — Curry County has the region's highest percentage. Almost half of all housing in Clatsop and Curry Counties was built prior to 1970 — prior to current seismic and floodplain management building standards. The cities in Tillamook County have FIRMs that are not as up to date as other areas of the state and therefore may not accurately represent flood risk.

2.3.1.3 Hazards and Vulnerability

Coastal Hazards

Characteristics

The Pacific Northwest (PNW) coast of Oregon is without doubt one of the most dynamic coastal landscapes in North America, evident by its long sandy beaches, sheer coastal cliffs, dramatic headlands and vistas, and ultimately the power of the Pacific Ocean that serves to erode and change the shape of the coast. Coastal communities in Oregon are increasingly under threat from a variety of natural hazards, including coastal erosion (both short and long term), landslides, earthquakes, and potentially catastrophic tsunamis generated by the Cascadia Subduction Zone (CSZ). Over time, these hazards are gradually being compounded, in part due to the degree of development that has evolved along the Oregon coast in recent decades. A particular concern is that the local geology and geomorphology of the region have restricted development to low-lying areas, chiefly along dunes, barrier spits, or along coastal bluffs present along the open coast that are subject to varying rates of erosion, and to low-lying areas adjacent to the numerous estuaries that make up the coast. All of these sites are highly susceptible to increased impacts as erosion processes and flood hazards intensify, driven by rising sea level and increased storminess.

Historic Coastal Hazard Events

Table 2-76. Historic Coastal Erosion and Flood Hazard Events in Region 1

Date	Location	Description
Jan. 1914	Newport	damage (Nicolai Hotel)
1931	Rockaway	coastal damage from December storm
Oct–Dec. 1934	Waldport and Rockaway	flooding (Waldport) coastal damage (Rockaway Beach)
Dec. 1935	Cannon Beach and Rockaway Beach	coastal damage
Jan. 1939	coastwide	severe gale; damage coastwide severe flooding (Seaside, and Ecola Creek near Cannon Beach): • multiple spit breaches (southern portion of Netarts Spit) • storm damage (along the shore of Lincoln City and at D River) • flooding (Waldport) • extensive damage (Sunset Bay Park) • storm surge overtopped foredune (Garrison Lake plus Elk River lowland)
Dec. 1940	Waldport	flooding
1948	Newport	wave damage (Yaquina Arts Center)
Jan. 1953	Rockaway	70-ft dune retreat; one home removed
Apr. 1958	Sunset Bay State Park and Newport	flooding (Sunset Bay); wave damage (Yaquina Arts Center in Newport)
Jan–Feb. 1960	Sunset Bay State Park	flooding
1964	Cannon Beach	storm damage
Dec. 1967	Netarts Spit, Lincoln City, Newport, and Waldport	damage: coastwide State constructed wood bulkhead to protect foredune along 600 ft section (Cape Lookout State Park campground) flooding and logs (Lincoln City) wave damage (Yaquina Arts Center, Newport) flooding (Waldport) storm damage (Beachside State Park washed up driftwood (Bandon south jetty parking lot)
1971–73	Siletz Spit	high-tide line eroded landward by 300 ft February 1973, one home completely destroyed; spit almost breached logs through Sea Gypsy Motel (Nov. 1973)
1982–83	Alsea Spit	northward migration of Alsea Bay mouth; severe erosion
1997–98	Lincoln and Tillamook Counties	El Niño winter (second strongest on record); erosion: considerable
Jan–Mar. 1999	coastwide	five storms; coastal erosion extensive, including: • significant erosion (Neskowin, Netarts Spit, Oceanside, Rockaway beach) • overtopping and flooding (Cape Meares) • significant erosion along barrier beach (Garrison Lake) • overtopping 27-ft-high barrier
Dec. 2007	Tillamook and Clatsop Counties	wind storm

Sources: Schlicker et al. (1972, 1973); Stembridge (1975); Komar and McKinney (1977); Komar (1986, 1987, 1997, 1998); Allan et al. (2003, 2009), and many others.

Table 2-77 lists historic landslides at the Oregon Coast. Landsliding in these areas will almost certainly continue due to the combination of steep terrain, local geology (seaward dipping tertiary sediments), and high precipitation.

Table 2-77. Historic Coastal Landslide Hazards in Region 1

Date	Location	Description
Ongoing	Clatsop County (Cannon Beach)	several large landslides exist along the Clatsop County coastline, particularly in the vicinity of Cannon Beach; these include: • large landslide block failure at Ecola State Park occurred in 1961 • Silver Point landslide in 1974 damaged several homes and affected US-101 • Slow-moving S-Curves landslide (1995) • landslide/rockfall at the south end of Falcon Cove about 2003
Ongoing	Tillamook County	several large landslides exist along the Tillamook County coastline; these include: • The Capes development on the north side of Netarts Bay and south of Oceanside • a large active landslide exists on the north side of Cape Meares and affects the southern portion of the community of Cape Meares • the Three Capes landslide, located to the south of Tierra del Mar, occurred during the 1997-98 El Niño and affected the Three Capes Scenic byway road; this landslide has been remediated • a small landslide failure developed on Aug. 21, 2011, above Happy Camp in Netarts; this landslide has been remediated
Ongoing	Lincoln County (Newport area)	Several large translational landslide blocks exist throughout Lincoln County. The majority of these are in the Newport/Beverly Beach area and include: • Cape Foulweather landslide failed in Dec. 1999 (since remediated) • Johnson Creek • Carmel Knoll • Moolack Shores • NW 73rd St landslide • Schooner Creek • landslide block failed immediately adjacent to the Jump-Off Joe headland destroying multiple homes over a period in 1942-1943 • Mark St
Jan. 2000	Lane County	Cape Cove landslide (immediately adjacent to the tunnel located between the Heceta Head lighthouse and the Sea Lion caves)
Ongoing	Curry County	Multiple large active landslide block failures exist along US-101 along the Curry County coastline; these include: • Gregory Point landslide 2.2 miles south of Port Orford occurred in Jan. 2006 • multiple landslides between Gregory Point and Humbug Mountain • Arizona landslide south of Humbug Mountain, north of Ophir

Sources: Schlicker et al. (1961, 1972, 1973); Komar (1997); Allan and Hart (2009); Witter et al. (2009); SLIDO web database (http://www.oregongeology.org/slido/index.html)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 1 will experience coastal erosion is shown in Table 2-78. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—).

Table 2-78. Local Probability Assessment of Coastal Erosion in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	H	H	—	H	—	—	—

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

The erosion of the Oregon coast is exceedingly complex, reflecting processes operating over both short and long time scales, and over large spatial scales. However, the most significant erosion effects are largely controlled by high-magnitude (relatively infrequent) events that occur over the winter (the months of October to March), when wave heights and ocean water levels tend to be at their highest.

Previous analyses of extreme waves for the Oregon coast estimated the "100-year" (1%) storm wave to be around 33 feet. In response to a series of large wave events that occurred during the latter half of the 1990s, the wave climate was subsequently re-examined and an updated projection of the 1% storm wave height was determined, which is now estimated to reach approximately 47 to 52 feet (Table 2-79), depending on which buoy is used. These estimates are of considerable importance to the design of coastal engineering structures and in terms of defining future coastal erosion hazard zones.

Table 2-79. Projection of Extreme Wave Heights for Various Recurrence Intervals: Each Wave Height Is Expected to Occur on Average Once during the Recurrence Interval

Recurrence Interval (years)	Extreme Wave Heights (feet)	
	NDBC buoy #46002* (Oregon)	NDBC buoy #46005+ (Washington)
10	42.5	41.7
25	46.2	44.0
50	48.8	—
75	50.1	45.7
100	51.2	47.1

Sources: *DOGAMI analyses; +Ruggiero et al. (2010)

In order to understand the potential extent of erosion for different communities, DOGAMI has completed coastal erosion hazard maps for Lincoln, Tillamook, and Clatsop Counties, as well in the Nesika Beach area in Curry County. Maps were undertaken for these areas mainly because they contain the largest concentration of people living along the coastal strip, and in the case of Nesika Beach in response to a specific request by the Oregon Department of Land Conservation and Development. In all cases, the maps depict erosion hazard zones that fall into four categories: Active, High, Medium, and Low. The High and Medium hazard zones reflect erosion associated with a 2% and 1% storm, respectively. The Low hazard zone includes a 1% storm coupled with a Cascadia subduction zone earthquake and has a much lower probability of occurrence. The erosion scenarios were defined using a combination of probabilistic (waves) and deterministic (water levels) approaches.

In July 2014, DOGAMI completed new updated maps for the dune-backed beaches in Tillamook County using a fully probabilistic approach of the waves and water levels to map the erosion hazard zones. The revised modeling used three total water level scenarios (10%, 2% and 1% events) produced by the combined effect of extreme wave runup (R) plus the measured tidal elevation (T), and erosion due to sea level rise (low/mean/maximum estimates) at 2030, 2050, and 2100. In total 81 scenarios of coastal erosion were modeled; an additional two scenarios were also modeled that considered the effects of a Cascadia subduction zone earthquake, and the effects of a single (1%) storm, where the storm's duration was taken into account. The completed study ultimately recommended five hazard zones for consideration. A sixth hazard zone was also proposed. This latter zone was defined using a more sophisticated dune erosion model that accounted for the effect of the duration of a storm. Table 2-80 provides the calculated erosion associated with an extreme (1%) storm for Tillamook County, after accounting for the storms duration. The results indicate that the storm induced erosion ranges from about 47 to 73 ft. When the duration of the storm is removed from consideration the amount of beach and dune erosion increases substantially to about 70 to 260 ft. Finally, modeling coastal change by nature is fraught with large uncertainty that is a function of variations in the morphology of the beach and the beach sediment budget.

Table 2-80. Storm-Induced Erosion Defined for Selected Sites in Tillamook County after Having Accounted for the Duration of the Event

	Maximum 1% Erosion Distance	
	(meters)	(feet)
Neskowin	20.6	67.6
Nestucca Spit	14.5	47.6
Sand Lake	18.7	61.4
Netarts Spit	22.2	72.8
Bayocean Spit	17.6	57.7
Rockaway	19.9	65.3
Nehalem Spit	19.3	63.3

Modeled erosion is for a 1% storm.

Although some coastal landslide failures have been remediated, the majority are considered active and hence will continue to move and fail. Without detailed knowledge of every slide, it is impossible to assign probabilities of failure. However, it is a high probability that all of these existing landslide sites would be activated following a Cascadia earthquake, and more new landslides would occur.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to coastal erosion is shown in Table 2-81. In some cases, counties either did not rank a particular hazard or did not find it to be significant, noted with a dash (—).

Table 2-81. Local Vulnerability Assessment of Coastal Erosion in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	H	M	—	L	—	—	—

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

The Department of Geology and Mineral Industries is the agency with primary oversight of coastal hazards. Based on agency staff review of the available hazard data, DOGAMI ranks Tillamook, Lincoln, Clatsop, and Curry Counties one through four respectively as the counties most vulnerable to coastal hazards in the state.

Coastal hazards in Coos, Lane, and Douglas Counties are considered to be generally negligible. This is because the bulk of these coastlines have little population base and hence are largely unmodified. In Coos County, coastal hazards can be found in a few discrete communities such as adjacent to the Coquille jetty in Bandon and along Lighthouse Beach near Cape Arago. Similarly, coastal hazards in Lane County are confined almost entirely to the Heceta Beach community and adjacent to the Siuslaw River mouth, particularly within the lower estuary mouth where development lines coastal bluffs that is gradually being eroded by riverine processes.

The counties and communities most vulnerable to coastal hazards on the Oregon Coast include:

Tillamook County (ranked #1) —

- Neskowin (erosion and flooding),
- Pacific City (erosion),
- Tierra del Mar (erosion and flooding),
- Cape Meares (flooding),
- Twin Rocks (erosion and flooding), and
- Rockaway Beach(erosion and flooding);

Lincoln County (ranked #2) —

- Yachats to Alsea Spit (erosion),
- Waldport (erosion and flooding),
- Alsea Spit (erosion),
- Seal Rock (erosion and landsliding),
- Ona Beach to Southbeach (erosion and landsliding),
- Newport (landsliding),
- Beverly Beach (erosion and landsliding),
- Gleneden Beach to Siletz Spit (erosion, landsliding, and flooding), and
- Lincoln City (erosion and landsliding);

Clatsop County (ranked #3) —

- Falcon Cove (erosion and landsliding),
- Arch Cape (erosion and flooding),
- Tolovana to Cannon Beach (erosion and flooding), and
- Seaside (Flooding);

Curry County (ranked #4) —

- Nesika Beach (erosion and landsliding), and
- Port Orford (flooding at Garrison Lake).

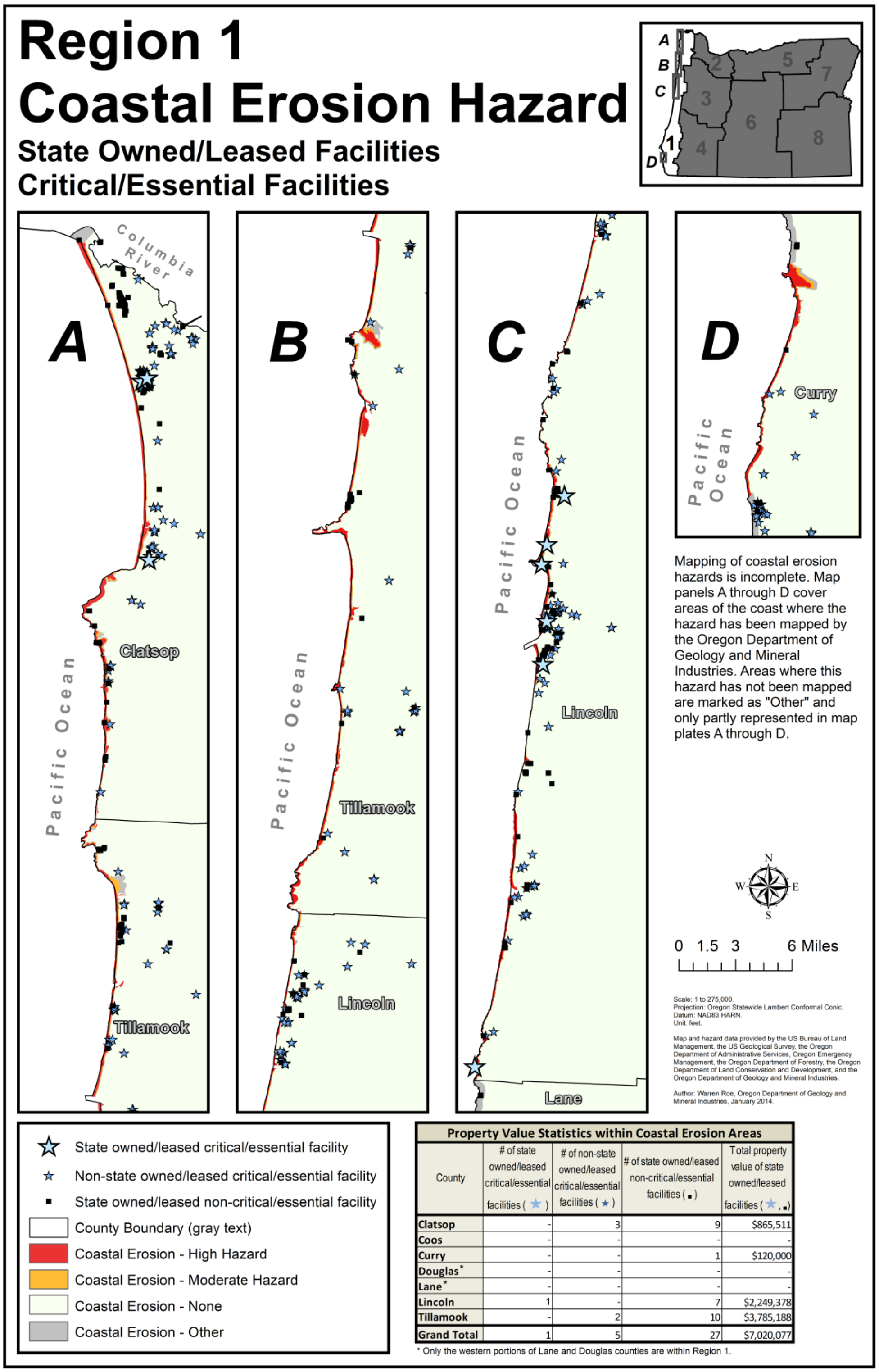
Coastal hazards in Lane and Douglas Counties are considered to be negligible.

State-Owned/Leased Facilities and Critical/Essential Facilities

The following information is based on a State facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. (See the State Risk Assessment, **Oregon Vulnerabilities** for more information.)

Of the 5,693 state facilities evaluated, 28 are currently located within a coastal erosion zone in Region 1, representing a value of approximately $7 million in property value (**Figure 2-92**). One of these (ODOT Cape Perpetua Radio building) is identified as a critical or essential facility. Five additional critical/essential facilities, not state owned/leased, are also located in a Region 1 coastal erosion zone.

Figure 2-92. State-Owned/Leased Facilities and Critical/Essential Facilities in a Coastal Erosion Zone in Region 1



County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★ , ▪)
Clatsop	-	3	9	$865,511
Coos	-	-	-	-
Curry	-	-	1	$120,000
Douglas*	-	-	-	-
Lane*	-	-	-	-
Lincoln	1	-	7	$2,249,378
Tillamook	-	2	10	$3,785,188
Grand Total	1	5	27	$7,020,077

* Only the western portions of Lane and Douglas counties are within Region 1.

Source: DOGAMI

Droughts

Characteristics

Drought is not a common occurrence in Region 1. Since 1995, the Governor has declared drought only once, in Coos and Curry Counties during 2002 when much of the state was facing drought conditions. Although Region 1 is less vulnerable to drought impacts than most of Oregon, droughts can still be problematic, especially given that they often precede major wildfires. Severe drought conditions resulted in the four disastrous Tillamook fires (1933, 1939, 1945, 1951), collectively known as the Tillamook Burn.

Historic Drought Events

Table 2-82. Historic Droughts in Region 1

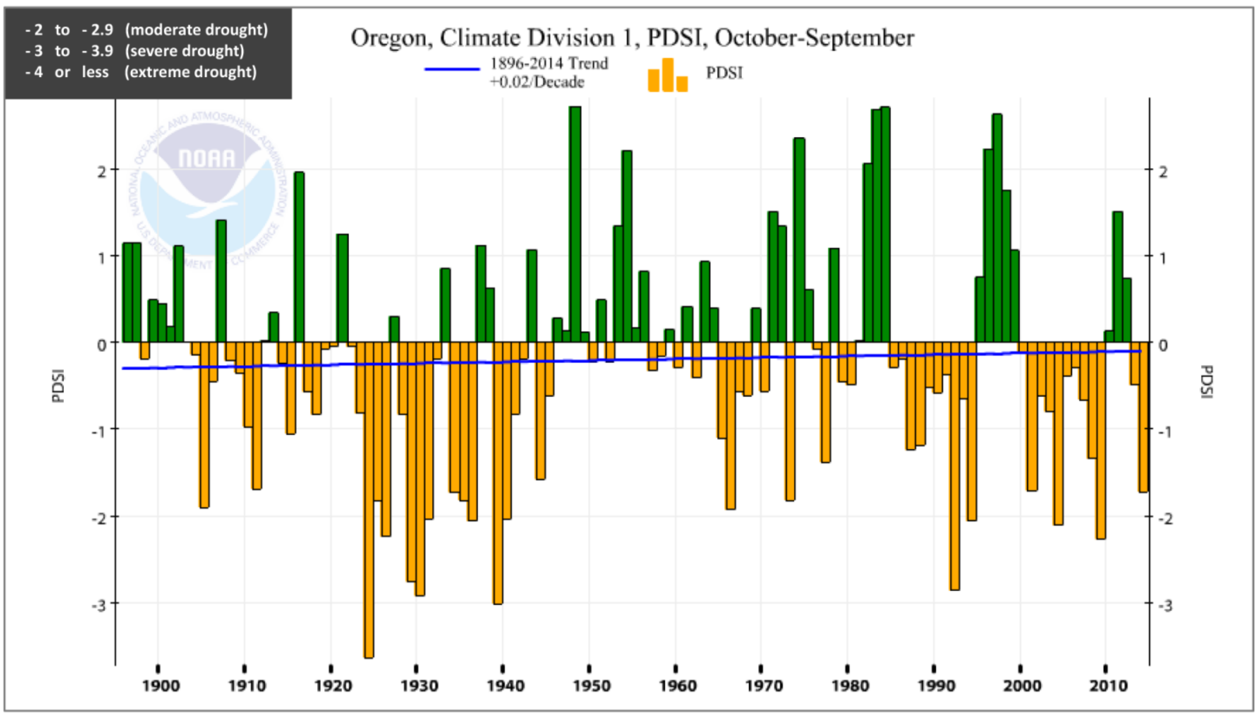
Date	Location	Description
1924	statewide	prolonged statewide drought that caused major problems for agriculture
1930	Regions 1, 2, 3, 5, 6, & 7	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country; moderate to severe drought affected much of the state
1939	statewide	Water Year 1939 was one of the more significant drought years in Region 1 during that period; the second of the three Tillamook Burns started in 1939
1992	statewide, especially Regions 1, 2, 3, 4, 8	1992 fell toward the end of a generally dry period, which caused problems throughout the state; the 1992 drought was most intense in eastern Oregon, with severe drought occurring in Region 1; the winter of 1991-1992 was a moderate El Niño event, which can manifest itself in warmer and drier winters in Oregon; Governor declared a drought for all 36 counties in September 1992
2001-02	affected all regions, except Regions 2 & 3	the second most intense drought in Oregon's history; 18 counties with state 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; Coos and Curry Counties in Region 1 were not under a drought declaration until December of 2002

Sources: Taylor and Hatton (1999); 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

Historical drought information can also be obtained from the National Climatic Data Center, which provides climate data showing wet and dry conditions, using the Palmer Drought Severity Index (PDSI) that dates back to 1895. The Palmer Index is not the best indicator of water availability for Oregon as it does not account for snow or ice (delayed runoff), but it has the advantage of providing the most complete, long-term record. Figure 2-93 shows years where drought or dry conditions affected the coastal areas of Oregon (Climate Division 1). Based on this index, Water Years 1924 and 1939 were severe drought years for the coastal region.

U.S Climate Divisions

Figure 2-93. Palmer Drought Severity Index for Region 1



Source: National Climatic Data Center, http://www.ncdc.noaa.gov/cag/

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 1 will experience drought is shown in **Table 2-83**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—).

Table 2-83. Local Probability Assessment of Drought in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	M	H	—	—	—	H	L

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Despite impressive achievements in the science of climatology, estimating drought probability and frequency continues to be difficult. This is because of the many variables that contribute to weather behavior, climate change and the absence of long historic databases. A comprehensive risk analysis is needed to fully assess the probability and impact of drought to Oregon communities. Such an analysis should be completed statewide in order to analyze and compare the risk of drought across the state.

Based on limited data, there is a low probability of drought occurring in Region 1.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to drought is shown in **Table 2-84**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—).

Table 2-84. Local Vulnerability Assessment of Drought in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	M	M	—	—	—	L	L

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Oregon has yet to undertake a comprehensive, statewide analysis to identify which communities are most vulnerable to drought. However, based on a review of Governor-declared drought declarations since 1992, Region 1 could be considered less vulnerable to drought impacts than many other parts of the state. Regardless, even short term droughts can be problematic. Potential impacts to community water supplies are the greatest threat. Long-term drought periods of more than a year can impact forest conditions and set the stage for potentially devastating wildfires.

Earthquakes

Characteristics

The geographic position of Region 1 makes it susceptible to earthquakes from three sources: (a) the off-shore Cascadia Fault Zone, (b) deep intra-plate events within the subducting Juan de Fuca plate, and (c) shallow crustal events within the North America Plate. All have some tie to the subducting or diving of the dense, oceanic Juan de Fuca Plate under the lighter, continental North America Plate. Stresses occur because of this movement.

There is no historic record of major damaging crustal earthquakes centered in Region 1 in the past 156 years, although the region has experienced small crustal earthquakes and crustal earthquakes that originated outside the region. The geologic record shows that movement has occurred along numerous offshore faults as well as a few onshore faults in Coos and Tillamook Counties. The faulting has occurred over the last 20,000 years. Intraplate earthquakes are very rare in Oregon, although such earthquakes originating outside of the state have been felt in Region 1. It is believed that the M7.3 near Brookings in 1873 was an intraplate quake.

In Region 1, geologic earthquake hazards include severe ground shaking, liquefaction of fine-grained soils, landslides, and flooding from local and distant tsunamis. The severity of these effects depends on several factors, including the distance from earthquake source, the ability of soil and rock to conduct seismic energy composition of materials, and ground and ground water conditions.

Historic Earthquake Events

Table 2-85. Significant Earthquakes Affecting Region 1

Date	Location	Magnitude (M)	Comments
Approximate Years: 1400 BCE*, 1050 BCE, 600 BCE, 400, 750, 900	offshore, Cascadia Subduction Zone	probably 8-9	these are the mid-points of the age ranges for these six events
Jan. 1700	offshore, Cascadia Subduction Zone	about 9.0	generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Nov. 1873	Brookings area, Oregon	7.3	intraplate event; origin probably Gorda block of the Juan de Fuca plate; chimneys fell (Port Orford, Grants Pass, and Jacksonville); no aftershocks
Nov. 1962	Portland, Oregon	5.2 to 5.5	crustal event; damage to many homes (chimneys, windows, etc.)
Mar. 1993	Scotts Mills, Oregon	5.6	crustal event; FEMA-985-DR-OR; damage: $28 million (homes, schools, businesses, state buildings [Salem])
Sep. 1993	Klamath Falls, Oregon	5.9 to 6.0	crustal event; FEMA-1004-DR-OR; two earthquakes; fatalities: two; damage $7.5 million (homes, commercial, and government buildings)

*BCE: Before Common Era.

Source: Wong and Bolt (1995)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 1 will experience earthquakes is shown in **Table 2-86**.

Table 2-86. Local Probability Assessment of Earthquake in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	H	H	M	M	M	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

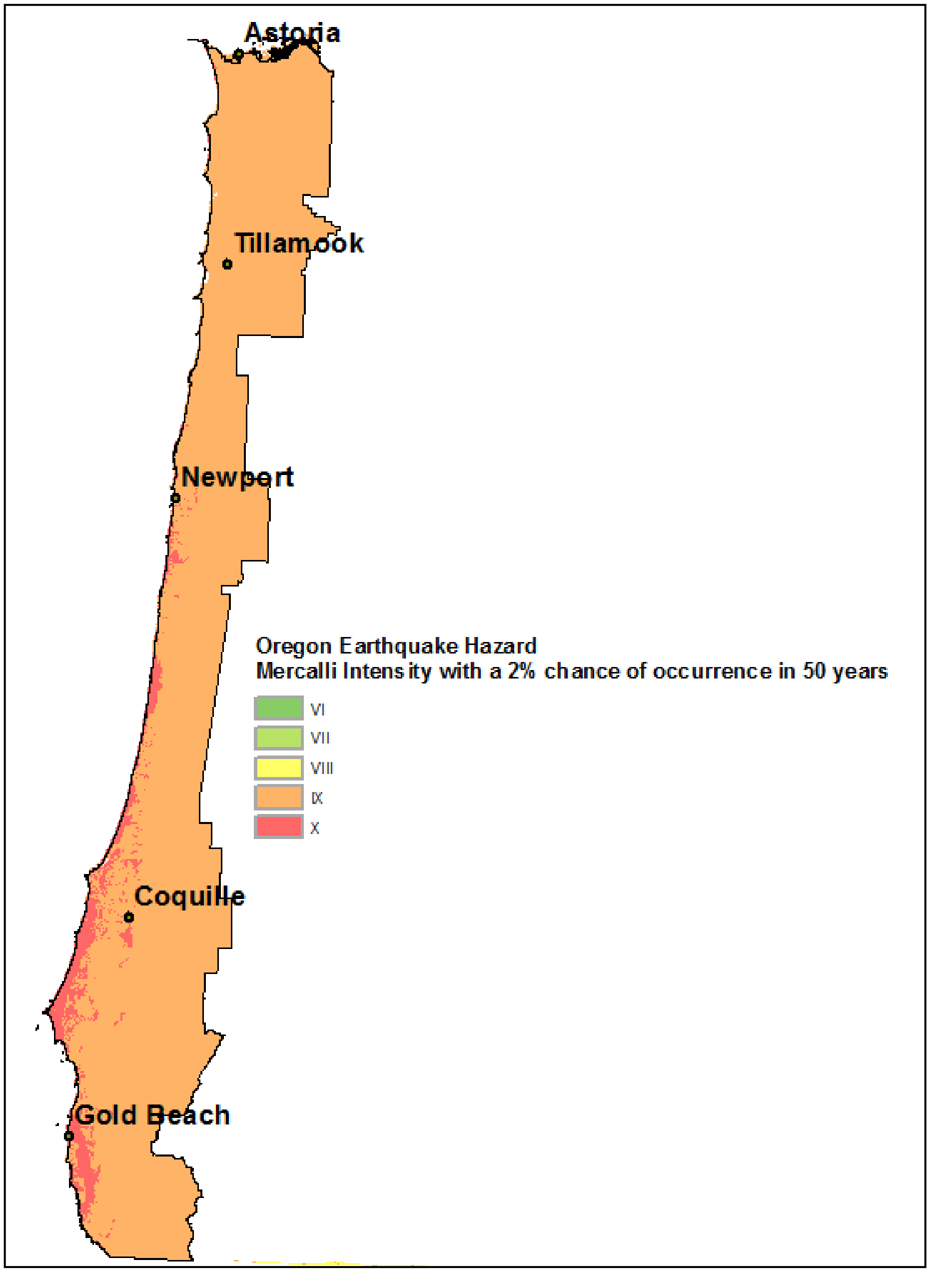
The probability of damaging earthquakes varies widely across the state. In Region 1, the hazard is dominated by Cascadia Subduction Zone (CSZ) earthquakes originating from a single fault with a well-understood recurrence history.

Figure 2-94 shows the expected level of earthquake damage that has a 2% chance of occurring in the next 50 years. The map is based on the 2008 USGS National Seismic Hazard Map and has been adjusted to account for the effects of soils following the methods of Madin and Burns (2013). In this case, the strength of shaking calculated as peak ground acceleration and peak ground velocity is expressed as Mercalli intensity, which describes the effects of shaking on people and structures. This map incorporates all that is known about the probabilities of earthquake on all Oregon faults, including the Cascadia Subduction Zone.

For Oregon west of the crest of the Cascades, the CSZ is responsible for most of the hazard shown in **Figure 2-94**. The paleoseismic record includes 18 magnitude 8.8–9.1 megathrust earthquakes in the last 10,000 years that affected the entire subduction zone. The return period for the largest earthquakes is 530 years, and the probability of the next such event occurring in the next 50 years ranges from 7 to 12%. An additional 10 to 20 smaller, magnitude 8.3–8.5, earthquakes affected only the southern half of Oregon and northern California. The average return period for these is about

240 years, and the probability of a small or large subduction earthquake occurring in the next 50 years is 37–43%.

Figure 2-94. Probabilistic Earthquake Hazard in Region 1



Color zones show the maximum level of earthquake shaking and damage (Mercalli Intensity Scale) expected with a 2% chance of occurrence in the next 50 years. A simplified explanation of the Mercalli levels is:

VI	Felt by all, weak buildings cracked;
VII	Chimneys break, weak buildings damaged, better buildings cracked;
VIII	Partial collapse of weak buildings, unsecured wood frame houses move;
IX	Collapse and severe damage to weak buildings, damage to wood-frame structures; and
X	Poorly built structures destroyed, heavy damage in well-built structures.

Source: Madin and Burns (2013)

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to earthquakes is shown in **Table 2-87**.

Table 2-87. Local Vulnerability Assessment of Earthquakes in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	H	H	H	H	H	M	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Of the 15 counties in Oregon with the highest expected damages and losses based on the 500-year model CSZ earthquake the following counties are located in in Region 1:

- Lane,
- Coos,
- Lincoln,
- Clatsop, and
- Douglas.

Region 1 is especially vulnerable to earthquake hazards. This is because of the built environment's proximity to the CSZ, regional seismicity, topography, bedrock geology, and local soil profiles. For example, a large number of buildings are constructed of unreinforced masonry (URM) or are constructed on soils that are subject to liquefaction during severe ground shaking. Also, some principal roads and highways are susceptible to earthquake-induced landslides. Bridges and tunnels need to be retrofitted to withstand ground shaking and the dams should be able to withstand earthquake forces to prevent uncontrolled releases. This is especially important as 12 dams in Region 1 have been designated as "high hazard." Problem areas within the region are readily identifiable online at Oregon's hazard viewer at http://www.oregongeology.org/sub/hazvu/index.htm and on earthquake hazard maps prepared by DOGAMI (available at website: http://www.oregongeology.org/pubs/ofr/p-O-13-06.htm).

Table 2-88 shows the number of school and emergency response buildings surveyed in each county with their respective rankings.

Table 2-88. Region 1 School and Emergency Response Building Collapse

	Level of Collapse Potential			
County	**Low (< 1%)**	**Moderate (>1%)**	**High (>10%)**	**Very High (100%)**
Clatsop	24	19	20	1
Tillamook	19	9	23	5
Lincoln	30	18	12	3
Lane*	8	4	5	—
Douglas**	3	2	10	—
Coos	41	11	48	7
Curry	15	10	10	2

*Includes only the Lane County coastal communities of Deadwood, Florence, Mapleton, and Swisshome.

**Includes only the Douglas County coastal communities of Gardiner, Reedsport, and Winchester Bay.

Source: Lewis (2007), available at http://www.oregongeology.org/sub/projects/rvs/default.htm

Other useful resources for planning for earthquakes include the following:

- **Maps of earthquake hazard areas:** DOGAMI has mapped all of the Region 1 counties and has statewide GIS earthquake hazard layers available through Open-File Report O-13-06 (Madin & Burns, 2013).
- **Map of coastal critical facilities vulnerable to hazards:** DOGAMI has developed these maps for all Region 1 counties. For more information about critical facilities in Region 1 see **State-Owned/Leased Facilities and Critical/Essential Facilities**.
- **Environmental geology maps:** DOGAMI has developed these maps for all Region 1 counties (DOGAMI Bulletins 74, 79, 81, 84, 85, and 87).
- Nuclear energy and hazardous waste sites inventories: No Region 1 counties have nuclear facilities.

DOGAMI also developed two earthquake loss models for Oregon based on the two most likely sources of seismic events: (a) the Cascadia Subduction Zone (CSZ), and (b) combined crustal events (500-year model). Both models use Hazus, a software program developed by the Federal Emergency Management Agency (FEMA) as a means of determining potential losses from earthquakes. The CSZ event is based on a potential M8.5 earthquake generated off the Oregon coast. The model does not take into account a tsunami, which probably would develop from such an event. The 500-year crustal model does not look at a single earthquake (as in the CSZ model); it encompasses many faults. Neither model takes unreinforced masonry buildings into consideration.

DOGAMI investigators caution that the models contain a high degree of uncertainty and should be used only for general planning and policy making purposes. Despite their limitations, the models do provide some approximate estimates of damage and are useful to understand the relative relationships between the counties.

Table 2-89 shows the projected dollar losses based on both models. Please note that the losses are in 1999 dollars. Since that time, additional growth and inflation has occurred, thus the values are too low. However, the relative rankings are between the counties likely remains the same. For example, the economic base (column 2) for Clatsop County remains lower than Coos County, and the expected losses from a magnitude 8.5 Cascadia earthquake (column 3) in Clatsop County remain lower than Coos County.

Table 2-89. Projected Dollar Losses in Region 1, Based on an M8.5 Subduction Event and a 500-Year Model

Region 1 Counties	Economic Base in Thousands (1999)	Greatest Absolute Loss in Thousands (1999) from an M8.5 CSZ Event[1]	Greatest Absolute Loss in Thousands (1999) from a 500-Year Model[2]
Clatsop	$2,198,000	$549,000	$760,000
Coos	$3,263,000	$1,339,000	$1,429,000
Curry	$1,093,000	$371,000	$388,000
Douglas[3]	$4,631,000	$275,000	$546,000
Lane[3]	$15,418,000	$1,614,000	$3,044,000
Lincoln	$2,668,000	$624,000	$793,000
Tillamook	$1,539,000	$226,000	$364,000

Notes:

[1] "…there are numerous unreinforced masonry structures (URMs) in Oregon, the currently available default building data does not include any URMs. Thus, the reported damage and loss estimates may seriously under-represent the actual threat" (Wang, 1998, p. 5).

[2]Every part of Oregon is subject to earthquakes. The 500-year model is an attempt to quantify the risk across the state. The estimate does not represent a single earthquake. Instead, the 500-year model includes many faults. More and higher magnitude earthquakes than used in this model may occur (DOGAMI, 1999).

[3]Entire county.

Source: Wang and Clark (1999)

Table 2-90 shows the projected dollar losses associated with the magnitude 8.5 Cascadia model.

Table 2-90. Estimated Losses in Region 1 Associated with a M8.5 Subduction Zone Event

	Region 1 Counties						
	Clatsop	**Coos**	**Curry**	**Douglas**[1]	**Lane**[1]	**Lincoln**	**Tillamook**
Injuries	298	854	221	151	1,036	358	132
Deaths	6	16	3	2	19	7	3
Displaced Households	788	2,069	430	255	2,345	592	158
Operational the "day after" the event[2]:							
Fire stations	16%	10%	9%	66%	49%	26%	31%
Police stations	15%	6%	5%	57%	42%	22%	44%
Schools	16%	8%	6%	44%	46%	19%	32%
Bridges	58%	44%	34%	74%	76%	51%	58%
Economic losses to[2]:							
Highways	$18 mil	$44 mil	$48 mil	$43 mil	$39 mil	$16 mil	$25 mil
Airports	$5 mil	$20 mil	$11 mil	$5 mil	$11 mil	$9 mil	$7 mil
Communications	$6 mil	$25 mil	$18 mil	$7 mil	$11 mil	$9 mil	$5 mil
Debris Generated (thousands of tons)	383	853	267	222	1,341	446	158

Remarks:

The Cascadia Subduction Zone (CSZ) is the most dangerous fault in Oregon. The entire coastline is essentially the epicenter. The earthquake could be M8.5 (or M9.0). The event might last as long as 4 minutes. Within a few minutes a tsunami would follow. (Tsunami damages are not included in the estimates for this earthquake but would dramatically increase losses for coastal counties.) A CSZ earthquake could affect a very large area. If the entire fault ruptures, destruction could occur from northern California to Canada. The number of deaths and injuries depends on the time of day, building type, occupancy class, and traffic pattern. (DOGAMI Special Paper 29 [Wang and Clark, 1999], p. 4).

[1]Entire county.

[2]"…there are numerous unreinforced masonry structures (URMs) in Oregon, the currently available default building data does not include any URMs. Thus, the reported damage and loss estimates may seriously under-represent the actual threat" (Wang, 1998, p. 5).

Source: Wang and Clark (1999)

Table 2-91 shows the estimated losses associated with the 500-year model.

Table 2-91. Estimated Losses in Region 1 Associated with a 500-Year Model

	Clatsop	Coos	Curry	Douglas[1]	Lane[1]	Lincoln	Tillamook
Injuries	397	845	212	294	2,254	436	181
Deaths	8	16	3	4	45	9	4
Displaced households	1,182	2,521	486	534	4,543	847	275
Economic losses for buildings[2]	$760 mil	$1.4 bil	$328 mil	$546 mil	$3 bil	$792 mil	$364 mil
Operational the "day after" the event[3]:							
Fire stations	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Police Stations	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Schools	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bridges	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Economic losses to[2]:							
Highways	$33 mil	$49 mil	$44 mil	$69 mil	$74 mil	$22 mil	$39 mil
Airports	$7 mil	$20 mil	$12 mil	$9 mil	$20 mil	$12 mil	$8 mil
Communications	$8 mil	$2 mil	$15 mil	$12 mil	$20 mil	$10 mil	$6 mil
Debris generated (thousands of tons)	474	864	261	411	2,424	525	224

Note: Every part of Oregon is subject to earthquakes. The 500-year model is an attempt to quantify the risk across the state. The estimate does not represent a single earthquake. Instead, the 500-year model includes many faults. More and higher magnitude earthquakes than used in this model may occur (DOGAMI, 1999).

[1]Entire county.

[2]"…there are numerous unreinforced masonry structures (URMs) in Oregon, the currently available default building data does not include any URMs. Thus, the reported damage and loss estimates may seriously under-represent the actual threat" (Wang, 1998, p. 5).

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

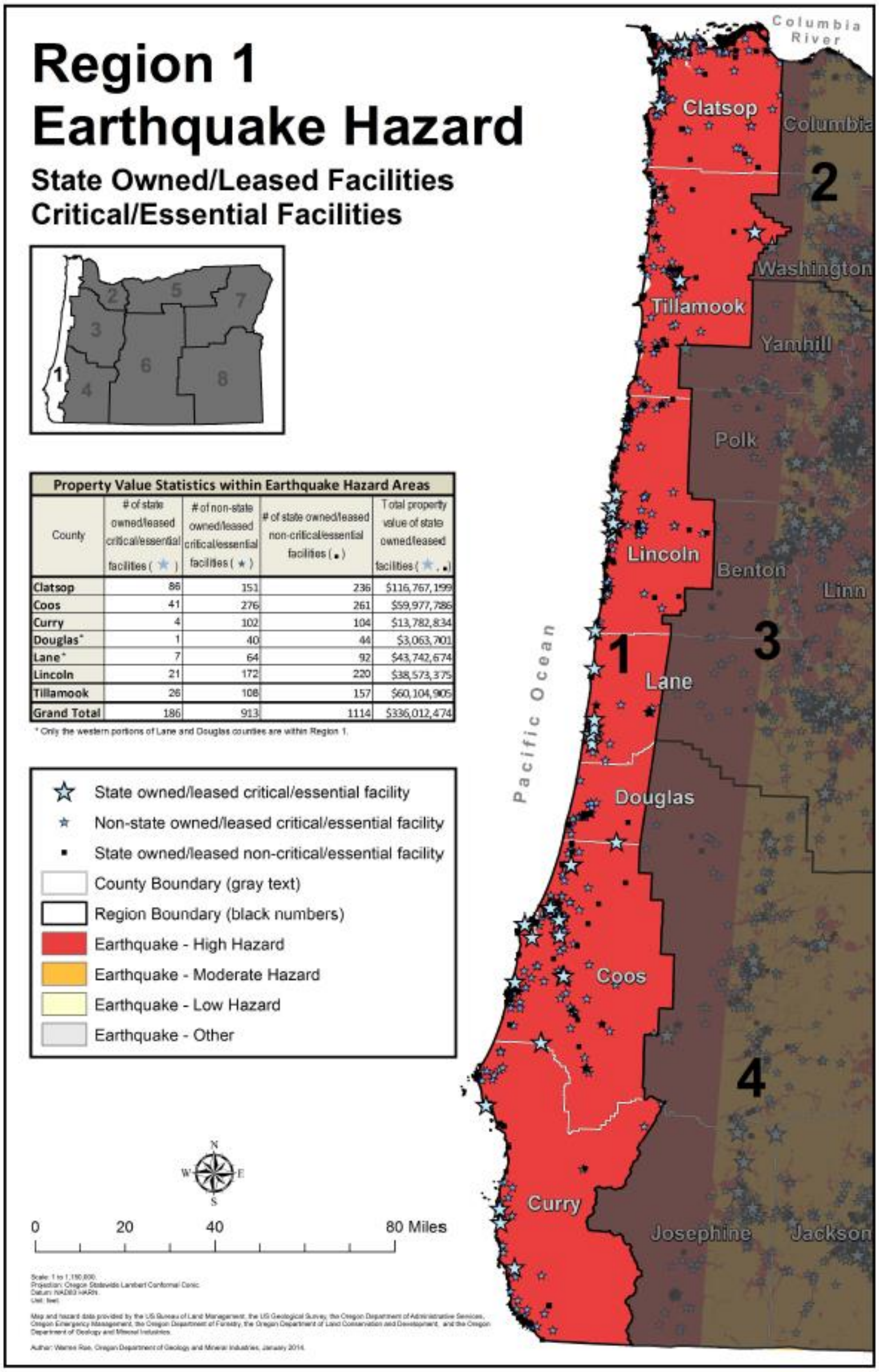
Source: Wang and Clark (1999)

State-Owned/Leased Facilities and Critical/Essential Facilities

The following information is based on a state facility and facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of 5,693 state facilities evaluated, 1,300 totaling over $336 million worth of property are located in an earthquake hazard zone in Region 1 (**Figure 2-95**). Among the 1,141 state-owned/leased critical/essential facilities, 186 are in an earthquake hazard zone in Region 1. Additionally, 913 non-state-owned/leased critical/essential facilities in Region 1 are located in an earthquake hazard zone.

Figure 2-95. State-Owned/Leased Facilities and Critical/Essential Facilities in an Earthquake Zone in Region 1



Property Value Statistics within Earthquake Hazard Areas				
County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Clatsop	86	151	236	$116,767,199
Coos	41	276	261	$59,977,786
Curry	4	102	104	$13,782,834
Douglas*	1	40	44	$3,063,701
Lane*	7	64	92	$43,742,674
Lincoln	21	172	220	$38,573,375
Tillamook	26	108	157	$60,104,905
Grand Total	186	913	1114	$336,012,474

* Only the western portions of Lane and Douglas counties are within Region 1.

Source: DOGAMI

SEISMIC LIFELINES

"Seismic lifelines" are the state highways ODOT has identified as most able to serve response and rescue operations, reaching the most people and best supporting economic recovery. The process, methodology, and criteria used to identify them are described in **Section 2.2.2.6, Seismic Transportation Lifeline Vulnerabilities**, and the full report can be accessed at **Appendix 9.1.13**, *Statewide Loss Estimates: Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification*. According to that report, seismic lifelines in Region 1 have the following vulnerabilities.

Region 1 has the most seismically vulnerable highway system of all the geographic zones and is the most difficult to access due to multiple geographic constraints. While it could be argued that the region's critical post-earthquake needs should dictate that all coastal area routes be Tier 1 (first priority roadways), the reality is that — to make the entire lifeline system resilient — the vulnerabilities in Region 1 are so extensive that the majority of the cost would be incurred for repairs done within this region. Furthermore, because of the high vulnerability of the region, it is paramount that emergency services and recovery resources are able to reach this region from other regions. Consequently, all needs are best served with a conservative Tier 1 backbone system, selected according to the criteria described earlier in this Plan.

The Tier 1 (first roadway priority) system in Region 1 consists of three access corridors:

- OR-30 from Portland to Astoria,
- OR-18 from the Willamette Valley to US-101 and north and south on US-101 between Tillamook and Newport, and
- OR-38 from I-5 to US-101 and north and south on US-101 from Florence to Coos Bay.

The Tier 2 (second roadway priority) system in Region 1 consists of three access corridors:

- US-26 from OR-217 in Portland to US-101 and north and south on US-101 from Seaside to Nehalem,
- OR-126 from the Valley to US-101 at Florence, and
- US-101 from Coos Bay to the California border.

The Tier 3 (third roadway priority) system in Region 1 would complete an integrated coastal lifeline system and consists of the following corridors:

- US-101 from Astoria to Seaside,
- US-101 from Nehalem to Tillamook,
- OR-22 from its junction with OR-18 to the Valley,
- OR-20 from Corvallis to Newport,
- OR-42 from I-5 to US-101, and
- US-199 from I-5 to the California border.

REGIONAL IMPACT. Coastal highways, most importantly US-101, will be fragmented in many areas. In some areas there are possible detours inland from US-101, but many of those routes are also vulnerable to ground shaking, landslides, and other hazards.

- Ground shaking: In Region 1 ground shaking will be intense and prolonged. Most unreinforced structures and many unreinforced roadbeds and bridges will be damaged to varying extents, and it is likely that many damaged areas will become impassable without major repairs.

- Landslides and Rockfall: Many areas along the coast highway, US-101, are cut into or along landslide prone features. Removal of slide and rockfall material is an ongoing responsibility of ODOT Maintenance crews on long stretches of the highway. A major seismic event will increase landslide and rockfall activities and may reactivate ancient slides that are currently inactive.
- Tsunami: Some reaches of US-101 and connecting and parallel routes will be inundated by tsunami. Tsunami debris may block large areas of the street and highway network.
- Liquefaction: Structures in wetland, estuarine, alluvial and other saturated areas will be subject to liquefaction damage; the total area of such impacts will vary with the extent of saturated soils at the time of the event.

Regional Loss Estimates. Highway-related losses include disconnection from supplies and replacement inventory, and the loss of tourists and other customers who must travel to do business with affected businesses.

Most Vulnerable Jurisdictions. The vulnerabilities studied in the OSLR project are geographic rather than jurisdictional. Other research suggests that the risks of a subduction zone seismic event are somewhat higher along the Southern Oregon Coast, but the risks assessed in this study pertain to the vulnerability of highway facilities in the case of a CSZ event and the higher vulnerabilities are generally low lying areas, active and ancient landslide and rockfall areas, and where critical bridges may not be easily repaired or detoured around. Vulnerability also relates to a current conditions context — high groundwater and saturated soils, high tides, and time of day as it relates to where people are relative to the highway system and other vulnerable facilities. Coos, Curry, Douglas, Lane, Lincoln, Tillamook, and Clatsop Counties are all highly vulnerable to a CSZ event.

Floods

Characteristics

In general, three types of flooding occur in Region 1: (a) riverine, (b) ocean flooding from high tides and wind-driven waves, and (c) flooding associated with a tsunami event. Tsunami flooding is not addressed in this section.

Riverine

There are two distinct periods of riverine flooding in Region 1 — winter and late spring — with the most serious occurring December through February. The situation is especially severe when riverine flooding, caused by prolonged rain and melting snow, coincides with high tides and coastal storm surges. In short, the rivers back up and flood the lowlands. This type of flooding is especially troublesome in the Tillamook Bay area where homes and livestock can be isolated for several days. Several northern coastal rivers carry heavy silt loads that originated in areas burned during the "Tillamook Burn" fires (1933 to 1951) or from areas covered with volcanic ash during the Mount St. Helens eruption (1980). Consequently, some rivers actually may be elevated above local floodplains, which increases flood hazards. The costs and long-term benefits of dredging these rivers have not been determined. **Table 2-92** lists the principal riverine flood sources in Region 1.

Ocean Flooding and Wave Action

Flooding from wind-driven waves is common during the winter, during El Niño events, and when spring and perigean tides occur. The Federal Emergency Management Agency has identified and mapped coastal areas subject to direct wave action (V zones) and sand dune over-topping (AH and AO zones). Direct wave action was especially severe during the winter storm events of 1972 (Siletz Spit), 1978 (Nestucca Spit), and the El Niño events of 1982-83 and 1997-98. Significant beach and cliff erosion occurred during these periods and a number of homes were destroyed. The following lessons were learned (and often forgotten between damaging events):

- Oregon coastal processes are complex and dynamic, sometimes eroding, sometimes aggrading;
- Some sections of the Oregon coast are rising in relation to ocean levels, others remain fairly constant or are becoming lower (Komar 1992, 40-41);
- Primary frontal dunes provide protection from ocean storms;
- Sand spits are not permanent features; and
- Erosion rates vary and are dependent on several factors including storm duration and intensity, composition of sea cliff, time of year, and impact of human activities (e.g., altering the base of sea cliffs, interfering with the natural movement of beach sand).

Historic Flood Events

Table 2-92. Historic Floods in Region 1

Date	Location	Description	Type of Flood
1813	NW Oregon	said to exceed "Great Flood" of 1861 (source: Native Americans)	unknown
Dec. 1861	coastal rivers	the "Great Flood"; largest flood of known magnitude on the Rogue	rain on snow
Feb. 1890	coastal rivers	widespread flooding; Siuslaw River dammed by a large debris flow	rain on snow
Jan. 1923	Lower Columbia	mild temperatures; large amount of rain; flooded roads and railroads	rain on snow
Mar. 1931	western Oregon	extremely wet and mild; saturated ground	rain on snow
Dec. 1933	northern Oregon	intense warm rains; Clatskanie River set record	rain on snow
Dec. 1937	western Oregon	heavy coastal rain; large number of debris flows	rain on snow
Oct. 1950	SW Oregon coast	heavy October rain	rain on snow
Dec. 1953	western Oregon	heavy rain accompanied major windstorm; serious log hazards on Columbia	rain on snow
Dec. 1955	Columbia and coastal streams	series of storms; heavy, wet snow; many homes and roads damaged	rain on snow
Dec. 1962	SW Oregon	severe flooding, especially the Rogue River	rain on snow
Mar. 1964	coast and Columbia River estuary	Ocean flooding	tsunami
Dec. 1964	entire state	two storms; intense rain on frozen ground	rain on snow
Jan. 1972	northern coast	severe flooding and mudslides; 104 evacuated from Tillamook	rain on snow
Jan. 1974	western Oregon	series of storms with mild temperatures; large snowmelt; rapid runoff	rain on snow
Dec. 1978	coastal streams	Intense warm rain; two fatalities on Yaquina River; widespread flooding	rain on snow
Feb. 1986	entire state	warm rain and melting snow; numerous homes evacuated	rain on snow
Feb. 1987	western Oregon	heavy rain; mudslides; flooded highways; damaged homes	rain on snow
Dec. 1989	Clatsop, Tillamook and Lincoln	warm Pacific storm system; high winds; fatalities; mudslides	rain on snow
Jan. 1990	W. Oregon	significant damage in Tillamook County; many streams had all-time records	rain on snow
Apr. 1991	Tillamook County	48-hour rainstorm. Wilson River 5 ft. above flood stage; businesses closed	rain on snow
Feb. 1996	NW Oregon	deep snow pack; warm temperatures; record-breaking rains	rain on snow
Nov. 1996	W. Oregon	record-breaking precipitation; flooding; landslides (FEMA-1149-DR-Oregon)	rain on snow
Dec. 2005	Coos, Curry, and Douglas Counties	$2,840,000.00 in property damage (includes Jackson and Josephine Counties)	riverine
Nov. 2006	Tillamook County	heavy rains caused major flooding in Nehalem and Tillamook, causing $1 million in damage in Nehalem and $15 million in Tillamook	riverine

Date	Location	Description	Type of Flood
Nov. 2006	Lincoln County	Siletz River crested at 7 feet above flood stage	riverine
Dec. 2006	Coos County	two floods in Coos County on the Coquille River inundated several roads, including OR-42 and OR-42S	riverine
Dec. 2007	Clatsop County	storm total of 7.3 inches of rain, causing many rivers to overflow their banks. $9.15 million in damages	riverine
Dec. 2007	Columbia County	Nehalem (Vernonia)	riverine
Dec. 2007	Tillamook County	heavy rains led to flooding in Tillamook along the Wilson River damaging businesses, homes, the railroad to the Port; county-wide damages total 26 million	riverine
Dec. 2007	Lincoln County	Siletz River had moderate flooding, causing flood damage near Siletz and Lincoln City; total county-wide damages include $124,000 in damages inland and $31,000 damages for coastal property	riverine
Dec. 2007	Lane County	flooding along coast, $31,000 in property damage	riverine
Dec. 2007	Curry County	Rogue river exceeds flood stage, but no known damages	riverine
Dec. 2008	Tillamook County	heavy rainfall caused flooding in downtown Tillamook; estimate of $3.8 million in damages throughout Tillamook County	riverine
Jan. 2012	Coos, Curry, Lincoln, and Tillamook Counties	a severe winter storm including flooding, landslides, and mudslides affected mostly the southern Oregon coastal counties	riverine
Nov. 2012	Curry and Josephine Counties	heavy precipitation caused over $4 million in damages to public infrastructure	riverine, sheet flow
Sep. 2013	Tillamook County	heavy rain caused flooding at the Wilson River	riverine

Source: Taylor and Hannan (1999), Source: Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://hvri.geog.sc.edu/SHELDUS/index.cfm?page=faq. National Climatic Data Center, Storm Events, http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

Table 2-93. Principal Riverine Flood Sources by County in Region 1

Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Lewis and Clark R	Coquille R	Chetco R	Umpqua R	Siuslaw R	Alsea R	Kilchis R
Little Walluski R	Willicoma R	Elk R	Smith R	Munsel Cr	Salmon R	Miami R
Necanicum R	Ten Mile Cr	Pistol R	Scholfield Cr		Siletz R	Nehalem R
Nehalem R	Palouse Cr	Rogue R			Yachats R	Nestucca R
Bear Cr	Larson Cr	Sixes R			Yaquina R	Three Rivers
Beerman Cr	Kentuck Sl	Winchuck R			Drift Cr	Tillamook R
Big Cr	Willanch Sl	Hunter Cr			Depot Cr	Trask R
Cow Cr	Pony Cr				Ollala Cr	Wilson R
Fishhawk Cr					Schooner Cr	Dogherty Sl
Humbug Cr						Hoquarten Sl
Little Cr						
Neacoxi Cr						
Neawanna Cr						
Northrup Cr						
Plymton Cr						

Note: R = river, Cr = creek, Sl = slough.

Sources: Federal Emergency Management Agency (FEMA), Clatsop County Flood Insurance Study (FIS), July 17, 2001, FEMA, Coos County FIS, May 15, 1984, FEMA, Curry County FIS, Feb. 04, 1998, FEMA, Douglas County FIS, Apr. 21, 1999, FEMA, Lane County FIS, June 02, 1999, FEMA, Lincoln County FIS, Mar. 1, 1980, FEMA, Tillamook County FIS, Aug. 20, 2002.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 1 will experience flooding is shown in **Table 2-94**.

Table 2-94. Local Probability Assessment of Flood in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	H	H	H	H	H	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores.

State Assessment

Riverine

FEMA has mapped the streams listed in **Table 2-93** for 10, 50, 100, and 500-year flood events, with the probability of flooding in a year being 10%, 2%, 1%, and 0.2%, respectively. Areas subject to the 1% annual flood are depicted on FEMA Flood Insurance Rate Maps (FIRMs). Recurrence intervals can differ between reaches of the same stream during the same flood event. For example, certain reaches of the Wilson River may experience a 100-year (1%) flood while other sections of the river may be having a 50-year (2%) or perhaps a 500-year (0.2%) flood event.

Flood Insurance Rate Maps (FIRM) show flood conditions; however, many maps are based on old flood models. The following is a list of Region 1 counties and the date of their most recent FIRM:

- Clatsop, September 17, 2010;
- Coos, September 25, 2009;
- Curry, September 25, 2009;
- Douglas, Feb. 17, 2010;
- Lane, June 2, 1999;
- Lincoln, Dec. 18, 2009; and
- Tillamook, Aug. 20, 2002.

Ocean Flooding / Wave Action

Ocean storms can be expected every year. El Niño effects, which tend to raise ocean levels, occur about every 3 to 5 years (Taylor & Hannan, 1999). V (wave velocity) zones, depicted on FEMA's Flood Insurance Rate Maps, are areas subject to 100-year events (i.e., 1% chance in any given year). The Flood Insurance Rate Maps show areas vulnerable to wave action (V zones), ponding and sheet-flow from waves over-topping dunes (AO and AH zones). All of the counties in Region 1 have hazardous areas identified on the maps. DOGAMI and FEMA also provide information about wave action.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to flooding is shown in **Table 2-95**.

Table 2-95. Local Vulnerability Assessment of Flood in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	H	H	H	M	H	L	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

The Oregon Department of Land Conservation and Development (DLCD) created a countywide flood vulnerability index by compiling data from NOAA's Storm Events Database and from FEMA's National Flood Insurance Program. Data were calculated statewide for the period 1978 through 2013 for five input datasets: number of events, structure and crop damage estimates in dollars and NFIP claims number and dollar amounts. The mean and standard deviation were calculated for each input. Then, each county was assigned a score ranging from 0 to 3 for each of these inputs according to **Table 2-96**.

Table 2-96. Scoring for Vulnerability Index

Score	Description
3	county data point is greater than 2.5 times standard deviation for the input data set
2	county data point is greater than 1.5 times standard deviation for the input data set
1	county data point is within standard deviation
0	no data reported

Source: DLCD

DLCD summed the scores for each of the five inputs to create a county-by-county vulnerability index. The maximum possible score is 15. A score over 6 indicates that at least one variable significantly exceeds average values.

Low-lying coastal areas in Region 1 are particularly vulnerable to flood hazards that can be exacerbated by high tides. Region 1 received the highest flood vulnerability index score (83) partly because seven counties (all or partial) are included in this region, but also because four of the highest scoring counties are located in Region 1. The lower Siletz and Siuslaw rivers in Lincoln and Lane Counties respectively and the rivers that feed Tillamook Bay in Tillamook County have all experienced significant flood losses. In fact, the meaning of the term "100-year flood" was lost when repetitive flood events impacting the City of Tillamook and adjacent portions of Tillamook County exceeded the base flood elevation numerous times, including major flood events in 1996, 1998 and 1999, 2007, and 2011. Many pre- and post-FIRM buildings experienced repetitive flood losses along US-101 north of the City of Tillamook, many of which have been mitigated using HMGP grants.

In general, the northern half of Region 1 is more vulnerable to riverine flood damage than the southern half because it is more densely populated and consequently contains much of the region's infrastructure. Physical location also makes a difference. For example, five rivers empty into Tillamook Bay, thereby increasing risk from riverine flooding on the relatively flat valley floor.

Fortunately, unlike the East and Gulf coasts, only a few of Oregon's coastal developments are within FEMA-designated Velocity (V) zones. Region 1 counties have not inventoried all buildings that are vulnerable to wave action (i.e., in V zones); however pertinent information from the National Flood Insurance Program (NFIP) indicates that Lincoln and Tillamook Counties and their coastal cities account for nearly all of the V-zone flood policies (275 of 277) and losses (18 out of 20) in Region 1.

While the exact number of buildings, parks, infrastructure, and critical facilities in Region 1 vulnerable to ocean storms is unknown, the low-lying areas adjacent to bays or the ocean are known to be at risk. Bayocean, Salishan Spit, Jumpoff Joe, Rogue Shores, and The Capes are examples of development in such areas whose buildings and infrastructure have been destroyed by wave attack. A number of local governments in Region 1 have initiated and accomplished building elevation and/or buy-out programs. Also, dairy farmers and other businesses have made considerable progress in protecting their investments.

Coastal highways have always been problematic. In Region 1, much of the problem is linked to the local geology. Bedrock conditions change abruptly within very short distances resulting in inconsistent highway foundation; some sections are more susceptible to wave action than others and require continuous maintenance. There is no practical solution outside of relocation of the highway; this option is not financially feasible at this point in time. Flood vulnerability scores for Region 1 are listed in **Table 2-97**.

Table 2-97. Flood Vulnerability Scores, by County in Region 1

County	Flood Vulnerability Score
Clatsop	6
Coos	7
Curry	7
Douglas*	6
Lane *	6
Lincoln	6
Tillamook	11

*Only coastal sections of Douglas and Lane Counties.

Source: DLCD

FEMA has identified 138 Repetitive Loss (RL) properties in Region 1, three of which are Severe Repetitive Loss (SRL) properties. This region has the most repetitive flood losses of any of the Oregon NHMP Natural Hazard Regions, reflecting the high rainfall amounts characteristic of the coastal region and the high density of watercourses. The coast is also subject to flooding from the Pacific Ocean.

Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS), which results in reduced flood insurance costs. Douglas and Lane Counties participate in CRS, as do the cities of Cannon Beach, Nehalem, and Tillamook.

Table 2-98. Flood Severe/Repetitive Losses and Community Rating System Communities by County in Region 1

County	RL	SRL	# of CRS Communities per County
Clatsop	6	1	1
Coos	12	—	0
Curry	3	—	0
*Douglas	0	—	0
*Lane	16	—	0
Lincoln	45	2	0
Tillamook	56	—	2
Total	**138**	**3**	**3**

*Includes only coastal sections of Douglas and Lane Counties.

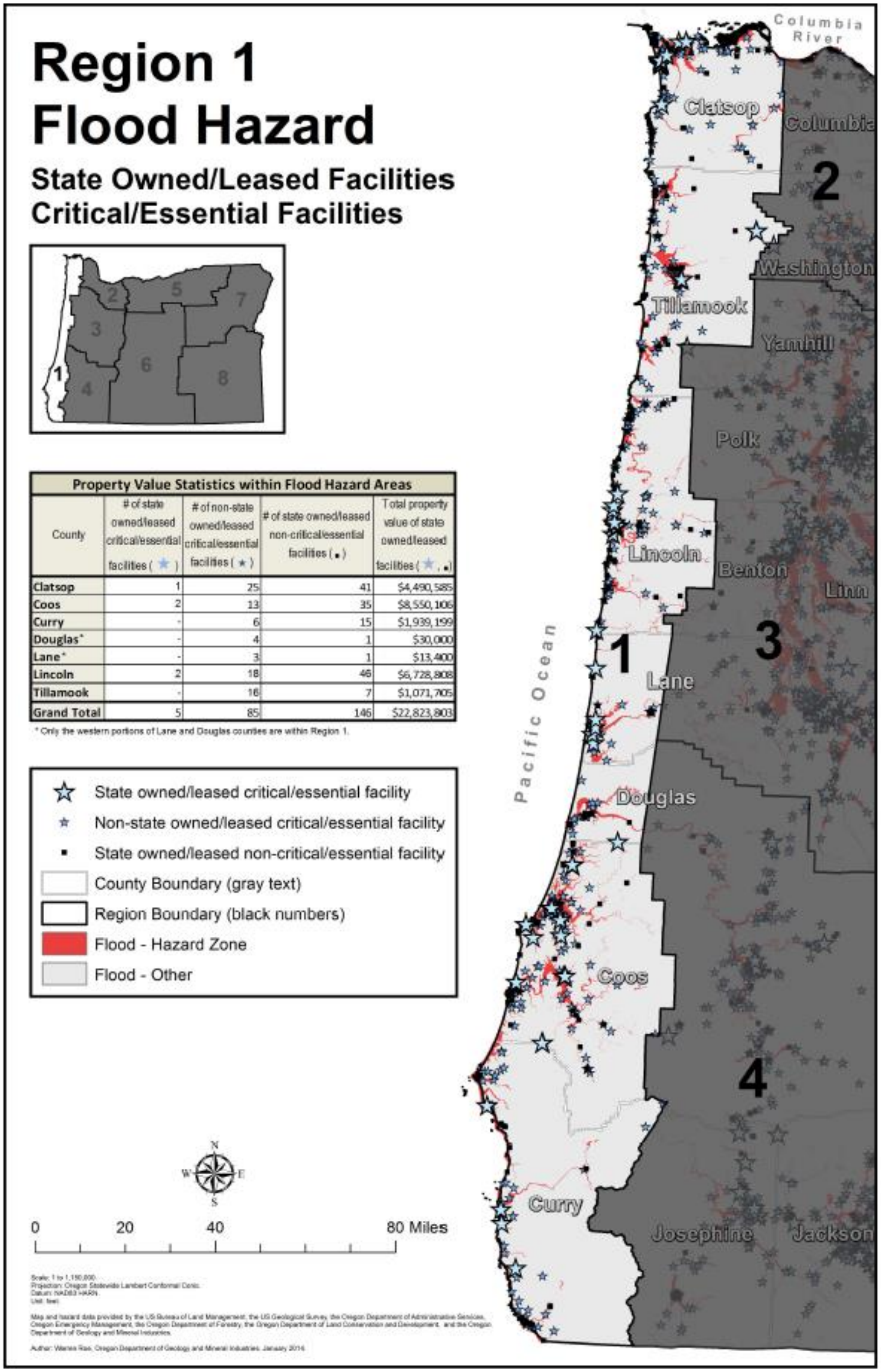
Source: FEMA NFIP BureauNet, http://bsa.nfipstat.fema.gov/, accessed Dec. 1, 2014

State-Owned/Leased Facilities and Critical/Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 151 are currently located within a flood hazard zone in Region 1 and have an estimated total value of nearly $23 million (**Figure 2-96**). Of these, five are identified as a critical or essential facility. An additional 85 non-state-owned/leased critical/essential facilities are located in a flood hazard zone in Region 1.

Figure 2-96. State-Owned/Leased Facilities and Critical/Essential Facilities in a Flood Zone in Region 1



Property Value Statistics within Flood Hazard Areas

County	# of state owned/leased critical/essential facilities (☆)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (☆, ▪)
Clatsop	1	25	41	$4,490,585
Coos	2	13	35	$8,550,106
Curry	-	6	15	$1,939,199
Douglas*	-	4	1	$30,000
Lane*	-	3	1	$13,400
Lincoln	2	18	46	$6,728,808
Tillamook	-	16	7	$1,071,705
Grand Total	5	85	146	$22,823,803

* Only the western portions of Lane and Douglas counties are within Region 1.

Source: DOGAMI

Landslides

Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. In general, the coast and Coast Range Mountains have a very high incidence of landslides. On occasion, major landslides occur on U.S. or state highways and sever these major transportation routes (including rail lines), causing temporary but significant economic damage to the state. Less commonly, landslides and debris flows in this area cause loss of life.

Historic Landslide Events

Table 2-99. Historic Landslides in Region 1

Date	Location	Description
Feb. 1926	between Coos Bay and Coquille, Oregon	damages: $25,000; closed Roosevelt Highway
Feb. 1961		large section of Ecola State Park slid into the Pacific Ocean
Feb. 1996		FEMA-1099-DR-Oregon; heavy rains and rapidly melting snow contributed to hundreds of landslides and debris flows across the state, many on clear cuts that damaged logging roads
Nov. 1996	Lane and Douglas Counties	FEMA-1149-DR-Oregon; heavy rain triggered mudslides (Lane and Douglas Counties); five fatalities; several injuries (Douglas County)
Feb. 1999	south of Florence, Oregon	two timber workers killed in a mud and rockslide (south of Florence)
Jan. 2000	north of Florence, Oregon	a landslide (north of Florence) closed US-101 for 3 months, resulting in major social and economic disruption to nearby communities
Dec. 2004	Lane, Polk, and Lincoln Counties	property damage: $12,500
Dec. 2007	Clatsop and Tillamook	property damage: $300,000

Sources: Taylor and Hatton (1999); and FEMA After-Action Report, 1996 events; and interviews, Oregon Department of Transportation representatives.

Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from: http://www.sheldus.org.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 1 will experience landslides is shown in **Table 2-100**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—).

Table 2-100. Local Probability Assessment of Landslides in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	H	H	H	H	H	—	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Landslides are found in every county in Oregon. There is a 100% probability of landslides occurring in Oregon in the future. Although we do not know exactly where and when they will occur, they are more likely to happen in the general areas where landslides have occurred in the past. Also, they will likely occur during heavy rainfall events or during a future earthquake.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to landslides is shown in **Table 2-101**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—).

Table 2-101. Local Vulnerability Assessment of Landslides in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	H	M	L	M	M	—	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Rain-induced landslides and debris flows can potentially occur during any winter in this region. This area is also subject to future very large earthquakes, which will trigger landslides. Many of the communities in Region 1 have a high exposure to the landslide hazard, for example Astoria. A new study of the landslide hazard and risk of Astoria found 121 landslides within the city limits and losses in a major earthquake are likely to be 50% greater than somewhere with low or no landslide hazards (Burns and Mickelson, 2013).

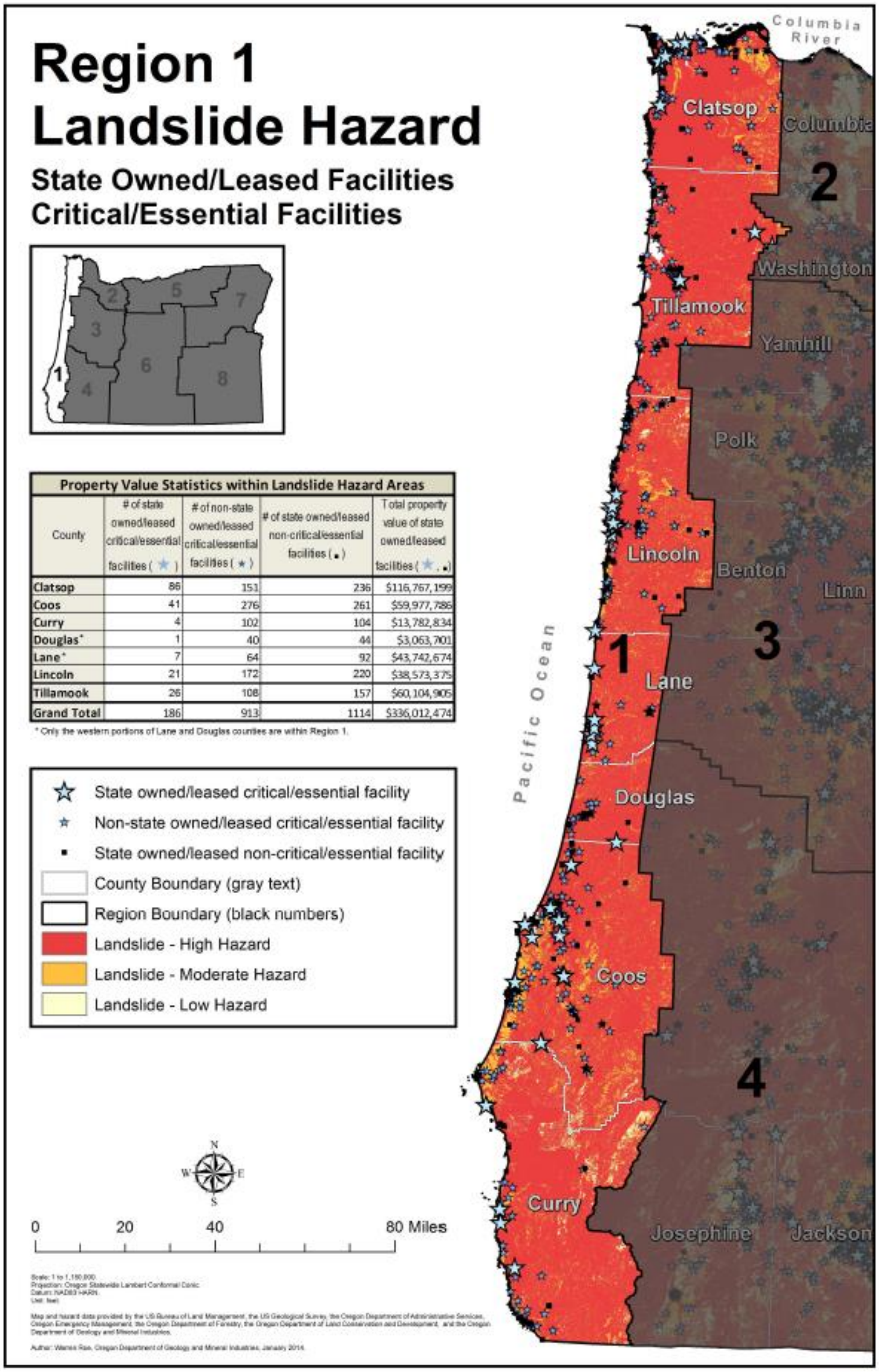
Some of the greatest exposure in Region 1 is the east-west roadways that carry traffic to and from the coast, with the potential for injuries and loss of life from rapidly moving landslide events.

STATE-OWNED/LEASED FACILITIES AND CRITICAL/ESSENTIAL FACILITIES

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 1,300 are located within landslide hazard areas in Region 1, totaling roughly $336 million (**Figure 2-97**). This includes 186 critical or essential facilities; 913 additional critical/essential facilities, not owned/leased by the state, are also located within a landslide hazard zone in Region 1.

Figure 2-97. State-Owned/Leased Facilities and Critical/Essential Facilities in a Tsunami Hazard Zone in Region 1



Property Value Statistics within Landslide Hazard Areas				
County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Clatsop	86	151	236	$116,767,199
Coos	41	276	261	$59,977,786
Curry	4	102	104	$13,782,834
Douglas*	1	40	44	$3,063,701
Lane*	7	64	92	$43,742,674
Lincoln	21	172	220	$38,573,375
Tillamook	26	108	157	$60,104,905
Grand Total	186	913	1114	$336,012,474

* Only the western portions of Lane and Douglas counties are within Region 1.

Source: DOGAMI

Tsunamis

Characteristics

Tsunami waves are infrequent events, but can be extremely destructive. They may be generated by earthquakes, submarine volcanoes, or landslides, and travel hundreds of miles before striking land. Hardly discernible at sea, tsunami waves travel as fast as 500 mph across open water until, at landfall, they slow down significantly and can reach heights from 20 to about 100 feet. Seward, Alaska, experienced tsunami waves as high as 25 feet during the 1964 earthquake-tsunami event.

Most tsunami waves have been described as an onrushing, rapidly rising tide, which can be seen in the few motion pictures that have captured the tsunami phenomenon. The size and behavior of tsunamis depend on a number of factors, including distance traveled, submarine topography and the shape and orientation of the coastline. Much of the damage results from water-borne debris, which can act as battering rams against on-shore development. Wave-borne fuel drums are especially hazardous because of their propensity to cause or exacerbate fires.

All Region 1 counties are susceptible to tsunami hazards. Oregon’s coastal communities have experienced, to various degrees, tsunamis that have originated in the oceanic regions near Russia’s Kamchatka Peninsula, Japan, Chile, Hawaii, the Gulf of Alaska, and northern California. Additionally, the geologic record implies that over the last 10,000 years approximately 42 tsunamis have been generated locally off the Oregon Coast along the Cascadia Subduction Zone (CSZ). Nineteen of these tsunamis were from full-margin ruptures of the CSZ and arrived in all parts of the coast about 15–20 minutes after the earthquake; the others arrived this quickly on parts of the south coast adjacent to each of the segment ruptures. Any locally generated tsunamis would cause significant damage to coastal ports and pose a threat to those near waterfront areas. This is the region’s greatest concern. See **Earthquake** section.

Historic Tsunami Events

Table 2-102 describes some of the tsunami history of Region 1.

Table 2-102. Historic tsunamis affecting Region 1

Date	Origin of Event	Affected Community	Damage	Remarks
04/1868	Hawaii	Astoria, Oregon		observed
08/1868	N. Chile	Astoria, Oregon		observed
08/1872	Aleutian Is	Astoria, Oregon		observed
11/1873	N. California	Port Orford, Oregon		debris at high tide line
04/1946	Aleutian Is	Bandon, Oregon		barely perceptible
04/1946		Clatsop Spit, Oregon		water 3.7 m above MLLW
04/1946		Depoe Bay, Oregon		bay drained; water returned as a wall
04/1946		Seaside, Oregon		wall of water swept up Necanicum River
11/1952	Kamchatka	Astoria, Oregon		observed
11/1952		Bandon, Oregon	log decks broke loose	
05/1960	S. Cent. Chile	Astoria, Oregon		observed
05/1960		Seaside, Oregon	bore on Necanicum River damaged boat docks	
05/1960		Gold Beach, Oregon		observed
05/1960		Newport, Oregon		observed for about four hours
05/1960		Netarts, Oregon	some damage observed	
Mar. 1964	Gulf of Alaska	Cannon Beach, Oregon	bridge and motel unit moved inland; $230,000 damage	
Mar. 1964		Coos Bay, Oregon	$20,000 damage	
Mar. 1964		Depoe Bay, Oregon	$5,000 damage; four children drowned at Beverly Beach	
Mar. 1964		Florence, Oregon	$50,000 damage	
Mar. 1964		Gold Beach, Oregon	$30,000 damage	
Mar. 1964		Seaside, Oregon	one fatality (heart attack); damage to city: $41,000; private: $235,000; four trailers, 10-12 houses, two bridges damaged	
05/1968	Japan	Newport, Oregon		observed
04/1992	N. California	Port Orford, Oregon		observed
10/1994	Japan	Oregon Coast		tsunami warning issued, but no tsunami observed
3/2011	Japan	Oregon Coast	$6.7 million; extensive damage to the Port of Brookings	tsunami warning issued, observed ocean waves

Sources: NOAA, 1993, Tsunamis Affecting the West Coast of the United States: 1806-1992; FEMA, 2011, Federal Disaster Declaration

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 1 will experience a tsunami is shown in **Table 2-103**.

Table 2-103. Local Probability Assessment of Tsunami in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	H	H	H	H	M	H	M

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

The entire coastal zone is highly vulnerable to tsunami impact. Distant tsunamis caused by earthquakes on the Pacific Rim strike the Oregon coast frequently but only a few of them have caused significant damage or loss of life. Local tsunamis caused by earthquakes on the CSZ happen much less frequently but will cause catastrophic damage and, without effective mitigation actions, great loss of life.

With respect to distant sources, Oregon has experienced 25 tsunamis in the last 145 years with only 3 causing measurable damage. Thus, the average recurrence interval for tsunamis on the Oregon coast from distant sources would be about 6 years. However, the time interval between events has been as little as one year and as much as 73 years. The two most destructive tsunamis occurred only 4 years apart (1960 and 1964) and originated from two different source areas (south central Chile and the Gulf of Alaska). Because only a few tsunamis caused measurable damage, a recurrence interval for distant tsunamis does not have much meaning for this region with respect to losses. However, every time NOAA issues a distant tsunami warning for the coast, evacuation plans are triggered at significant cost to local government and business.

Geologists predict a 10% chance that a CSZ tsunami will be triggered by a shallow, undersea earthquake offshore Oregon in the next 30 years, causing a tsunami that will strike all parts of the Oregon coast about 15–20 minutes after the earthquake. This forecast comes from the 10,000-year geologic record of 19 CSZ fault ruptures extending the entire length of the Oregon coast (i.e., recurrence of approximately 500 years) (DOGAMI, 2009). As previously mentioned, the southern Oregon coast has a higher chance of experiencing a local tsunami and earthquake, the probability increasing progressively southward. The last CSZ event occurred approximately 300 years ago (Satake et al., 1996).

Owing to much faster arrival and generally larger size, tsunamis originating from the CSZ will cause much larger life and property losses than most distant tsunamis and are at least as frequent as the largest distant tsunamis. Inundation from the largest distant tsunamis approximates inundation from the "Small" Cascadia tsunami on Oregon Tsunami Inundation Maps (TIMs).

Vulnerability

Local Assessment

Based on an OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to tsunami is shown in **Table 2-104**.

Table 2-104. Local Vulnerability Assessment of Tsunami in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	H	H	H	H	H	M	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

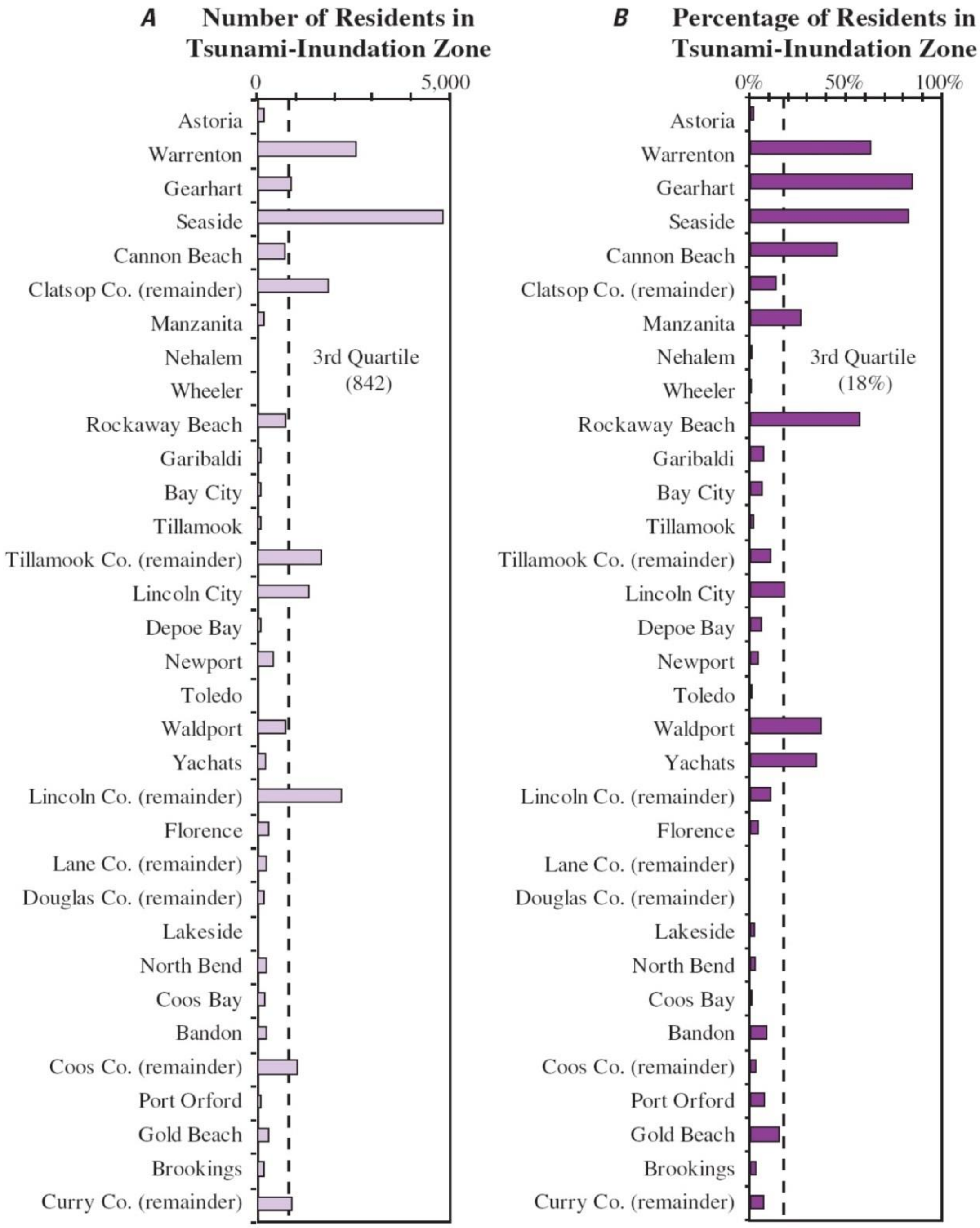
The entire coastal zone is highly vulnerable to tsunami impact. Distant tsunamis caused by earthquakes on Pacific Rim strike the Oregon coast frequently but only a few of them have caused significant damage or loss of life. Local tsunamis caused by earthquakes on the Cascadia Subduction Zone (CSZ) happen much less frequently but will cause catastrophic damage and, without effective mitigation actions, great loss of life.

All communities in Region 1 are especially vulnerable to tsunamis because of their coastal settings and locations in low-lying areas. Seaside is the most vulnerable city due to its low elevation and high resident and tourist populations, and its county, Clatsop, is the most vulnerable county, having the largest exposed population (**Figure 2-98**) (Wood, 2007). Although many communities have evacuation maps and evacuation plans, many casualties are expected. The built environment in the inundation zone will be especially hard hit.

The United States Geological Survey (USGS) completed a comprehensive study (Wood, 2007) of coastal cities' exposure and sensitivity to a CSZ tsunami similar to the most likely "Medium" scenario depicted in the 2010–2013 DOGAMI Tsunami Inundation Map series. The tsunami zone of the USGS study is the 1995 regulatory inundation zone used by the Oregon Building Code to limit new construction of critical/essential, hazardous, and high-occupancy facilities. Results indicate that the regulatory inundation zone contains approximately 22,201 residents (4% of the total population in the seven coastal counties), 14,857 employees (6% of the total labor force), and 53,714 day-use visitors on average every day to coastal Oregon State Parks within the tsunami-inundation zone. The zone also contains 1,829 businesses that generate approximately $1.9 billion in annual sales volume (7% and 5% of study-area totals, respectively) and tax parcels with a combined total value of $8.2 billion (12% of the study-area total). Although occupancy values are not known for each facility, the tsunami-inundation zone also contains numerous dependent-population facilities (for example, adult-residential-care facilities, child-day-care facilities, and schools), public venues (for example, religious organizations and libraries), and critical facilities (for example, police stations).

Additionally, results indicate that vulnerability, described in the study by exposure (the amount of assets in tsunami-prone areas) and sensitivity (the relative percentage of assets in tsunami-prone areas) varies considerably among 26 incorporated cities in Region 1 (Wood, 2007). City exposure and sensitivity to tsunami hazards is highest in the northern portion of the coast. The City of Seaside in Clatsop County has the highest exposure, the highest sensitivity, and the highest combined relative exposure and sensitivity to tsunamis. Results also indicate that the amount of city assets in tsunami-prone areas is weakly related to the amount of a community's land in this zone; the percentage of a city's assets, however, is strongly related to the percentage of its land that is in the tsunami-prone areas.

Figure 2-98. Number (A) and Percentage (B) of Residents in the Oregon Regulatory Tsunami Inundation Zone



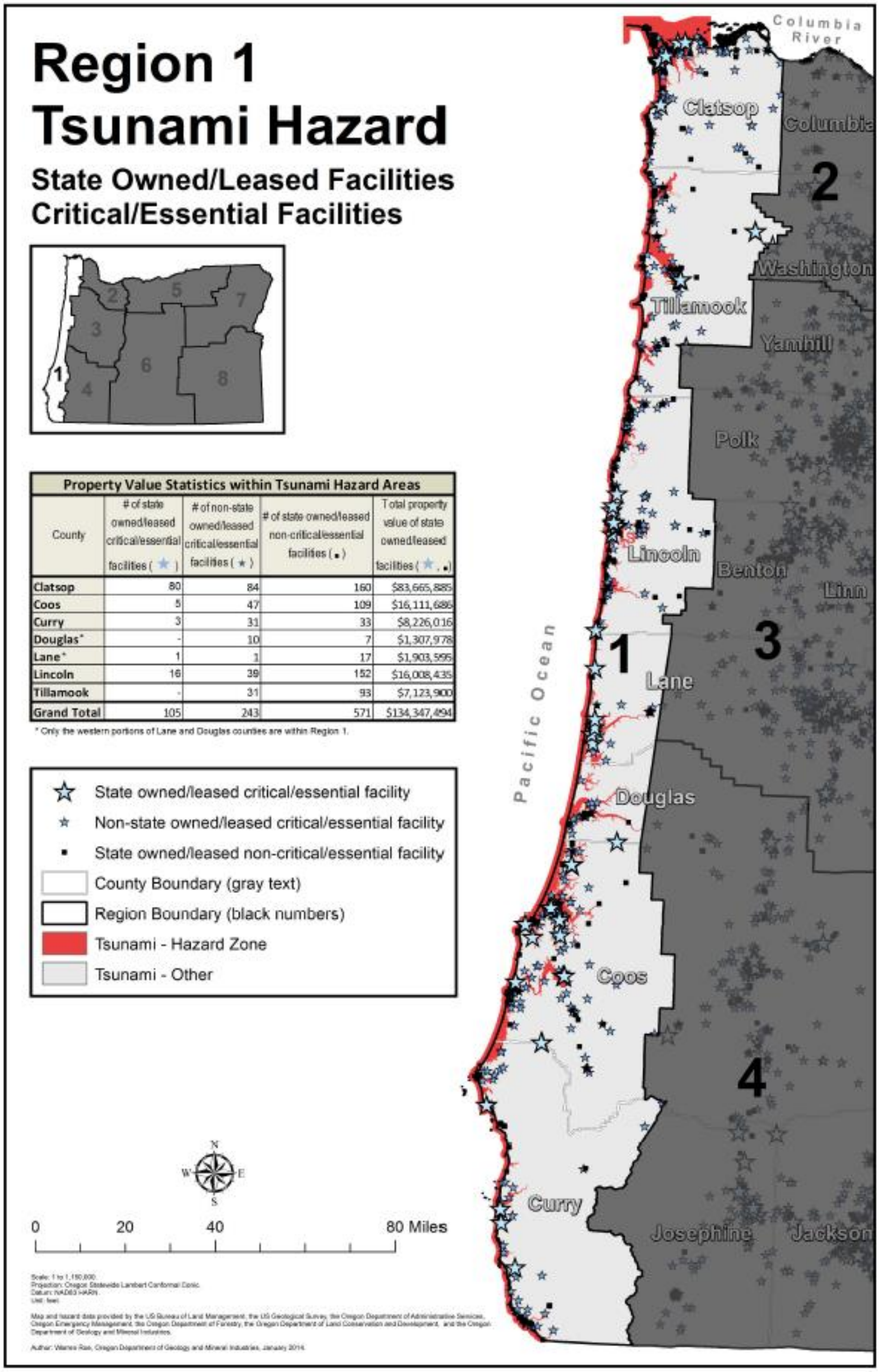
Source: Wood (2007)

STATE-OWNED/LEASED FACILITIES AND CRITICAL/ESSENTIAL FACILITIES

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the state 5,693 facilities evaluated, 676 are currently located within the tsunami hazard zone and have an estimated total value of $134 million (**Figure 2-99**). Of these, 105 are identified as state-owned/leased critical/essential facilities. An additional 243 non-state critical/essential facilities are also located with a tsunami hazard zone in Region 1.

Figure 2-99. State-Owned/Leased Facilities and Critical/Essential Facilities in a Tsunami Hazard Zone in Region 1



Property Value Statistics within Tsunami Hazard Areas				
County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Clatsop	80	84	160	$83,665,885
Coos	5	47	109	$16,111,686
Curry	3	31	33	$8,226,016
Douglas*	-	10	7	$1,307,978
Lane*	1	1	17	$1,903,595
Lincoln	16	39	152	$16,008,435
Tillamook	-	31	93	$7,123,900
Grand Total	105	243	571	$134,347,494

* Only the western portions of Lane and Douglas counties are within Region 1.

Source: DOGAMI

Volcanoes

Characteristics

The volcanic Cascade Mountain Range is not within Region 1 counties; consequently, the risk from local volcano-associated hazards (e.g., lahars, pyroclastic flows, lava flows, etc.) is not a priority consideration to Coastal Oregon. However, there is some risk from volcanic ashfall. This fine-grained material, blown aloft during a volcanic eruption, can travel many miles from its source. For example, the cities of Yakima (80 miles) and Spokane (150 miles), Washington, were inundated with ash during the May 1980, Mount St. Helens eruption. Ashfall can reduce visibility to zero, and bring street, highway, and air traffic to an abrupt halt. The material is noted for its abrasive properties and is especially damaging to machinery. It would be prudent for communities that may be exposed to ashfall to identify disposal areas for large quantities of ash. Part of Clatsop County borders the Columbia River, which in theory makes it vulnerable to lahars or mudflows carried by the river. Although unlikely, such an event cannot be dismissed out of hand. A lahar or mudflow that traveled down Washington's Cowlitz River following the eruption of Mount St. Helens, filled the Columbia River channel overnight from its previous 40-foot depth to a mere 14 feet. This delayed ship movements in the vicinity of the Cowlitz for months (Wolfe and Pierson, 1995).

Historic Volcanic Events

There are no significant volcanoes within Region 1 and no historic volcano-related events.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 1 will experience volcanic hazards is shown in **Table 2-105**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—).

Table 2-105. Local Probability Assessment of Volcanic Hazards in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	M	M	L	—	—	L	M

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Mount St. Helens is a probable source of ashfall and lahars that can reach the Columbia River. The probability of coastal counties receiving ashfall is about 1 in 10,000 — with a large portion of Curry County being even less (Sherrod et al., 1997). A lahar mudflow that traveled down Washington's Cowlitz River following the 1980 eruption of Mount St. Helens filled the Columbia River channel overnight from its previous 40-foot depth to a mere 14 feet. This delayed ship movements for months.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to volcanic hazards is shown in **Table 2-106**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—).

Table 2-106. Local Vulnerability Assessment of Volcanic Hazards in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	M	M	H	—	—	L	M

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

None of the communities identified by DOGAMI as being most vulnerable to volcano hazards are located in Region 1. However, as noted earlier, there is some risk of ashfall that can be especially damaging to machinery. Although remote, the threat of lahars or volcanic related mudflows could impact the shipping industry on the Columbia River in Region 1.

Wildfires

Characteristics

Existing development near wildland areas combined with the spread of gorse and other flammable plant species throughout the region is increasing the level of wildfire risk. Wildfires in the wildland-urban interface (WUI) pose serious threats to life and endanger property, critical infrastructure, water resources, and valued commercial and ecological forest resources. While the region is characterized as moist and regarded as lower than normal fire danger, some the largest fire events have occurred in this area. The historic Tillamook Burn, comprising devastating wildfires every 6 years between 1933 and 1951, burned a total of 355,000 acres. Much of the burn was attributed to powerful east wind events and heavy fuels.

Historically, lighting has been the primary ignition source of wildfires in the region. Weather patterns from May through October are characterized by periods of drought separated by storms that produce dry forest fuels followed by frequent lightning strikes, a common source of ignitions. During the past two decades, fires caused by human activities were more frequent than those ignited by natural processes.

Long periods of drought are common during the summer and electrical storms are a common cause of wildfire. These types of storms are most frequent from May through October. Long periods of drought during the summer months also create challenges for wildfire responders. Many small rural communities lack the type of water systems that make water accessible for fire suppression. Instead fire fighters in these areas are often dependent on water from ponds, creeks, and rivers. Often in the mid- to late summer months, these sources are low or completely dry.

Wind direction changes to an easterly flow in early fall when landscapes are at their driest. These “east wind events” resemble the well-known Santa Anna winds of southern California that produce large, destructive wildfires.

Wildfires have played a significant role in shaping the species composition and forest structure in the region. Intensive fire suppression has resulted in forest fuel buildup and changes in species composition and structure in the past 60 years.

Coastal and Lower Columbia River counties are heavily timbered and have a long history of devastating forest fires. Some of the history is derived from Native Americans who recall extensive forest fires before the arrival of Euro-Americans. Fires involving the wildland interface occur in portions of the state where urbanization and natural vegetation fuels allow a fire to spread rapidly from natural fuels to structures and vice versa. Especially in the early stage of such fires, structural fire suppression resources can be quickly overwhelmed increasing the number of structures destroyed. Such fires are known for the large number of structures that are simultaneously exposed to fire, increasing the total losses per structure ignited. Nationally, wildland interface fires commonly produce widespread, extreme losses. Thus far, Oregon has escaped the level of property losses experienced by neighboring states.

Gorse, a spiny evergreen shrub, was introduced in south coastal Oregon from Europe. It has become an established invasive weed that displaces native vegetation, significantly altering the native vegetation patterns. Because Gorse is highly flammable, it increases wildfire risk wherever it spreads. Infestations of Gorse are particularly common along the coastal area; these areas are a major concern for wildfire managers.

Wildfire managers in the southern part of the region are also concerned with the spread of Port-Orford-Cedar root disease and Sudden Oak Death. Trees infected by these pathogens are at increased risk to wildfire and vegetation management activities need to be conducted in a way that minimizes the spread of disease pathogens. The Rogue River-Siskiyou National Forest, Bureau of Land Management, Oregon Department of Forestry, and Oregon State Parks have implemented actions to manage the spread of these pathogens.

Historic Wildfire Events

Table 2-107. Historic Wildfires in Region 1

Date	Name of Fire	Location	Characteristics	Remarks
1846	Yaquina	Lincoln and Lane Counties	> 450,000 acres	event related by Native American hunters
1853	Nestucca		> 320,000 acres	
1868	Coos Bay	Coos	296,000 acres	
1922	Astoria	downtown City of Astoria	many buildings (32 city blocks burned!)	early December structural fire most likely not related to wildfire
1933	Tillamook		240,000 acres	the Tillamook Forest burned every 6 years between 1933 and 1951; total acreage burned was over 350,000 acres; together, the four events are called the Tillamook Burn; dry forest conditions seems to have been a major factor (Taylor)
1936	Bandon		143,000 acres	
1939	Saddle Mountain	Clatsop County	207,000 acres	
1945	Wilson River / Salmonberry	Tillamook County	173,000 acres	
1951	North Fork / Elkhorn	Tillamook County	33,000 acres	
2002	Florence / Biscuit	Curry County	almost 500,000 acres (perimeter)	largest forest fire in Oregon since arrival of Euro-Americans; the perimeter contained many unburned islands within the overall acreage

Source: Brian Ballou, 2002, A Short History of Oregon Wildfires, Oregon Department of Forestry, unpublished; unknown sources from previous versions of the Oregon NHMP

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 1 will experience wildfire is shown in **Table 2-108**.

Table 2-108. Local Probability Assessment of Wildfire in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	H	M	H	M	L	H	M

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

The potential that wildland fires, both small and large, will threaten life, property and natural resources is a reality. Fire statistics show that fire incident rates, and therefore risks, are prevalent in the WUI areas. Population growth and development continue to encroach into and fragment forests. 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/recurrence estimates.

The probability of significant fire activity occurring in Region 1 is most likely during the late summer and early fall months when temperatures remain high, vegetation has had the entire summer to dry out and east winds are more prevalent coming out of the Columbia Gorge in the north and Chetco drainages in the south portions of the region.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to wildfire is shown in **Table 2-109**.

Table 2-109. Local Vulnerability Assessment of Wildfire in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	H	M	H	M	L	M	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Most counties within Region 1 have low to moderate risk from wildfire based primarily on cool, moist weather conditions. However, this region has had some of the largest wildfires that posed threats to communities when they occurred. The 1936 Bandon Fire is a prime example of a fire that, when combined with heavy fuels (gorse) and powerful dry east winds, an entire city was destroyed killing 13 people.

Gorse, brush, and timber still make up much of the landscape in Region 1. Given the right conditions, this region's vulnerability to wildfire exists. However, due to infrequent fire activity, the level of vulnerability can be categorized as moderate. A large wildfire in this region would affect local economies that rely on tourism and recreation dollars.

The economic stability of the region is dependent on a major state highway (US-101) that runs along the Oregon Coast. Should a major wildfire or other natural event (such as a tsunami) threaten or impact this major thoroughfare, coastal tourism and recreational economies would come to a halt.

Based on data from the 2013 West Wide Wildfire Risk Assessment, in Region 1, Douglas County has a high percentage of wildland acres subject to Fire Risk, Wildland Development Areas, and Fire Effects, making it especially vulnerable. Note: WWRA data does not differentiate between coastal and non-coastal Douglas County. Therefore, all of Douglas County is considered most vulnerable to wildfire.

In addition, each year a significant number of people build homes within or on the edge of the forest (urban-wildland interface), thereby increasing wildfire hazards. These communities have been designated "Wildland-Urban Interface Communities" and are listed in Table 2-110.

Table 2-110. Wildland-Urban Interface Communities in Region 1

Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook	
Arch Cape	Bandon	Agness	Gardiner	Dunes City	Depoe Bay	Bay City	Oceanside
Astoria	Charleston	Brookings	Reedsport	Florence	E. Lincoln Co.	Beaver	Oretown
Brownsmead	Coos Bay	Gold Beach	Winchester Bay	Mapleton	Elk City	Blaine	Pacific City
Cannon Beach	Coquille	Langlois		Swisshome	Lincoln City	Cape Meares	Pleasant Valley
Coastal Strip	Dora	Nesika Beach		Triangle Lake	Newport	Cloverdale	Rockaway
Elsie-Vinemaple	Fairview	Port Orford			Otter Rock	Foley Creek	Sandlake
Fern Hill	Green Acres				Rose Lodge	Garibaldi	Siskeyville
Ft. Clatsop	Lakeside				Seal Rock	Hebo	Tierra del Mar
Hamlet	Millington				Siletz	Hemlock	Tillamook
Hewell	Myrtle Point				Tidewater	Jordan Creek	Winema Beach
Knappa-Svensen	North Bend				Toledo	Lees Camp	Woods
Lewis and Clark	Powers				Waldport	Nehalem Bay	
Necanicum	Saunders Lake				Yachats	Neskowin	
Olney	Sumner					Netarts	
West Port							

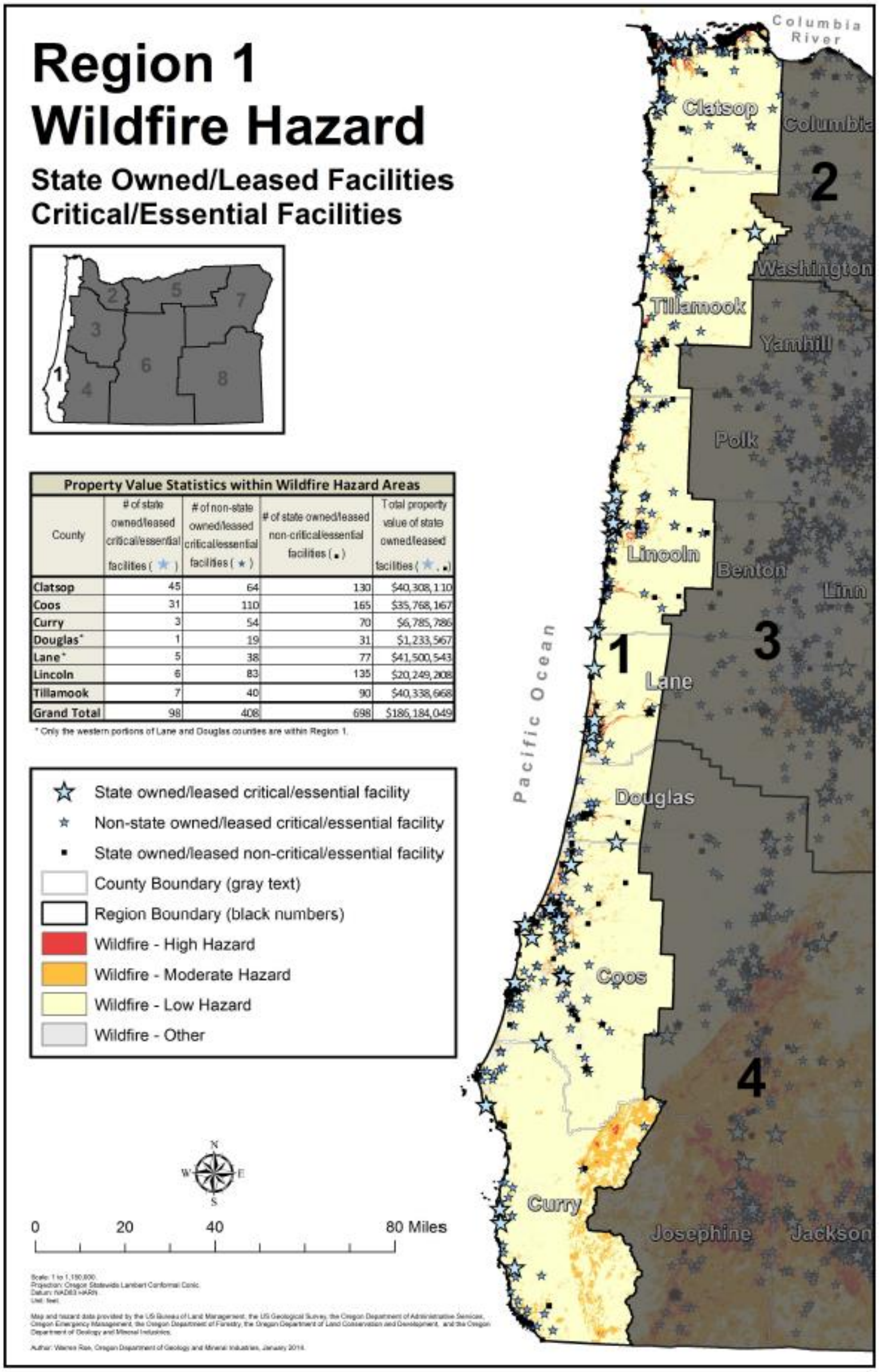
Source: Oregon Dept. of Forestry Statewide Forest Assessment September, 2006

State-Owned/Leased Facilities and Critical/Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, Oregon Vulnerabilities for more information.

Of the 5,693 state facilities evaluated, 796 are within a wildfire hazard zone in Region 1 and total about $186 million in value (Figure 2-100). Among those, 98 are state critical/essential facilities. An additional 408 non-state critical/essential facilities are located in a wildfire hazard zone in Region 1.

Figure 2-100. State-Owned/Leased Facilities and Critical/Essential Facilities in a Wildfire Zone in Region 1



Property Value Statistics within Wildfire Hazard Areas				
County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Clatsop	45	64	130	$40,308,110
Coos	31	110	165	$35,768,167
Curry	3	54	70	$6,785,786
Douglas*	1	19	31	$1,233,567
Lane*	5	38	77	$41,500,543
Lincoln	6	83	135	$20,249,208
Tillamook	7	40	90	$40,338,668
Grand Total	98	408	698	$186,184,049

Source: DOGAMI

Windstorms

Characteristics

High winds can be expected throughout Region 1, due to their coastal location. Destructive wind storms are less frequent, and their pattern is fairly well known. They form over the North Pacific during the cool months (October through March), move along the coast, and swing inland in a northeasterly direction. Wind speeds vary with the storms. Gusts exceeding 100 miles per hour have been recorded at several coastal locations (**Table 2-111**) but lessen as storms move inland. These storms, such as the Columbus Day Storm of October, 1962, can be very destructive. Less destructive storms can topple trees and power lines and cause building damage. Flooding can be an additional problem. A large percentage of Oregon's annual precipitation comes from these events (Taylor & Hatton [1999]; FEMA-1405-DR-OR, 2002YEAR, Reducing Windstorm Damage to Property and Electrical Utilities).

Tornadoes

Most people do not associate tornadoes with the State of Oregon, and certainly not in coastal areas. Nevertheless, tornadoes have occurred in Region 1. The first recorded tornado on the Oregon Coast occurred in 1897 (**Table 2-112**). They are characteristically brief and small, but also damaging.

Historic Windstorm Events

Table 2-111. Historic Windstorms in Region 1

Date	Location	Description	Remarks
Jan. 1880	western Oregon	very high winds, 65-80 mph near Portland	flying debris; fallen trees
Jan. 1921	Oregon coast / Lower Columbia	winds 113 mph at mouth of Columbia; gusts at Astoria, 130 mph	widespread damage
Apr. 1931	western Oregon	unofficial reports of wind speeds up to 78 mph	widespread damage
Nov. 1951	most of Oregon	winds 40–60 mph with 75–80 mph gusts	widespread damage, especially to transmission lines
Dec. 1951	most of Oregon	winds, 60–100 mph, strongest along coast	many damaged buildings; telephone/power lines down
Dec. 1955	western Oregon	wind gusts at North Bend 90 mph	significant damage to buildings and farms
Jan. 1956	western Oregon	heavy rains, high winds, mud slides	estimated damage: $95,000 (1956 dollars)
Nov. 1958	most of Oregon	wind gusts to 75 mph at Astoria; gusts to 131 mph at Hebo	damage to buildings and utility lines
Nov. 1962	statewide	wind speeds of 131 mph on the Oregon coast (Columbus Day Windstorm Event)	Oregon's most destructive storm: 23 fatalities; damage at $170 million
Mar. 1963	Coast and NW Oregon	100 mph gusts (unofficial)	widespread damage
Oct. 1967	western and N. Oregon	winds on Oregon Coast 100–115 mph	significant damage to buildings, agriculture, and timber
Mar. 1971	most of Oregon	notable damage in Newport	falling trees took out power lines; building damage

Date	Location	Description	Remarks
Jan. 1986	N and central Oregon coast	75 mph winds	damaged trees, buildings, power lines
Jan. 1987	Oregon coast	wind gusts to 96 mph at Cape Blanco	significant erosion (highways and beaches); several injuries
Dec. 1987	Oregon coast / NW Oregon	winds on coast 60 mph	saturated ground enabled winds to uproot trees
Mar. 1988	N. and central coast	wind gusts 55–75 mph	one fatality near Ecola State Park; uprooted trees
Jan. 1990	statewide	100 mph winds in Netarts and Oceanside	one fatality; damaged buildings; falling trees (FEMA-853-DR-Oregon)
Feb. 1990	Oregon coast	wind gusts of 53 mph at Netarts	damage to docks, piers, boats
Jan. 1991	most of Oregon	winds of 63 mph at Netarts; 57 at Seaside	75-foot trawler sank NW of Astoria
Nov. 1991	Oregon coast	slow-moving storm; 25-foot waves off shore	buildings, boats, damaged; transmission lines down
Jan. 1992	southwest Oregon	wind gusts of 110 mph at Brookings	widespread damage
Jan. 1993	Oregon coast / N. Oregon	Tillamook wind gusts at 98 mph	widespread damage, esp. Nehalem Valley
Dec. 1995	statewide	wind gusts over 100 mph; Sea Lion Caves: 119 mph; followed path of Columbus Day Storm (Dec. 1962)	four fatalities; many injuries; widespread damage (FEMA-1107-DR-Oregon)
Nov. 1997	western Oregon	winds of 89 mph at Florence; 80 mph at Netarts and Newport	severe beach erosion; trees toppled
Feb. 2002	SW Oregon	75–100 mph on the SW coast (Douglas, Coos, and Curry Counties)	widespread loss of electricity and damage to public utility infrastructure (FEMA-1405-DR-Oregon)
Apr. 2004	Lane County		$5,000 in property damage (figure includes damages outside of Lane County)
Dec. 2004	Lane County		$6,250 in property damage (figure includes damages outside of Lane County)
Dec. 2004	Lincoln County		$6,250 in property damage (figure includes damages outside of Lincoln County)
Dec. 2004	Tillamook County		$6,250 in property damage (figure includes damages outside of Tillamook County)
Dec. 2004	Clatsop County		$6,250 in property damage (figure includes damages outside of Clatsop County)
Jan. 2006	Clatsop, Tillamook, Lincoln, Lane Counties	two storm events with high winds of 86 mph and 103 mph	$244,444 and $144,444 in estimated property damage among all four coastal counties; the storm also impacted 5 other counties outside Region 1; total damages equal $300,000 and $200,000, respectively
Feb. 2006	Clatsop, Tillamook, Lincoln, Lane Counties	wind storm event with winds measured at 77 mph	$150,000 and $91,600 in estimated property damage among all four coastal counties; the storm also impacted nine other counties outside of Region 1; total damages equal $300,000 and $275,000

Date	Location	Description	Remarks
Mar. 2006	Clatsop, Tillamook, Lincoln, Lane Counties	two wind storm events with winds measured at 60 mph and 75 mph	$75,000 and $211,000 in estimated property damage among all four coastal counties; the storms also impacted 10 other counties outside of Region 1; total damages equal $75,000 and $475,000
Nov. 2006	Coos, Curry, Douglas Counties	storm with winds measured at 70 mph.	total of $10,000 in damages
Dec. 2006	Coos, Curry, Douglas Counties	storm with winds measured at 90 mph	total of $225,000 in estimated damages for Coos, Curry, and Douglas Counties; the storm also impacted Josephine County, leading to a total storm damage of $300,000
Dec. 2006	Clatsop, Tillamook Counties	storm with high winds	total of $10,000 in damages
Nov. 2007	Clatsop, Tillamook Counties	storm with high winds	total of $10,000 in damages
Dec. 2007	Clatsop, Tillamook Counties	series of powerful Pacific storms	resulted in Presidential Disaster Declaration; $180 million in damage in the state, power outages for several days, and five deaths attributed to the storm
Dec. 2008	Clatsop, Lane, Tillamook, Lincoln Counties	intense wind and rain events	resulted in nearly $8 million in estimated property and crop damages for Clatsop, Lane, Tillamook, and Lincoln Counties

Sources: Taylor and Hatton (1999); Hazards and Vulnerability Research Institute (2007); Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org

Table 2-112. Tornadoes Recorded in Region 1

Date	Location	Remarks
June 1897	Bay City, Oregon	observed, but no damage recorded
Oct. 1934	Clatskanie, Oregon	observed; no damage
Apr. 1960	Coquille, Oregon	accompanied by heavy rain; no damage
Nov. 1965	Rainier, Oregon	crossed Columbia River; two buildings damaged
Oct. 1966	Seaside, Oregon	windows broken, telephone lines down, outdoor signs destroyed
Oct, 1967	Near Astoria, Oregon airport	began over ocean and moved inland. Several homes and commercial buildings damaged
Dec, 1973	Newport, Oregon	some roof damage
Dec. 1975	Tillamook, Oregon	90 mph wind speed; damage to several buildings
Aug. 1978	Scappoose, Oregon	manufactured home destroyed; other damage
Mar. 1983	Brookings, Oregon	minor damage
Nov. 1984	Waldport, Oregon	damage to automobiles and roofs
Feb. 1994	Near Warrenton, Oregon	damage in local park
Nov. 2002	Curry County, Oregon	$500,000.00 in property damage
Nov. 2009	Lincoln County, Oregon	$35,000 in property damage, damage to homes and automobiles

Sources: National Weather Service, Portland; Taylor and Hatton (1999); National Climatic Data Center (2013) Storm Events Database, http://www.ncdc.noaa.gov/stormevents/; Hazards and Vulnerability Research Institute (2007); the Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org ; National Climatic Data Center (2013); U.S. Tornado Climatology, http://www.ncdc.noaa.gov/oa/climate/severeweather/tornadoes.html

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 1 will experience windstorms is shown in **Table 2-113**.

Table 2-113. Local Probability Assessment of Windstorm in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	H	H	H	H	H	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

High winds occur yearly in Region 1. The 100-year event is considered to be a storm with 1-minute average winds of 90 miles per hour. A 50-year event has average winds of 80 mph, and a 25-year event has winds of 75 miles per hour.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to windstorm is shown in **Table 2-114**.

Table 2-114. Local Vulnerability Assessment of Windstorm in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	H	H	H	M	H	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Many buildings, utilities, and transportation systems within Region 1 are vulnerable to wind damage. This is especially true in open areas, such as along the Oregon Coast, natural grasslands, or farmland. It also is 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. All the coastal counties are most vulnerable to windstorm damage.

Oregon's history of wind damage underscores the need for a comprehensive wind-hazard mitigation program. The necessity of such an action is partly supported in an after-action report focusing on western Oregon's high-wind event of February 7, 2002 (Hazard Mitigation Survey Team Report, FEMA-1405-DR-OR). Other historic events (e.g., 1962 Columbus Day Storm) provide additional insights.

Structures most vulnerable to high winds in Region 1 include insufficiently-anchored manufactured homes and older buildings in need of roof repair. Section 307 of the Oregon Building Code identifies high-wind areas along the Oregon Coast and sets anchoring standards for manufactured homes located in those areas. It is essential that coastal counties ensure that the standards are enforced. The Oregon Department of Administrative Service's inventory of state-owned and operated buildings includes an assessment of roof conditions as well as the overall condition of the structure.

Fallen trees are especially troublesome. They can block roads and rails for long periods, which can affect emergency operations. In addition, uprooted or shattered trees can down power and/or utility lines, effectively bringing local economic activity and other essential activities to a standstill. Much of the problem may be attributed to a shallow or weakened root system in saturated ground. Many roofs have been destroyed by uprooted ancient trees growing next to a house. In some situations, strategic pruning may be the answer. Prudent counties will work with utility companies to identify problem areas and establish a tree maintenance and removal program.

Tree-lined coastal roads and highways present a special problem. This is because much of the traveling public enjoys the beauty of forested corridors and most certainly would be concerned with any sort of tree removal program. In short, any safety program involving tree removal must be convincing, minimal, and involve a variety of stakeholders.

Wind-driven waves are common along the Oregon coast and are responsible for road and highway wash-outs and the erosion of beaches and headlands. These problems are addressed in the Flood section of this regional analysis. Unlike Oregon's Willamette Valley (Regions 2 and 3), there are no water-borne ferry systems in Region 1 whose operations would be affected by high winds. Bridges spanning bays or the lower Columbia River would be closed during high-wind periods.

Winter Storms

Characteristics

Severe winter weather in Region 1 is characterized by extreme cold, snow, ice, and sleet. Snow and ice are less common in the coastal regions, but often bring flooding after snow melts. Flooding is where the problem begins. See the **Flood** section in this regional analysis for more about flooding along the Oregon Coast.

Historic Winter Storm Events

Table 2-115. Historic Winter Storms in Region 1

Date	Location	Description
Jan. 1998	Clatsop County	trees and large tree limbs were knocked down causing widespread power outages; citizens urged to stay home; 3 known fatalities
Jan. 2002	statewide	strong winter storm with high winds at coast and heavy snows to the inland areas of Northwest Oregon; Florence had 46 mph sustained winds and 36 mph gusts to 63 mph, Newport Jetty 39 mph with gusts to 53 mph, and Garibaldi 42 mph; 32 inches of snow at Timberline Lodge on Mount Hood and 30 inches at Santiam Pass
Jan. 2004	statewide	frigid arctic air mass, heavy snow, sleet and freezing rain; weight from the snow and ice buildup resulted in widespread downed trees and power lines, leaving 46,000 customers without power, and collapsed roofs; Oregon Governor Kulongoski estimated cost of damages to public property at $16 million
Dec. 2008	northern Oregon coast	third unusually cold storm system that season with heavy snow in northwest Oregon; heavy snowfall across northwest Oregon; 11–24 inches of snow in the north Oregon Coast Range

Source: National Weather Service

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 1 will experience winter storms is shown in **Table 2-116**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—).

Table 2-116. Local Probability Assessment of Winter Storms in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	H	H	—	H	L	—	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

On the basis of historical data, severe winter storms could occur about every 4 years in Region 1. We can expect to have continued annual storm events in this region. However, there are no solid statistical data available upon which to base these judgments. There is no statewide program to study the past, present, and potential impacts of winter storms in the state of Oregon at this time.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to winter storms is shown in **Table 2-117**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—).

Table 2-117. Local Vulnerability Assessment of Winter Storms in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	H	H	—	M	L	—	H

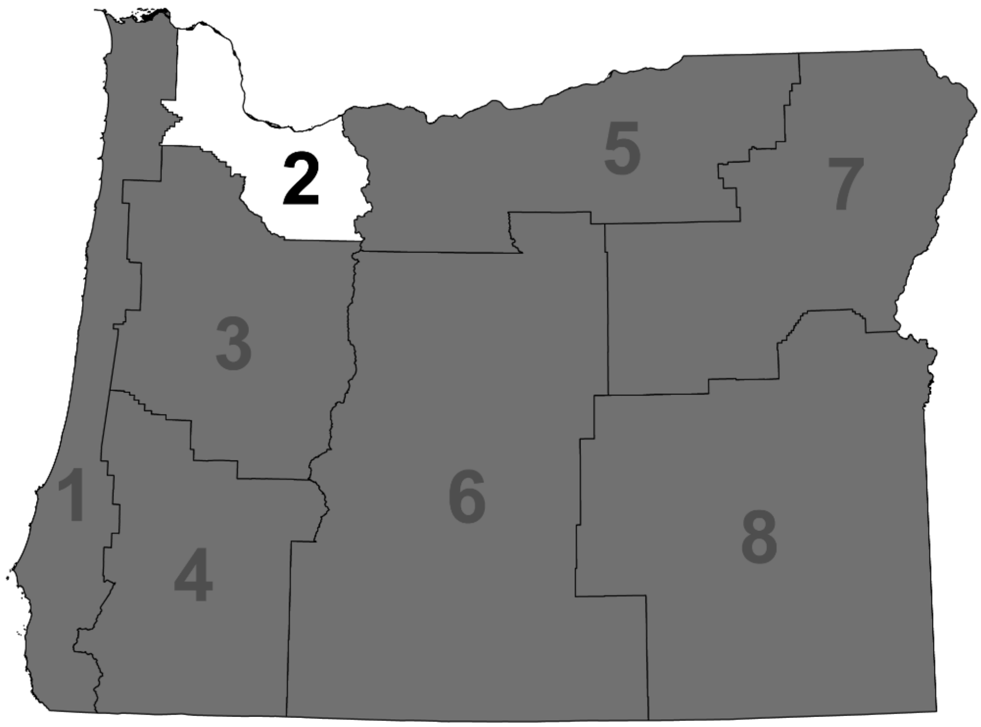
Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Severe winter weather in Region 1 is characterized by extreme cold, snow, ice, and sleet. These conditions bring widespread power outages and road closures due to downed trees from the heavy ice. These events close roads and isolate communities. Due to the logistics of the coastal regions many of the communities may become isolated due to winter storms. Countywide road closures can cause considerable travel delays. Communities in Region 1 that may be impacted by severe winter storms include Astoria, Cannon Beach, Rockaway Beach, Oceanside, Lincoln City, Depot Bay and Newport.

2.3.2 Region 2: Northern Willamette Valley / Portland Metro

Clackamas, Columbia, Multnomah, and Washington Counties



2.3.2.1 Summary

Profile

The region's demographic, economic, infrastructure, and development patterns indicate that some populations, structures, and places may be more vulnerable to certain natural hazards than others. Mitigation efforts directed at these vulnerabilities may help boost the area's ability to bounce back after a natural disaster.

Regionally, social vulnerability is driven by a high number of tourists who are likely not familiar with the hazard types and level of risk in the region. At the county level, high numbers of disabled persons in Multnomah County; a dramatic increase in the homeless population in Clackamas County; and higher numbers of renters and of persons who do not speak English "very well" in Multnomah and Washington Counties increase the level of risk to these populations. Columbia County's low incomes and high poverty rates make it especially vulnerable to heightened economic hardship that often follows a hazard event.

Compared to other areas of the state, communities around the Portland Metro area weathered the financial crisis that began in 2007 due to the diversity of key industries, employment sectors, and higher wages than the state average. The region's resilience is bolstered by strong Professional and Business Services, Health and Social Assistance, and Government sectors, which have low vulnerability to natural disasters and are key to post-disaster recovery efforts. Columbia County's economy is struggling the most, with higher unemployment and lower wages.

Transportation networks across the state are vulnerable to natural hazard events, especially seismic events. Following a Cascadia earthquake event, access across the Willamette River and along I-5 may be limited due to bridge collapse. The region has two ports with facilities, including the Portland International Airport, that are key to the statewide economy and are vulnerable to disruptions in service that can impact the transport of people, goods, and emergency services.

Older centralized water infrastructure is vulnerable to flooding and pollution. Upstream pollution in the Willamette and Columbia Rivers threaten ecosystems and public health.

Eight power-generating facilities and many dams — including Bonneville Power Administration's main dam, the Bonneville Dam — are in this region. Additionally, the site of Oregon's Critical Energy Infrastructure Hub, located in Portland, is subject to seismically induced liquefaction, making it exceptionally vulnerable to a Cascadia earthquake. Disruption or failure to these systems could be devastating to the region and state.

Region 2 is developing at a slightly faster pace than the rest of the state. The majority of growth is occurring in urban areas surrounding Portland. Over half the homes in Multnomah County were built prior to current seismic and floodplain management standards, making them particularly vulnerable to seismic and flood events.

Hazards and Vulnerability

Region 2 is affected by eight of the 11 natural hazards that affect Oregon communities. Coastal hazards, dust storms, and tsunami do not directly impact this region.

Droughts: The region is affected by droughts to a lesser extent than other areas in the state. Moderate-type drought years have occurred in Region 2 more than a dozen times between 1939 and 2001.

Earthquakes: Four types of earthquakes affect Region 2 (a) shallow crustal events, (b) deep intra-plate events within the subducting Juan de Fuca plate, (c) the offshore Cascadia Subduction Zone (CSZ) Fault, and (d) earthquakes associated with renewed volcanic activity. The CSZ is the chief earthquake hazard for the Northern Willamette Valley. The region is particularly vulnerable to earthquakes due to the amount of area that is susceptible to earthquake-induced landslide, liquefaction, and ground shaking. Region 2 is home to the majority of the state's population, employment, and built environment. A CSZ event will dramatically impact the region's critical infrastructure, including seismic lifelines along Interstate-5 and Oregon's Critical Energy Hub in North Portland. There are 849 state-owned/leased facilities, valued at over $1 billion, in Region 2's earthquake hazard zone. Of these, 120 are critical/essential facilities. An additional 2,675 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Floods: All counties in the Northern Willamette Valley are affected by riverine flooding. Rain-on-snow events and heavy rain events leading to tributary backups are common in this region. Clackamas and Columbia Counties are most vulnerable to flooding events. Region 2 has the second highest number of repetitive flood losses in the state (which is one third of all losses statewide), of which four are severe repetitive losses. Many of these are along the Columbia River where high rainfall impacts high population density. Following floods in 1996 and 2007, elevation and acquisition projects initiated by the City of Vernonia helped reduce flood risk in Columbia County. There are 51 state-owned/leased facilities, valued at approximately $25.4 million, located in the region's flood hazard zone. Of these, two are considered critical/essential facilities. In addition, 56 non-state-owned/leased critical/essential facilities are located in this hazard zone.

Landslides: Landslides can occur throughout the region, though more tend to occur in areas with steeper slopes, weaker geology, and higher annual precipitation. Rain-induced landslides can occur during winter months, and earthquakes can trigger landslides. Vulnerability is increased in populated areas such as the Portland Metro Area and in the Coast and Cascade Mountain Ranges. In general, the counties of Washington, Multnomah, and Clackamas have relatively high vulnerability. There are 848 state-owned/leased facilities, valued at over $1 billion, in Region 2's earthquake hazard zone. Of these, 120 are critical/essential facilities. An additional 2,675 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Volcanoes: The region can be impacted by volcanic activity, particularly within parts of eastern Clackamas and Multnomah Counties (including Portland) that coincide with the crest of the Cascade Mountain Range. Most volcanic activity is considered local. However, some activity, such as lahars and ashfall, can travel many miles and could impact the communities of Government Camp, Rhododendron, and Welches. There are 220 state-owned/leased facilities, valued at approximately $73.7 million, located in a volcanic hazard zone. Of these, 17 are identified as critical/essential facilities. In addition, 601 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Wildfires: The region's vulnerability to wildfire is moderate at best. Wildfires are most common during the late summer. The areas of greatest vulnerability are within the wildland-urban interface communities. Much of the risk to wildfire in Region 2 is mitigated by large expanses of urban development and quick response times. There are 234 state-owned/leased facilities, valued at approximately $115 million, located in a wildfire hazard zone. Of these, 18 are identified as critical/essential facilities. In addition, 380 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Windstorms: Windstorms affect the region annually. The most frequent and strongest originate in the Pacific Ocean and travel southwest. Columbia, Multnomah, and Washington Counties are most vulnerable to these types of storms. To a lesser degree, eastern winds traveling through the Columbia River Gorge also affect Region 2 communities. Windstorms can impact the region's buildings, utilities, tree-lined roads, transmission lines, residential parcels, and transportation systems along open areas such as grasslands and farmland.

Winter Storms: Winter storms occur annually. The Columbia River Gorge can bring colder weather, higher precipitation, and high westerly winds to the region causing severe weather for short periods of time. Because these storms are infrequent and short lived, communities including the Portland Metro Area are often unprepared for them.

Climate Change

The most reliable information on climate change to date is at the state level. The state information indicates that hazards projected to be impacted by climate change in Region 2 include drought, wildfire, flooding, and landslides. Climate models project warmer drier summers and a decline in mean summer precipitation for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, all eight regions are expected to be affected by an increased incidence of drought and wildfire. In addition, flooding and landslides are projected to occur more frequently throughout western Oregon. An increase in extreme precipitation is projected for some areas of Region 2 and can result in a greater risk of flooding in certain basins, including an increased incidence of magnitude and return interval. Landslides in Oregon are strongly correlated with rainfall, so increased rainfall — particularly extreme events — will likely trigger increased landslides. While winter storms and windstorms affect Region 2, there is little research on how climate change influences these hazards in the Pacific Northwest. For more information on climate drivers and the projected impacts of climate change in Oregon, see the section **Introduction to Climate Change**.

2.3.2.2 Profile

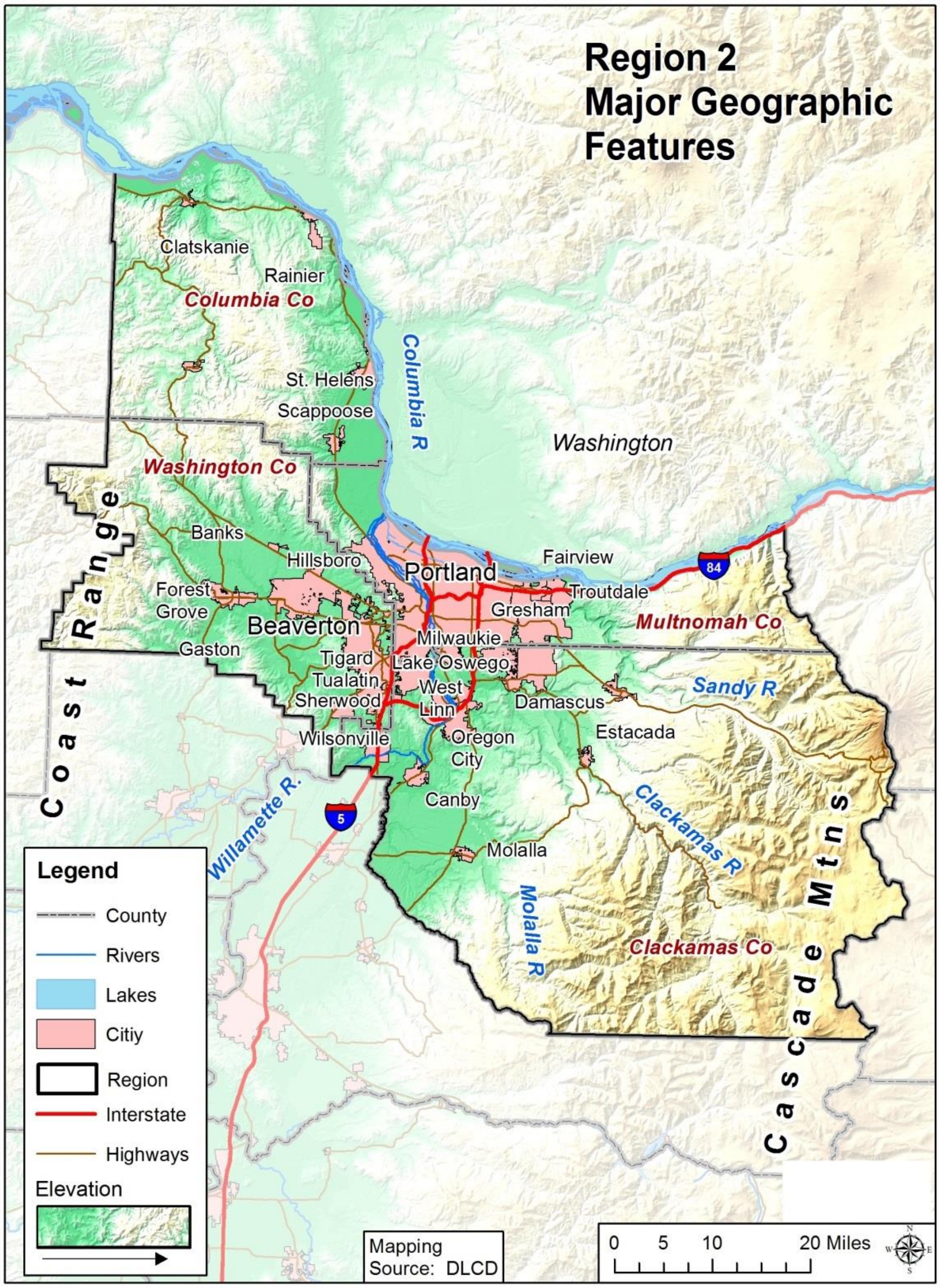
Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

Natural Environment

Geography

The Northern Willamette Valley and Portland Metro Area is approximately 3,758 square miles in size, and includes Clackamas, Columbia, Multnomah, and Washington Counties. Mountain ranges and watersheds shape the region's topography. Region 2 begins at the Cascade Mountain Range in the east and extends westward through the Willamette Valley and into the Coast Range and southward from the Columbia River in the North to the Mid-Willamette Valley. Two rivers shape the region's main watersheds, the Columbia River and the Willamette River. **Figure 2-101** shows the dominant mountain ranges, major watersheds, and political boundaries of Region 2.

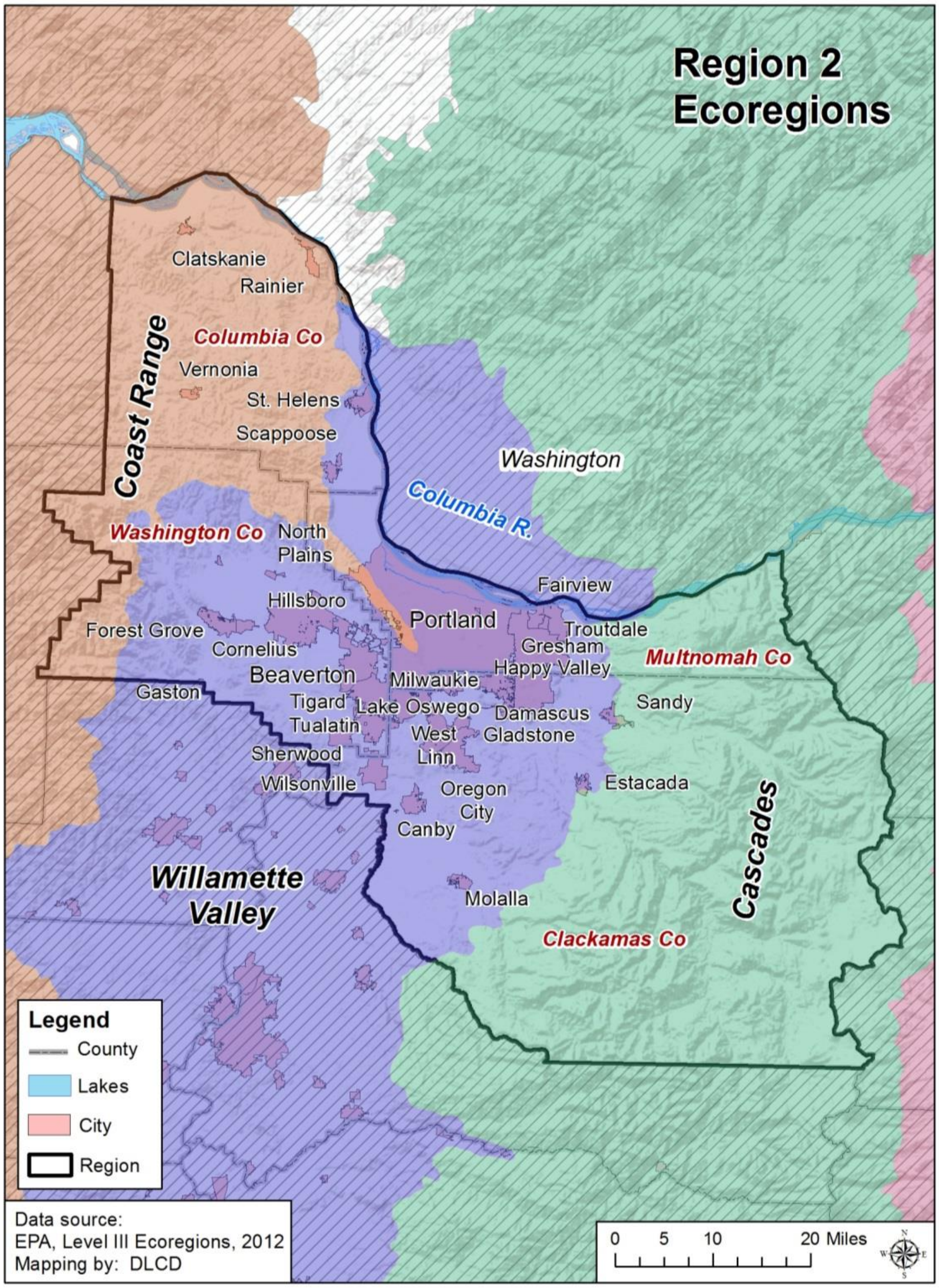
Figure 2-101. Region 2 Major Geographic Features



Source: Department of Land Conservation and Development, 2014

The U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Region 2 is composed of three ecoregions: the Coast Range, the Willamette Valley, and the Cascades (**Figure 2-102**).

Figure 2-102. Region 2 Ecoregions



Cascades: Soil in this ecoregion is volcanic. Mixed conifer forests have given way to predominantly Douglas fir forests that are managed for commercial logging. Logging activities have put a strain on the ecological health of streams in the area (Thorson et al., 2003). Waterways in the steeper valleys support threatened cold-water salmonids including Chinook salmon, steelhead, and bull trout. Streams, lakes, reservoirs, rivers, and glacial lakes at higher elevations are key sources of water (Thorson et al., 2003).

Willamette Valley: Terraces and floodplains dominate the nearly flat central Willamette Valley. The valley floor is dotted with scattered hills, buttes, and bordered by the adjacent foothills. Historically, valley waterways meandered throughout floodplains on the nearly flat valley floor, contributing to the valley's highly fertile soil and supporting the dominance of oak savannah and prairie ecosystems. Today the Willamette River and its tributaries are highly channelized, restricting the flow of these waterways, helping protect property but also threatening stream health. The productive soils and temperate climate make this ecoregion one of the most important agricultural areas in Oregon. The valley's flat terraces have made urban and suburban development possible in the valley (Thorson et al., 2003).

Coast Range: The east slope of the Coast Range is located within Region 2. Soils are a mix of sedimentary and volcanic composition. Sedimentary soils can create more concerns for stream sedimentation than areas with volcanic soils (Thorson et al., 2003). Volcanic soils are underlain by basaltic rocks resulting in more consistent summer stream flows. This soil composition supports runs of spring Chinook salmon and summer steelhead. On the other hand, sedimentary soils are prone to failure following clear cuts. This may be of concern as the commercial Douglas fir forests are highly productive commercial logging areas.

Climate

This section covers historic climate information only. For estimated future climate conditions and possible impacts refer to the **State Risk Assessment**.

Variations in temperature and precipitation vary widely by sub-ecoregion and microclimate. Precipitation generally occurs in the winter months. Wet winters and dry summers increase risk to droughts, floods, landslides, wildfires, and winter storms. For more detailed and locally relevant climate data refer to the Oregon Climate Service.

Table 2-118. Average Precipitation and Temperature Ranges in Region 2 Ecoregions

Ecoregion	Mean Annual Precipitation Range (inches)	Mean Temperature Range (°F) January min/max	Mean Temperature Range (°F) July min/max
Cascades*	55–140	16/41	38/78
Willamette Valley*	37–60	32/46	50/85
Coast Range*	50–200	30/46	50/76

*Data have been generalized from all the sub-ecoregions of the ecoregion in Region 2.

Source: Thorson et al. (2003)

Demography

Population

Population forecasts are an indicator of future development needs and trends. Community demographics may indicate where specific vulnerabilities may be present in the aftermath of a natural hazard (Cutter et al., 2003). If a population is forecast to increase substantially, a community's capacity to provide adequate housing stock, services, or resources for all populations post disaster may be stressed or compromised.

Overall, from 2000 to 2013, Region 2 grew at about the same rate as the state. The exception is Washington County, which grew almost most 10% more than the rest of the region. By 2020, all counties in Region 2 except Multnomah are projected to grow at a rate greater than the state.

Table 2-119. Population Estimate and Forecast for Region 2

	2000	2013	Percent Change (2000 to 2013)	2020 Projected	Percent Change (2013 to 2020)
Oregon	3,421,399	3,919,020	14.5%	4,252,100	8.5%
Region 2	1,487,779	1,743,450	17.2%	1,906,659	9.4%
Clackamas	338,391	386,080	14.1%	422,576	9.5%
Columbia	43,560	49,850	14.4%	54,517	9.4%
Multnomah	660,486	756,530	14.5%	807,198	6.7%
Washington	445,342	550,990	23.7%	622,368	13.0%

Source: Population Research Center, Portland State University, 2013; U.S. Census Bureau, 2010 Decennial Census. Table DP-1; Office of Economic Analysis, Long-Term Oregon State's County Population Forecast, 2010-2050, 2013

Tourists

Tourists are not counted in population statistics and are therefore considered separately in this analysis. Tourism activities in Region 2 are largely centered on special events (such as fairs, festivals or sporting events), city trips, and touring (traveling to experience scenic beauty, history and culture) (Longwoods International, 2011). Thirty percent of all overnight trips in Oregon included time in the Northern Willamette Valley/Portland Metro area. The average travel party contains 3.4 persons and 68% of these trips originate from Oregon or California. The average trip length is 3.5 nights (Longwoods International, 2011). In 2013, over 70% of visitors in Clackamas, Columbia, and Washington Counties lodged in private homes.

Difficulty locating or accounting for travelers increases their vulnerability in the event of a natural disaster. Furthermore, tourists are often unfamiliar with evacuation routes, communication outlets, or even the type of hazard that may occur (MDC Consultants, n.d.). Targeting natural hazard mitigation outreach efforts to places where tourists lodge can help increase awareness and minimize the vulnerability of this population.

Table 2-120. Annual Visitor Estimates in Person Nights in Region 2

	2011		2012		2013	
	Number	Percent	Number	Percent	Number	Percent
Region 2	25,731	—	26,367	—	26,780	—
Clackamas	6,626	100%	6,832	100%	6,828	100%
Hotel/Motel	1,205	18.2%	1,279	18.7%	1,292	18.9%
Private Home	4,849	73.2%	4,974	72.8%	4,948	72.5%
Other	572	8.6%	579	8.5%	588	8.6%
Columbia	627	100%	622	100%	622	100%
Hotel/Motel	51	8.1%	43	6.9%	38	6.1%
Private Home	496	79.1%	493	79.3%	493	79.3%
Other	80	12.8%	86	13.8%	91	14.6%
Multnomah	10,996	100%	11,475	100%	11,686	100%
Hotel/Motel	5,440	49.5%	5,785	50.4%	5,979	51.2%
Private Home	5,127	46.6%	5,251	45.8%	5,262	45.0%
Other	429	3.9%	439	3.8%	445	3.8%
Washington	7,482	100%	7,438	100%	7,644	100%
Hotel/Motel	1,693	22.6%	1,682	22.6%	1,769	23.1%
Private Home	5,640	75.4%	5,604	75.3%	5,721	74.8%
Other	149	2.0%	152	2.0%	154	2.0%

Source: Oregon Travel Impacts: 1991–2013, April 2014. Dean Runyan Associates, http://www.deanrunyan.com/doc_library/ORImp.pdf

Persons with Disabilities

Disabilities appear in many forms. While some disabilities may be easily identified, others may be less perceptible. Disabled populations, while difficult to identify and measure, are disproportionately affected during disasters (Cutter et al., 2003). While somewhat fewer people in Region 2 identify as having a disability than do people throughout the state, 46% of those who consider themselves to have a disability live in Multnomah County. Local natural hazard mitigation plans should specifically target outreach programs toward helping disabled residents better prepare for and recover from hazard events.

Table 2-121. People with a Disability by Age Group in Region 2, 2012

	Total Population*	With a Disability (Total Population)		Under 18 Years with a Disability		65 Years and Over with a Disability	
	Estimate	Estimate	Percent	Estimate	Percent**	Estimate	Percent**
Oregon	3,796,881	511,297	13.5%	39,439	4.6%	200,374	37.8%
Region 2	1,683,829	184,388	11.0%	15,218	3.9%	68,586	36.4%
Clackamas	375,412	42,579	11.3%	3,849	4.3%	17,787	34.6%
Columbia	49,072	6,968	14.2%	546	4.7%	2,600	38.1%
Multnomah	730,762	85,534	11.7%	6222	4.1%	29,888	39.1%
Washington	528,583	49,307	9.3%	4,601	3.4%	18,311	34.3%

*Total population does not include institutionalized population.

**Percent of age group.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Homeless Population

Population estimates of the homeless in Oregon are performed each January. These are rough estimates and can fluctuate with many factors, including the economy or season. The overwhelming majority of homeless people are either single adult males or families with children. Communities located along major transportation corridors, such as I-5, tend to have higher concentrations of homeless people (Thomas et al., 2008). This population has increased in the region by roughly 30% from 2009 to 2011. The greatest increase, roughly 163%, in homeless populations in the Northern Willamette Valley and Portland Metro Area has taken place in Clackamas County.

Extra attention is needed to care for and serve homeless communities**.** Some homeless people choose to remain hidden or anonymous, making it especially difficult to mitigate harm to them from natural hazard events. Accessible shelter and social services are key emergency considerations for the homeless community.

Table 2-122. Homeless Population Estimate for Region 2

	2009	2010	2011	3-Year Average
Oregon	17,122	19,208	22,116	19,482
Region 2	6,440	5,132	9,439	7,004
Clackamas	168	208	2,741	1,039
Columbia	256	342	285	294
Multnomah	4,808	3,199	5,059	4,355
Washington	1,208	1,383	1,354	1,315

Source: Oregon Point in Time Homeless Count, Oregon Housing and Community Services. http://www.oregon.gov/ohcs/pages/ra_point_in_time_homeless_count.aspx

Gender

The gender breakdown in Region 2 is similar to that of the state, roughly 50:50 (U.S. Census Bureau, 2010, American Community Survey, Table DP-1). 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 (Cutter et al., 2003).

Age

The region's percentage of seniors is slightly lower than the state. Senior citizens may require special consideration due to sensitivity to heat and cold, reliance upon transportation to obtain medication, and comparative difficulty in making home modifications that reduce risk to hazards. In addition, the elderly may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to elderly (Morrow, 1999).

The region's percentage of children is similar to the statewide percentage. Special consideration should be given to young children, schools, and parents during the natural hazard mitigation process. Young children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities. Parents may lose time and money when their children's childcare facilities and schools are impacted by disasters.

Table 2-123. Population by Vulnerable Age Groups in Region 2, 2012

	Total Population	Under 18 Years Old		65 Years and Older	
	Estimate	Estimate	Percent	Estimate	Percent
Oregon	3,836,628	864,243	22.5%	540,527	14.1%
Region 2	1,695,451	386,620	22.8%	191,947	11.3%
Clackamas	377,206	88,732	23.5%	52,187	13.8%
Columbia	49,317	11,704	23.7%	6,926	14.0%
Multnomah	737,110	150,824	20.5%	78,778	10.7%
Washington	531,818	135,360	25.5%	54,056	10.2%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP05, http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml

Language

Special consideration in hazard mitigation should be given to populations who do not speak English as their primary language. These populations can be harder to reach with outreach materials. They are less likely to be prepared if special attention is not given to language and culturally appropriate outreach techniques. In the region, Multnomah and Washington Counties have the highest percentages of residents who do not speak English very well. Outreach materials used to communicate with and plan for this community should take into consideration their language needs.

Table 2-124. English Usage in Region 2, 2012

	Speak English "Very Well"		Speak English Less Than "Very Well"	
	Estimate	Percent	Estimate	Percent
Oregon	3,376,744	93.8%	224,905	6.2%
Region 2	1,458,376	91.9%	128,981	8.1%
Clackamas	339,863	95.5%	16,163	4.5%
Columbia	46,006	98.9%	528	1.1%
Multnomah	626,678	90.7%	64,290	9.3%
Washington	445,829	90.3%	48,000	9.7%

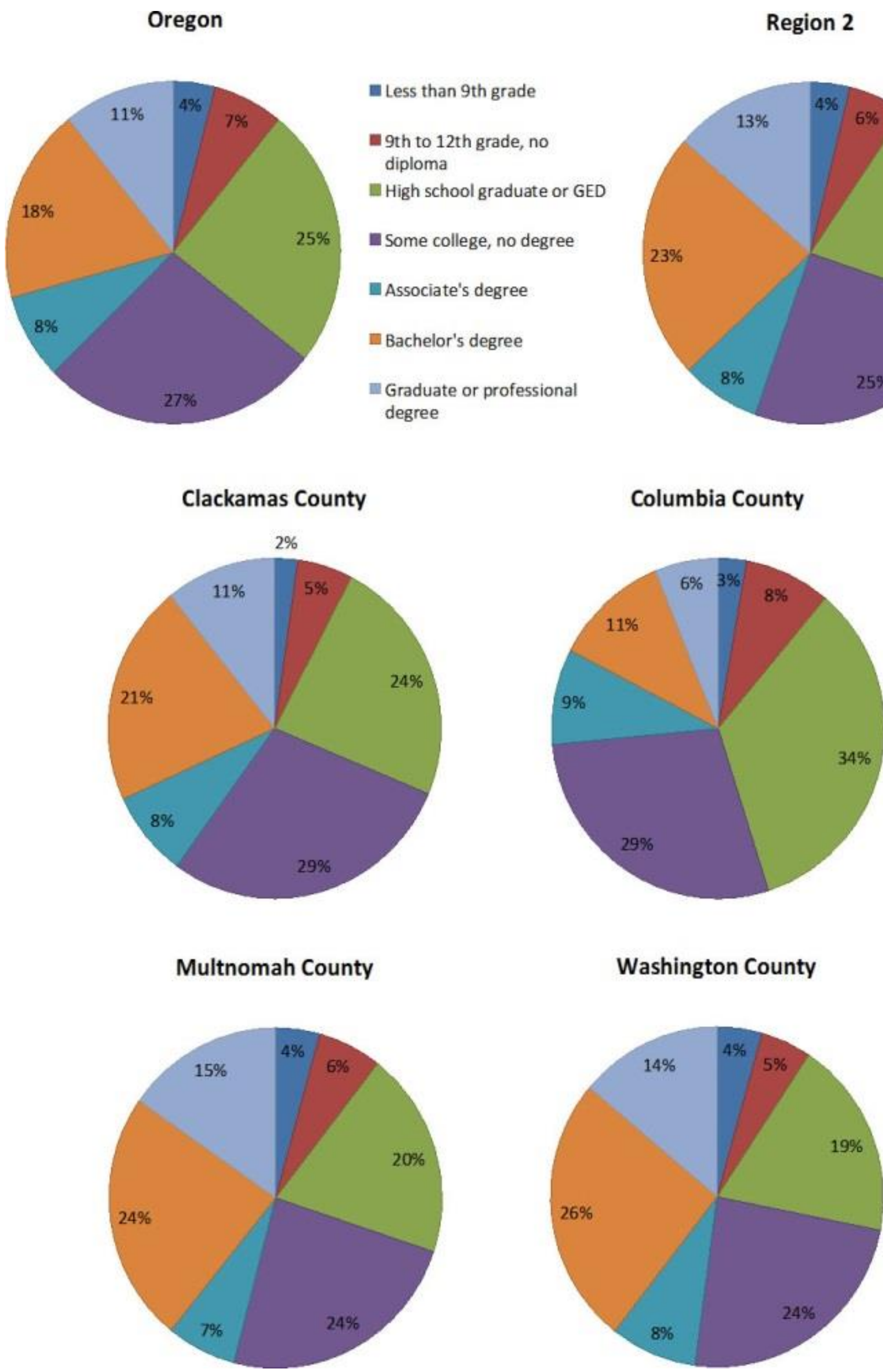
Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02, http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml

Education Level

Studies (Cutter et al., 2003) show that education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings. Furthermore, education can influence the ability to understand warning information (Cutter et al., 2003) and to access hazard resources.

There is a higher percentage of bachelor's and graduate or professional degrees in the Northern Willamette Valley and Portland Metro Area compared to statewide numbers (**Figure 2-103**). There is a lower percentage of people with only a high school degree or GED.

Figure 2-103. Educational Attainment in Region 2, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Income

The impact of a disaster in terms of loss and the ability to recover varies among population groups. "The causes of social vulnerability are explained by the underlying social conditions that are often quite remote from the initiating hazard or disaster event" (Cutter, 2006, p. 76). Historically, 80% of the disaster burden falls on the public. Of this number, a disproportionate burden is placed upon those living in poverty. People living in poverty are more likely to be isolated, are less likely to have the savings to rebuild after a disaster, and less likely to have access to transportation and medical care.

The recent financial crisis that began in 2007 moderately affected Region 2. Overall, median household incomes in the region are between $5,000 and $14,000 above those for the state, except in Multnomah County where they are only about $1,000 more than statewide numbers. Between 2009 and 2012, the greatest percent decrease in median household incomes occurred in Columbia County, falling by 9% — dropping by roughly 2 times median household incomes statewide.

Table 2-125. Median Household Income in Region 2

	2009	2012	Percent Change
Oregon	$52,474	$50,036	-4.6%
Region 2	N/A	N/A	N/A
Clackamas	$66,383	$63,951	-3.7%
Columbia	$60,897	$55,358	-9.1%
Multnomah	$52,622	$51,582	-2.0%
Washington	$66,585	$64,375	-3.3%

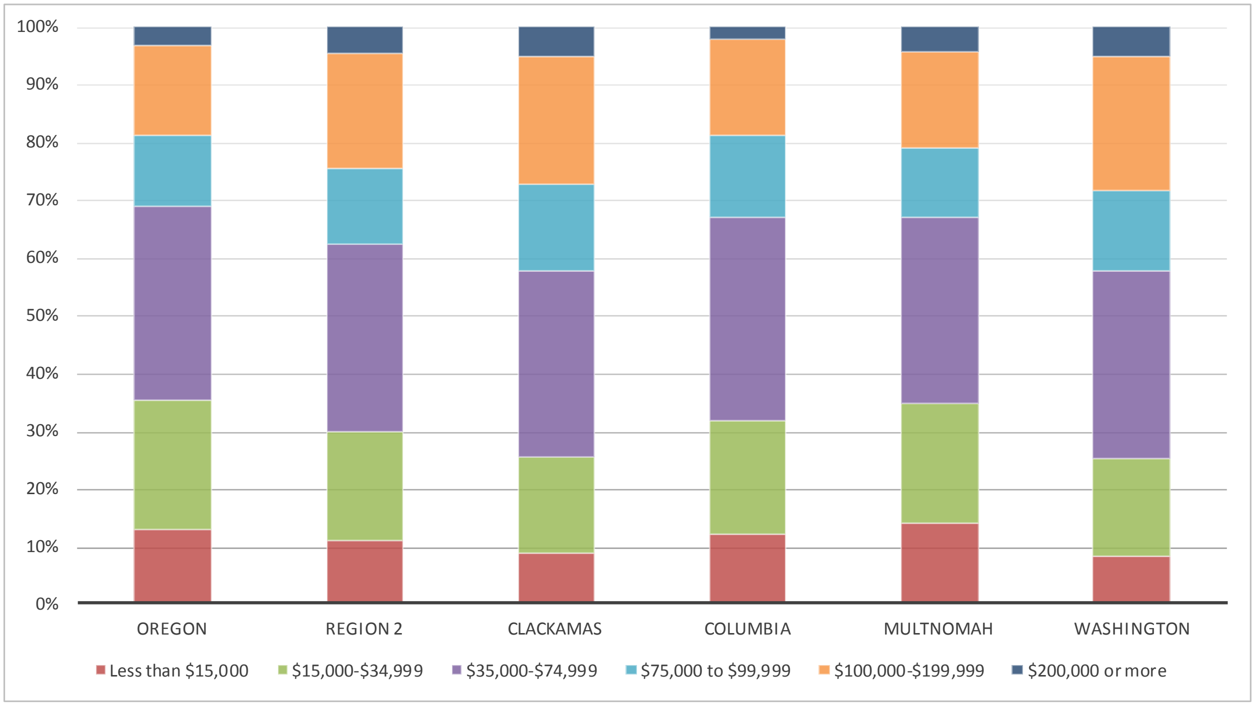
Note: 2009 dollars are adjusted for 2012 using Bureau of Labor Statistics' Consumer Price Index Inflation Calculator.

N/A = data not aggregated at the regional level.

Source: U.S. Census Bureau, 2005–2009 and 2008–2012 American Community Survey – 5-Year Estimates, Table DP03

The region has a smaller percentage of households earning less than $35,000 per year than the state as a whole. Clackamas and Washington Counties have the largest percentages of households earning more than $75,000 per year.

Figure 2-104. Median Household Income Distribution in Region 2, 2012



Source: U.S. Census Bureau; 2008–2012 American Community Survey 5-Year Estimates, Table DP03

The region has 2% fewer individuals and 3% fewer children living in poverty than the statewide average. Multnomah County has the highest percentage of its population living in poverty. However, the most dramatic increase in poverty rates has been in Columbia County with an almost 59% increase in overall poverty, including an 86% increase in child poverty.

Table 2-126. Poverty Rates in Region 2, 2012

	Total Population in Poverty			Children Under 18 in Poverty		
	Number	Percent	Percent Change*	Number	Percent	Percent Change*
Oregon	584,059	15.5%	17.7%	175,303	20.6%	17.6%
Region 2	223,962	13.4%	15.6%	66,738	17.5%	14.4%
Clackamas	36,265	9.7%	9.2%	11,161	12.7%	9.0%
Columbia	6,797	13.9%	58.7%	2,257	19.6%	86.2%
Multnomah	123,434	17.1%	16.3%	34,231	23.1%	13.5%
Washington	57,466	10.9%	14.7%	19,089	14.3%	14.2%

*Percent change since 2009

Source: U.S. Census Bureau, 2005–2009 and 2008–2012 American Community Survey – 5-Year Estimates, Table S1701

Low-income populations require special consideration when mitigating loss to a natural hazard. Often, those who earn less have little to no savings and other assets to withstand economic setbacks. When a natural disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the natural disaster. To reduce the compounded loss incurred by low-income populations post-disaster, mitigation actions need to be specially tailored to ensure safety nets are in place to provide further support to those with fewer personal resources.

Housing Tenure

Wealth can increase the ability to recover from a natural disaster (Cutter et al., 2003), and homeownership, versus renting, is often linked to having more wealth. Renters often do not have personal financial resources or insurance to help recover post-disaster. Further, renters are typically not in a position to be able to decide to and make substantive improvements such as seismic retrofits to their residences. On the other hand, renters tend to be more mobile and have fewer assets at risk. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable due to natural disaster events.

Compared to the state overall, Multnomah and Washington Counties have a higher share of rental units. Almost half of the units in Multnomah County are rented. Columbia County has the highest percentage of owner occupied households — nearly 15% more than the region's average.

Table 2-127. Housing Tenure in Region 2

	Total Occupied Units	Owner Occupied		Renter Occupied		Vacant*	
		Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	945,824	62.5%	566,894	37.5%	105,417	6.3%
Region 2	667,878	404,784	60.6%	263,094	39.4%	39,156	5.5%
Clackamas	145,004	100,759	69.5%	44,245	30.5%	9,203	5.9%
Columbia	19,060	14,383	75.5%	4,677	24.5%	1,436	7.0%
Multnomah	303,654	166,200	54.7%	137,454	45.3%	17,496	5.4%
Washington	200,160	123,442	61.7%	76,718	38.3%	11,021	5.2%

*Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

Source: U.S. Census Bureau, 2008–2012 American Community Survey, Table DP04

Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households (Cutter et al., 2003). Every county in the region except Multnomah has a slightly higher share of family households with children when compared to statewide numbers. Multnomah County's share is slightly less.

Table 2-128. Family vs. Non-family Households in Region 2, 2012

	Total Households	Family Households		Nonfamily Households		Householder Living Alone	
	Estimate	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	964,274	63.7%	548,444	36.3%	421,620	27.9%
Region 2	667,878	413,103	61.9%	254,775	38.1%	191,979	28.7%
Clackamas	145,004	100,694	69.4%	44,310	30.6%	35,549	24.5%
Columbia	19,060	13,440	70.5%	5,620	29.5%	4,499	23.6%
Multnomah	303,654	164,793	54.3%	138,861	45.7%	101,623	33.5%
Washington	200,160	134,176	67.0%	65,984	33.0%	50,308	25.1%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Table 2-129. Family Households with Children by Head of Household in Region 2, 2012

	Family Households with Children		Single Parent (Male)		Single Parent (Female)		Married Couple with Children	
	Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	415,538	27.5%	35,855	2.4%	93,575	6.2%	286,108	18.9%
Region 2	192,041	28.8%	13,723	2.1%	40,615	6.1%	137,703	20.6%
Clackamas	43,804	30.2%	3,346	2.3%	8,026	5.5%	32,432	22.4%
Columbia	5,328	28.0%	424	2.2%	1,226	6.4%	3,678	19.3%
Multnomah	75,794	25.0%	5,957	2.0%	19,076	6.3%	50,761	16.7%
Washington	67,115	33.5%	3,996	2.0%	12,287	6.1%	50,832	25.4%

Note: The table shows the percent of total households represented by each family household structure category.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Social and Demographic Trends

The social and demographic analysis shows that Region 1 is particularly vulnerable during a hazard event in the following categories:

- Thirty percent of all tourists in the state visited this region.
- Columbia County has a greater percentage of disabled citizens than the region overall and the state overall.
- Clackamas County has seen a drastic increase in its homeless population.
- Multnomah and Washington Counties have the greatest proportion of residents who do not speak English well.
- Columbia County has seen a drop in median household income and dramatic increase in poverty.
- The percentage of renters in Multnomah County significantly exceeds that of the region and the state overall.

Economy

Economic characteristics include the financial resources present and revenue generated in the community to achieve a higher quality of life. Employment characteristics, income equality, employment, and industry sectors 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 employment sectors, workforce, resources, and infrastructure are interconnected in the existing economic picture.

Employment

Employment status and salary level may impact the resilience of individuals and families in the face of disasters as well as their ability to mitigate against natural hazards (Cutter et al., 2003). Since the end of the financial crisis that began in 2007 job recovery in Region 2 has outpaced the state's as a whole. Most major private sector industries are at or above pre-recession employment levels. Portland has regained about 90% of jobs lost, and half of these new jobs pay more than $50,000 annually.

Regional unemployment rates have been declining steadily since 2009. Unemployment rates in all counties except Columbia are generally 1% lower than the state. Columbia County has the smallest labor force in the region, the highest unemployment rate, and the lowest average salary. The majority of the region's employees are within Multnomah County. Washington County has the highest average wage, $59,481 (132% of the state average).

Winter months tend to have the lowest employment rates due to less tourism and fewer employment opportunities in outdoor industries such as construction and agriculture (Tauer, 2014). "The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster" (Cutter et al., 2003). Lower employment rates during winter months could be further exacerbated by a hazard event.

Table 2-130. Employment and Unemployment Rates in Region 2, 2013

	Civilian Labor Force	Employed Workers		Unemployed	
	Total	Total	Percent	Total	Percent
Oregon	1,924,604	1,775,890	92.3%	148,714	7.7%
Region 2	910,110	848,951	93.3%	61,159	6.7%
Clackamas	196,081	182,673	93.2%	13,408	6.8%
Columbia	23,449	21,516	91.8%	1,933	8.2%
Multnomah	400,250	372,664	93.1%	27,586	6.9%
Washington	290,330	272,098	93.7%	18,232	6.3%

Source: Oregon Employment Department, 2014

Table 2-131. Unemployment Rates in Region 2, 2009–2013

	2009	2010	2011	2012	2013	Change (2009–2013)
Oregon	11.1%	10.8%	9.7%	8.8%	7.7%	-3.4%
Region 2	10.1%	9.7%	8.5%	7.7%	6.7%	-3.4%
Clackamas	10.2%	10.1%	8.9%	8.0%	6.8%	-3.4%
Columbia	13.2%	12.1%	10.7%	9.7%	8.2%	-4.9%
Multnomah	10.4%	9.9%	8.7%	7.8%	6.9%	-3.5%
Washington	9.4%	9.0%	7.8%	7.1%	6.3%	-3.1%

Source: Oregon Employment Department, 2014

Table 2-132. Employment and Payroll in Region 2, 2013

	Employees	Average Pay	Percent State Average
Oregon	1,679,364	$45,010	100%
Region 2	861,474	$52,136	116%
Clackamas	143,101	$45,274	100.6%
Columbia	9,797	$34,558	76.8%
Multnomah	452,060	$50,521	112.2%
Washington	256,516	$59,481	132.2%

Source: Oregon Employment Department, 2014

Employment Sectors and Key Industries

In 2013 the five major employment sectors in Region 2 were: (a) Trade, Transportation, and Utilities; (b) Professional and Business Services; (c) Education and Health Services; (d) Government; and (e) Manufacturing. The following information is from the State of Oregon Employment Department (https://www.qualityinfo.org): Columbia County is within the Portland Metro area but remains a strong natural resource based economy that also has an increasing number of residents commuting to jobs in Portland and Cowlitz County, Washington. Multnomah and Washington Counties have a diverse economic base that has seen the most recovery in the state since the financial crisis that began in 2007. Industries in these counties include manufacturing, trade, and services. The high-tech industry is of particular importance to the region. Clackamas County has some of the state's most fertile farmland and is known for a strong agriculture based economy.

Table 2-133. Covered Employment by Sector in Region 2, 2013

Industry	Region 2	Clackamas Employment	Clackamas Percent	Columbia Employment	Columbia Percent
Total All Ownerships	861,474	143,101	100%	9,797	100%
Total Private Coverage	87.3%	127,251	88.9%	7,886	80.5%
Natural Resources & Mining	1.1%	4,527	3.2%	311	3.2%
Construction	4.7%	8,806	6.2%	517	5.3%
Manufacturing	11.1%	17,657	12.3%	1,336	13.6%
Trade, Transportation & Utilities	18.8%	31,903	22.3%	1,941	19.8%
Information	2.3%	1,963	1.4%	53	0.5%
Financial Activities	5.8%	7,260	5.1%	368	3.8%
Professional & Business Services	15.6%	15,952	11.1%	638	6.5%
Education & Health Services	13.7%	19,382	13.5%	1,110	11.3%
Leisure & Hospitality	10.1%	13,790	9.6%	1,075	11.0%
Other Services	3.9%	5,970	4.2%	535	5.5%
Private Non-Classified	0.0%	42	0.0%	(c)	-
Total All Government	12.7%	15,850	11.1%	1,911	19.5%
Federal Government	1.6%	1,062	0.7%	67	0.7%
State Government	1.9%	2,322	1.6%	256	2.6%
Local Government	9.2%	12,466	8.7%	1,588	16.2%

Industry	Region 2	Multnomah Employment	Multnomah Percent	Washington Employment	Washington Percent
Total All Ownerships	861,474	452,060	100%	256,516	100%
Total Private Coverage	87.3%	381,281	84.3%	235,231	91.7%
Natural Resources & Mining	1.1%	1,760	0.4%	3,228	1.3%
Construction	4.7%	18,809	4.2%	12,546	4.9%
Manufacturing	11.1%	32,874	7.3%	44,128	17.2%
Trade, Transportation & Utilities	18.8%	83,202	18.4%	45,297	17.7%
Information	2.3%	10,504	2.3%	7,307	2.8%
Financial Activities	5.8%	27,481	6.1%	14,644	5.7%
Professional & Business Services	15.6%	69,947	15.5%	47,522	18.5%
Education & Health Services	13.7%	66,568	14.7%	30,830	12.0%
Leisure & Hospitality	10.1%	51,072	11.3%	21,298	8.3%
Other Services	3.9%	19,036	4.2%	8,345	3.3%
Private Non-Classified	0.0%	30	0.0%	85	0.0%
Total All Government	12.7%	70,779	15.7%	21,286	8.3%
Federal Government	1.6%	12,271	2.7%	705	0.3%
State Government	1.9%	11,063	2.4%	2,763	1.1%
Local Government	9.2%	47,444	10.5%	17,818	6.9%

Note: (c) = confidential, information not provided by Oregon Employment Department to prevent identifying specific businesses.

Source: Oregon Employment Department, 2013

Each industry faces distinct vulnerabilities to natural hazards. Identifying key industries in the region enables communities to target mitigation activities toward those industries' specific sensitivities. Each of the primary private employment sectors has sensitivity to natural hazards, as follows.

Trade, Transportation, and Utilities: Retail Trade is the largest employment subsector within this sector. Retail Trade is vulnerable to disruptions in the disposable income of regional residents and to disruptions in the transportation system. Residents' discretionary spending diminishes after natural disasters as spending priorities tend to focus on essential items. Disruption of the transportation system could sever connectivity of people and retail hubs. Retail businesses are concentrated in the larger cities of the region and are most numerous in the Portland Metro area.

Professional and Business Services: This sector is composed of professional service providing industries including scientific and technical, management professionals and administrative and support services (e.g., engineering, law, headquarters, temp help, etc.). In general, this sector has low vulnerability to natural disasters. Vulnerability is increased if suppliers are affected or physical infrastructure such as buildings, roads, telecommunications, or water systems is damaged. Mitigation efforts for this sector should include preparing business continuity and recovery plans.

Education and Health Services: The Health and Social Assistance industries play important roles in emergency response in the event of a disaster. The importance of the health care and social assistance sector is underscored in Region 2 because the region serves as a hub for health care. Health care is a relatively stable revenue sector with an abundant distribution of businesses primarily serving a local population.

Manufacturing: This sector is highly dependent upon transportation networks in order to access supplies and send finished products to outside markets. For these reasons the manufacturing sector may be susceptible to disruptions in transportation infrastructure. However, manufacturers are not dependent on local markets for sales, which may contribute to the economic resilience of this sector. Within the region, manufacturers are primarily based in Multnomah and Washington Counties.

Revenue by Sector

Region 2 accounts for almost half of all revenue generated in Oregon. In 2007 Trade (Retail and Wholesale), Manufacturing, and Healthcare and Social Assistance were the highest revenue grossing industries in the region. (Revenue data from the 2012 Economic Census will not be released prior to the publication of this Plan.) Combined, these three industries generated over $114 billion (86%) in revenue. Trade (Retail and Wholesale) is the largest grossing sector in Clackamas and Multnomah Counties. Manufacturing is the highest grossing sector in Columbia and Washington Counties.

Table 2-134. Revenue of Top Industries (in Thousands of Dollars) in Region 2, 2007

	Total Revenue (in Thousands)	Trade (Retail and Wholesale)	Manufacturing	Health Care and Social Assistance
Oregon	$277,017,733	44.4%	24.1%	7.3%
Region 2	$132,790,589	47.1%	30.9%	7.9%
Clackamas	$19,898,459	52.2%	28.5%	8.6%
Columbia	$1,423,749	31.9%	58.0%	3.8%
Multnomah	$61,238,728	52.1%	17.2%	10.0%
Washington	$50,229,653	39.4%	47.9%	5.1%

Source: U.S. Census, Economic Census. 2007, Table ECO700A1

Sectors that are anticipated to be major employers in the future warrant special attention, especially in the hazard mitigation planning process so the workforce and employers can be more prepared to respond and adapt to needs that arise after a natural hazard event. According to the Oregon Employment Department, between 2010 and 2020, the largest job growth in Region 2 is expected to occur in the following sectors: (a) Education and Health services; (b) Trade, Transportation, and Utilities (including retail trade); (c) Professional and Business Services; (d) Leisure and Hospitality; and (e) Manufacturing (Oregon Employment Department, 2012; Employment Projections by Industry and Occupation: 2010–2020 Oregon and Regional Summary Retrieved April 10, 2014, from http://www.qualityinfo.org/olmisj/PubReader?itemid=00005720).

Identifying sectors with a large number of businesses and targeting mitigation strategies to support those sectors can help the region's resiliency. The Trade, Transportation, and Utilities sector includes the most businesses in Region (19.2%). The Other Services sector is the second most abundant and Education and Health Services sector ranks third. Leisure and Hospitality and Construction round out the top five sectors (Oregon Employment Department, 2012). While many of these are small businesses, employing fewer than 20 employees, collectively they represent 40% of the business units in the region. Due to their small size and large collective share of the economy, these businesses are particularly sensitive to temporary decreases in demand, such as may occur following a natural hazard event.

Economic Trends and Issues

Because a strong and diverse economic base increases the ability of individuals, families, and communities to absorb impacts of a disaster and recover more quickly, current and anticipated financial conditions of a community are strong determinants of community resilience. This analysis shows that the economy in Region 2 is particularly strong in the following areas:

- The Portland Metro area has rebounded from the financial crisis that began in 2007 more strongly than any other area in the state and is near pre-recession employment levels.
- Much of the growth in employment within the region is spurred by the high-tech industry, which grew by 70% over the last decade (Oregon Employment Department, n.d., Region 2 data).
- Regionally, Columbia County is still struggling the most after the financial crisis that began in 2007. The unemployment rate is higher, overall educational attainment is lower, and the average salary is only 77% of state average.

Supporting the growth of dominant industries and employment sectors, as well as emerging sectors identified in this analysis, can help the region become more resilient to economic downturns that often follow a hazard event (Stahl et al., 2000).

Infrastructure

Transportation

Roads

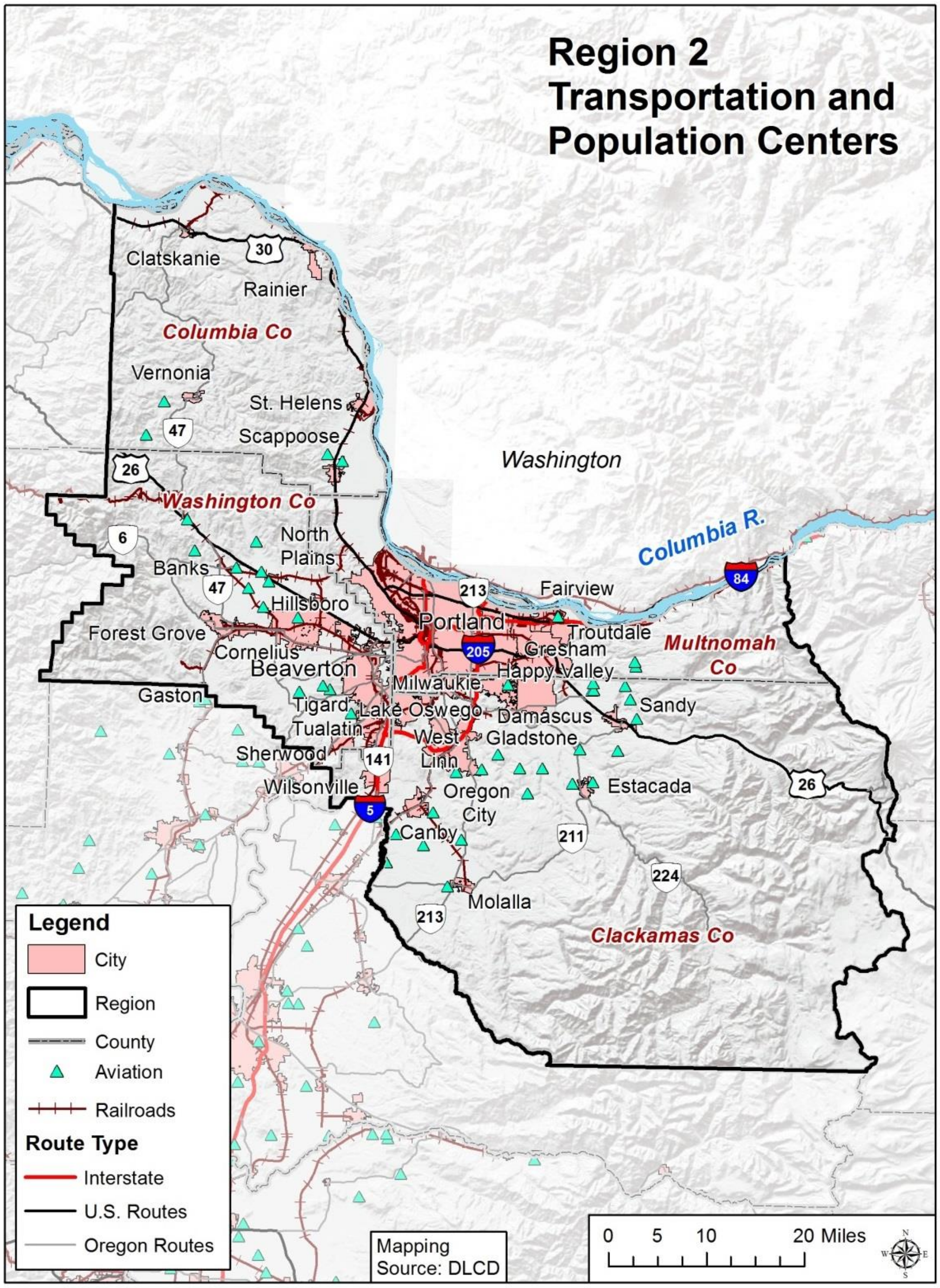
The largest population bases in Region 2 are located along the region's major freeways: I-5, I-205, and I-84. I-5 runs north-south through Region 2 and is the main passage for automobiles and trucks traveling along the West Coast. I-205 is a loop route that serves Portland and Vancouver and provides access through the eastern edge of the Portland area. I-84 runs east-west and is the main passage for automobiles and trucks traveling between Oregon and central and eastern states.

Region 2's growing population centers bring more workers, automobiles and trucks onto roads. Collectively, these create additional stresses on transportation systems through added maintenance, congestion, and oversized loads. Furthermore, a high percentage of workers driving alone to work, coupled with interstate and international freight movement on the interstate corridors, can cause added traffic congestion and accidents.

Natural hazards and emergency events can further disrupt automobile traffic, create gridlock, and shut down local transit systems, making evacuations and other emergency operations difficult. Hazards such as localized flooding can render roads unusable. Likewise, a severe winter storm has the potential to disrupt the daily driving routine of thousands of people.

The region has high exposure to earthquakes, especially a Cascadia Subduction Zone event. Therefore, the seismic vulnerability of the region's lifelines, including roadways and bridges, is an important issue. For information on ODOT's Seismic Lifeline Report findings for Region 2, see **Seismic Lifelines**.

Figure 2-105. Region 2 Transportation and Population Centers



Source: Oregon Department of Land Conservation and Development, 2014

Bridges

As mentioned, the region's bridges are highly vulnerable to seismic activity. 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 region's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or that are part of regional and local systems that are maintained by the region's counties and cities.

Table 2-135 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. A deficient bridge (De) is a federal performance measure used for non-ODOT bridges. These ratings do not imply that a bridge is unsafe (ODOT, 2012, 2013). 30% of region's bridges are distressed or deficient. About 28% of the region's ODOT bridges are distressed; 51% of those are in Multnomah County. Five bridges within the Portland Metro area are part of an I-5 seismic retrofit project scheduled to begin in the summer of 2014.

Table 2-135. Bridge Inventory for Region 2

	State Owned			County Owned			City Owned			Other Owned			Area Total			Historic
	Di	ST	%D*	De	ST	%D	De	ST	%D	De	ST	%D	D	ST	%D	Covered
Oregon	610	2,718	22%	633	3,420	19%	160	614	26%	40	115	35%	1,443	6,769	21%	334
Region 2	154	549	28%	117	429	27%	64	182	35%	11	23	48%	346	1137	30%	76
Clackamas	22	114	20%	36	154	23%	5	17	29%	1	1	100%	64	283	23%	16
Columbia	10	33	32%	14	81	17%	2	9	22%	0	2	0%	26	123	21%	8
Multnomah	95	282	38%	23	45	51%	52	122	43%	5	13	38%	175	429	41%	50
Washington	27	120	24%	44	149	30%	5	34	15%	5	7	71%	81	302	27%	2

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.

Source: ODOT (2012, 2013)

Railroads

Railroads that run through Region 2 support cargo and 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 Port of Portland is a major marine gateway for rail freight. There are six major rail yards and terminals in the region — all of which are in Portland — operated by UP or BNSF. Oregon's freight rail system is critical to the state's economy, energy, and food systems. Rail systems export lumber and wood products, pulp and paper, and other goods produced in the state, as well as products from other states that are shipped to and through Oregon by rail.

Amtrak provides passenger rail service throughout the region. In addition, the Portland Westside Express Service provides passenger rail options for commuters in Washington County. The area is also serviced by a regional transit system (TriMet) that provides both bus and light rail service through the greater Portland Metropolitan area.

Rails are sensitive to icing from winter storms that can occur in Region 2. Disruptions in the rail system can result in economic losses for the region. The potential for harm from rail accidents can also have serious implications for local communities, especially if hazardous materials are involved.

Airports

The Portland International Airport is the only primary commercial airport in the region and is the busiest airport in Oregon (Federal Aviation Administration, 2012). The airport is owned, operated, and administered by the Port of Portland. It serves 17 passenger air carriers and seven cargo carriers with approximately 183,000 annual commercial flights, 20,300 cargo flights, and 21,000 military and general aviation annual flights (Portland International Airport, 2014). The Port of Portland also operates two relief airports, Portland-Hillsboro and Portland-Troutdale, that serve the region.

Table 2-136. Public and Private Airports in Region 2

	Number of Airports by FAA Designation				
	Public Airport	**Private Airport**	**Public Heliport**	**Private Heliport**	**Total**
Region 2	12	33	1	24	70
Clackamas	5	19	0	6	30
Columbia	2	2	0	0	4
Multnomah	2	1	1	10	14
Washington	3	11	0	8	22

Source: FAA Airport Master Record (Form 5010), 2014

In the event of a natural disaster, public and private airports are important staging areas for emergency response activities. Public airport closures will impact the region’s tourism industries, as well as the ability for people to leave the region by air. Businesses relying on air freight may also be impacted by airport closures.

Ports

Oregon’s ports have historically been used for timber transport and for commercial and recreational fishing. With the decline in the timber industry, ports have evolved to embrace economic development and tourism by offering industrial land and river, rail, road, and air infrastructure. There are two ports within Region 2, the Port of St. Helens and the Port of Portland. The Port of St. Helens includes 93 acres of light industrial and is approximately 30 miles from Portland (Port of St. Helens, http://www.portsh.org/index.php). The Port of Portland is responsible for overseeing the Portland International Airport and other aviation and marine activities in the Portland Metro area. The Port of Portland includes four marine terminals, five industrial parks, and three airports (Port of Portland, http://www.portofportland.com).

Energy

Electricity

The region is served by several investor-owned, public, cooperative, and municipal utilities. Portland General Electric (PGE) is the largest investor-owned utility in the region, serving large areas of Clackamas, Multnomah, and Washington Counties. Pacific Power and Light (Pacific Power) is another investor-owned utility company serving a small portion of Multnomah County. Additionally, the Western Oregon Electric Cooperative, Inc. provides electricity for portions of Region 2. Three municipal utility districts support the region: City of Cascade Locks, City of Forest Grove, and City of Canby. In addition, the Clatskanie People's Utility District and the Columbia River PUD serve portions of the region.

The Northern Willamette Valley / Portland Metro area has eight power-generating facilities: six generate hydroelectric and two generate natural gas. In total, these facilities have the ability to produce up to 1,121 megawatts (MW) of electricity.

Table 2-137. Power Plants in Region 2

	Hydro-electric	Natural Gas	Wind	Coal	Other*	Total
Region 2	6	2	0	0	0	8
Clackamas	6	0	0	0	0	6
Columbia	0	2	0	0	0	2
Multnomah	0	0	0	0	0	0
Washington	0	0	0	0	0	0
Energy Production (MW)	203	918	0	0	0	1,121

*Other includes biomass, geothermal, landfill gas, solar, petroleum, and waste.

Source: Army Corps of Engineers; Biomass Power Association; Calpine Corporation; Eugene Water and Electric Board; Iberdola Renewables; Idaho Power Company; Klamath Energy LLC; Oregon Department of Energy; Owyhee Irrigation District; Form 10K Annual Report (2013), PacifiCorp; Form 10K Annual Report (2013), Portland General Electric; U.S. Geothermal, Inc.

Hydropower

Bonneville Power Administration (BPA) provides hydro-generated electricity to the state's consumer owned utilities. The Bonneville Dam is BPA's major dam in the region, located on the Columbia River. Other dams in the region are located on the Willamette, Clackamas, and Sandy Rivers.

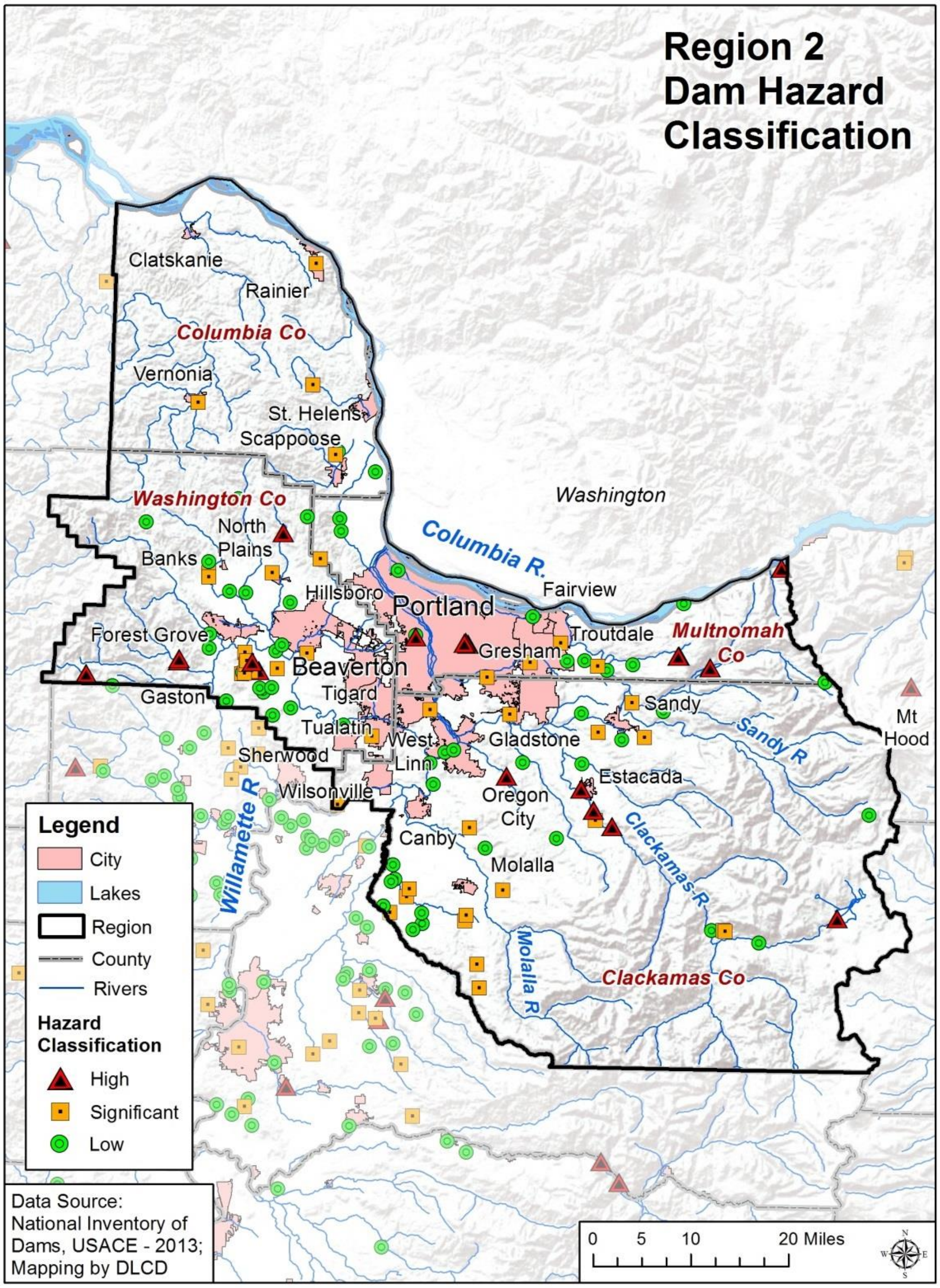
Minor dam failures can occur at any time. Most dam failures result in minor damage to structures and pose little or no risk to life safety. However, the potential for severe damage and fatalities does exist. For example, major dam failures occurred near Hermiston in 2005, and in Klamath Lake in 2006 (Association of Dam Safety Officials, n.d.). The Oregon Water Resources Department uses the National Inventory of Dams (NID) threat potential methodology and maintains an inventory of all large dams in Oregon. **Table 2-138** lists the number of dams included in the inventory. The majority of dams in the region are located in Clackamas and Washington Counties. There are 17 High Threat Potential dams and 42 Significant Threat Potential dams in the region.

Table 2-138. Threat Potential of Dams in Region 2

	Threat Potential			Total Dams
	High	Significant	Low	
Region 2	17	42	144	203
Clackamas	7	20	44	71
Columbia	0	3	9	12
Multnomah	7	5	14	26
Washington	3	14	77	94

Source: Oregon Water Resources Department, Dam Inventory Query, 2014

Figure 2-106. Region 2 Dam Hazard Classification

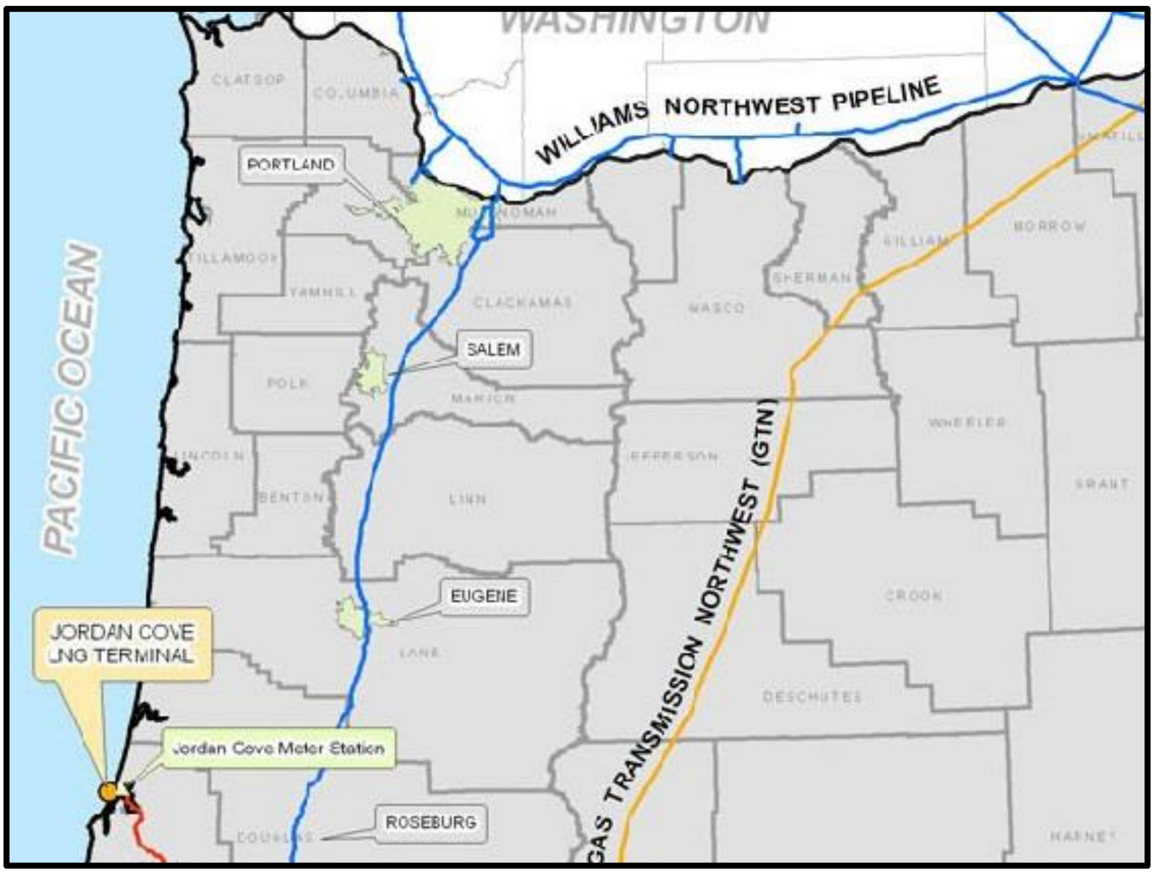


Source: USACE National Inventory of Dams, 2013

Natural Gas

Although natural gas does not provide the most energy to the region, it does contribute a significant amount of energy to the region's energy portfolio. Liquefied natural gas (LNG) is transported via pipelines throughout the United States. **Figure 2-107** shows the Williams Northwest Pipeline, which runs through Clackamas and Multnomah Counties (in blue) (Pipelines International, 2009). LNG pipelines, like other buried pipe infrastructure are vulnerable to earthquakes and can cause danger to human life and safety, as well as environmental impacts in the case of a spill.

Figure 2-107. Liquefied Natural Gas Pipelines in Region 2



Source: Retrieved from http://gs-press.com.au/images/news_articles/cache/Pacific_Connector_Gas_Pipeline_Route-0x600.jpg

Oregon's Critical Energy Infrastructure Hub

Oregon's critical energy infrastructure hub (CEI Hub) is located in north Portland on the lower Willamette River between the south tip of Sauvie Island and the Fremont Bridge along US-30. Over 90% of Oregon's refined petroleum is imported to Oregon via the Puget Sound and arrives to Oregon CEI Hub via pipeline or marine vessels (Wang et al., 2013). In addition, much of Oregon's natural gas passes through the CEI Hub and a high voltage electrical transmission corridor crosses, and supplies distribution for, the area. The CEI Hub includes the following energy sector facilities (Pipelines International, 2009):

- All of Oregon's major liquid fuel port terminals,
- Liquid fuel transmission pipelines and transfer stations,
- Natural gas transmission pipelines,
- A liquefied natural gas storage facility,
- High-voltage electric substations and transmission lines, and
- Electrical substations for local distribution.

In 2013, the Oregon Department of Geology and Mineral Industries (DOGAMI) conducted a study of the CEI Hub's earthquake risk entitled Earthquake Risk Study for Oregon's Critical Energy Infrastructure Hub (DOGAMI Open-File Report O-13-09). The study determined (a) the vast majority of facilities are constructed on soils susceptible to liquefaction and (b) significant seismic risk exists within the various energy sector facilities. The CEI Hub was identified as being highly vulnerable to a Cascadia Subduction Zone (CSZ) event: "western Oregon is likely to face an electrical blackout, extended natural gas service outages, liquid fuel shortage, as well as damage and losses in the tens of billions of dollars" (Pipelines International, 2009). Significant pro-active seismic mitigation projects are recommended to be integrated into the affected energy sector companies' business practices in order to allow Oregon to adequately recover from a CSZ event within a reasonable period of time. For more information see the full report.

Utility Lifelines

The Northern Willamette Valley / Portland Metro region is an important thoroughfare for oil and gas pipelines and electrical transmission lines, connecting Oregon to California and Canada. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy. These lines may be vulnerable to severe, but infrequent natural hazards, such as earthquakes. If these lines fail or are disrupted essential functions of the community can become severely impaired.

Region 2 primarily receives oil and gas from Alaska by way of the Puget Sound through pipelines and tankers. Oil and gas are supplied by Northern California from a separate network. The electric, oil, and gas lifelines that run through the region are municipally and privately owned (Loy et al., 1976).

Portland General Electric and Bonneville Power Administration primarily operate the electrical transmission lines running through Region 2, and these lines produce and distribute power locally (Loy et al., 1976). Most of the natural gas Oregon uses originates in Alberta, Canada. Avista Utilities owns the main natural gas transmission pipeline (Loy et al., 1976).

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio). Region 2 is part of the Portland Operational Area under The Oregon State Emergency Alert System Plan (Oregon Office of Emergency Management, 2013), which also includes Clark County, Washington. There is a memorandum of understanding between these counties that facilitates the launching of emergency messages. Counties in this area can launch emergency messages by contacting the Oregon Emergency Response System (OERS), which in turn creates emergency messages to communities statewide.

Beyond day-to-day operations, maintaining communications capabilities during disaster events and other emergency situations helps keep citizens safe by keeping them informed of the situation's status, areas to avoid, and other procedural information. Additionally, responders depend on telecommunications infrastructure to be routed to sites where they are needed.

Television

Television serves as a major provider for local, regional, and national news and weather information and can play a vital role in emergency communications. The Oregon State Emergency Alert System Plan does not identify a local primary station for emergency messages.

Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband service providers serve Region 2. Broadband technology including mobile wireless is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless, and mobile wireless. Internet service is readily available throughout most parts the region with a smaller number of providers and service types available in eastern Multnomah County and a small area of central Columbia County (NTIA, n.d.). Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

Wireless providers sometimes offer free emergency mobile phones to those impacted by disasters, which can aid in communication when landlines and broadband service are unavailable.

Radio

Radio is readily available to those who live within Region 2 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Radio transmitters for the Portland Operational Area are (Oregon Office of Emergency Management, 2013):

- KXL-FM, 10.1 MHZ, Portland;
- KGON-FM, 92.3 MHZ, Portland; and
- KOPB-FM, 91.5 MHZ, Portland.

Ham Radio

Amateur radio, or ham radio, is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). Region 2 is served by ARES District 1. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (Oregon Office of Emergency Management, n.d.). The official ham emergency station calls for Region 2 include (American Relay Radio League Oregon Chapter, http://www.arrloregon.org):

- Clackamas County: KA7OZO;
- Columbia County: W7OR;
- Multnomah County: N9VCU; and
- Washington County: KE7WKM.

Water

Drinking water, stormwater, and wastewater systems all possess some level of vulnerability to natural hazards that can have repercussions on human health, ecosystems, and industry.

Drinking Water

In Region 2 the majority of the municipal drinking water supply is obtained primarily from surface water sources such as rivers. These surface water sources are often backed up by groundwater that is drawn from an aquifer when surface water levels get low, especially in summer months. For many communities in Regions 2 and 3, the Willamette River is both a source of potable water and a discharge location for wastewater treatment facilities. Cities that draw water from the Willamette River face water rights disputes and issues related to water quality. The Bull Run watershed is the primary drinking source for the City of Portland and its 19 wholesale customers and does not face the same water quality issues as the Willamette River. However, Portland residents have expressed concerns about the well field that is the City's backup water source. Portlanders have complained of the water's unpleasant taste and expressed concern that water quality may be compromised due to the well field's close proximity to industrial facilities.

Rural residents in the region draw water from surface water, groundwater wells, or springs. Areas with sedimentary and volcanic soils may be subject to high levels of arsenic, hydrogen sulfide, and fecal coliform bacteria, which can impact the safety of groundwater sources. In areas where no new live-flow water rights are available, farmers and ranchers are turning to above-ground storage to help supply water for crop irrigation during dry seasons. At times, urban water districts with an abundant supply have sold water to rural areas. The City of Portland has a long history of these transactions and in recent years has faced competition from other sellers.

Surface sources for drinking water are vulnerable to pollutants caused by non-point sources and natural hazards. Non-point source pollution is a major threat to surface water quality, and may include stormwater runoff from roadways, agricultural operations, timber harvest, erosion and sedimentation. Landslides, flood events, and earthquakes and resulting liquefaction can cause increased erosion and sedimentation in waterways

Underground water supplies and aging or outdated infrastructure such as reservoirs, treatment facilities, and pump stations can be severed during a seismic event. Rigid materials such as cast iron may snap under the pressure of liquefaction. More flexible materials such as polyvinyl chloride (PVC) and ductile iron may pull apart at joints under the same stresses. These types of infrastructure damages could result in a loss of water pressure in municipal water supply systems, thus limiting access to potable water. This can lead to unsanitary conditions that may threaten human health. Lack of water can also impact industry, such as the manufacturing sector. Moreover, if transportation infrastructure is impacted by a disaster event, repairs to water infrastructure will be delayed.

Stormwater and Wastewater

In urbanized areas severe precipitation events may cause flooding that leads to stormwater runoff. A non-point source of water pollution, stormwater runoff can adversely impact drinking water quality. It can also lead to environmental issues such as increasing surface water temperatures that can adversely affect habitat health. Furthermore, large volumes of fast-moving stormwater that enter surface waterways can cause erosion issues.

Stormwater can also impact water infrastructure. Leaves and other debris can be carried into storm drains and pipes, which can clog stormwater systems. In areas where stormwater systems are combined with wastewater systems (combined sewers), flooding events can lead to combined sewer overflows (CSOs). CSOs present a heightened health threat as sewage can flood urban areas and waterways. Underground stormwater and wastewater pipes are also vulnerable to damage by seismic events.

In Region 2, most local building codes and stormwater management plans emphasize the use of centralized storm sewer systems to manage stormwater. Requirements for stormwater mitigation vary in Region 2. Low-impact development (LID) mitigation strategies can alleviate or lighten the burden to a jurisdiction's storm sewer system by allowing water to percolate through soil onsite or detaining water so water enters the storm sewer system at lower volumes, lower speeds, and lower temperatures. The City of Portland has been recognized as a national innovator in stormwater management and code because of its progressive LID stormwater mitigation strategies in the City's building code. However, the majority of jurisdictions in the region do not require LID strategies in their building code. Promoting and requiring decentralized LID stormwater management strategies could help reduce the burden of new development on storm sewer systems and increase a community's resilience to many types of hazard events.

Infrastructure Trends and Issues

Physical infrastructure is critical for everyday operations and is essential following a disaster. Lack or poor condition of infrastructure can negatively affect a community's ability to cope with, respond to, and recover from a hazard event. Diversity, redundancy, and consistent maintenance of infrastructure systems help create system resiliency (Meadows, 2008).

Roads, bridges, and rail systems in the region support Oregon's largest population centers and freight moving through the Pacific Northwest. These transportation systems and are vulnerable to a variety of natural hazards that could disrupt transportation of goods, block evacuation routes and sever lifelines. The effects of road, bridge, and rail failures on the economy and health of the region's residents could be devastating. ODOT understands this risk and began seismically upgrading five of the areas key bridges within the Portland Metro area in summer 2014.

In addition, the region has two ports with marine terminals, industrial parks and aviation facilities. The Portland International Airport is the busiest in the state, moving the majority of passengers and freight. These ports, including airports, face potential disruptions in services due to natural hazard events.

The region is an energy hub for the state. There are multiple dams and eight power-generating facilities. The Bonneville Power Administration (BPA) provides hydro-generated electricity to the state's consumer owned utilities. BPA's main dam, the Bonneville Dam, is located on this region on the Columbia River. Liquid Natural Gas is transported through the region via the Williams Northwest Pipeline that runs through Clackamas and Multnomah Counties. Of particular concern is Oregon's critical energy infrastructure hub, located in north Portland, which is highly vulnerable to a Cascadia event.

Decentralization and redundancy in the region's telecommunication systems can help boost the area's ability to communicate before, during, and after a disaster event. It is important to note that broadband and mobile telephone services may not cover rural areas of the region that are distant from Portland, especially central Columbia and eastern Multnomah Counties. This may present a communication challenge in the wake of a hazard event. Encouraging residents to keep AM/FM radios available for emergency situations could help increase the capacity for communicating important messages throughout the region.

Water systems in the region are particularly vulnerable to hazard events because they tend to be centralized and lacking in system redundancies. Furthermore, because most drinking water is sourced from surface water, the region is vulnerable to high levels of pollutants entering waterways during high-water events. The City of Portland has been recognized as a leader in stormwater management best practices because of its decentralized Low Impact Development (LID) stormwater systems.

Built Environment

Development Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's land use program is 19 land use goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards (DLCD, http://www.oregon.gov/).

Settlement Patterns

The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people or an "urban cluster" of at least 2,500 people (but less than 50,000). Wheeler County does not meet either definition; therefore all of its population is considered rural even though the county has incorporated cities.

Washington and Columbia Counties have experienced the region's greatest percent urban growth during the decade from 2000 to 2010, roughly 5% and 7% more than the state average respectively. Similar to the state, the region is becoming less rural. However, Columbia County, the least populated county along the coast, is the only county in the region to increase its rural population.

The region's urban housing units grew eight times those in rural areas. Multnomah County was the only county to decrease its share of rural residences, notably by 11%. Columbia County had the largest percent growth in in both urban and rural units 24.1% and 10.8% respectively.

Not surprisingly, populations tend to cluster around major road corridors and waterways. The region's largest population is clustered around the Portland Metro area.

Table 2-139. Urban and Rural Populations in Region 2

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	2,694,144	3,104,382	15.2%	727,255	726,692	-0.1%
Region 2	1,352,896	1,561,409	15.4%	134,883	128,978	-4.4%
Clackamas	266,367	308,018	15.6%	72,024	67,974	-5.6%
Columbia	22,769	27,828	22.2%	20,791	21,523	3.5%
Multnomah	649,010	725,464	11.8%	11,476	9,870	-14.0%
Washington	414,750	500,099	20.6%	30,592	29,611	-3.2%

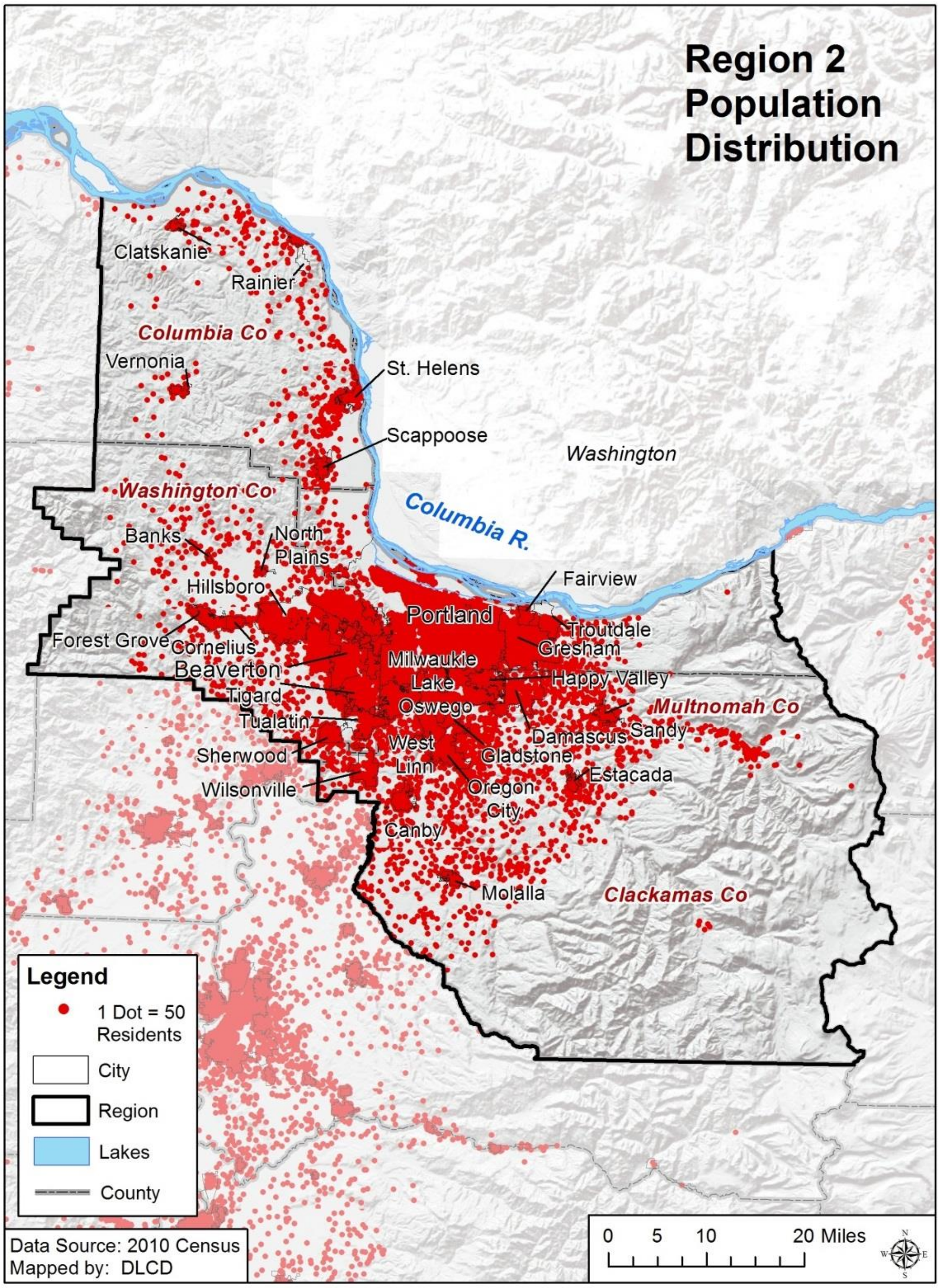
Source: U.S. Census Bureau. 2000 Decennial Census, Table P002 and 2010 Decennial Census, Table P2

Table 2-140. Urban and Rural Housing Units in Region 2

	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 2	569,834	661,845	16.1%	52,166	53,080	1.8%
Clackamas	109,047	128,740	18.1%	27,907	28,205	1.1%
Columbia	9,247	11,474	24.1%	8,325	9,224	10.8%
Multnomah	283,957	320,735	13.0%	4,604	4,097	-11.0%
Washington	167,583	200,896	19.9%	11,330	11,554	2.0%

Source: U.S. Census Bureau. 2000 Decennial Census, Table H002 and 2010 Decennial Census, Table H2

Figure 2-108. Region 2 Population Distribution



Source: U.S. Census, 2012

Land Use

Approximately 65% of the land in Region 2 is in private ownership, followed by federal (31%), state (3%), and local government (1%). Subtracting the Cascade Mountain area leaves nearly the entire Region 2 in private holdings.

Not surprisingly, between 1974 and 2009, the Portland area, followed by the North Willamette Valley area, demonstrated the greatest rates of change in the state in the conversion of private land in resource land uses to low-density residential and urban uses. Within the Portland area, the highest rate of increase took place in Washington County, followed by Clackamas County. Both counties experienced much higher rates of conversion to low-density residential and urban uses than was the case in highly urbanized Multnomah County (Lettman, 2011).

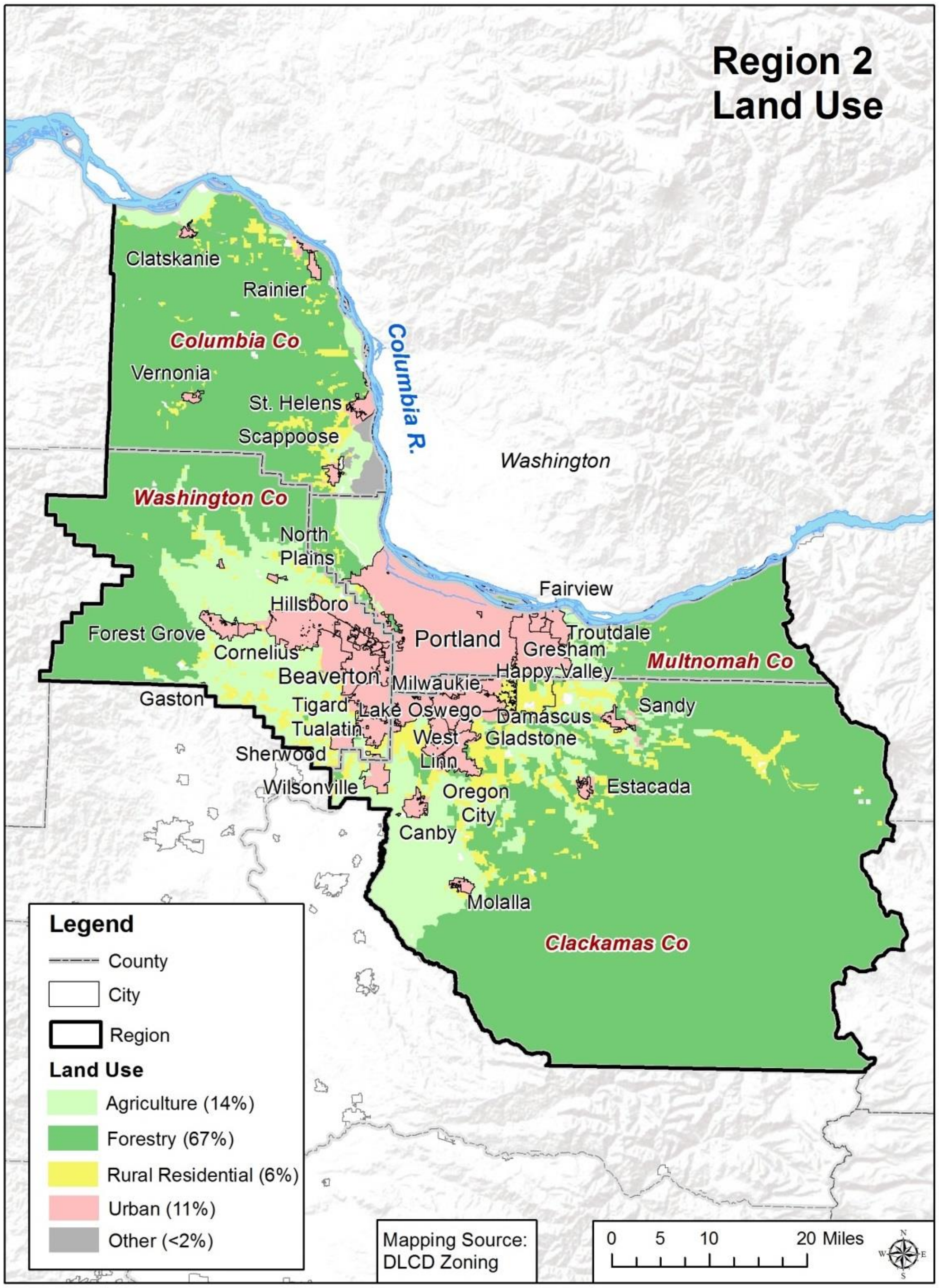
In the past few years, along with most of Western Oregon, Region 2 has experienced an upswing in residential building permits as the local and national economies rebounded. For example, in the first four months of 2014 the region saw a surge in these types of residential building permits. The City of Portland dominated the residential permit numbers, up 16% from the same period in 2013 (State of Oregon Employment Department, May 2014, Portland Economic Indicators). Since 2007, 58% of the new residential growth in the Portland area has been either infill or redevelopment. The rest of the residential construction in that time, about 42%, has been on vacant land (Lettman, 2011).

Overall, 2013 saw the strongest surge of new residents in 5 years for Region 2. According to the most recent estimates from the regional government Metro, by 2035 the Portland-Beaverton-Vancouver area (including Multnomah, Clackamas, Washington, Yamhill, Columbia, Clark, and Skamania Counties) might grow by up to 725,000 people, topping the 3 million population mark.

Under Oregon law, each of the state's cities and metropolitan areas has created around its perimeter an urban growth boundary (UGB), which is a land use planning line to control urban expansion onto farm and forest lands. The UGB is assessed every 6 years, in a process that involves various levels of government and the public. In 2013-2014 Metro will revise its UGB. Most notable will be changes in the urban and rural reserves of Washington County.

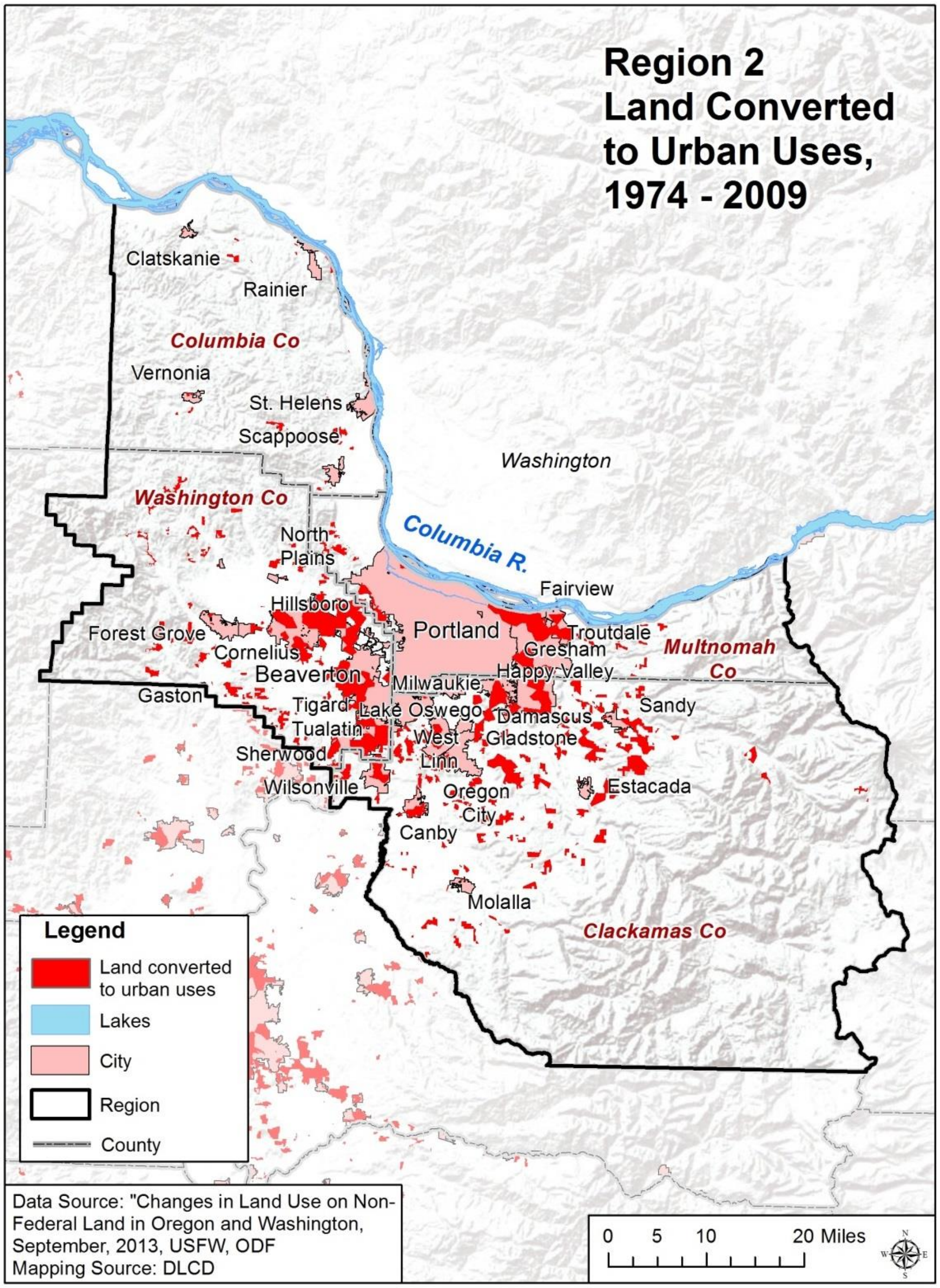
Potential upgrades to the 28 miles of levees that protect the north Portland area from the Columbia River remain a continuing land use issue for the region. As of July 2014, potential costs to the four drainage districts involved were estimated at $100 million dollars. Failure to maintain certification and FEMA accreditation may result in thousands of property owners and businesses subject to federal flood insurance regulations (DLCD, internal communication, 2014).

Figure 2-109. Region 2 Land Use



Source: DLCD, Statewide Zoning

Figure 2-110. Region 2 Land Converted to Urban Uses, 1974–2009



Source: "Changes in Land Use on Non-Federal Land in Oregon and Washington," September 2013, USFS, ODF

Housing

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. The majority of the region's housing stock is single-family homes. Nearly half of the region's multi-family units are located in Multnomah County, in the Portland area in particular. Mobile residences make up only 3.5% of all housing in the region. Columbia County has the highest percentage of mobile homes (12.6%), and Clackamas County has the highest number of units (9,752). In natural hazard events such as earthquakes and floods, mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of OES, 1997).

Table 2-141. Housing Profile for Region 2

	Total Housing Units	Single Family		Multi-Family		Mobile Homes	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	1,140,319	68.1%	460,852	27.5%	139,768	8.4%
Region 2	714,150	469,018	65.7%	219,384	30.7%	24,748	3.5%
Clackamas	156,933	114,764	73.1%	32,160	20.5%	9,752	6.2%
Columbia	20,639	15,577	75.5%	2,334	11.3%	2,599	12.6%
Multnomah	324,192	196,592	60.6%	120,404	37.1%	6,657	2.1%
Washington	212,386	142,085	43.8%	64,486	19.9%	5,740	1.8%

Note: The percentages listed above do not reflect the number of structures that are built within special flood hazard areas or that are at risk of seismic damage

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, B25024

Aside from location and type of housing, the year a structure was built (Table 2-142) has implications for level of vulnerability to natural hazards. Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for the Cascadia earthquake fault (Judson, 2012). Therefore, homes built before 1994 are more vulnerable to seismic events.

Also in the 1970s, FEMA began assisting communities with floodplain mapping as part of administering 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. Regionally, 38.7% of the housing stock was built prior to 1970, before the implementation of floodplain management ordinances. Notably, over 55% of homes in Multnomah County were constructed before 1970. Regionally, approximately two thirds of the housing stock was built before 1990 and the codification of seismic building standards. Washington County has the highest percentage (43.5%) and largest number (92,732) of units built after 1990.

Table 2-142. Age of Housing Stock in Region 2

	Total Housing Units	Pre 1970		1970 to 1989		1990 or later	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	609,062	36.4%	518,569	31.0%	545,962	32.6%
Region 2	714,150	276,458	38.7%	208,448	29.2%	229,244	32.1%
Clackamas	156,933	45,462	29.0%	56,471	36.0%	55,000	35.0%
Columbia	20,639	7,324	35.5%	6,115	29.6%	7,200	34.9%
Multnomah	324,192	180,658	55.7%	68,862	21.2%	74,672	23.0%
Washington	212,386	43,014	20.3%	77,000	36.3%	92,372	43.5%

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, B25034

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. **Table 2-143** shows the initial and current FIRM effective dates for Region 2 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, **Flood** section.

Table 2-143. Community Flood Map History in Region 2

	Initial FIRM	Current FIRM
Clackamas County	March 1, 1978	June 17, 2008
Barlow	May 5, 1981	June 17, 2008
Canby	June 15, 1984	June 17, 2008
Damascus	July 19, 2000	June 17, 2008
Estacada	June 17, 2008	June 17, 2008
Gladstone	March 15, 1977	June 17, 2008
Happy Valley	December 4, 1979	June 17, 2008
Lake Oswego	August 4, 1987	June 17, 2008
Milwaukie	June 18, 1980	June 17, 2008
Molalla	June 17, 2008	June 17, 2008
Oregon City	December 15, 1980	June 17, 2008
Portland	see Multnomah County	see Multnomah County
Rivergrove	August 4, 1987	June 17, 2008
Sandy	December 11, 1979	June 17, 2008
Tualatin	see Washington County	see Washington County
West Linn	March 15, 1977	June 17, 2008
Wilsonville	January 6, 1982	June 17, 2008
Columbia County	August 16, 1986	November 26, 2010
Clatskanie	September 29, 1986	November 26, 2010
Columbia, City	June 5, 1985	November 26, 2010
Prescott	August 16, 1988	November 26, 2010
Rainier	August 16, 1988	November 26, 2010
St. Helens	September 29, 1986	November 26, 2010
Scappoose	December 19, 1975	November 26, 2010
Vernonia	August 16, 1988	November 26, 2010
Multnomah County	June 15, 1982	December 18, 2009
Fairview	March 18, 1986	December 18, 2009
Gresham	July 16, 1979	December 18, 2009
Lake Oswego	see Clackamas County	see Clackamas County
Milwaukie	see Clackamas County	see Clackamas County
Portland	October 15, 1980	November 26, 2010
Troutdale	September 30, 1988	December 18, 2009
Wood Village	December 18, 2009	December 18, 2009
Washington County	September 30, 1982	February 18, 2005
Beaverton	September 28, 1984	February 18, 2005
Cornelius	January 6, 1982	January 6, 1982
Durham	January 6, 1982	February 18, 2005
Forest Grove	March 15, 1982	March 15, 1982
Gaston	July 5, 1982	July 5, 1982
Hillsboro	May 17, 1982	May 17, 1982
King City	February 18, 2005	February 18, 2005
Lake Oswego	see Clackamas County	see Clackamas County
North Plains	April 1, 1982	March 16, 1989
Portland	see Multnomah County	see Multnomah County
Rivergrove	see Clackamas County	see Clackamas County
Sherwood	January 6, 1982	January 6, 1982
Tigard	March 1, 1982	February 18, 2005
Tualatin	May 2, 1978	February 19, 1987
Wilsonville	see Clackamas County	see Clackamas County

Source: Federal Emergency Management Agency, Community Status Book Report

State-Owned/Leased and Critical/Essential Facilities

In 2014 the Department of Geology and Mineral Industries updated the 2012 Oregon NHMP inventory and analysis of state-owned/leased facilities and critical/essential facilities. Results from this report relative to Region 2 can be found in **Table 2-144**. The region contains 13.7% of the total value of state-owned/leased critical/essential facilities, valued at over $1 billion.

Table 2-144. Value of State-Owned/Leased Critical and Essential Facilities in Region 2

	Total Property Value (State Facilities)	Percent State Total
Oregon	$7,339,087,023	100%
Region 2	$1,002,513,064	13.7%
Clackamas	$233,143,765	3.2%
Columbia	$9,287,172	0.1%
Multnomah	$300,609,402	4.1%
Washington	$459,472,725	6.3%

Source: DOGAMI

Built Environment Trends and Issues

The trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. Region 2 is largely an urban county with urban development focused around the Portland Metropolitan area. The region's urban areas are growing at about the same rate as the state's. Columbia and Washington Counties have the fastest urban growth rates within the region. The region's housing stock is largely single-family homes. However, the region has a slightly higher percentage of multi-family units than the state as a whole; Multnomah County has the highest percentage (37%). Conversely, the region has a lower percentage of mobile homes than the state, with the exception of Columbia County. About 55% of housing in Multnomah was built prior to 1970, prior to current seismic and floodplain management standards. In contrast, over 44% of housing in Washington County was built after 1990. With the exception of some cities within Washington County all of the region's FIRMs have been modernized or updated. The cities in Washington County may have maps that are not as up-to-date as other areas of the state and therefore may not accurately represent flood risk.

2.3.2.3 Hazards and Vulnerability

Droughts

Characteristics

Droughts are uncommon in Region 2. In 1992, the Governor declared a drought for all 36 counties in Oregon. Since 1992, no Governor-declared droughts have occurred in this region.

Historic Drought Events

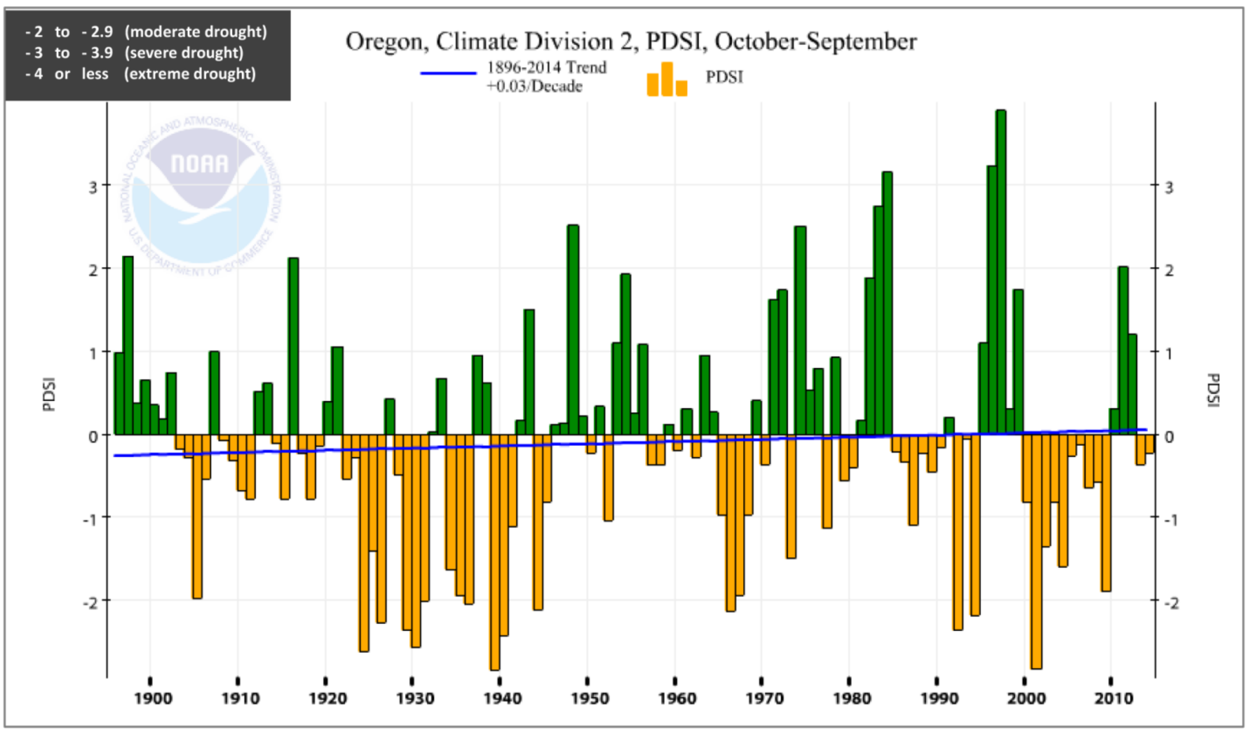
Table 2-145. Historic Droughts in Region 2

Date	Location	Description
1924	statewide	prolonged statewide drought that caused major problems for agriculture
1930	Regions 1–3, 5–7	moderate to severe drought affected much of the state; the worst years in Region 2 were 1928–1930, which kicked off an era of many drier than normal years
1939	statewide	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country
1992	statewide, especially Regions 1–4, 8	1992 fell toward the end of a generally dry period, which caused problems throughout the state; the 1992 drought was most intense in eastern Oregon, with severe drought occurring in Region 1
2001	Regions 2–4, 6, 7	the driest water year on record in the Willamette Valley (NOAA Climate Division 2); warmer than normal temperatures combined with dry conditions

Sources: Taylor and Hatton (1999); Oregon Secretary of State's Archives Division; 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

Historical drought information can also be obtained from the National Climatic Data Center, which provides historical climate data showing wet and dry conditions, using the Palmer Drought Severity Index (PDSI) that dates back to 1895. The Palmer Index is not the best indicator of water availability for Oregon as it does not account for snow or ice (delayed runoff), but it has the advantage of providing the most complete, long-term record. Figure 2-111 shows years where drought or dry conditions affected the Willamette Valley (Climate Division 2). Based on this index, Water Years 1939 and 2001 were the driest years with values of -2.84 and -2.83 respectively. These moderate-type drought years have occurred more than a dozen times during this record.

Figure 2-111. Palmer Drought Severity Index for Region 2



Source: National Climatic Data Center, http://www.ncdc.noaa.gov/cag/

Although not shown here, drought data from Climate Division 4, “the High Cascades,” could also be analyzed to show a broader picture of drought impacts in Hazard Regions 2 and 3.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 2 will experience drought is shown in **Table 2-146**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-146. Local Probability Assessment of Drought in Region 2

	Columbia	Clackamas	Multnomah	Washington
Probability	M	M	—	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

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

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

Based on limited data, there is a low probability of drought occurring in this region. There has only been one drought declaration in this region, which occurred in 1992 when all 36 counties were affected by a drought.

Vulnerability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the region's vulnerability to drought is shown in **Table 2-147**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-147. Local Vulnerability Assessment of Drought in Region 2

	Columbia	Clackamas	Multnomah	Washington
Vulnerability	L	L	—	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Oregon has yet to undertake a comprehensive, statewide analysis to identify which communities are most vulnerable to drought. However, based on a review of Governor drought declarations since 1992, Region 2 could be considered less vulnerable to drought impacts than many other parts of the state.

Earthquakes

Characteristics

The geographic position of Region 2 makes it susceptible to earthquakes from four sources: (a) the off-shore Cascadia Fault Zone, (b) deep intraplate events within the subducting Juan de Fuca plate, (c) shallow crustal events within the North America Plate, and (d) earthquakes associated with renewed volcanic activity. All have some tie to the subducting or diving of the dense, oceanic Juan de Fuca Plate under the lighter, continental North America Plate. Stresses occur because of this movement and there appears to be a link between the subducting plate and the formation of volcanoes some distance inland from the off-shore fault zone.

Region 2 has had at least seven crustal earthquakes of magnitude 4 or greater since 1877. The region's largest earthquakes were the 1877 M5.3 and the 1962 M5.2. In addition, the region has been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered outside the area. There is good reason to believe that the most devastating future earthquakes would probably originate along shallow crustal faults in the region and along the Cascadia Fault Zone. Deep-seated intraplate events, as occurred near Olympia, Washington in 1949 and 2001, could generate magnitudes as large as M7.5, but none have been identified in the region's historical or prehistoric records.

Earthquakes produced through volcanic activity could possibly reach magnitudes of 5.5. The 1980 Mount St. Helens eruption was preceded by a magnitude 5.1 earthquake. Despite the fact that Cascade volcanoes are some distance away from the major population centers in Region 2, earthquake shaking and secondary earthquake-related hazards such as lahars could cause major damage to these centers.

The City of Portland has been built on three identified crustal faults that stretch the length of Portland: the Oatfield Fault west of the northwest hills; the East Bank Fault, traversing the Willamette into Oregon City and the Portland Hills Fault which runs parallel to Forest Park into downtown Portland. Each of these crustal faults is capable of generating large earthquakes of M6.0–6.8.

Historic Earthquake Events

Table 2-148. Significant Earthquakes Affecting Region 2

Date	Location	Magnitude (M)	Description
Approximate Years: 1400 BCE*, 1050 BCE, 600 BCE, 400, 750, 900	Offshore, Cascadia Subduction Zone (CSZ)	probably 8.0–9.0	these are the mid-points of the age ranges for these six events
Jan. 1700	CSZ	about 9.0	generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Oct, 1877	Portland area, Oregon	5.2	two events in one day; affected area: 41,000 sq km; damage: chimney damage
Feb. 1892	Portland area, Oregon	5.0	no major damage occurred
Dec. 1941	Portland area, Oregon	4.5	felt by most Portland residents; damage: shattered windows and cracked plaster (Hillsboro and Sherwood)
Apr. 1949	Olympia, Washington	7.1	damage: in Washington and NW Oregon
Dec. 1953	Portland area, Oregon	4.5	cracked plaster and caused objects to fall (Portland)
Nov. 1961	Portland area, Oregon	5.0	principal damage: from cracked plaster
Nov. 1962	Portland area, Oregon	5.5	shaking: up to 30 seconds; damage: chimneys cracked, windows broken, furniture moved
Dec. 1963	Portland area, Oregon	4.5	damage: books and pictures fell (Plains)
Mar. 25, 1993	Scotts Mills, Oregon	5.6	FEMA-985-DR-Oregon; center: Mt. Angel-Gales Creek fault; damage: $30 million (including Oregon Capitol Building in Salem)
Feb. 2001	Nisqually, Washington	6.8	felt in the region, no damage reported

*BCE: Before Common Area.

Source: Wong and Bolt (1995)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local

probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 2 will experience an earthquake is shown in **Table 2-149**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-149. Local Probability Assessment of Earthquakes in Region 2

	Columbia	Clackamas	Multnomah	Washington
Vulnerability	L	M	H	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

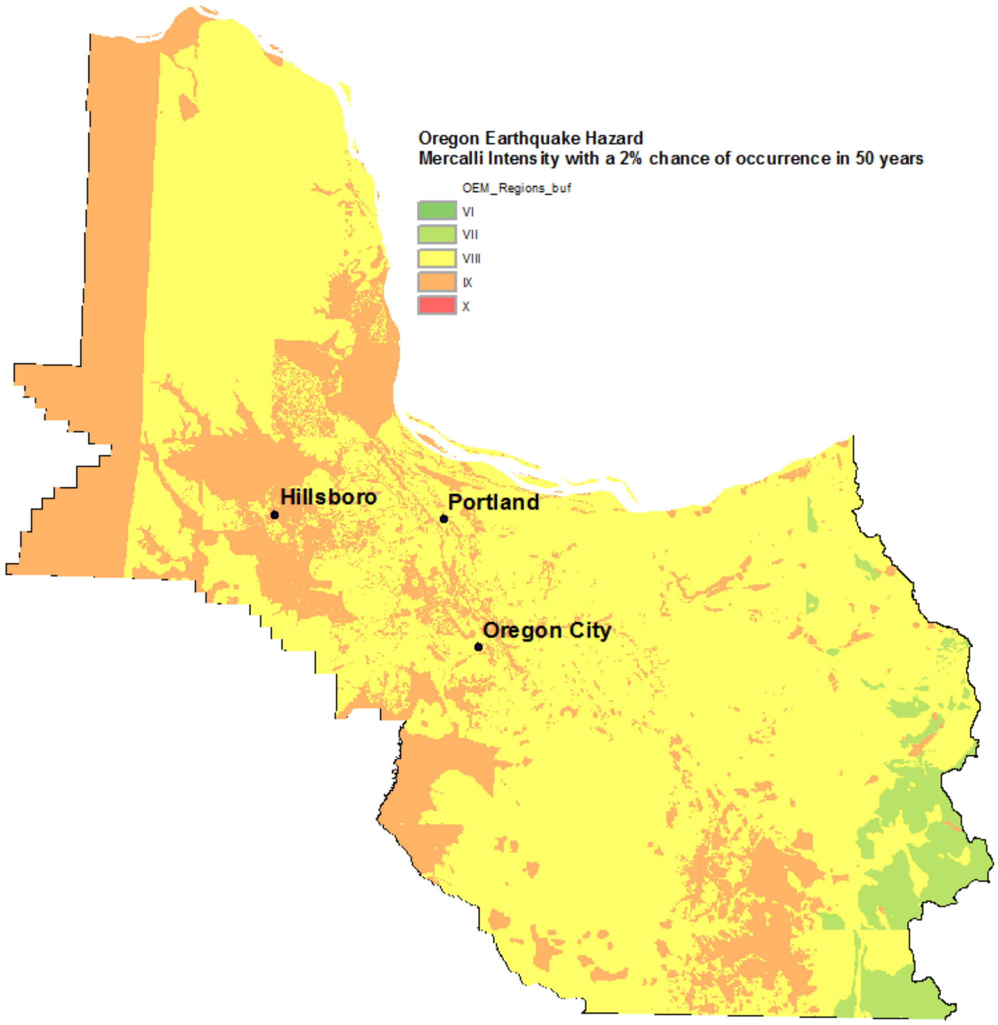
State Assessments

The probability of damaging earthquakes varies widely across the state. In Region 2 the hazard is dominated by Cascadia subduction earthquakes originating from a single fault with a well-understood recurrence history.

The probabilistic earthquake hazard for Region 2 is depicted in **Figure 2-112**. This map shows the expected level of earthquake damage that has a 2% chance of occurring in the next 50 years. The map is based on the 2008 USGS National Seismic Hazard Map and has been adjusted to account for the effects of soils following the methods of Madin and Burns (2013). In this case, the strength of shaking calculated as peak ground acceleration and peak ground velocity is expressed as Mercalli intensity, which describes the effects of shaking on people and structures. This map incorporates all that is known about the probabilities of earthquake on all Oregon faults, including the Cascadia Subduction Zone (CSZ).

For Oregon west of the crest of the Cascades, the CSZ is responsible for most of the hazard shown in **Figure 2-112**. The paleoseismic record includes 18 magnitude 8.8–9.1 megathrust earthquakes in the last 10,000 years that affected the entire subduction zone. The return period for the largest earthquakes is 530 years, and the probability of the next such event occurring in the next 50 years ranges from 7 to 12%. An additional 10 to 20 smaller, magnitude 8.3–8.5, earthquakes affected only the southern half of Oregon and northern California. The average return period for these is about 240 years, and the probability of a small or large subduction earthquake occurring in the next 50 years is 37–43%.

Figure 2-112. Probabilistic Earthquake Hazard in Region 2



Color zones show the maximum level of earthquake shaking and damage (Mercalli Intensity Scale) expected with a 2% chance of occurrence in the next 50 years. A simplified explanation of the Mercalli levels is:

VI	Felt by all, weak buildings cracked;
VII	Chimneys break, weak buildings damaged, better buildings cracked;
VIII	Partial collapse of weak buildings, unsecured wood frame houses move;
IX	Collapse and severe damage to weak buildings, damage to wood-frame structures; and
X	Poorly built structures destroyed, heavy damage in well-built structures.

Source: Madin and Burns (2013)

Vulnerability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the region's vulnerability to earthquakes is shown in **Table 2-150**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-150. Local Vulnerability Assessment of Earthquakes in Region 2

	Columbia	Clackamas	Multnomah	Washington
Vulnerability	M	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

All of Region 2 is especially vulnerable to earthquake hazards for two reasons: (a) much of the area is susceptible to earthquake-induced landslides, liquefaction, and severe ground shaking; and (b) the region contains the bulk of Oregon's population and built environment.

Of the 15 counties in the state with the highest expected damages and losses, based on a 500-year model, the following counties are located in Region 2:

- Multnomah,
- Washington, and
- Clackamas.

Table 2-151 shows the number of school and emergency response buildings surveyed in each county with their respective rankings.

Table 2-151. School and Emergency Response Building Collapse Potential in Region 2

	Level of Collapse Potential			
County	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Clackamas	123	48	40	6
Columbia	19	13	15	3
Multnomah	68	118	116	29
Washington	81	69	80	6

Source: Lewis (2007), available at http://www.oregongeology.org/sub/projects/rvs/default.htm.

The Oregon Department of Geology and Mineral Industries (DOGAMI) has also developed two earthquake loss models for Oregon based on the two most likely sources of seismic events: (a) the Cascadia Subduction Zone (CSZ), and (b) combined crustal events (500-year model). Both models use Hazus, a software program developed by the Federal Emergency Management Agency (FEMA), as a means of determining potential losses from earthquakes. The CSZ event is based on a potential M8.5 earthquake generated off the Oregon coast. The model does not take into account a tsunami, which probably would develop from such an event. The 500-year crustal model does not look at a single earthquake (as in the CSZ model); it encompasses many faults. Neither model takes unreinforced masonry buildings into consideration.

DOGAMI investigators caution that the models contain a high degree of uncertainty and should be used only for general planning and policy making purposes. Despite their limitations, the models do provide some approximate estimates of damage and are useful to understand the relative relationships between the counties. Results are found in **Table 2-152**.

Metro (the elected regional government that serves more than 1.3 million residents in Clackamas, Multnomah, and Washington Counties and the 24 cities in the Portland Metro area) has likewise evaluated earthquake potential and losses for its three-county area. The analysis included an inventory of over 50,000 commercial and multi-family dwellings at risk. Single-family dwellings within the Metro boundary were not evaluated because their structural similarity (Metro, 1998).

Other useful resources for planning for earthquakes include the following:

Maps of earthquake hazard areas: DOGAMI has mapped all of the Region 2 counties and has statewide GIS earthquake hazard layers available (Madin & Burns, 2013).

Map of critical facilities vulnerable to hazards: DOGAMI has developed these maps for all Region 2 counties.

Environmental geology maps: DOGAMI has developed these maps for all Region 2 counties.

Nuclear energy/hazardous waste sites inventories: No Region 2 counties have nuclear facilities.

Table 2-152. Projected Dollar Losses in Region 2, Based on an M8.5 Subduction Event and a 500-Year Model

M8.5 CSZ Event					**500-Year Model**[1]			
COUNTIES	**Multnomah**	**Washington**	**Columbia**	**Clackamas**	**Multnomah**	**Washington**	**Columbia**	**Clackamas**
Injuries	1,521	555	36	128	8,659	2,910	150	1,402
Deaths	28	10	0	2	186	62	3	29
Displaced households	2,803	2,062	94	426	13,777	7,666	326	2,525
Economic losses for buildings[2]	$1.9 b	$931 m	N/A	$316 m	$9.2 b	$3.8 b	$267 m	$2.1 b
Operational "day after" the quake Fire Stations Police Stations Schools Bridges	 78% 76% 81% 94%	 66% 64% 64% 79%	 unknown 45% 63% 82%	 84% 84% 84% 90%	 N/A[3] N/A * *	 * * * *	 * * * *	 * * * *
Economic losses to Highways Airports Communications	 $21 m $2 m $3 m	 $15 m $5 m $752,000	 $2 m $2 m $97,000	 $6 m $3 m $232,000	 $437 m $12 m $31 m	 $61 m $23 m $4 m	 $10 m $8 m $950,000	 $74 m $32 m $4 m
Debris generated (thousands of tons)	1,598	763	57	237	6,745	2,817	184	1,588

[1]Every part of Oregon is subject to earthquakes. The 500-year model is an attempt to quantify the risk across the state. The estimate does not represent a single earthquake. Instead, the 500-year model includes many faults. More and higher magnitude earthquakes than used in this model may occur (DOGAMI, 1999).

[2]"…there are "numerous unreinforced masonry structures (URMs) in Oregon, the currently available default building data does not include any URMs. Thus, the reported damage and loss estimates may seriously under-represent the actual threat" (Wang, 1998, p. 5).

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

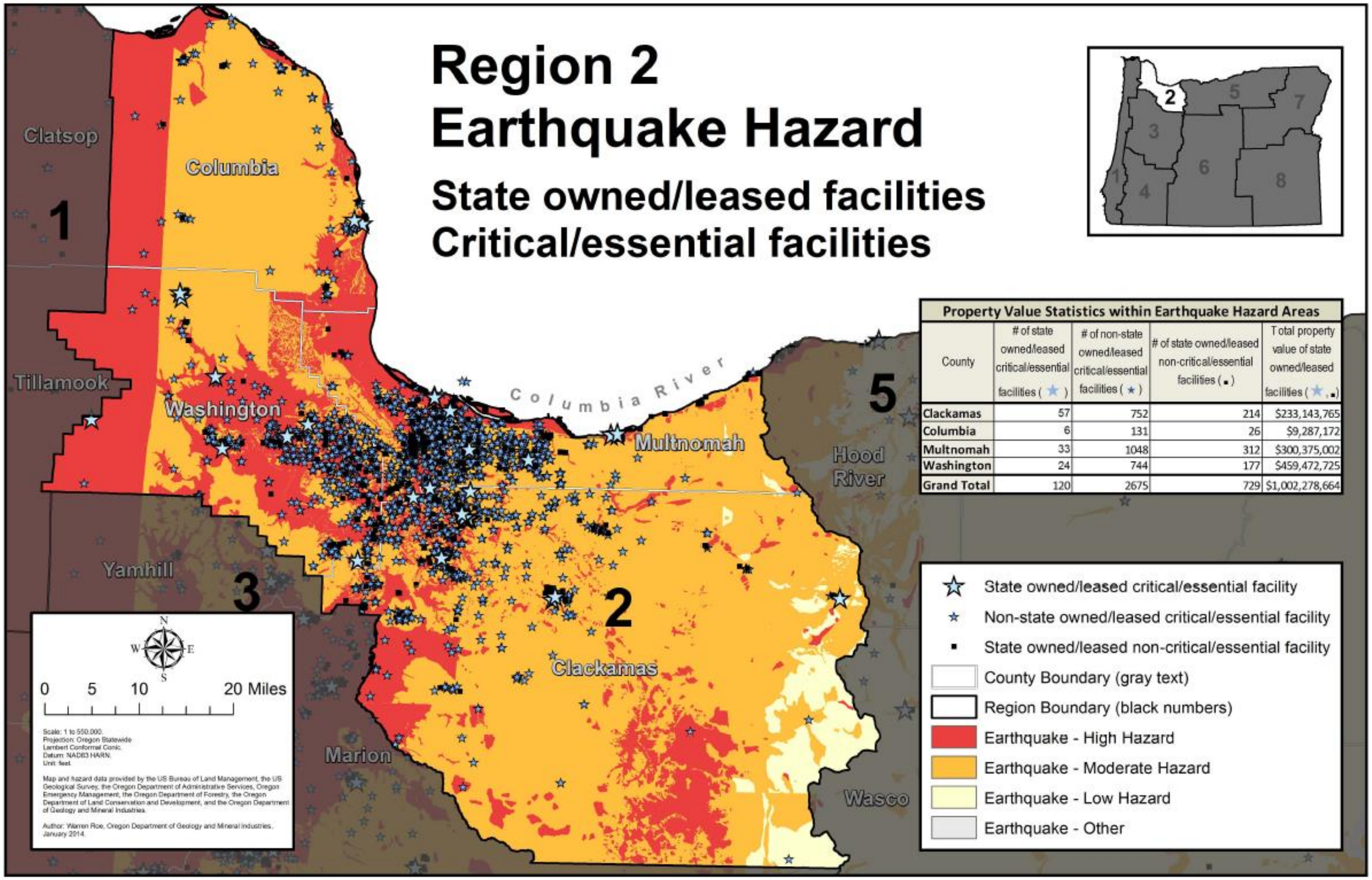
Source: Wang and Clark (1999)

State-Owned/Leased Facilities and Critical/Essential Facilities

The following information is based on a State facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. (See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.)

Of 5,693 state facilities evaluated, 849 totaling over $1 billion worth of property are located in an earthquake hazard zone in Region 2 (**Figure 2-113**). Among the 1,141 State critical/essential facilities, 120 are in an earthquake hazard zone in Region 2. Additionally, 2675 non-state critical/essential facilities in Region 2 are located in an earthquake hazard zone.

Figure 2-113. State-Owned/Leased Facilities and Critical/Essential Facilities in an Earthquake Zone in Region 2



Property Value Statistics within Earthquake Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (■)	Total property value of state owned/leased facilities (★, ■)
Clackamas	57	752	214	$233,143,765
Columbia	6	131	26	$9,287,172
Multnomah	33	1048	312	$300,375,002
Washington	24	744	177	$459,472,725
Grand Total	120	2675	729	$1,002,278,664

Source: DOGAMI

SEISMIC LIFELINES

"Seismic lifelines" are the state highways ODOT has identified as most able to serve response and rescue operations, reaching the most people and best supporting economic recovery. The process, methodology, and criteria used to identify them are described in **Section 2.2.2.6, Seismic Transportation Lifeline Vulnerabilities**, and the full report can be accessed at **Appendix 9.1.13**, *Statewide Loss Estimates: Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification* (OSLR). According to that report, seismic lifelines in Region 2 have the following vulnerabilities.

The following geographic zones identified in the OSLR are located within Region 2:

- *Portland Metro Geographic Zone:* In addition to encompassing the largest population concentration in the state, this zone contains extensive facilities (such as transportation, communication, and fuel depots) that are critical to statewide earthquake response and recovery. For these reasons, it has a higher concentration of lifeline routes than the other geographic zones and redundant Tier 1 crossings of the Willamette River.

  The Tier 1 system (highest priority roadway) in the Portland Metro Geographic Zone consists of the following corridors:

    - I-5, excluding the section between the northern and southern I-405 interchanges,
    - I-405,
    - I-205, and
    - OR-99 W from I-5 to OR-217.

  The Tier 2 system (second highest priority roadway) in the Portland Metro Geographic Zone consists of three access corridors:

    - I-84,
    - I-5 between the northern and southern I-405 interchanges, and
    - US-26 from OR-217 to I-405.

  The Tier 3 system in the Portland Metro Geographic Zone consists of the following corridors:

    - OR-217,
    - US-26 from I-5 to I-205, and
    - OR-43.

- *Cascades Geographic Zone:* This region also includes part of the OSLR Cascades Zone. The recommended seismic lifelines for this region include three crossings of the Cascades from western to central Oregon that have areas vulnerable to landslides and may be subject to damage from ground shaking. These routes connect the highly seismically impacted western portion of the state to the less seismically impacted central portion of the state. The Tier 1 system in the Cascades Geographic Zone that serves this region is I-84. The Tier two routes in the Cascades Geographic Zone that serve this region are OR-212 and US-26. There are no corridors designated as Tier 3 in the Cascades Geographic Zone.

Regional Impact.

- Ground shaking: In the Northern Willamette Valley / Portland Metro Region, the level of damage from ground shaking levels depends upon its intensity and duration. Unreinforced structures, roadbeds, and bridges will be damaged to varying extents, and it is expected that river crossings and areas with limited surface transportation alternatives will isolate some neighborhoods hindering rescue and recovery activities. There are also several localized faults in the region about which not much is known; it is possible that a major CSZ event could activate local faults.
- Landslides and rockfall: Many roadways in the area are cut into or along landslide prone features. Removal of slide and rockfall material is an ongoing responsibility of ODOT Maintenance crews in hilly areas and the parts of the Cascades and Coast Regions that fall within Region 2. A major CSZ event may increase landslide and rockfall activities in this region and may reactivate ancient slides that are currently inactive. In the Lower Columbia River basin, ground shaking may change the shipping channel and other features.
- Tsunamis: There may be tsunami impacts in the Lower Columbia area, with variables including the size and force of the tsunami, whether jetties hold up to the tsunami and water levels in the river. Damage to ports, shipping channels, water-dependent uses, and other low lying areas is possible.
- Liquefaction: Structures in wetland, estuarine, alluvial, and other saturated areas may be subject to liquefaction damage; the total area of such impacts will vary with the extent of saturated soils at the time of the event. Bridge approaches, low lying roadways, and transportation fuel supplies are all at risk in this region.

Regional Loss Estimates. Highway-related losses include disconnection from supplies and replacement inventory, and the loss of tourists and other customers who must travel to do business with affected businesses.

Most Vulnerable Jurisdictions. Columbia and Multnomah Counties are the most vulnerable to water related effects, particularly liquefaction. The whole region, including Clackamas and Washington Counties, is likely to have significant impacts related to ground shaking. Landslides are likely in some hilly areas. Vulnerabilities with both regional and statewide transportation impacts in Multnomah County, Portland, and the Portland Metro area include potential loss of stored fuels and distribution infrastructure; interruption of services at Portland International Airport; interruption of intermodal freight capacity due to river channel changes; damage to onshore facilities and surface transportation facilities; and bridge or bridge approach failures across both the Willamette and Columbia Rivers.

Floods

Characteristics

The northern Willamette Valley (including the Portland Metro area) has a lengthy flood history with significant floods occurring about every 5–7 years (**Table 2-153**). The Willamette and Columbia Rivers have produced numerous floods, some of which are shown in **Table 2-153**. Most Willamette River flooding is a winter phenomenon. The common pattern includes the accumulation of heavy wet snow in higher elevations followed by a mild, rainy, weather system. The resulting snowmelt on saturated or frozen ground sometimes produces devastating flood conditions. These conditions would be worse were it not for many dams (used for, among other purposes, flood control) on the upper reaches of the Willamette and some of its tributaries.

Clackamas County is the third most populated county in the state, with nearly all development concentrated in the western half of the county, downstream from significant sources of mountain runoff.

Columbia County, smaller in area and less populated than Clackamas County, receives more annual rainfall and, as a result, has a denser stream network. The City of Vernonia (see **3.3.5.5, Mitigation Success — City of Vernonia, 2014**), suffered extensive flooding in 2007 resulting in damage to over 300 buildings. Mitigation activities in Vernonia, including relocation of the K–12 school buildings, following the 2007 flood event have significantly reduced damage potential in this small city.

The Columbia River Estuary is the second largest river in the United States and the largest river to flow into the eastern North Pacific. Columbia River floods usually occur in the early summer and are associated with seasonal runoff from melting snow. Although unusually extreme, the Vanport Flood (1948) provides an example of such an event. The 20-day flood was the greatest single disaster in the recorded history of the Columbia River Basin. The toll was 32 dead and 7 missing in the Portland area. Flooding occurred when the Columbia River broke through a dike surrounding the community of Vanport and forced 50,000 people to evacuate their homes. Economic losses reportedly exceeded $100 million. Vanport, a Vancouver-Portland suburban community and the largest public housing project ever built in the United States, was not rebuilt. Prolonged winter rain, debris dams, and breeched dikes have produced flood conditions at several Columbia County locations. Tidal influences are observed on the Columbia River inland to the Bonneville Dam and on the Willamette in Portland.

A common Willamette Valley phenomenon involves tributary stream backup during periods of high water. When tributary streams cannot enter swollen main stem rivers during periods of high water, tributary streams are forced out of their banks. During the February 1996 flood, dams controlled Columbia River flows. This allowed the Willamette River to enter the Columbia, averting flooding in downtown Portland, but other streams produced widespread flooding throughout the region. **Table 2-154** summarizes the sources of flooding for each of the major rivers in the region.

Historic Flood Events

Table 2-153. Significant Historic Floods in Region 2

Date	Location	Description	Type of Flood
Dec. 1861	coastal rivers	the "Great Flood;" largest flood of known magnitude on the Willamette River; every town on the river was flooded or washed away; widespread damage	rain on snow and snow melt
Dec. 1862	Willamette River Basin	widespread flooding	rain on snow
Feb. 1890	Willamette Basin	second largest flood of known magnitude; water levels in Portland: 22.3 ft	rain on snow
June 1894	main stem Columbia	largest flood ever observed on the river; current small in Portland; little damage	snow melt
Jan. 1923	Willamette and Columbia Rivers	rain and mild weather; widespread damage to roads and railroads	rain on snow
Dec. 1937	Willamette Basin	considerable flooding; landslides	rain on snow
Dec. 1945	Willamette Basin / NW Oregon	very warm temperatures; considerable flood damage	rain on snow
June 1948	main stem of the Columbia	Vanport near Portland completely destroyed	snow melt
Dec. 1955	Columbia River and Willamette Basin	strong winds/flooding; five fatalities	rain on snow
Dec. 1964	entire state	record-breaking December rainfall; widespread damage; warm temperatures	rain on snow
Jan. 1972	Willamette and Sandy Rivers	widespread damage; many fish buildings, etc. destroyed; five fatalities	rain on snow
Jan. 1974	western Oregon	mild storms followed heavy snow and freezing rain; nine counties declared disasters	rain on snow
Jan. 1978	Willamette River and NW Oregon	intense rain/snowmelt; widespread flooding	rain on snow
Feb. 1986	entire state	numerous homes evacuated; intense rain and melting snow	snow melt
Feb. 1987	western Oregon	Willamette and tributaries; mud slides, flooded highways, damaged homes	rain on snow
Jan. 1990	western Oregon	10 rivers in eight counties flooded; many bridges washed away	rain on snow
Feb. 1996	NW Oregon	warm temperatures / record breaking rains; widespread flooding (FEMA-1099-DR-OR. 1996)	rain on snow
Dec. 1996	western Oregon	mild subtropical moisture led to extensive flooding. 14 county disaster	rain on snow
Jan. 2006	Washington County	Tualatin River in Dilley and Farmington reached above flood stages	riverine
Nov. 2006	Clackamas County	heavy rain caused the Sandy River and Clackamas River to flood, causing damage in Estacada and Oregon City. Total county-wide damages of $3 million	riverine
Dec. 2007	Washington County	flooding of the Tualatin River following heavy rainfall from a tropical storm; old OR-47 and OR-47 closed temporarily; total of $2.3 million in damages	riverine
Dec. 2007	Columbia County	flooding of the Nehalem River caused widespread damage in Vernonia, flooding numerous homes and causing a total of $36 million in damages for Columbia County	riverine
Jan. 2009	Washington County	severe winter storm/snow event that included snow, high winds, freezing rain, ice, blizzard conditions, mudslides, and landslides	
Jan. 2011	Clackamas County	severe winter storm, flooding, mudslides, landslides, and debris flows	
Sep. 2013	Multnomah County	heavy rain resulted in damage to the Legacy Good Samaritan Medical Center and several businesses in northwest Portland	riverine

Sources: Taylor and Hatton (1999); National Climatic Data Center; KPTV_KPDX (2013)

Table 2-154. Principal Riverine Flood Sources in Region 2

Clackamas	Columbia	Multnomah	Washington
Willamette River and tributaries:	Clatskanie River	Columbia and Willamette Rivers and tributaries:	Willamette River and tributaries:
Abernethy Creek	Columbia River	Sandy River	Tualatin River
Clackamas River	Conyers Creek	Multnomah Channel	Fanno Creek
Clear Creek	McNulty Creek	Johnson Creek	Summer Creek
Dear Creek	Milton Creek	Fairview Creek	Ash Creek
Eagle Creek	Multnomah Channel	Columbia Slough	Rock Creek
Johnson Creek	Nehalem Creek	Ponding within Drainage Dist. #1	Cedar Creek
Kellogg Creek	Rock Creek	Beaver Creek	Butternut Creek
Milk Creek	Scappoose Creek	Fairview Creek	Dawson Creek
Molalla River		Kelley Creek	Beaverton Creek
Mt. Scott Creek		Mitchell Creek	Bronson Creek
Nyberg Slough			Willow Creek
Oswego Channel			Cedar Mill Creek
Phillips Creek			Johnson Creek
Pudding River			Dairy Creek
Salmon River			McKay Creek
Sandy River			Council Creek
Still Creek			Gales Creek
Tualatin River			Wapato Creek
Zig Zag River			Nyberg Slough
Tickle Creek			

Sources: FEMA, Clackamas County Flood Insurance Study (FIS), Aug. 15, 1996, FEMA, Lane County FIS, June 2, 1999, FEMA, Linn County FIS, Sept. 29, 1986, FEMA, Marion County FIS, July 13, 2001, FEMA, Polk County FIS, Dec. 19, 1995, FEMA, Yamhill County FIS, Sept. 30, 1983

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 2 will experience flooding is shown in **Table 2-155**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-155. Local Probability Assessment of Flood in Region 2

	Columbia	Clackamas	Multnomah	Washington
Probability	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

All Region 2 counties have Flood Insurance Rate Maps (FIRM) depicting the extent of the 1% flood (100 year). Most of the flood zones shown on these maps are based on old modeling and could be outdated. The FIRM maps were issued at the following times:

- Clackamas County, June 2008;
- Multnomah County, December 2009;
- Washington County, September 1982 (rural areas) and February 2005 (urban areas); and
- Columbia County, November 2010.

Vulnerability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the region's vulnerability to flooding is shown in **Table 2-156**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-156. Local Vulnerability Assessment of Flood in Region 2

	Columbia	Clackamas	Multnomah	Washington
Vulnerability	H	M	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The Oregon Department of Land Conservation and Development (DLCD) created a countywide flood vulnerability index by compiling data from NOAA's Storm Events Database and from FEMA's National Flood Insurance Program. Data were calculated statewide for the period 1978 through 2013 for five input datasets: number of events, structure and crop damage estimates in dollars and NFIP claims number and dollar amounts. The mean and standard deviation were calculated for each input. Then each county was assigned a score ranging from 0 to 3 for each of these inputs according to **Table 2-157**.

Table 2-157. Scoring for Vulnerability Index

Score	Description
3	county data point is greater than 2.5 times standard deviation for the input data set
2	county data point is greater than 1.5 times standard deviation for the input data set
1	county data point is within standard deviation
0	no data reported

Source: DLCD

DLCD summed the scores for each of the five inputs to create a county-by-county vulnerability index. The maximum possible score is 15. A score over 6 indicates that at least one variable significantly exceeds average values.

The four counties in Region 2 received flood vulnerability scores ranging from 5 to 9: Clackamas (9), Columbia (8), Multnomah (5), and Washington (5). Clackamas County has the most repetitive losses of the group, which supports that county's higher than average vulnerability score. Washington County, on the other hand, reports a similar number of repetitive losses, but its vulnerability score is below average. The reasons for this difference have not been quantified; however, it is likely due to the very damaging flood and channel migration incidents that occurred in eastern Clackamas County on the flanks of Mount Hood. More research is needed to articulate the exact reasons why Clackamas County is the most vulnerable in the region to damaging floods. Columbia County's score is likely due to the very damaging floods in the City of Vernonia and Nehalem Valley in 1996 and 2007. After the 2007 floods, the city and county completed many mitigation projects (elevations and buy-outs) with the likely outcome that this region is actually less vulnerable now than reported here because past losses were used to calculate vulnerability scores.

FEMA has identified 98 Repetitive Loss properties in Region 2, four of which are Severe Repetitive Loss properties. This region has the second most repetitive flood losses of the Oregon NHMP Natural Hazard Regions, reflecting high rainfall amounts near the Columbia River and a high population density.

Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS), which results in reduced flood insurance costs. Clackamas County participates in CRS, as do the cities of Oregon City, Portland, Scappoose, and Troutdale.

Table 2-158. Severe/Repetitive Flood Losses and Community Rating System Communities by County in Region 2

County	RL	SRL	# of CRS Communities per County
Clackamas	53	3	2
Columbia	6		1
Multnomah	4		2
Washington	35	1	0
Totals:	**98**	**4**	**5**

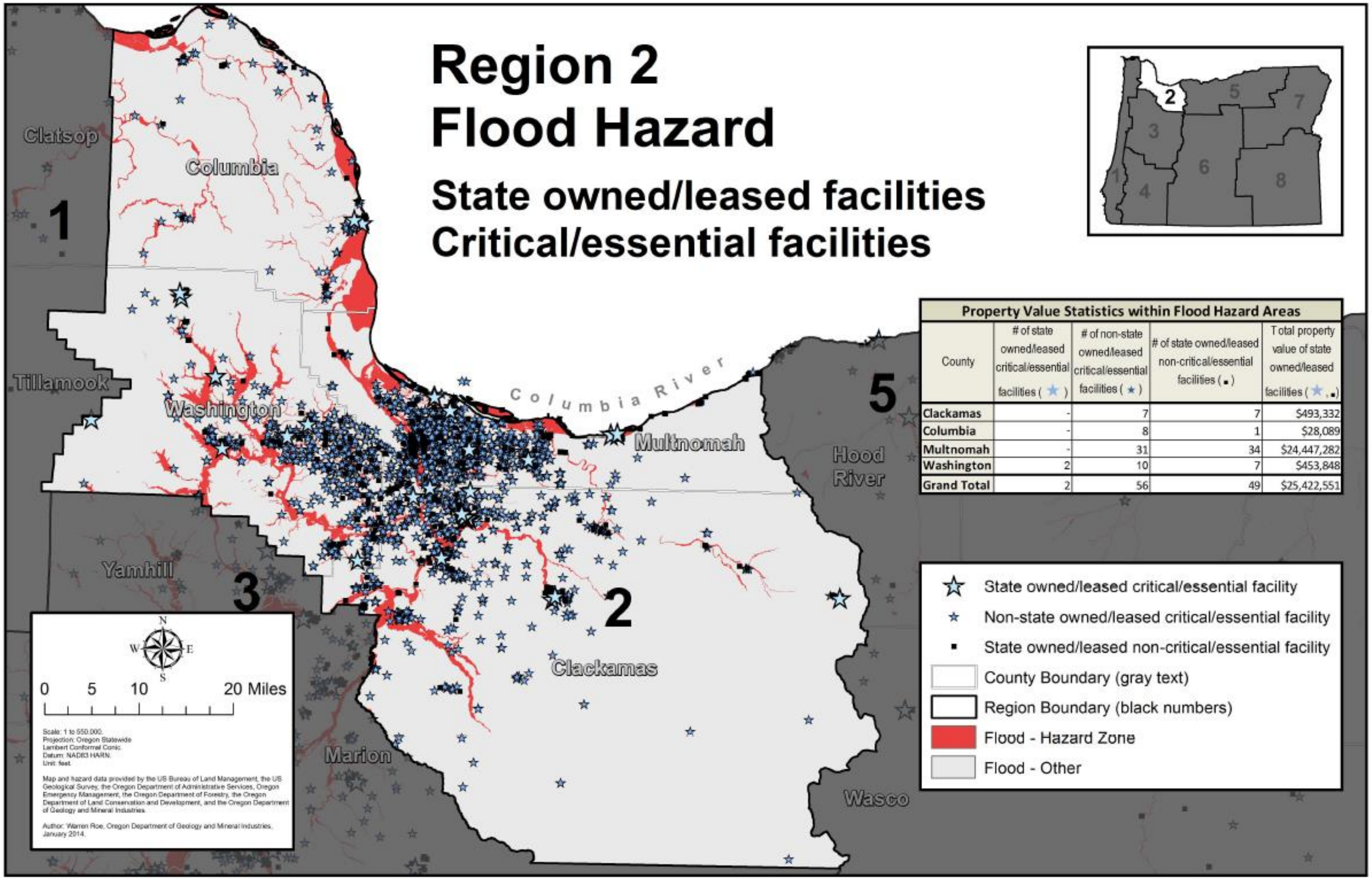
Source: FEMA NFIP BureauNet, http://bsa.nfipstat.fema.gov/, accessed 12/1/2014

State-Owned/Leased Facilities and Critical/Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of the 5,693 state facilities evaluated, 51 are currently located within a flood hazard zone in Region 2 and have an estimated total value of $25.4 million (**Figure 2-114**). Of these, two are identified as a critical or essential facility. An additional 56 non-state-owned/leased critical/essential facilities are located in a flood hazard zone in Region 2.

Figure 2-114. State-Owned/Leased Facilities and Critical/Essential Facilities in a Flood Zone in Region 2



Property Value Statistics within Flood Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (■)	Total property value of state owned/leased facilities (★, ■)
Clackamas	-	7	7	$493,332
Columbia	-	8	1	$28,089
Multnomah	-	31	34	$24,447,282
Washington	2	10	7	$453,848
Grand Total	2	56	49	$25,422,551

Source: DOGAMI

Landslides

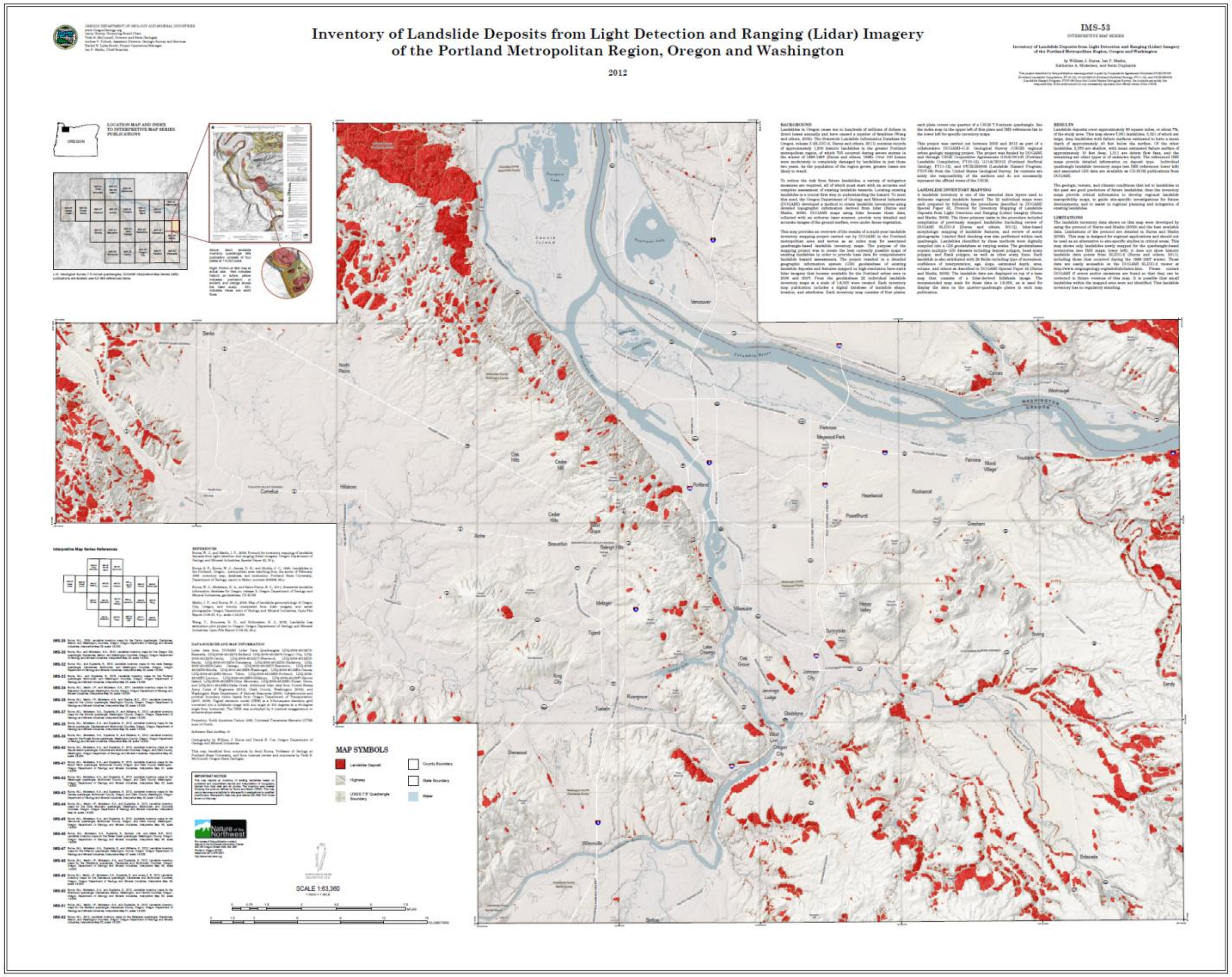
Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. In general, the Coast Range and Cascade Mountains have a very high incidence of landslides. On occasion, major landslides sever major transportation routes such as U.S. or state highways and rail lines, causing temporary but significant economic damage to the state.

In Multnomah County (including the city of Portland) landslide activity has been a recurring problem for many years. In February 1996, landslide activity that occurred in Portland and the Dodson-Warrendale area (east Multnomah County) was notable and severely impacted homeowners and transportation routes. In fact, I-84 in the Columbia River Gorge was closed for a number of days by fast moving debris flows that covered the roadway and the east-west railroad tracks.

New lidar-based landslide inventory mapping was just completed for most of the Portland Metro area (Burns et al., 2012b). Landslide deposits cover approximately 83 square miles, or about 7%, of the study area. This map shows 7,081 landslides, 3,321 of which are large, deep landslides with failure surfaces estimated to have a mean depth of approximately 40 feet below the surface. Of the other landslides, 2,376 are shallow, with mean estimated failure surface of approximately 10 feet deep; 1,311 are debris flow fans; and the remaining are other types or of unknown depth. The geologic, terrain, and climatic conditions that led to landslides in the past are good predictors of future landslides; thus the inventory maps provide critical information to develop regional landslide susceptibility maps, to guide site-specific investigations for future developments, and to assist in regional planning and mitigation of existing landslides.

Figure 2-115. Inventory of Landslide Deposits from Lidar Imagery of the Portland Metro region, Oregon and Washington



Source: Burns et al. (2012b)

Historic Landslides

In 1996-1997, 700 landslides occurred in the Portland Metro area. Over 100 homes were moderately to completely damaged by landslides in just those two years (Burns et al., 1998). As the population of the region grows, greater losses are likely to result.

Table 2-159. Historic Landslides in Region 2

Date	Location	Description
Mar. 1972	near Portland, Oregon	mud and rock slide on I-5; injured: three motorists
Oct. 1984	I-84 near Cascade Locks, Oregon	rockslide; fatalities: two children; cost of stabilizing the slide area: $4 million
Sep. 1990	near Troutdale, Oregon	landslide; injuries: four highway workers
Feb. 1996	Dodson-Warrendale, Portland Metro area, Oregon	FEMA-1099-DR-Oregon; heavy rains and rapidly melting snow contributed to thousands of landslides and debris flows across the state; many occurred on clear cuts that damaged logging roads; I-84 closed at Dodson-Warrendale (700 in the Portland Metro area)
Dec. 2007	Clatsop, Columbia, Tillamook, Washington, and Yamhill Counties, Oregon	landslide due to heavy rains from a strong winter storm; damages: $1.5 million total (Clatsop, Columbia, Tillamook, Washington, and Yamhill Counties); $300,000 (to Columbia County alone)

Sources: ODOT Emergency Operations Plan, May, 2002; Interagency Hazard Mitigation Team Report, FEMA-1099-DR-OR, June, 1997; Interagency Hazard Mitigation Team Report, FEMA-1149-DR-OR, March, 1997; Taylor and Hatton, 1999; Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 2 will experience landslides is shown in **Table 2-160**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-160. Local Probability Assessment of Landslides in Region 2

	Columbia	Clackamas	Multnomah	Washington
Probability	M	H	H	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Landslides are found in every county in Oregon. There is a 100% probability of landslides occurring in Oregon in the future. Although we do not know exactly where and when they will occur, they are more likely to happen in the general areas where landslides have occurred in the past. Also, they will likely occur during heavy rainfall events or during a future earthquake.

Vulnerability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the region's vulnerability to landslides is shown in **Table 2-161**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-161. Local Vulnerability Assessment of Landslides in Region 2

	Columbia	Clackamas	Multnomah	Washington
Vulnerability	M	L	M	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

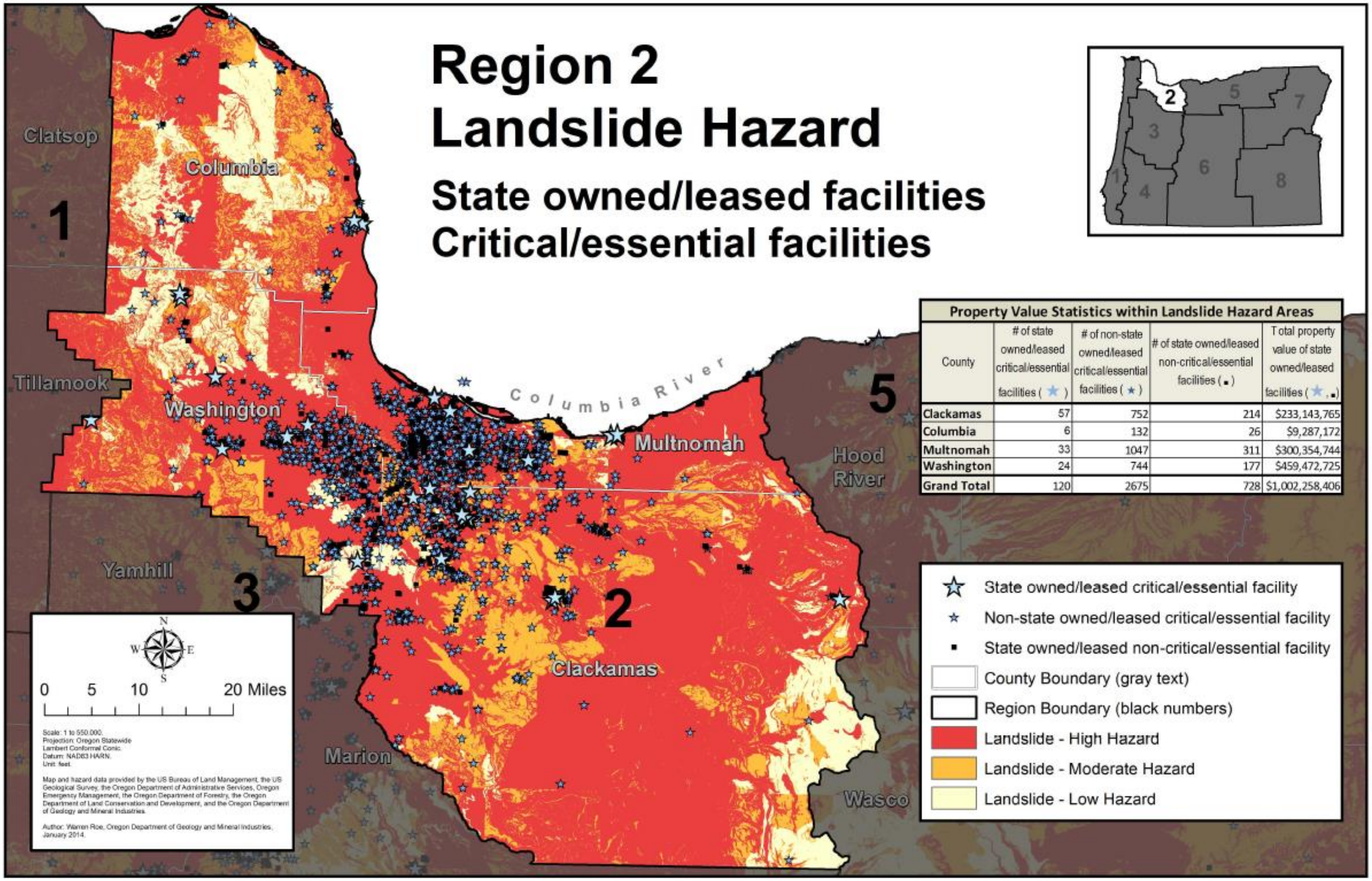
Many communities in this region are vulnerable to landslides; for example, the Portland Hills and the Oregon City area both have high exposure to landslides. In general, Washington, Multnomah, and Clackamas Counties have relatively high vulnerability.

State-Owned/Leased Facilities and Critical/Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. (See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.)

Of the 5,693 state facilities evaluated, 848 are located within landslide hazard areas in Region 2, totaling roughly $1 billion (**Figure 2-116**). This includes 120 state critical or essential facilities. An additional 2,675 critical/essential facilities, not owned/leased by the state, are also located within a landslide hazard zone in Region 2.

Figure 2-116. State-Owned/Leased Facilities and Critical/Essential Facilities in a Landslide Zone in Region 2



Property Value Statistics within Landslide Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Clackamas	57	752	214	$233,143,765
Columbia	6	132	26	$9,287,172
Multnomah	33	1047	311	$300,354,744
Washington	24	744	177	$459,472,725
Grand Total	120	2675	728	$1,002,258,406

Source: DOGAMI

Volcanoes

Characteristics

The eastern boundaries of Clackamas and Multnomah Counties coincide with the crest of the Cascade Mountains. Volcanic activity in the Cascades will continue, but questions regarding how, to what extent, and when remain. Most volcano-associated hazards are local (e.g., explosions, debris, lava, and pyroclastic flows). However, lahars can travel considerable distances through stream valleys, and ashfall can blanket areas many miles from the source.

Historic Volcanic Events

Table 2-162. Historic Volcanic Events in Region 2

Date	Location	Description
about 20,000 to 13,000 YBP	Polallie eruptive episode, Mount Hood	lava dome, pyroclastic flows, lahars, tephra
about 1,500 YBP	Timberline eruptive period, Mount Hood	lava dome, pyroclastic flows, lahars, tephra
1760–1810	Crater Rock/Old Maid Flat on Mount Hood	pyroclastic flows in upper White River; lahars in Old Maid Flat; dome building at Crater Rock
1859/1865	Crater Rock on Mount Hood	steam explosions/tephra falls
1907 (?)	Crater Rock on Mount Hood	steam explosions
1980	Mount St. Helens (Washington)	debris avalanche, ashfall, flooding on Columbia River

Note: YBP is years before present.

Sources: U.S. Geological Survey, Cascades Volcano Observatory: http://volcanoes.usgs.gov/observatories/cvo/; Wolfe and Pierson (1995); Scott et al. (1997)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 2 will experience volcanic activity is shown in **Table 2-163**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-163. Local Probability Assessment of Volcanic Activity in Region 2

	Columbia	Clackamas	Multnomah	Washington
Probability	L	L	H	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Region 2 communities are closest to Mount Hood (Clackamas County), a stratovolcano. Stratovolcanoes have wide ranging modes of eruption, making future volcanic activity difficult to predict definitively. Mount Hood's eruptive history can be traced to late Pleistocene times (15,000–30,000 years ago) and will no doubt continue. However, the central question remains: When?

The most recent series of events (1760–1907) consisted of small lahars, debris avalanches, steam explosions, and minor ashfalls. Mount Hood's recent history also includes ashfalls, dome building, lahars, pyroclastic flows, and steam explosions. These occurred approximately 200 years ago. Geoscientists have provided estimates of future activity in the vicinity of Crater Rock, a well-known feature on Mount Hood. They estimate a 1 in 300 chance that some dome activity will take place in a 30-year period (1996–2026). For comparison, the 30-year probability of a house being damaged by fire in the United States is about 1 in 90 (Scott et al., 1997).

The probability of 1 cm or more of ashfall from eruptions throughout the Cascade Range include (Sherrod et al., 1997):

- Clackamas County: between 1 in 500 and 1 in 1000;
- Multnomah County: between 1 in 500 and 1 in 1,000;
- Washington County: between 1 in 1,000 and 1 in 5,000; and
- Columbia County: between 1 in 5,000 to 1 in 10,000.

Mount St. Helens is less than 50 air miles from some Columbia County communities and is still active. Prevailing wind direction is of paramount importance. Because the prevailing winds are westerly in Columbia County, the risk of ashfall is considerably reduced.

Table 2-164 summarizes the probability of volcano-related hazards for each county. Debris from the 1980 eruption of Mount St. Helens impacted the shipping channel on the Columbia River by reducing water depth to such an extent that dredging was required.

Table 2-164. Probability of Volcano-Related Hazards in Region 2

Volcano Related Hazards	Washington	Multnomah	Clackamas	Columbia	Remarks
Volcanic ash (annual probability of 1cm or more accumulation from eruptions throughout the Cascade Range)	1 in 5,000 to 1 in 10,000	1 in 1,000 to 1 in 5,000	1 in 1,000 to 1 in 5,000	1 in 5,000 to 1 in 10,000	Sherrod et al. (1997)
Lahar	no risk	Source: Mount Hood	Source: Mount Hood	no risk	Scott et al. (1997)
Lava flow	no risk	no risk	Source: Mount Hood	no risk	Scott et al. (1997)
Debris flow / avalanche	no risk	Source: Mount Hood	Source: Mount Hood	Mount St. Helens	Scott et al. (1997)
Pyroclastic flow	no risk	no risk	Source: Mount Hood	no risk	Scott et al. (1997)

Vulnerability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the region's vulnerability to volcanic activity is shown in **Table 2-165**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-165. Local Vulnerability Assessment of Volcanic Activity in Region 2

	Columbia	Clackamas	Multnomah	Washington
Vulnerability	M	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

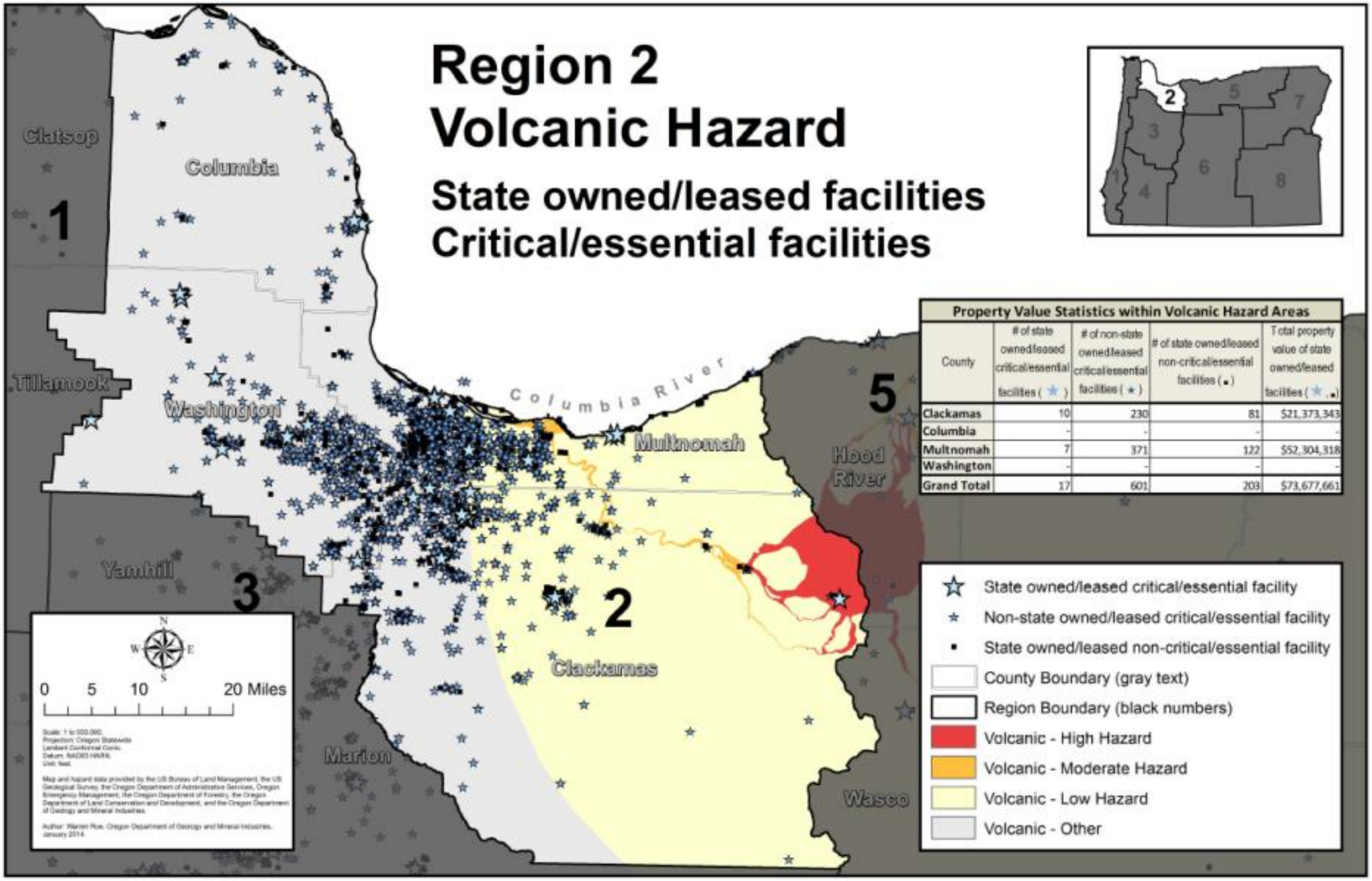
The U.S. Geological Survey has addressed volcanic hazards at Mount Hood (Scott et al., 1997) and Mount St. Helens (Wolfe and Pierson, 1995). These reports include maps depicting the areas at greatest risk. Clackamas and Multnomah Counties, including the Portland Metro area, are at risk and should consider the impact of volcano-related activity on small mountain communities, dams, reservoirs, energy-generating facilities, and highways. These counties also should consider probable impacts on the local economy (e.g., wood products and recreation). The communities of Government Camp, Rhododendron, and Welches merit special attention. There is virtually no risk from volcanoes in Washington County, although normal prevailing winds could shift and carry ash into that area. Debris entering the Columbia River from eruptions at Mount St. Helens or Mount Hood may disrupt shipping operations based in Columbia and Multnomah Counties.

State-Owned/Leased Facilities and Critical/Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. (See the State Risk Assessment, **Oregon Vulnerabilities** for more information.)

Of the 5,693 state facilities evaluated, are 220 located within a volcanic hazard in Region 2; and total roughly $73.7 million in value. Of those facilities, 17 are critical or essential facilities. In addition, there are 601 non-state-owned/leased critical or essential facilities located within a volcanic hazard zone in Region 2 (**Figure 2-117**).

Figure 2-117. State-Owned/Leased Facilities and Critical/Essential Facilities in a Volcanic Hazard Zone in Region 2



Property Value Statistics within Volcanic Hazard Areas				
County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Clackamas	10	230	81	$21,373,343
Columbia	-	-	-	-
Multnomah	7	371	122	$52,304,318
Washington	-	-	-	-
Grand Total	17	601	203	$73,677,661

Source: DOGAMI

Wildfires

Characteristics

There is extensive forested land in Columbia, Clackamas, Multnomah, and Washington Counties, both in undeveloped National Forest land and developing wildland-urban interface areas. All of it is at risk, but especially within the interface areas. In recent years, the cost of fire suppression has risen dramatically. A large number of homes have been threatened or burned, more firefighters have been placed at risk, and fire protection in wildland areas has been reduced. These factors have prompted communities and protection agencies to come together and use or create extensive fire prevention/mitigation programs. Community Wildfire Protection Plans lead the way for the development of Firewise Communities and fuel reduction projects throughout the region.

Residents have a high risk of experiencing a wildland fire due to the extensive forestland present in the communities and the current trend toward rural home site development. The age of the surrounding timber stands can be a factor in determining whether a non-threatening ground fire will spread to the canopy and become a dangerous crown fire. Clearings and fuel breaks will disrupt a slow moving wildfire enabling successful suppression. Agricultural and ranching activities throughout the area increase the risk of a human-caused wildfire spreading to forested areas. Large expanses of fallow fields or non-annual cash crops provide areas of continuous fuels that have potential to threaten several homes and farmsteads. Under extreme weather conditions, escaped agricultural fires could threaten individual homes or a town site; however, this type of fire is usually quickly controlled. High winds increase the rate of fire spread and intensity of fires.

Table 2-166 shows the single significant fire affecting Region 2.

Historic Wildfire Events

Table 2-166. Historic Wildfires in Region 2

Year	Name of Fire	Counties	Acres Burned	Remarks
1902	Columbia	Clackamas/Multnomah	170,000	—

Source: Brian Ballou, 2002, A Short History of Oregon Wildfires, Oregon Department of Forestry, unpublished

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 2 will experience wildfire is shown in **Table 2-167**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-167. Local Probability Assessment of Wildfire in Region 2

	Columbia	Clackamas	Multnomah	Washington
Probability	M	M	H	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

This document defines wildfire as an uncontrolled burning of forest, brush, or grassland. Wildfires have always been a part of these ecosystems, sometimes with devastating effects. Wildfire may result from natural causes (e.g., lightning strikes), a mechanical failure (Oxbow Fire), or human causes (unattended campfire, debris burning, or arson). Most wildfires can be linked to human carelessness.

Vulnerability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the region's vulnerability to wildfire is shown in **Table 2-168**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-168. Local Vulnerability Assessment of Wildfire in Region 2

	Columbia	Clackamas	Multnomah	Washington
Vulnerability	M	M	M	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The vulnerability in this region is mild at best. The Northern Willamette Valley / Portland Metro area is dominated by highly populated rural interface as well as metropolitan areas. Timber and agriculture land line suburban areas. A cooler climate and reduced fire danger results in fewer wildfires. In addition, response times are typically much quicker in this region due to large populations and several fire agencies nearby.

Each year a significant number of people build homes within or on the edge of the forest (wildland-urban interface), thereby increasing wildfire hazards. These communities have been designated "Wildland-Urban Interface Communities" and include those in **Table 2-169**.

Table 2-169. Wildland-Urban Interface Communities in Region 2

Clackamas	Columbia	Multnomah	Washington
Beaver Creek	Alston	Bonneville	Buxton
Bull Run	Clatskanie	Burlington	Cherry Grove
Cedarhurst Park	Columbia City	East Metro	Gales Creek
Colton	Deer Island	Holbrook	Gaston
Dickey Prairie	Goble	Lower Columbia Gorge	Glenwood
Eagle Creek	Mist Birkenfeld	Portland Metro	Stimson Mill
Estacada	Pittsburg	Shelternoon	Timber
Fallsview	Prescott	Skyline	Tualatin Valley
Firgrove	Quincy	Warrendale	
Government Camp	Rainier		
Hoodland Corridor	St. Helens		
Maple Grove	Scappoose		
Molalla	Spitzenburg		
Molino	Swedetown		
Redland	Vernonia		
Sandy	Warren		
Springwater	Yankton		
Timber Grove			

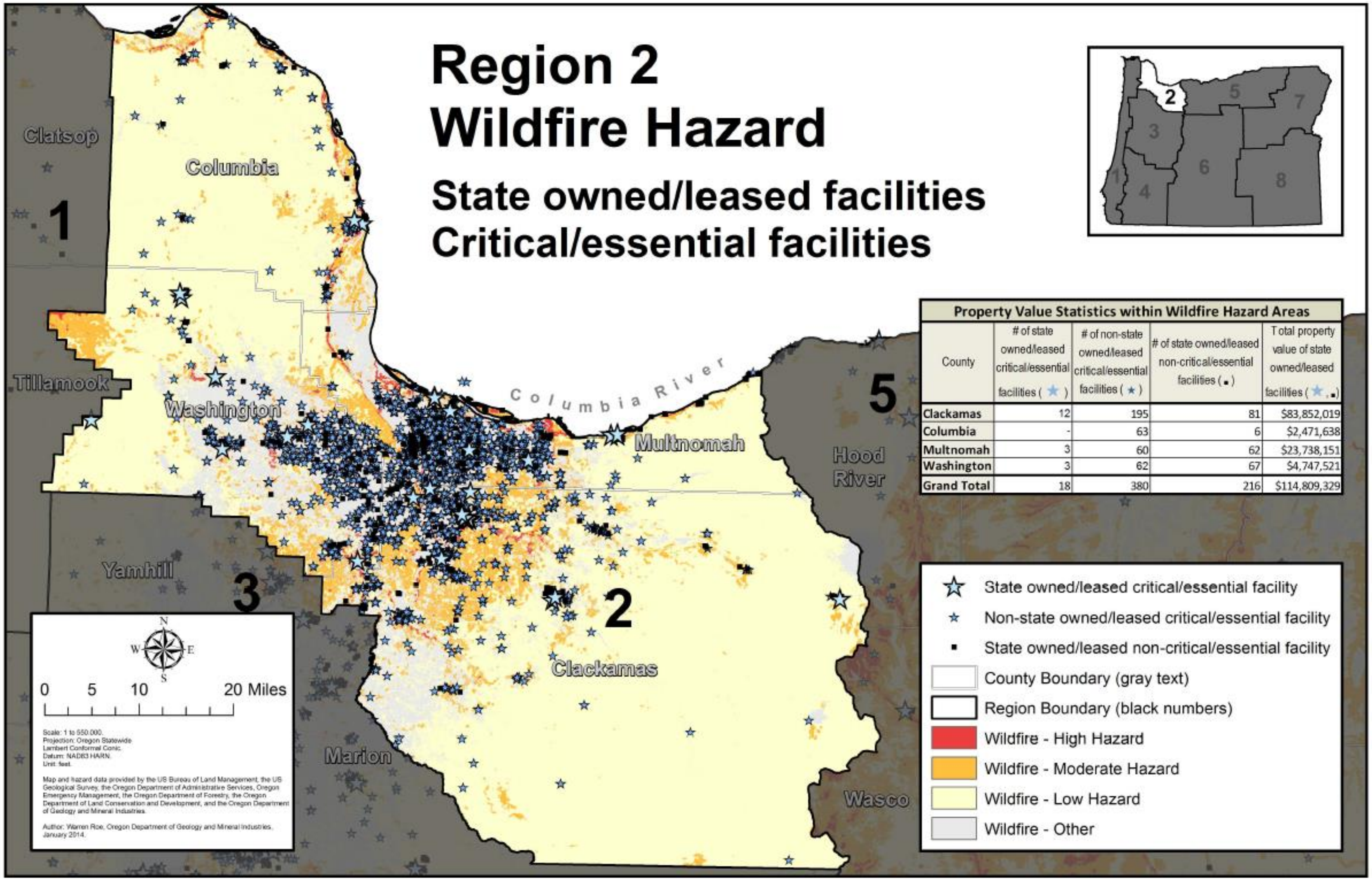
Oregon Dept. of Forestry Statewide Forest Assessment September, 2006

State-Owned/Leased Facilities and Critical/Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 234 are within a wildfire hazard zone in Region 2 and total about $ 115 million in value (**Figure 2-118**). Eighteen of these facilities are state critical/essential facilities. An additional 380 non-state critical/essential facilities are also located in a wildfire hazard zone in Region 2.

Figure 2-118. State-Owned/Leased Facilities and Critical/Essential Facilities in a Wildfire Hazard Zone in Region 2



Property Value Statistics within Wildfire Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Clackamas	12	195	81	$83,852,019
Columbia	-	63	6	$2,471,638
Multnomah	3	60	62	$23,738,151
Washington	3	62	67	$4,747,521
Grand Total	18	380	216	$114,809,329

Source: DOGAMI

Windstorms

Characteristics

Extreme winds (other than tornadoes) are experienced in all of Oregon's eight regions. The most persistent high winds occur along the Oregon Coast and the Columbia River Gorge; these areas have special building code standards. A majority of the destructive surface winds in Region 2 are from the southwest. Under certain conditions, very strong east winds may occur, but these usually are limited to small areas in the vicinity of the Columbia River Gorge or other low mountain passes.

The much more frequent and widespread strong winds from the southwest are associated with storms moving onto the coast from the Pacific Ocean. If the winds are from the west, they may be stronger on the coast than in the interior valleys because of the north-south orientation of the Coast Range and Cascades. These mountain ranges obstruct and slow down the westerly surface winds. The most destructive winds are those which blow from the south, parallel to the major mountain ranges. The Columbus Day Storm of 1962 was a classic example of such a storm, and its effects were so devastating that it has become the benchmark from which other windstorms in Oregon are measured. The storm caused significant damage in Region 2.

Historic Windstorm Events

Table 2-170. Historic Windstorms in Region 2

Date	Location	Description
Apr. 1931	western Oregon	unofficial wind speeds reported at 78 mph; damage to fruit orchards and timber
Nov. 10-11, 1951	statewide	widespread damage; transmission and utility lines; wind speed 40-60 mph; gusts 75–80 mph
Dec. 1951	statewide	wind speed 60 mph in Willamette Valley; 75-mph gusts; damage to buildings and utility lines
Dec.1955	statewide	wind speeds 55–65 mph with 69-mph gusts; considerable damage to buildings and utility lines
Nov. 1958	statewide	wind speeds at 51 mph with 71-mph gusts; every major highway blocked by fallen trees
Oct. 1962	statewide	Columbus Day Storm; Oregon's most destructive storm to date; 116-mph winds in Willamette Valley; estimated 84 houses destroyed, with 5,000 severely damaged; total damage estimated at $170 million
Mar. 1971	most of Oregon	greatest damage in Willamette Valley; homes and power lines destroyed by falling trees; destruction to timber in Lane County
Nov. 1981	most of Oregon	highest winds since Oct. 1962; wind speed 71 mph in Salem; marinas, airports, and bridges severely damaged
Jan. 1990	statewide	heavy rain with winds exceeding 75 mph; significant damage; one fatality
Dec. 1995	statewide	followed path of Columbus Day Storm; wind speeds 62 mph in Willamette Valley; damage to trees (saturated soil a factor) and homes (FEMA-1107-DR-Oregon)
Nov. 1997	western Oregon	wind speed 52 mph in Willamette Valley; trees uprooted; considerable damage to small airports
Feb. 2002	western Oregon	strongest storm to strike western Oregon in several years; many downed power lines (trees); damage to buildings; water supply problems (lack of power); estimated damage costs: $6.14 million (FEMA-1405-DR-Oregon)
June 2004	Washington Count	$100 in property damage from a tornado
Dec. 2004	Clackamas County	$6,250 in property damage *damage estimate includes areas outside of Region 2
June 2005	Multnomah County	lightning causes $50,000 in damage
Dec. 2005	Clackamas, Multnomah, and Washington Counties	$9,000 in property damage
Jan. 2006	Clackamas, Columbia, Washington, and Multnomah Counties	wind storm with winds up to 58 mph caused a total of $500,000 in damages spread out over all four counties and included Yamhill, Marion, and Polk Counties as well
Feb. 2006	Columbia, Multnomah, Clackamas, Washington Counties	strong wind storm caused $167,000 in damage for all four counties; storm also impacted counties in Regions 3 and 1 for a total storm damage of $575,000
May 2007	Clackamas County	windstorm brought wind gusts up to 50 mph and produced extensive hail, causing $5000 in damages
July 2007	Multnomah and Washington Counties	heavy windstorm with 58-mph winds downed several trees, caused $5000 in damage/$1000 in damage in Beaverton
Sep. 2007	Multnomah County	severe storm that produced hail and a tornado, caused $5000 in damages
June 2008	Clackamas County	severe storms produced heavy winds and hail near the Cascades, caused $5000 in damages
Mar. 2009	Columbia County	72-mph winds caused $20,000 in property damage
Nov. 2012	Lincoln County	97-mph winds at Newport cost $1 million in property damage

Sources: Taylor and Hatton (1999; and FEMA-1405-DR-OR: February 7, 2002, Hazard Mitigation Team Survey Report, Severe Windstorm in Western Oregon; Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org; National Climatic Data Center, Storm Events, Database http://www.ncdc.noaa.gov/stormevents/

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 2 will experience windstorms is shown in **Table 2-171**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-171. Local Probability Assessment of Windstorms in Region 2

	Columbia	Clackamas	Multnomah	Washington
Probability	M	M	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The 100-year storm in Region 2 is considered to be one-minute average winds of 80mph. A 50-year storm is 72 mph. And a 25-year storm is 65 mph in this region.

Vulnerability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the region's vulnerability to windstorms is shown in **Table 2-172**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-172. Local Vulnerability Assessment of Windstorms in Region 2

	Columbia	Clackamas	Multnomah	Washington
Vulnerability	H	L	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Columbia, Multnomah, and Washington Counties are listed as most vulnerable to windstorms, as determined by the staff of the Oregon Public Utilities Commission and OCCRI.

Many buildings, utilities, and transportation systems within Region 2 are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It also is 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 and affect emergency operations. In addition, uprooted or shattered trees can down power and other 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. Many roofs have been destroyed by uprooted ancient trees growing next to a house. In some situations, strategic pruning may be the answer. Prudent counties will work with utility companies to identify problem areas and establish a tree maintenance and removal program.

Additional considerations include ferry systems and bridges, which may be closed during high-wind periods.

Winter Storms

Characteristics

Winter storm events occur annually in Region 2, sometimes becoming severe. Severe winter weather in this region is characterized by extreme cold, snow, ice, and sleet. While most communities are prepared for severe winter weather, some are unprepared financially and otherwise. This is particularly true in the vicinity of Portland, where frigid air sometimes moves westward through the Columbia River Gorge. During these periods, it is not unusual for northern Willamette Valley communities to receive snow or ice storms known as “silver thaws.” Severe weather conditions do not last long in Region 2. Consequently, winter preparedness is a moderate priority.

Historic Winter Storms

Table 2-173. Historic Winter Storms in Region 2

Date	Location	Description
Dec. 1861	statewide	snowfall 1-3 ft; snow in Willamette Valley until late Feb.
1862, 1866, 1884, 1885, 1890, 1892, 1895	Portland area / Northern Willamette Valley	severe winter conditions, especially in the Portland area; record-breaking snowfalls
Jan. 1916	statewide	two snow storms, each totaling 5 inches or more
Dec. 1919	Portland area	third heaviest snowfall on record; Columbia River froze, closing navigation
1927, 1936, 1937, 1943, 1949	Portland area, Western Oregon	heavy snowfalls recorded
Jan. 1950	statewide	heaviest snowfall since 1890; many highway closures; considerable property damage
1956, 1960, 1962	western Oregon	packed snow became ice; automobile accidents throughout the region
Mar. 1960	statewide	snowfall: 3-12 inches, depending on location
Jan. 1969	statewide	record-breaking snowfalls; $3 to $4 million in property damage
Jan. 1980	statewide	a series of storms bringing snow, ice, wind, and freezing rain; six fatalities
Feb. 1985	statewide	western valleys received between 2-4 inches of snow; massive power failures (tree limbs broke power lines)
Dec. 1985	Willamette Valley	heavy snowfall throughout valley
Mar. 1988	statewide	strong winds and heavy snow
Feb. 1989	statewide	heavy snowfall and record low temperatures
Feb. 1990	statewide	average snowfall from one storm about 4 inches (Willamette Valley)
Dec. 1992	western Oregon	heavy snow; interstate highway closed
Feb. 1993	western Oregon	record snowfalls
Winter 1998-1999	statewide	series of storms; one of the snowiest winters in Oregon history
Dec. 2007	Columbia County	resulted in Presidential Disaster Declaration; $180 million in damage in the state; severe flooding in Vernonia; power outages for several days; five fatalities
Dec. 2008	Columbia County	snow and freezing rain in the Portland Metro area; $300,000 in property damage
Dec. 2009	statewide	snow and freezing rain in Salem, and Portland to Hood River; I-84 closed for 22 hours
Nov. 2010	statewide	snow, freezing rain, and ice accumulation in Portland to Hood River
Jan. 2012	Multnomah County	snow and ice east of Troutdale; I- 84 closed for 9 hours

Source: Taylor and Hatton (1999)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 2 will experience winter storms is shown in **Table 2-174**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-174. Local Probability Assessment of Winters Storms in Region 2

	Columbia	Clackamas	Multnomah	Washington
Probability	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Winter storms occur annually in Region 2. On the basis of historical data, severe winter storms could occur about every 4 years in this region. We can expect to have continued annual storm events in this region. However, there are no solid statistical data available upon which to base these judgments. There is no statewide program to study the past, present, and potential impacts of winter storms in the state of Oregon at this time.

Vulnerability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the region's vulnerability to winter storms is shown in **Table 2-175**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-175. Local Vulnerability Assessment of Winter Storms in Region 2

	Columbia	Clackamas	Multnomah	Washington
Vulnerability	H	M	H	H

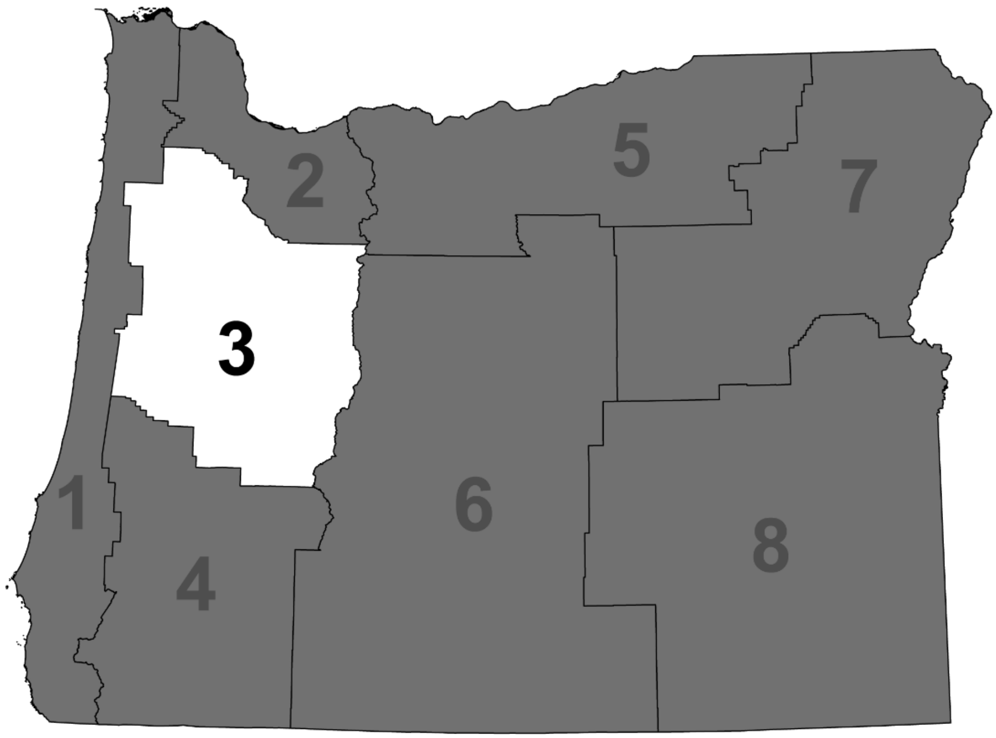
Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Due to the large population and large truck commodity transport through this region, it is extremely costly when the roads are closed due to severe winter storms.

2.3.3 Region 3: Mid/Southern Willamette Valley

Benton, *Lane (non-coastal), Linn, Marion, Polk, and Yamhill Counties



Note: The coastal portion of Lane County is within Region 1. Where data are available for the coastal areas of Lane County, the data are provided within the Region 1 profile; otherwise, countywide datasets are reported in this profile.

2.3.3.1 Summary

Regional Profile

The region's demographic, economic, infrastructure, and development patterns indicate that some populations, structures, and places may be more vulnerable to certain natural hazards than others. Mitigation efforts directed at these vulnerabilities may help boost the area's ability to bounce back after a natural disaster.

The region's social vulnerability is particularly challenged in Lane, Marion, Benton, and Linn Counties. The following vulnerability indicators have been identified for one or more of those counties: high numbers of tourists, persons with disabilities, renters, people living in poverty, people who do not speak English very well, children, and seniors. Median household incomes have fallen in Marion and Lane Counties. Homeless populations have dramatically increased in Lane and Yamhill Counties.

The region has a number of key industries and employment sectors providing economic stability for the region. The exceptions are Linn and Yamhill Counties, which rely heavily on fewer key industries. Except for in Benton County, wages are lower in Region 3 than statewide.

Transportation networks across the region are vulnerable to natural hazard events, especially seismic events. Following a Cascadia earthquake event, access across the Willamette River and along I-5 may be limited due to bridge collapse. Lane County has a particularly high number of state-owned bridges that are distressed or deficient. The Eugene Airport, the state's second largest airport, could become a staging ground after a natural disaster, but is also vulnerable to a catastrophic seismic event.

Energy facilities and conveyance system infrastructure in the region support the regional economy and are vulnerable to natural hazard events. The region is a key provider of hydroelectricity for the state. Roughly 14% (53) of all dams in the region have either Significant or High Threat Potential. The majority of dams in the region are in Marion and Yamhill Counties. Liquid Natural Gas is transmitted via pipelines that run through Marion, Linn, and Lane Counties.

Water systems in the region are particularly vulnerable to hazard events because they tend to be older, centralized, lacking in system redundancies and sourced from surface water. Combined sewer overflow (CSO) during high-water events is one such threat. Low impact development (LID) stormwater systems, such as those employed by the City of Eugene, can help communities better manage high-precipitation events.

Urban growth in Region 3 is 4 times rural growth. The majority of growth is occurring in urban areas along I-5, in the region's major cities: Eugene, Albany, Corvallis, Salem, and the Portland Metro Area. Linn County has the highest percentage of mobile homes, which are inherently more vulnerable to natural hazards events. Almost two thirds of all homes in the region were built before 1990 and seismic building standards. Over one third of all homes in Polk and Yamhill Counties were built before floodplain management standards.

Hazards and Vulnerability

Region 3 is affected by eight of the 11 natural hazards that affect Oregon communities. Coastal hazards, dust storms, and tsunamis do not directly impact this region.

Droughts: The region is affected by droughts to a lesser extent than other areas in the state. Though not common in Region 3, a dry winter or spring could reduce community water supplies, impacting recreation, agriculture and the regional economy.

Earthquakes: Four types of earthquakes affect Region 3: (a) shallow crustal events, (b) deep intra-plate events within the subducting Juan de Fuca plate, (c) the offshore Cascadia Subduction Zone (CSZ) Fault, and (d) earthquakes associated with renewed volcanic activity. The CSZ is the chief earthquake hazard for the Mid/Southern Willamette Valley. This area is particularly vulnerable due to the large area susceptible to earthquake-induced landslide, liquefaction, and ground shaking. In a 500-year model for a CSZ event or combined crustal events, five of the 15 counties with highest expected damages and losses are in this region: Lane, Marion, Benton, Linn, and Yamhill. Seismic lifelines will be affected by prolonged ground shaking with several roadways susceptible to landslide, rockfall, or liquefaction. There are 2,134 state-owned/leased facilities in this region’s earthquake hazard zone, valued at over $4.2 billion. Of these, 455 are critical/essential facilities. An additional 2,413 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Floods: The most common types of flooding events affecting the Mid/Southern Willamette Valley are riverine and sheet flooding. The most damaging floods are rain-on-snow events and the backing up of tributaries that takes place in December and January in association with La Niña events. While all of the region’s counties are considered moderately vulnerable to flooding, the coastal portion of Lane County and the cities of Eugene-Springfield, Salem, Scio, and Sheridan are considered the most vulnerable. This region has the third most repetitive flood loss properties (46) of which four are Severe Repetitive Loss (SRL) properties. There are 28 state-owned/leased facilities, valued at approximately $13 million, located in the region’s flood hazard zone. Of these, one is considered a critical/essential facility. An additional 90 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Landslides: Landslides can occur throughout the region, though more tend to occur in areas with steeper slopes, weaker geology, and higher annual precipitation. Rain-induced landslides can occur during winter months. Earthquakes can also trigger landslides. Vulnerability is increased in highly populated areas, such as in the Cities of Corvallis, Eugene, and Salem, and in the Coast and Cascade Mountains. There are 2,134 state-owned/leased facilities, valued at over $4.2 billion, within this hazard zone in Region 3. Of these, 455 are critical/essential facilities. An additional 2,413 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Volcanoes: Volcanic activity may occur within the eastern areas of Lane, Linn, and Marion Counties that coincide with the crest of the Cascade mountain range. Most volcanic activity is considered local; however, lahars and ashfall can travel many miles. As such, small mountain communities, dams, reservoirs, energy-generating facilities, and highways in the region may be vulnerable to volcanic activity. There are 28 state-owned/leased facilities located in the volcanic hazard zone in this region, with an approximate value of $13 million. Of these, one is identified as a critical/essential facility. An additional 90 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Wildfires: Wildfire risk is low to moderate in the Mid/Southern Willamette Valley. Wildfires that do occur usually happen in the late summer. The areas of greatest vulnerability are wildland-urban interface communities. There are 610 state-owned/leased facilities located in a wildfire hazard zone with a value of approximately $315 million. Of these, 70 are identified as critical/essential facilities. An additional 587 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Windstorms: Windstorms can occur when winds generated in the Pacific Ocean travel inland in a northeasterly direction. Strong winds from the south are also possible in this region and often cause the most damage. Windstorms affect the region annually. These storms generally impact the region's buildings, utilities, tree-lined roads, transmission lines, residential parcels, and transportation systems along open areas such as grasslands and farmland.

Winter Storms: Colder weather and higher precipitation and can occur in the region annually. More severe winter storms occur about every 4 years. Due to the infrequent nature of severe storms in Region3, winter storm preparedness is not a priority of most communities.

Climate Change

The most reliable information on climate change to date is at the state level. The state information indicates that hazards projected to be impacted by climate change in Region 3 include drought, wildfire, flooding, and landslides. Climate models project warmer, drier summers and a decline in mean summer precipitation for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, all eight regions are expected to be affected by increased incidences of drought and wildfire. In addition, an increase in extreme precipitation is projected for some areas in Region 3 and can result in a greater risk of flooding in certain basins, including an increased incidence of magnitude and return intervals. While winter storms and windstorms affect Region 3, there is little research on how climate change influences these hazards in the Pacific Northwest. Landslides in Oregon are strongly correlated with rainfall, so increased rainfall — particularly extreme events — will likely trigger more landslides. For more information on climate drivers and the projected impacts of climate change in Oregon, see the section **Introduction to Climate Change**

2.3.3.2 Profile

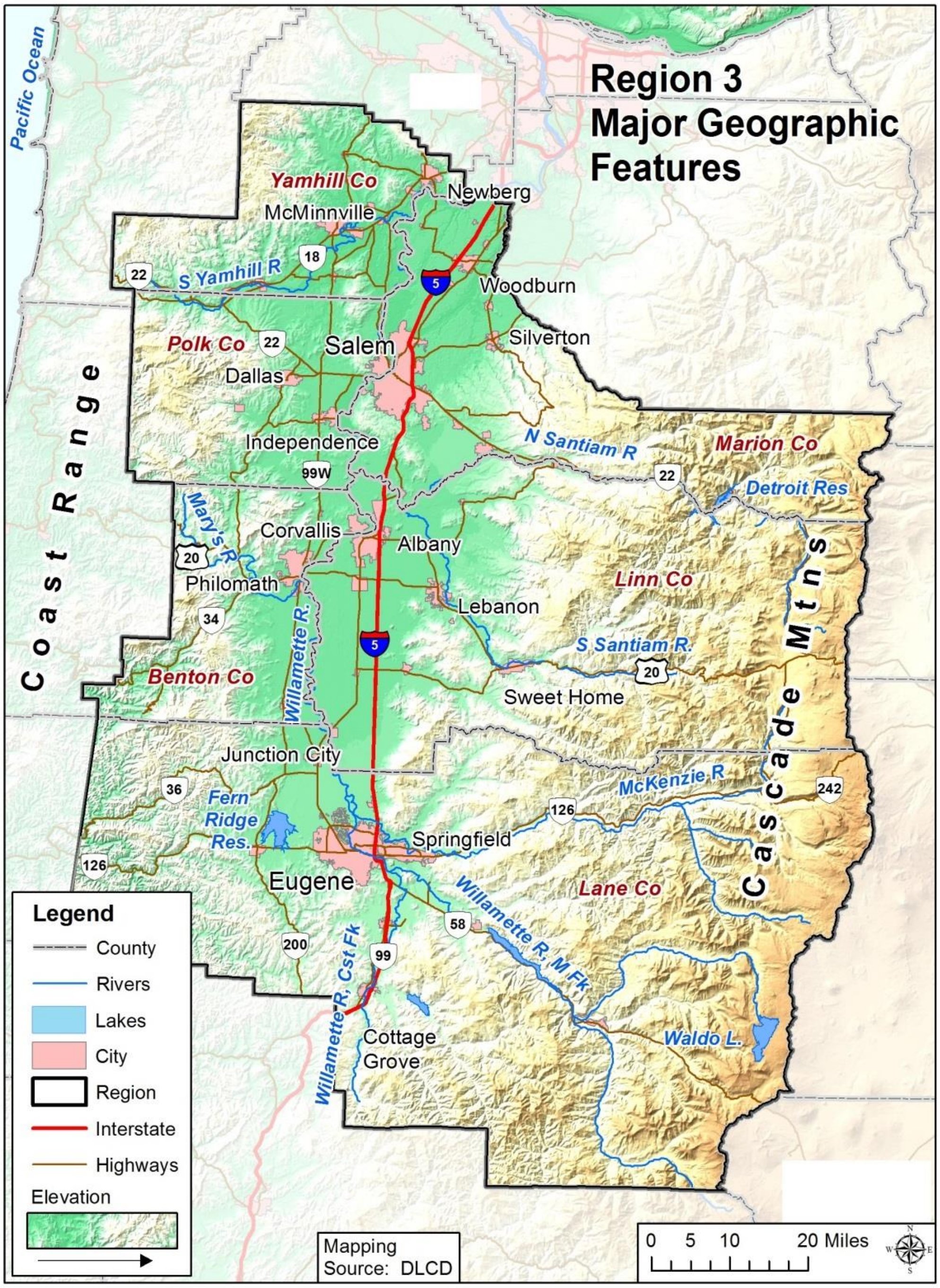
Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

Natural Environment

Geography

The Mid/Southern Willamette Valley is approximately 10,163 square miles in size, and includes Benton, Lane (non-coastal), Linn, Marion, Polk, and Yamhill Counties. Mountain ranges and watersheds shape the region's topography. Region 3 begins at the Cascades crest in the east, and extends to the Coast Range in the west. It extends from the base of the Calapooya Mountains in the south to the Portland suburbs in the north. The major watershed is the Willamette River with smaller water bodies feeding it as it flows north into the Columbia River. The original Oregon Trail settlers sought out the fertile soil and ample rainfall of the Willamette Valley for their homesteads. The region is still an agriculturally vital area.

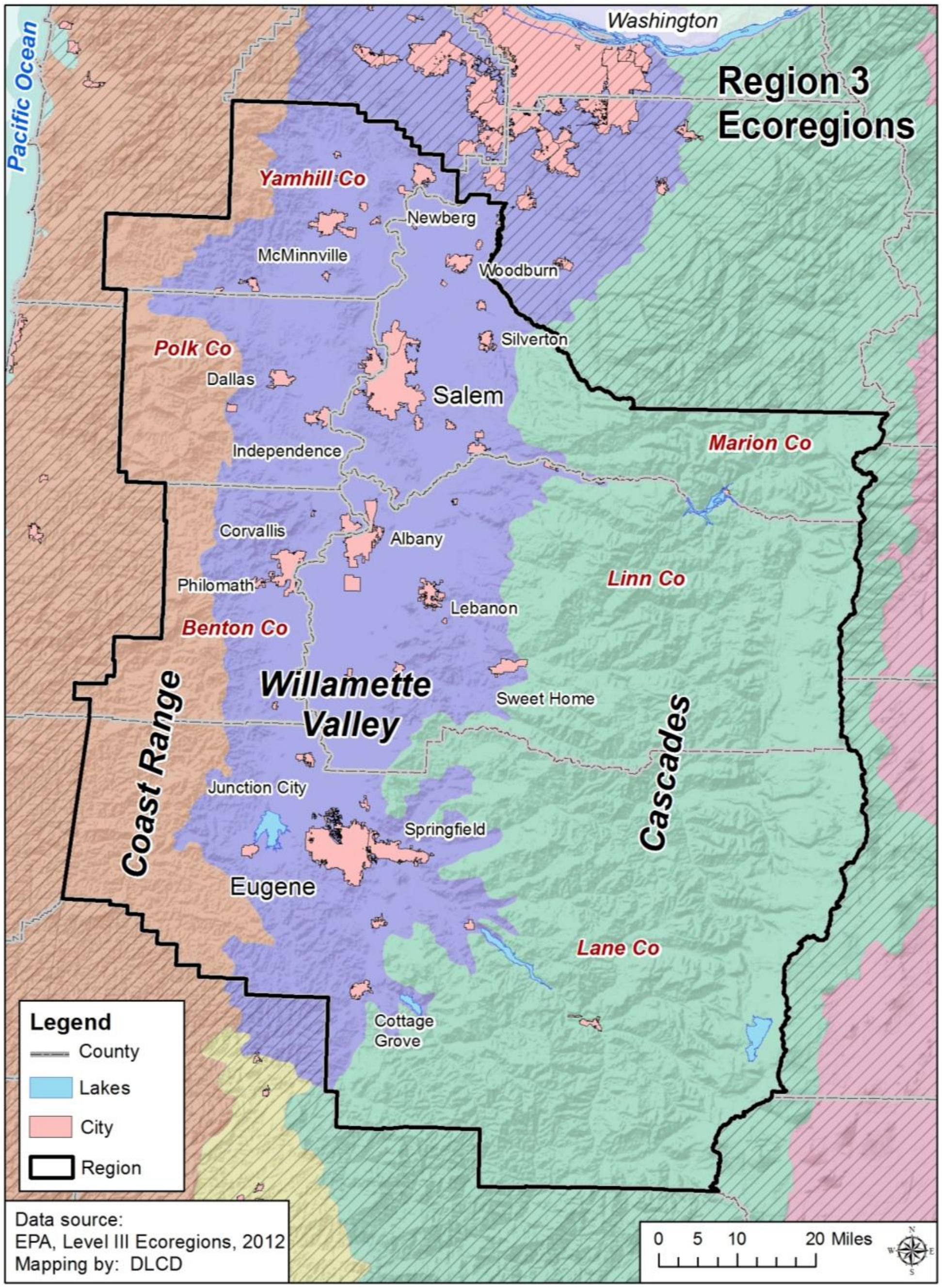
Figure 2-119. Region 3 Major Geographic Features



Source: Department of Land Conservation and Development, 2014

The U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Region 3 is composed of three ecoregions: the Cascades, the Willamette Valley, and the Coast Range.

Figure 2-120. Region 3 Ecoregions



Cascades: This ecoregion is underlain by volcanic soils. Naturally occurring mixed conifer forests have given way to predominantly Douglas fir forests that are managed for commercial logging. Logging activities have put a strain on the ecological health of streams in the area (Thorson et al., 2003). Waterways in the steeper valleys support threatened cold-water salmonids including Chinook salmon, steelhead, and bull trout. Streams, lakes, reservoirs, rivers, and glacial lakes at higher elevations are key sources of water. Large volcanic peaks, glaciers, and year-round snowfields punctuate the alpine and subalpine areas of the ecoregion (Thorson et al., 2003).

Coast Range: The eastern slope of the Coast Range is located within Region 3. Soils in this ecoregion are a mixture of sedimentary and volcanic composition. Volcanic soils are underlain by basaltic rocks resulting in more consistent summer streamflows and supporting runs of spring Chinook salmon and summer steelhead. Sedimentary soils in this ecoregion are prone to failure following clearcuts, which may be of concern as the commercial Douglas fir forests located here are highly productive commercial logging areas. Landslides can impact the safety of nearby infrastructure and health of the region's waterways. The ecoregion's sedimentary soils can create more concerns for stream sedimentation than areas with volcanic soils (Thorson et al., 2003).

Willamette Valley: Terraces and floodplains dominate the nearly flat central Willamette Valley. The valley floor is dotted with scattered hills and buttes and is bordered by the adjacent foothills. Historically, valley waterways meandered throughout floodplains on the nearly flat valley floor, contributing to the valley's highly fertile soil and supporting the dominance of oak savannah and prairie ecosystems. Today the Willamette River and its tributaries are highly channelized, helping to protect property, but also restricting the flow of these waterways and threatening stream health. Productive soils and temperate climate make this ecoregion one of the most important agricultural areas in Oregon. The valley's flat terraces have made urban and suburban development possible (Thorson et al., 2003).

Climate

This section covers historic climate information only. For estimated future climate conditions and possible impacts refer to the **State Risk Assessment**.

Region 3 has diverse ecoregions with varying climatic conditions. Precipitation generally occurs in the winter months. Wet winters and dry summers influence drought, floods, landslides, wildfires, and winter storms. When considering the climate, snowfall should also be taken into account. Flooding can be a direct result of rain-on-snow events. Likewise, the amount of snowpack in a region can also impact the ability of communities to cope with drought. Variations in temperature and precipitation vary widely by sub-ecoregion and microclimates. For more detailed and locally relevant climate data refer to the Oregon Climate Service.

Table 2-176. Average Precipitation and Temperature Ranges in Region 3 Ecoregions

Ecoregion	Mean Annual Precipitation Range (inches)	Mean Temperature Range (°F) January min/max	Mean Temperature Range (°F) July min/max
Cascades*	55–140	16/41	38/78
Willamette Valley*	40–60	32/46	50/85
Coast Range*	60–200	30/48	48/78

*Data have been generalized from all the sub-ecoregions of the ecoregion in Region 3.

Source: Thorson et al. (2003)

Demography

Population

Population forecasts are an indicator of future development needs and trends. Community demographics may indicate where specific vulnerabilities may be present in the aftermath of a natural hazard (Cutter et al., 2003). If a population is forecast to increase substantially, a community's capacity to provide adequate housing stock, services, or resources for all populations after a disaster may be stressed or compromised.

Polk and Yamhill Counties experienced the most growth in the region during the decade from 2000 to 2010. By 2020, Marion, Polk, and Yamhill Counties are expected to grow at a higher rate than the state as a whole. Conversely, Lane County is expecting to grow at half the rate of the state as a whole.

Table 2-177. Population Estimate and Forecast for Region 3

	2000	2013	Percent Change (2000 to 2013)	2020 Projected	Percent Change (2013 to 2020)
Oregon	3,421,399	3,919,020	14.5%	4,252,100	8.5%
Region 3	936,387	1,063,860	13.6%	1,155,049	8.6%
Benton	78,153	87,725	12.2%	91,379	4.2%
Lane	322,959	356,125	10.3%	378,335	6.2%
Linn	103,069	118,665	15.1%	128,454	8.2%
Marion	284,834	322,880	13.4%	355,189	10.0%
Polk	62,380	77,065	23.5%	88,081	14.3%
Yamhill	84,992	101,400	19.3%	113,611	12.0%

Source: Population Research Center, Portland State University, 2013; U.S. Census Bureau, 2010 Decennial Census. Table DP-1; Office of Economic Analysis, Long-Term Oregon State's County Population Forecast, 2010-2050, 2013

Tourists

Tourists are not counted in population statistics and are therefore considered separately in this analysis. Tourism activities in Region 3 are largely centered on touring (traveling to experience scenic beauty, history, and culture), special events, and outdoor activities (Longwoods Travel USA, 2011c). The average travel party contains 3.1 persons, and 76% of their trips originate from Oregon or Washington. In this region, the average trip length is 3.5 nights (Longwoods Travel USA, 2011c). The majority of tourists visit Lane County. In 2013, more than 20% of Region 3's visitors lodged in hotels, motels and other venues.

Difficulty locating or accounting for travelers increases their vulnerability in the event of a natural disaster. Furthermore, tourists are often unfamiliar with evacuation routes, communication outlets, or even the type of hazard that may occur (MDC Consultants, n.d.). Targeting natural hazard mitigation outreach efforts to places where tourists lodge can help increase awareness and minimize the vulnerability of this population.

Table 2-178. Annual Visitor Estimates in Person Nights in Region 3

	2011		2012		2013	
	Number	Percent	Number	Percent	Number	Percent
Region 3	16,784	—	17,280	—	17,463	—
Benton	1,334	100%	1,382	100%	1,399	100%
Hotel/Motel	395	29.6%	424	30.7%	443	31.7%
Private Home	860	64.5%	878	63.5%	874	62.5%
Other	79	5.9%	80	5.8%	82	5.9%
Lane	7,348	100%	7,484	100%	7,550	100%
Hotel/Motel	1,599	21.8%	1,669	22.3%	1,727	22.9%
Private Home	4,498	61.2%	4,550	60.8%	4,539	60.1%
Other	1,251	17.0%	1,265	16.9%	1,284	17.0%
Linn	1,775	100%	1,836	100%	1,860	100%
Hotel/Motel	287	16.2%	316	17.2%	336	18.1%
Private Home	1,184	66.7%	1,211	66.0%	1,206	64.8%
Other	304	17.1%	309	16.8%	318	17.1%
Marion	4,794	100%	4,973	100%	5,103	100%
Hotel/Motel	882	18.4%	932	18.7%	1,007	19.7%
Private Home	3,418	71.3%	3,535	71.1%	3,572	70.0%
Other	494	10.3%	506	10.2%	524	10.3%
Polk	N/A	N/A	N/A	N/A	N/A	N/A
Hotel/Motel	N/A	N/A	N/A	N/A	N/A	N/A
Private Home	N/A	N/A	N/A	N/A	N/A	N/A
Other	N/A	N/A	N/A	N/A	N/A	N/A
Yamhill	1,533	100%	1,605	100%	1,551	100%
Hotel/Motel	437	28.5%	492	30.7%	475	30.6%
Private Home	1,010	65.9%	1,025	63.9%	987	63.6%
Other	86	5.6%	88	5.5%	89	5.7%

N/A = data were not available for Polk County

Source: Oregon Travel Impacts: 1991–2013, April 2014. Dean Runyan Associates, http://www.deanrunyan.com/doc_library/ORImp.pdf

Persons with Disabilities

Disabilities appear in many forms. While some disabilities may be easily identified, others may be less perceptible. Disabled populations, while difficult to identify and measure, are disproportionately affected during disasters (Cutter et al., 2003). A similar percentage of the people in Region 3 identify as having a disability as do people throughout the state. In Region 3, residents of Lane and Marion Counties together account for 65% of all persons with disabilities. Two thirds (67%) of these counties' children (under 18) and almost two thirds (63%) of their seniors (65 and older) are reported to have a disability. Local natural hazard mitigation plans should specifically target outreach programs toward helping disabled residents better prepare for and recover from hazard events.

Table 2-179. People with a Disability by Age Groups in Region 3, 2012

	Total Population*	With a Disability (Total Population)		Under 18 Years with a Disability		65 Years and Over with a Disability	
	Estimate	Estimate	Percent	Estimate	Percent**	Estimate	Percent**
Oregon	3,796,881	511,297	13.5%	39,439	4.6%	200,374	37.8%
Region 3	1,032,370	145,668	14.1%	11,829	5.0%	55,210	38.0%
Benton	85,132	8,606	10.1%	555	3.7%	3,483	33.9%
Lane	349,806	51,391	14.7%	3,575	5.2%	19,826	37.7%
Linn	115,996	18,982	16.4%	1578	5.6%	7,523	42.2%
Marion	309,462	43,319	14.0%	4403	5.3%	14,814	37.1%
Polk	75,054	10,428	13.9%	732	4.0%	4,456	39.3%
Yamhill	96,920	12,942	13.4%	986	4.0%	5,108	38.7%

*Total population does not include institutionalized population.

**Percent of age group.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Homeless Population

Population estimates of the homeless in Oregon are performed each January. These are rough estimates and can fluctuate with many factors, including the economy or season. The overwhelming majority are either single adult males or families with children. Communities located along major transportation corridors, such as I-5, tend to have higher concentrations of homeless people (Thomas et al., 2008). Over the 3-year period between 2009 and 2011, the most notable shifts in homeless populations included a 155% increase in Lane County and a 206% increase in Yamhill County. This was followed by a reduction in homeless people in all counties by 2011, to less than 2009 numbers. In Yamhill County that reduction was exceptional, 101% below 2009 numbers.

Extra attention is needed to care for and serve homeless communities**.** Some homeless people choose to remain hidden or anonymous, making it especially difficult to mitigate harm to them from natural hazard events**.** Accessible shelter and social services are key emergency considerations for the homeless community.

Table 2-180. Homeless Population Estimate for Region 3

	2009	2010	2011	3-Year Average
Oregon	17,122	19,208	22,116	19,482
Region 3	4,268	5,795	3,480	4,514
Benton	154	154	107	138
Lane	2,232	3,467	2,136	2,612
Linn	269	245	135	216
Marion	1,195	1,152	943	1,097
Polk	52	23	122	66
Yamhill	366	754	37	386

Source: Oregon Point in Time Homeless Count, Oregon Housing and Community Services. http://www.oregon.gov/ohcs/pages/ra_point_in_time_homeless_count.aspx

Gender

The gender breakdown in Region 3 is similar to that of the state, almost 50:50 (U.S. Census Bureau, American Community Survey, 2010 Demographic Profile Data, Table DP-1). 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 (Cutter et al., 2003).

Age

Lane County has the most seniors but about the same proportion of senior population as the other counties in Region 3. Senior citizens may require special consideration due to sensitivity to heat and cold, reliance upon transportation to obtain medication, and comparative difficulty in making home modifications that reduce risk to hazards. In addition, the elderly may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to elderly (Morrow, 1999).

Marion County has the highest number and greatest percentage of children in the region. Special consideration should be given to young children, schools, and parents during the natural hazard mitigation process. Young children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities. Parents may lose time from work and money when their children's childcare facilities and schools are impacted by disasters (Cutter, 2003).

Table 2-181. Population by Vulnerable Age Groups, in Region 3, 2012

	Total Population	Under 18 Years Old		65 Years and Older	
	Estimate	Estimate	Percent	Estimate	Percent
Oregon	3,836,628	864,243	22.5%	540,527	14.1%
Region 3	1,044,124	238,590	22.9%	148,032	14.2%
Benton	85,501	14,995	17.5%	10,411	12.2%
Lane	351,794	69,322	19.7%	53,449	15.2%
Linn	116,871	28,296	24.2%	18,142	15.5%
Marion	315,391	83,103	26.3%	41,047	13.0%
Polk	75,448	18,201	24.1%	11,447	15.2%
Yamhill	99,119	24,673	24.9%	13,536	13.7%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP05

Language

Special consideration should be given to populations who do not speak English as their primary language. These populations can be harder to reach with hazard outreach materials. They are less likely to be prepared if special attention is not given to language and culturally appropriate outreach techniques. Similar to the state, almost 94% of the region's population speaks English very well. Notably, 11% of the people in Marion County speak English less than very well. Outreach materials used to communicate with and plan for this community should take into consideration their language needs.

Table 2-182. English Usage in Region 3, 2012

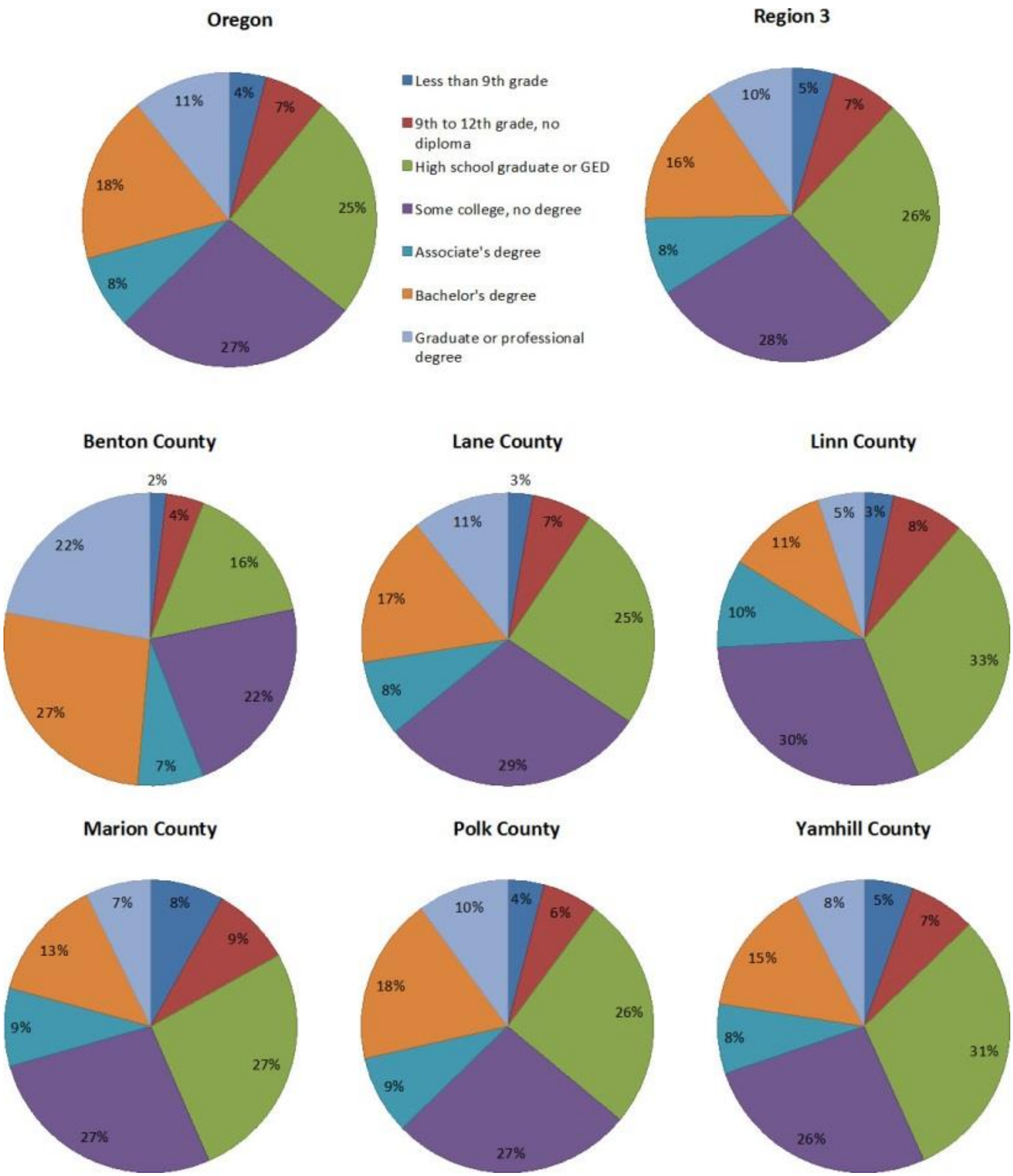
	Speak English "Very Well"		Speak English Less Than "Very Well"	
	Estimate	**Percent**	**Estimate**	**Percent**
Oregon	3,376,744	93.8%	224,905	6.2%
Region 3	922,262	94.1%	57,814	5.9%
Benton	78,954	96.6%	2,738	3.4%
Lane	323,424	96.9%	10,235	3.1%
Linn	106,495	97.5%	2,762	2.5%
Marion	259,286	88.8%	32,727	11.2%
Polk	67,542	95.5%	3,216	4.5%
Yamhill	86,561	93.4%	6,136	6.6%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Education Level

Studies (Cutter et al., 2003) show that education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings. Furthermore, education can influence a person's and community's ability to understand warning information and to access resources before and after a natural disaster. With the exception of Benton County, the populations in all counties in the region have the following education attainment breakdown: 35–44% with no college, 26–30% with some college; 26–36% with a college degree. OSU's presence in Benton County likely contributes to the facts that more than half of the county's population has a college degree and the county has the lowest percentage of population with no college experience.

Figure 2-121. Educational Attainment in Region 3, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Income

The impact of a disaster in terms of loss and the ability to recover varies among population groups. "The causes of social vulnerability are explained by the underlying social conditions that are often quite remote from the initiating hazard or disaster event" (Cutter, 2006, p.76). Historically, 80% of the disaster burden falls on the public. Of this number, a disproportionate burden is placed upon those living in poverty. People living in poverty are more likely to be isolated, are less likely to have the savings to rebuild after a disaster, and are less likely to have access to transportation and medical care.

The financial crisis that began in 2007 significantly affected Mid/Southern Willamette Valley communities. Between 2009 and 2012, median household incomes dropped most significantly in Lane and Marion Counties. Conversely, median incomes in Polk and Yamhill Counties were higher than median incomes statewide.

Table 2-183. Median Household Income in Region 3

	2009	2012	Percent Change
Oregon	$52,474	$50,036	-4.6%
Region 3	N/A	N/A	N/A
Benton	$49,926	$48,635	-2.6%
Lane	$45,860	$42,628	-7.0%
Linn	$48,907	$47,129	-3.6%
Marion	$49,713	$46,654	-6.2%
Polk	$54,312	$52,365	-3.6%
Yamhill	$54,784	$53,950	-1.5%

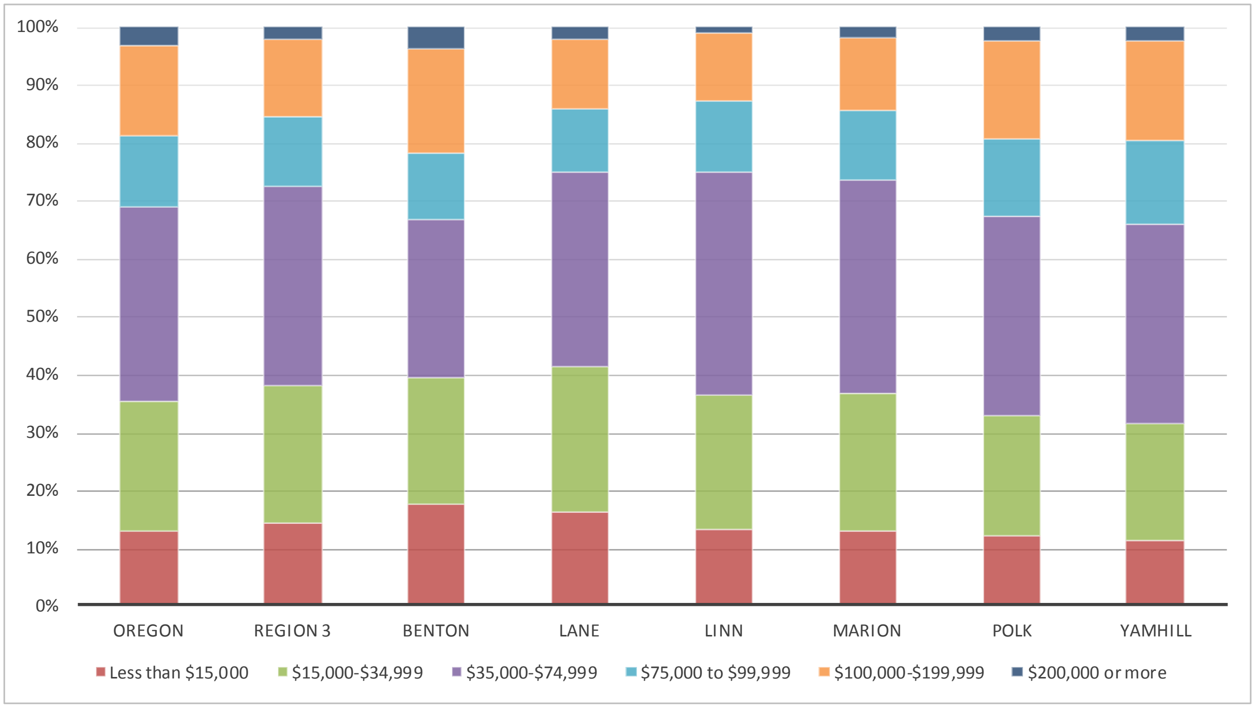
Note: 2009 dollars are adjusted for 2012 using Bureau of Labor Statistics' Consumer Price Index Inflation Calculator.

N/A = data not aggregated at the regional level.

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates. Table DP03

The region has a larger share of its households earning less than $35,000 per year than the state as a whole. Benton, Polk, and Yamhill Counties have a higher percentage of households earning more than $75,000 per year than the state.

Figure 2-122. Median Household Income Distribution in Region 3, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP03

Benton, Lane, and Marion Counties have had the greatest increase in poverty rates in Region 3. Over a quarter of the children in Marion and Linn Counties live in poverty.

Table 2-184. Poverty Rates in Region 3, 2012

	Total Population in Poverty			Children Under 18 in Poverty		
	Number	Percent	Percent Change*	Number	Percent	Percent Change*
Oregon	584,059	15.5%	17.7%	175,303	20.6%	17.6%
Region 3	180,439	17.8%	18.3%	53,096	22.7%	20.3%
Benton	17,418	21.6%	20.4%	2,413	16.4%	23.4%
Lane	64,705	18.8%	19.3%	13,754	20.3%	24.4%
Linn	19,237	16.7%	16.2%	6,934	25.2%	23.4%
Marion	55,223	18.0%	19.8%	22,046	27.1%	21.4%
Polk	10,788	14.6%	14.1%	3,400	18.9%	11.8%
Yamhill	13,068	13.9%	11.7%	4,549	18.8%	6.1%

*Percent change since 2009.

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates, Table S1701

Low-income populations require special consideration when mitigating loss to a natural hazard. Often, those who earn less have little to no savings and other assets to withstand economic setbacks. When a natural disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the natural disaster. To reduce the compounded loss incurred by low-income populations post-disaster, mitigation actions need to be specially tailored to ensure safety nets are in place to provide further support to those with fewer personal resources.

Housing Tenure

Wealth can increase the ability to recover following a natural disaster (Cutter et al., 2003), and homeownership, versus renting, is often linked to having more wealth. Renters often do not have personal financial resources or insurance to help recover post-disaster. On the other hand, renters tend to be more mobile and have fewer assets at risk. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable due to natural disaster events.

The percentage of homeownership exceeds that of the state in Linn, Polk, and Yamhill Counties. Benton County has a higher rate of renter occupied units than other counties in the region. This number is likely driven by rental demand for off campus housing for students attending Oregon State University in Corvallis. The region has a lower vacancy rate than the state as a whole. Lane County has a high rate of seasonal, or recreational, housing units contributing approximately two thirds of the region's total (U.S. Census Bureau, 2008–2012, American Community Survey, Table DP04 and Table B25004).

Table 2-185. Housing Tenure in Region 3, 2012

	Total Occupied Units	Owner Occupied		Renter Occupied		Vacant^	
		Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	945,824	62.5%	566,894	37.5%	105,417	6.3%
Region 3	398,662	246,901	61.9%	151,761	38.1%	20,389	5.2%
Benton	33,502	19,342	57.7%	14,160	42.3%	2,428	6.7%
Lane	145,474	86,739	59.6%	58,735	40.4%	7,464	4.8%
Linn	44,566	29,735	66.7%	14,831	33.3%	1,738	3.6%
Marion	113,227	68,766	60.7%	44,461	39.3%	6,748	5.6%
Polk	27,973	18,681	66.8%	9,292	33.2%	2,011	6.7%
Yamhill	33,920	23,638	69.7%	10,282	30.3%	2,760	7.4%

^ = Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04 and Table B25004

Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households. Region 3 is predominantly composed of family households. Roughly 70% of households in Marion and Yamhill Counties are households with children, including both married and single-parent (male or female) households. Benton and Lane Counties have the highest percentages of one-person households and the lowest percentages of family households. These numbers are likely influenced by the presence of

Oregon State University (OSU) in Corvallis (Benton County) and the University of Oregon in Eugene (Lane County).

Table 2-186. Family vs. Non-family Households in Region 3, 2012

	Total Households	Family Households		Nonfamily Households		Householder Living Alone	
	Estimate	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	964,274	63.7%	548,444	36.3%	421,620	27.9%
Region 3	398,662	258,374	64.8%	140,288	35.2%	105,894	26.6%
Benton	33,502	18,825	56.2%	14,677	43.8%	9,910	29.6%
Lane	145,474	86,939	59.8%	58,535	40.2%	41,652	28.6%
Linn	44,566	30,389	68.2%	14,177	31.8%	11,027	24.7%
Marion	113,227	78,115	69.0%	35,112	31.0%	29,184	25.8%
Polk	27,973	19,244	68.8%	8,729	31.2%	6,853	24.5%
Yamhill	33,920	24,862	73.3%	9,058	26.7%	7,268	21.4%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Table 2-187. Family Households with Children by Head of Household in Region 3, 2012

	Family Households with Children		Single Parent (Male)		Single Parent (Female)		Married Couple with Children	
	Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	415,538	27.5%	35,855	2.4%	93,575	6.2%	286,108	18.9%
Region 3	111,129	27.9%	10,297	2.6%	26,455	6.6%	74,377	18.7%
Benton	7,375	22.0%	493	1.5%	1,403	4.2%	5,479	16.4%
Lane	35,308	24.3%	4,045	2.8%	8,648	5.9%	22,615	15.5%
Linn	12,316	27.6%	1,068	2.4%	3,083	6.9%	8,165	18.3%
Marion	36,724	32.4%	3,205	2.8%	9,546	8.4%	23,973	21.2%
Polk	8,263	29.5%	541	1.9%	1,611	5.8%	6,111	21.8%
Yamhill	11,143	32.9%	945	2.8%	2,164	6.4%	8,034	23.7%

Note: The table shows the percent of total households represented by each family household structure category.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Social and Demographic Trends

The social and demographic analysis shows that Region 3 is particularly vulnerable during a hazard event in the following categories:

- Many more tourists visit Lane County than visit other counties In Region 3.
- Land and Yamhill Counties has seen dramatic increases in their homeless populations.
- Marion County has a high percentage of people in who do not speak English "very well."
- Marion and Lane Counties have experienced the highest percentage drop in median household incomes.
- Benton County has a greater percentage of renters than other counties in Region 3.
- Benton, Lane, and Marion Counties have had the greatest increases in poverty in Region 3 and significantly greater increases than the state overall.
- Marion and Yamhill Counties are home to more households with children than the region and the state overall.

Economy

Economic characteristics include the financial resources present and revenue generated in the community to achieve a higher quality of life. Employment characteristics, income equality, employment, and industry sectors 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 employment sectors, workforce, resources, and infrastructure are interconnected in the existing economic picture.

Employment

Employment status and salary level may impact the resilience of individuals and families in the face of disasters as well as their ability to mitigate against natural hazards (Cutter et al., 2003). "The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster" (Cutter et al., 2003). In 2009, Yamhill, Linn, and Lane Counties had the highest unemployment percentages in the region, above 10%. Since then all counties have experienced job growth; job growth in Lane, Linn, and Yamhill Counties has been 4% or higher. From 2009 to 2012, Benton County has consistently had the lowest unemployment rate in the region and Linn County has had the highest. Across the region, average salaries are lower than the state as a whole except in Benton County.

Table 2-188. Unemployment Rates in Region 3, 2009–2013

	2009	2010	2011	2012	2013	Change (2009-2013)
Oregon	11.1%	10.8%	9.7%	8.8%	7.7%	-3.4%
Region 3	11.3%	10.8%	9.8%	9.0%	7.9%	-3.4%
Benton	7.8%	7.4%	6.7%	6.2%	5.8%	-2.0%
Lane	12.1%	11.1%	9.7%	8.7%	7.6%	-4.5%
Linn	13.8%	13.3%	11.8%	11.0%	9.7%	-4.1%
Marion	11.0%	11.1%	10.4%	9.7%	8.4%	-2.6%
Polk	9.3%	9.3%	9.0%	8.5%	7.6%	-1.8%
Yamhill	11.5%	10.7%	9.5%	8.6%	7.4%	-4.0%

Source: Oregon Employment Department, 2014

Table 2-189. Employment and Unemployment Rates in Region 3, 2013

	Civilian Labor Force	Employed Workers		Unemployed	
	Total	Total	Percent	Total	Percent
Oregon	1,924,604	1,775,890	92.3%	148,714	7.7%
Region 3	505,807	465,842	92.1%	39,965	7.9%
Benton	43,092	40,588	94.2%	2,504	5.8%
Lane	172,339	159,176	92.4%	13,163	7.6%
Linn	53,237	48,068	90.3%	5,169	9.7%
Marion	151,876	139,126	91.6%	12,750	8.4%
Polk	37,856	34,996	92.4%	2,860	7.6%
Yamhill	47,407	43,888	92.6%	3,519	7.4%

Source: Oregon Employment Department, 2013

Table 2-190. Employment and Payroll in Region 3, 2013

	Employees	Average Pay	Percent State Average
Oregon	1,679,364	$45,010	100%
Region 3	398,005	$38,636	85.8%
Benton	34,291	$45,491	101.1%
Lane	138,712	$38,349	85.2%
Linn	40,668	$37,384	83.1%
Marion	134,979	$38,919	86.5%
Polk	17,191	$32,095	71.3%
Yamhill	32,164	$36,463	81.0%

Source: Oregon Employment Department, 2014

Employment Sectors and Key Industries

In 2012 the five major employment sectors in Region 3 were: (a) Government; (b) Trade, Transportation and Utilities; (c) Education and Health Services; (d) Manufacturing; and (e) Leisure and Hospitality. Although wood products have historically been the main industry within the manufacturing sector in Lane County, this industry declined by 35% between 2001 and 2013. The region has had an increase in food products, health care, and call centers. Other key players that provide economic stability within the Government sector for the region include the University of Oregon and the Federal Courthouse (Oregon Employment Department, n.d., Region 5 data, retrieved May 5, 2014). Benton County has a strong economic base in higher education and high-tech manufacturing. The Linn County economy is primarily manufacturing based (Oregon Employment Department, n.d., Region 5 data, retrieved May 5, 2014). The counties of Marion, Polk, and Yamhill are key agricultural producers, producing nearly 30% of the state's farm sales (Oregon Employment Department, n.d., Region 3 data, retrieved May 5, 2014).

Table 2-191. Covered Employment by Sector in Region 3

		Benton County		Lane County		Linn County	
Industry	**Region 3**	**Employment**	**%**	**Employment**	**%**	**Employment**	**%**
Total All Ownerships	398,005	34,291	100%	138,712	100%	40,668	100%
Total Private Coverage	79.2%	25,212	73.5%	114,667	82.7%	33,914	83.4%
Natural Resources & Mining	5.1%	1,103	3.2%	2,205	1.6%	2,285	5.6%
Construction	4.0%	830	2.4%	5,223	3.8%	2,044	5.0%
Manufacturing	10.2%	3,003	8.8%	12,579	9.1%	6,831	16.8%
Trade, Transportation & Utilities	17.3%	4,207	12.3%	27,617	19.9%	8,546	21.0%
Information	1.4%	646	1.9%	3,365	2.4%	363	0.9%
Financial Activities	3.8%	1,011	2.9%	6,109	4.4%	1,147	2.8%
Professional & Business Services	8.9%	3,878	11.3%	14,796	10.7%	3,121	7.7%
Education & Health Services	15.2%	5,549	16.2%	22,425	16.2%	4,953	12.2%
Leisure & Hospitality	9.5%	3,565	10.4%	15,050	10.8%	3,106	7.6%
Other Services	3.8%	1,414	4.1%	5,292	3.8%	1,514	3.7%
Private Non-Classified	0.0%	7	0.0%	6	0.0%	7	0.0%
Total All Government	20.8%	9,079	26.5%	24,045	17.3%	6,754	16.6%
Federal Government	1.1%	527	1.5%	1,593	1.1%	306	0.8%
State Government	9.0%	6,031	17.6%	7,791	5.6%	1,227	3.0%
Local Government	10.7%	2,521	7.4%	14,662	10.6%	5,221	12.8%

		Marion County		Polk County		Yamhill County	
Industry	**Region 3**	**Employment**	**%**	**Employment**	**%**	**Employment**	**%**
Total All Ownerships	398,005	134,979	100%	17,191	100%	32,164	100%
Total Private Coverage	79.2%	101,487	75.2%	12,170	70.8%	27,830	86.5%
Natural Resources & Mining	5.1%	10,072	7.5%	1,537	8.9%	3,103	9.6%
Construction	4.0%	6,038	4.5%	673	3.9%	1,170	3.6%
Manufacturing	10.2%	9,792	7.3%	1,892	11.0%	6,408	19.9%
Trade, Transportation & Utilities	17.3%	21,963	16.3%	2,023	11.8%	4,433	13.8%
Information	1.4%	973	0.7%	52	0.3%	168	0.5%
Financial Activities	3.8%	5,627	4.2%	440	2.6%	959	3.0%
Professional & Business Services	8.9%	10,983	8.1%	865	5.0%	1,711	5.3%
Education & Health Services	15.2%	19,453	14.4%	2,501	14.5%	5,538	17.2%
Leisure & Hospitality	9.5%	11,582	8.6%	1,411	8.2%	3,092	9.6%
Other Services	3.8%	4,970	3.7%	771	4.5%	1,236	3.8%
Private Non-Classified	0.0%	34	0.0%	(c)	—	12	0.0%
Total All Government	20.8%	33,492	24.8%	5,021	29.2%	4,333	13.5%
Federal Government	1.1%	1,296	1.0%	72	0.4%	466	1.4%
State Government	9.0%	18,862	14.0%	1,484	8.6%	422	1.3%
Local Government	10.7%	13,334	9.9%	3,465	20.2%	3,445	10.7%

Note: (c) = confidential, information not provided by Oregon Employment Department to prevent identifying specific businesses.

Source: Oregon Employment Department, 2013

Each industry faces distinct vulnerabilities to natural hazards. Identifying key industries in the region enables communities to target mitigation activities toward those industries' specific sensitivities. Each of the primary private employment sectors has sensitivity to natural hazards, as follows.

Trade, Transportation, and Utilities: Retail Trade is the largest employment subsector within the Trade, Transportation, and Utilities sector. Retail Trade is vulnerable to disruptions in the disposable income of regional residents and to disruptions in the transportation system. Residents' discretionary spending diminishes after natural disasters as spending priorities tend to focus on essential items. Disruption of the transportation system could sever connectivity of people and retail hubs. Retail businesses are concentrated in the larger cities of the region.

Education and Health Services: The Health and Social Assistance industries play important roles in emergency response in the event of a disaster. Health care is a relatively stable revenue sector regionally with an abundant distribution of businesses primarily serving a local population.

Manufacturing: This sector is highly dependent upon transportation networks in order to access supplies and send finished products to outside markets. For these reasons the manufacturing sector may be susceptible to disruptions in transportation infrastructure. However, manufacturers are not dependent on local markets for sales, which may contribute to the economic resilience of this sector. The timber manufacturing industry is particularly vulnerable to droughts, landslides, and wildfires.

Leisure and Hospitality: This sector primarily serves regional residents with disposable income and tourists. The behavior of both of these social groups would be disrupted by a natural disaster. Regional residents may have less disposable income and tourists may choose not to visit a region with unstable infrastructure.

Revenue by Sector

In 2007 Trade (Retail and Wholesale), Manufacturing, and Healthcare and Social Assistance were the highest revenue grossing industries in Region 3. (Revenue data from the 2012 Economic Census will not be released prior to the publication of this Plan.) Combined, these three industries generated over $39.2 billion in revenue for the region (88% of total).

Table 2-192. Revenue of Top Industries (in Thousands of Dollars) in Region 3, 2007

	Total Revenue (in Thousands)	Trade (Retail and Wholesale)	Manufacturing	Health Care and Social Assistance
Oregon	$277,017,733	44.4%	24.1%	7.3%
Region 3	$44,717,701	44.3%	32.9%	10.5%
Benton	$2,885,212	37.2%	20.5%	17.5%
Lane	$18,119,991	40.5%	34.3%	10.7%
Linn	$5,593,199	37.8%	48.9%	5.7%
Marion	$13,087,937	57.1%	21.7%	11.1%
Polk	$1,192,318	37.4%	34.9%	10.7%
Yamhill	$3,839,044	35.1%	49.1%	8.9%

Source: U.S. Census, Economic Census. 2007, Table ECO700A1

Sectors anticipated to be major employers in the future warrant special attention, especially in the hazard mitigation planning process so the workforce and employers can be more prepared to respond and adapt to needs that arise after a natural hazard event. According to the Oregon Employment Department, between 2012 and 2022 the largest job growth in Region 3 is expected to occur in the following sectors: (a) Education and Health Services (primarily health care); (b) Government; (c) Professional and Business Services; (d) Trade, Transportation, and Utilities (including retail trade); and (e) Leisure and Hospitality (Oregon Employment Department, 2012).

Identifying sectors with a large number of businesses and targeting mitigation strategies to support those sectors can help the region's resiliency. The Trade, Transportation, and Utilities sector includes the most businesses units, 17.5% of all businesses in the region. The Other Services sector is the second most abundant. The Professional and Business Services sector, Education and Health Services sector, and Construction sector round out the top five sectors in the Mid/Southern Willamette Valley (Oregon Employment Department, 2012). While many of these are small businesses, employing fewer than 20 employees, collectively they represent 66% of the business units in the region. Due to their small size and large collective share of the economy, these businesses are particularly sensitive to temporary decreases in demand, such as may occur following a natural hazard event.

Economic Trends and Issues

Current and anticipated financial conditions of a community are strong determinants of community resilience, since a strong and diverse economic base increases the ability of individuals, families, and communities to absorb impacts of a disaster and recover more quickly. The Economic analysis shows that Region 3 is particularly vulnerable during a hazard event due to the following:

- The region is rebounding from the financial crisis that began in 2007. Linn and Polk have fewer key industries, and may therefore experience greater difficulty recovering after a disaster than counties with a more diverse economic base, such as Benton and Marion.
- Average salaries are 71% to 85% the state average. The exception is in Benton County where average salaries are just over the state average.

Supporting the growth of dominant industries and employment sectors as well as emerging sectors identified in this analysis can help the region become more resilient to economic downturns that often follow a hazard event (Stahl et al., 2000).

Infrastructure

Transportation

Roads

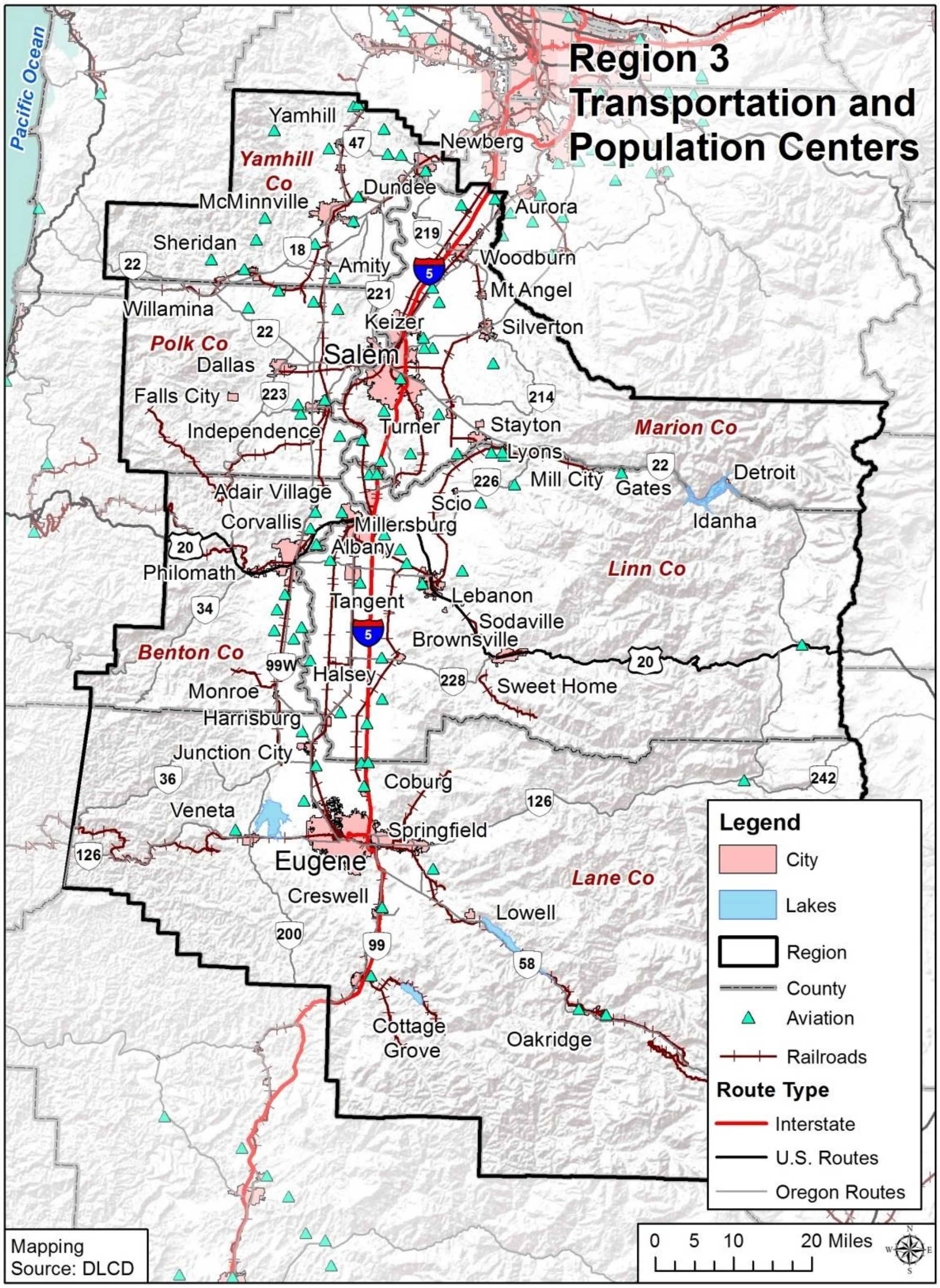
The highway system in the Region 3 centers on I-5 and the major east-west highways that intersect it. Recent population growth in the region has increased the number of vehicles on the roads. Many trips through the region originate outside the region in the Portland Metropolitan Area. Portland drivers commonly enter the region to reach Salem, The Spirit Mountain Casino, and coastal destinations. Many new residents of Yamhill County commute to Portland for work. **Figure 2-123** shows Region 3's highways and population centers.

Region 3's growing population centers bring more workers, automobiles and trucks onto roads. A high percentage of workers driving alone to work coupled with interstate and international freight movement on the I-5 corridor create additional stresses on transportation systems. Some of these include added maintenance, congestion, oversized loads, and traffic accidents.

Natural hazards and emergency events can further disrupt automobile traffic, create gridlock, and shut down local transit systems, making evacuations and other emergency operations difficult. Hazards such as localized flooding can render roads unusable. Likewise, a severe winter storm has the potential to disrupt the daily driving routine of thousands of people.

According to the Oregon Department of Transportation's (ODOT's) Seismic Lifeline Report (**Appendix 9.1.13**), the region has high exposure to earthquakes, especially a Cascadia Subduction Zone event. Therefore, the seismic vulnerability of the region's lifelines, including roadways and bridges, is an important issue. For information on ODOT's Seismic Lifeline Report findings for Region 3, see **Seismic Lifelines**.

Figure 2-123. Region 3 Transportation and Population Centers



Source: Oregon Department of Transportation, 2014

Bridges

Because of earthquake risk in Region 3, the seismic vulnerability of the region'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 region's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or that are part of regional and local systems that are maintained by the region's counties and cities.

Table 2-193 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. These ratings do not imply that a bridge is unsafe (ODOT, 2012, 2013). 21% of state-owned bridges in the region have been identified as distressed or deficient. 44% of those bridges are located in Lane County.

Table 2-193. Bridge Inventory for Region 3

	State Owned			County Owned			City Owned			Other Owned			Area Total			Historic
	Di	ST	%D*	De	ST	%D	De	ST	%D	De	ST	%D	D	T	%D	Covered
Oregon	610	2,718	22%	633	3,420	19%	160	614	26%	40	115	35%	1,443	6,769	21%	334
Region 3	118	610	19%	194	942	21%	44	208	21%	6	24	25%	362	1741	21%	71
Benton	11	44	27%	14	95	15%	3	28	11%	0	2	0%	28	166	17%	12
Lane	70	289	25%	44	408	11%	13	71	18%	3	12	25%	130	770	17%	32
Linn	13	142	10%	88	299	29%	7	39	18%	2	4	50%	110	474	23%	11
Marion	24	135	21%	48	140	34%	21	70	30%	1	6	17%	94	331	28%	8
Polk	14	51	28%	11	88	13%	4	13	31%	1	2	50%	30	153	20%	6
Yamhill	16	41	40%	33	89	37%	0	0	—	0	1	0%	49	130	38%	2

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.

Source: ODOT (2012, 2013)

Railroads

Railroads are major providers of regional and national cargo and trade flows. Railroads that run through the Mid/Southern Willamette region primarily run in a north-south direction. The Union Pacific Railroad (UP) is the major freight railroad. An Amtrak passenger train also runs on the UP line. It runs north to Spokane and south to Southern California where the tracks turn east and continue to Texas. Other freight railroads in the region include the Central Oregon and Pacific, the Albany and Eastern, the Portland and Western, the Hampton Railway, the Willamette and Pacific, and the Willamette Valley Railway.

Oregon's rail system is critical to the state's economy, energy, and food systems. Rail systems export lumber and wood products, pulp and paper, and other goods produced in Oregon and products from other states that are shipped to and through Oregon by rail (Cambridge Systematics, 2014).

Rails are sensitive to icing from winter storms that can occur in the Mid/Southern Willamette Valley. Disruptions to the rail system can result in economic losses for the region. The potential for harm from rail accidents can also have serious implications for local communities, particularly if hazardous materials are involved.

Airports

Fifteen public airports, 73 private airports, two public helipads, and 16 private helipads serve Region 3. The Eugene Airport is the largest public airport in the region and the second busiest in Oregon (Federal Aviation Administration, 2012). The airport is owned, operated, and administered by the City of Eugene. It serves 10 hubs and six air carriers with approximately 56 arriving and departing flights daily (Eugene, Oregon website, Visitors page, https://www.eugene-or.gov/index.aspx?NID=1715).

Table 2-194. Public and Private Airports in Region 3

	Number of Airports by FAA Designation				
	Public Airport	**Private Airport**	**Public Helipad**	**Private Helipad**	**Total**
Region 3	15	73	2	16	106
Benton	1	9	0	1	11
Lane	7	9	1	5	22
Linn	3	20	0	2	25
Marion	2	13	1	6	22
Polk	1	7	0	0	8
Yamhill	1	15	0	2	18

Source: FAA Airport Master Record (Form 5010), 2014

In the event of a natural disaster, public and private airports are important staging areas for emergency response activities. Public airport closures will impact the region’s tourism industries, as well as the ability for people to leave the region by air. Businesses relying on air freight may also be impacted by airport closures.

Energy

Electricity

The region is served by several investor-owned, public, cooperative, and municipal utilities. The Bonneville Power Administration is the area’s wholesale electricity distributor. Pacific Power and Light (Pacific Power) is the largest investor-owned utility company serving primarily Linn, Polk, and Marion Counties. Portland General Electric is another investor-owned utility and serves Marion and Yamhill Counties. The Blachly-Lane Electric Cooperative, Lane County Electric Cooperative, and Western Oregon Electric Cooperative each serve a portion of Region 3. Four municipal utility districts serve the region: Eugene Water and Electric Board, Monmouth, McMinnville, and Springfield Utility Board. In addition, the Central Lincoln People’s Utility District, Consumer’s Power, Inc., Emerald People’s Utility District, and Salem serve portions of the region.

The Mid/Southern Willamette Valley has a total of 16 power-generating facilities: 11 hydroelectric power facilities, one natural gas power facility, and four “other” facilities (primarily biomass and solar photovoltaic). In total, the power-generating facilities have the ability to produce up to 668 megawatts (MW) of electricity.

Table 2-195. Power Plants in Region 3

	Hydro-electric	Natural Gas	Wind	Coal	Other*	Total
Region 3	11	1	0	0	4	16
Benton	0	0	0	0	0	0
Lane	7	1	0	0	1	9
Linn	4	0	0	0	1	5
Marion	0	0	0	0	0	0
Polk	0	0	0	0	0	0
Yamhill	0	0	0	0	2	2
Energy Production (MW)	585	51	0	0	32	668

*"Other" includes biomass, geothermal, landfill gas, solar, petroleum, and waste.

Source: Army Corps of Engineers; Biomass Power Association; Calpine Corporation; Eugene Water and Electric Board; Iberdola Renewables; Idaho Power Company; Klamath Energy LLC; Oregon Department of Energy; Owyhee Irrigation District; Form 10K Annual Report (2013), PacifiCorp; Form 10K Annual Report (2013), Portland General Electric; U.S. Geothermal, Inc.

Hydropower

The majority of electrical power in Region 3 is generated hydroelectrically. The Detroit, Carmen-Smith, and Lookout Point dams generate the most power for the region. They are each capable of generating over 100 MW. There are also several power plants that use biomass as their energy source (Loy, 2001). Bonneville Power Administration (BPA) provides hydro-generated electricity to the state's consumer-owned utilities. BPA's major dams in Region 3 are located on the following rivers: North Santiam River (Big Cliff and Detroit), South Santiam River (Foster and Green Peter), McKenzie River (Cougar), and Middle Fork of the Willamette River (Dexter, Lookout Point and Hills Creek).

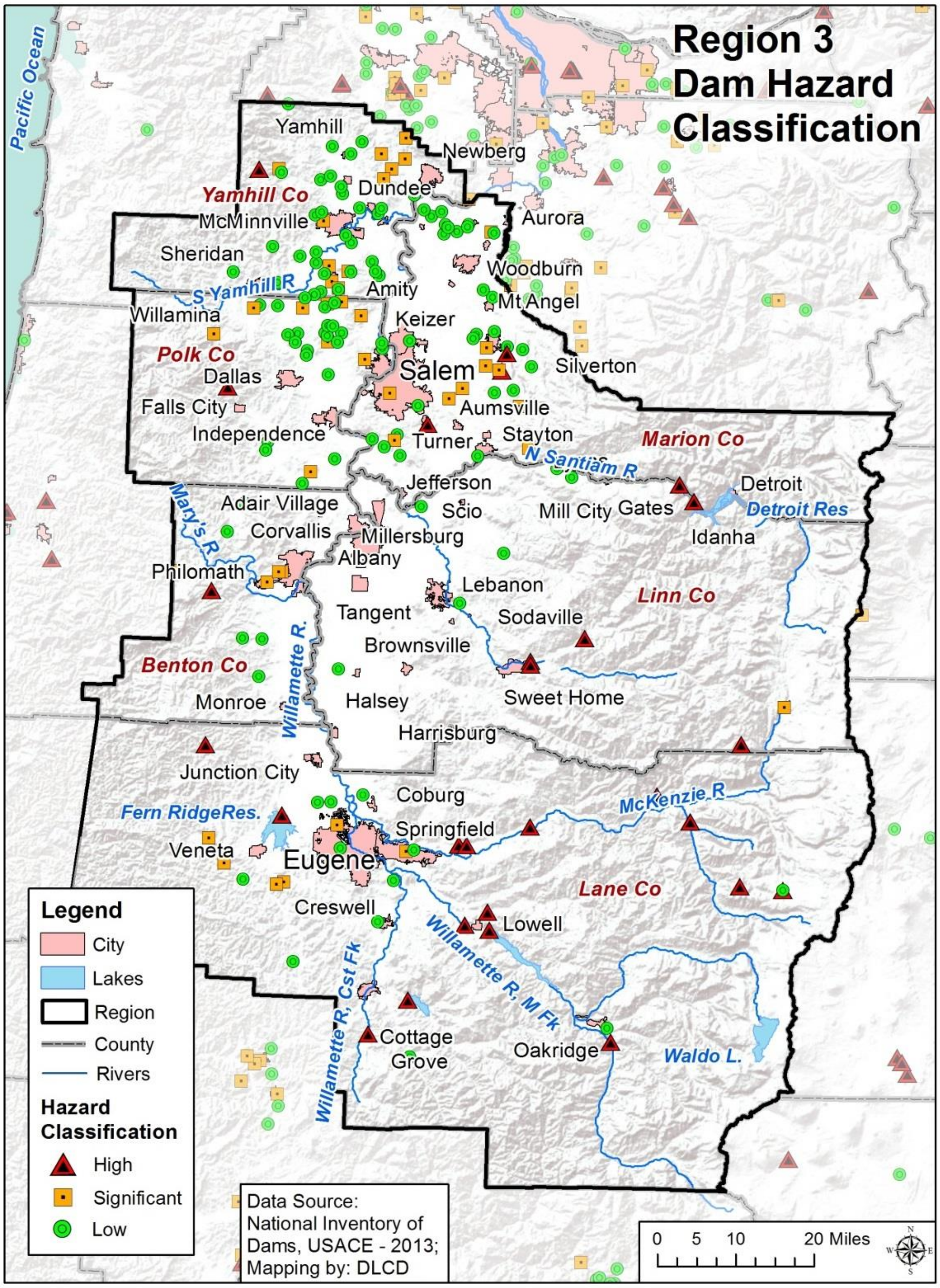
Minor dam failures can occur at any time. Most dam failures result in minor damage to structures and pose little or no risk to life safety. However, the potential for severe damage and fatalities does exist. For example, major dam failures occurred near Hermiston in 2005 and in Klamath Lake in 2006 (Association of Dam Safety Officials, n.d.). The Oregon Water Resources Department uses the National Inventory of Dams (NID) threat potential methodology and maintains an inventory of all large dams in Oregon. Table 2-196 lists the number of dams included in the inventory. The majority of dams in the region are located in Marion and Yamhill Counties. There are 26 High Threat Potential dams and 27 Significant Threat Potential dams in the region.

Table 2-196. Threat Potential of Dams in Region 3

	Threat Potential			Total Dams
	High	Significant	Low	
Region 3	26	27	312	365
Benton	1	2	19	22
Lane	12	6	37	55
Linn	7	1	19	27
Marion	2	11	79	92
Polk	2	7	70	79
Yamhill	2	0	88	90

Source: Oregon Water Resources Department, Dam Inventory Query 2014

Figure 2-124. Region 3 Dam Hazard Classification

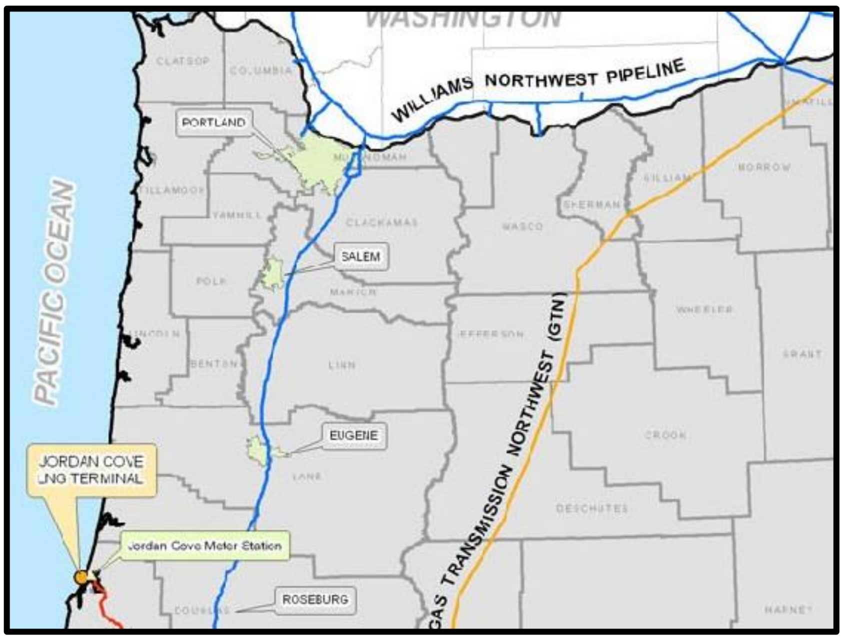


Source: National Inventory of Dams, USACE, 2013

Natural Gas

Although natural gas does not provide the most energy to the region, it does contribute a significant amount of energy to Pacific Power's portfolio. Liquefied natural gas (LNG) is transported via pipelines throughout the United States. **Figure 2-125** shows the Williams Northwest Pipeline, which runs through Marion, Linn, and Lane Counties (in blue) (Pipelines International, 2009). LNG pipelines, like other buried pipe infrastructure, are vulnerable to earthquakes and can cause danger to human life and safety, as well as environmental impacts in the case of a spill.

Figure 2-125. Liquefied Natural Gas Pipelines in Region 3



Source: Retrieved from http://gs-press.com.au/images/news_articles/cache/Pacific_Connector_Gas_Pipeline_Route-0x600.jpg

Utility Lifelines

The Mid/Southern Willamette Valley is an important thoroughfare for oil and gas pipelines and electrical transmission lines, connecting Oregon to California and Canada. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy. These lines may be vulnerable to severe but infrequent natural hazards such as earthquakes. If these lines fail or are disrupted, the essential functions of the community can become severely impaired.

The electric, oil, and gas lines that run through the Mid/Southern Willamette region are both municipally and privately owned. A network of electrical transmission lines running through the region allows Oregon utility companies to exchange electricity with other states and Canada. Most of the natural gas Oregon uses originates in Alberta, Canada. Northwest Natural Gas owns one main natural gas transmission pipeline. An oil pipeline originating in the Puget Sound runs through the region and terminates in Eugene.

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio) under the Oregon State Emergency Alert System Plan (Oregon Office of Emergency Management, 2013). Marion, Yamhill, and Polk Counties are part of the Capitol Operational Area. Lane, Benton, Linn, and coastal Douglas Counties are part of the South Valley Operational Area. Counties in this area can launch emergency messages by contacting the Oregon Emergency Response System (OERS) which in turn creates emergency messages to communities statewide.

Beyond day-to-day operations, maintaining communication capabilities during disaster events and other emergency situations helps to keep citizens safe by keeping them informed of the situation's status, areas to avoid, and other procedural information. Additionally, responders depend on telecommunications infrastructure to be routed to sites where they are needed.

Television

Television serves as a major provider for local, regional, and national news and weather information and can play a vital role in emergency communications. The local primary station identified as the emergency messengers by the Oregon State Emergency Alert System Plan in Region 3 is KWVT-TV Channel 17 in Salem.

Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband service providers serve Region 3. Broadband technology including mobile wireless is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless, and mobile wireless. Internet service is becoming more readily available in the region with a greater number of providers and service types available within major communities and along major transportation corridors (I-5, OR-99, etc.). The majority of areas that lack access to broadband service are in Coast Range and the Cascades mountains (NTIA, n.d.). Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

Wireless providers sometimes offer free emergency mobile phones to those impacted by disasters, which can aid in communication when landlines and broadband service are unavailable.

Radio

Radio is readily available to those who live within Region 3 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Radio transmitters for the Capitol Operational Area are:

- KOPB-FM, 91.5 MHZ, Salem; and
- WXL-96.475 MHZ, Salem.

Radio transmitters for the South Valley Operational Area are (Oregon Office of Emergency Management, 2013):

- KWAX-FM, 91.1 MHZ, Eugene; 91.6 MHZ, Florence; 101.9 MHZ, Cottage Grove;
- KKNU-FM, 93.3 MHZ Eugene; 100.9 MHZ, Florence; 101.9 MHZ, Cottage Grove; and

- KOAC-AM, 550 KHZ, Albany, 103.1 MHZ, Corvallis.

Ham Radio

Amateur radio, or ham radio, is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). Region 3 is served by ARES District 4. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (Oregon Office of Emergency Management, n.d.). The official ham emergency station calls for Region 3 include (American Relay Radio League Oregon Chapter, www.arrloregon.org) include:

- Benton County: W7DMR;
- Lane County: K7BHB, N7NFS;
- Linn County: W7ACW;
- Marion County: KE70LU, KD7MGF, KC7BRZ, WA7ABU, KE7EXX, W7SDP;
- Polk County: KG7G; and
- Yamhill County: W7IG.

Water

Water infrastructure includes drinking water, stormwater, and wastewater systems. All of these systems possess some level of vulnerability to natural hazards that can have repercussions on human health, ecosystems, and industry.

Drinking Water

In Region 3 the majority of the municipal drinking water supply is obtained primarily from surface water sources. Surface water is drawn from rivers and smaller tributaries. These surface water sources are often backed up by groundwater that is drawn from an aquifer when surface water levels get low, especially in summer months

Rural residents draw water from surface water, groundwater wells, or springs. Areas with sedimentary and volcanic soils may be subject to high levels of arsenic, hydrogen sulfide, and fecal coliform bacteria, which can impact the safety of groundwater sources. In Polk County, saltwater naturally occurs in some aquifers, which presents a challenge during water shortages when aquifers are relied upon for backup water supply. In areas where no new live-flow water rights are available, farmers and ranchers are turning to above-ground storage to help supply water for crop irrigation during dry seasons.

Surface sources for drinking water are vulnerable to pollutants caused by non-point sources and natural hazards. Non-point source pollution is a major threat to surface water quality, and may include stormwater runoff from roadways, agricultural operations, timber harvest, erosion and sedimentation. Landslides, flood events, and liquefaction from earthquakes can cause increased erosion and sedimentation in waterways.

Underground water supplies and aging or outdated infrastructure — such as reservoirs, treatment facilities, and pump stations — can be severed during a seismic event. Rigid materials such as cast iron may snap under the pressure of liquefaction. More flexible materials such as polyvinyl chloride (PVC) and ductile iron may pull apart at joints under the same stresses. These types of infrastructure damages could result in a loss of water pressure in municipal water supply systems, limiting access to potable water. This can lead to unsanitary conditions that may threaten human health. Lack of water can also impact industry, such as the manufacturing sector. Moreover, if transportation infrastructure is impacted by a disaster event, repairs to water infrastructure will be delayed.

Stormwater and Wastewater

In urbanized areas severe precipitation events may cause flooding that leads to stormwater runoff. A non-point source of water pollution, stormwater runoff can adversely impact drinking water quality. It can also lead to environmental issues such as increasing surface water temperatures that can adversely affect habitat health. Furthermore, large volumes of fast-moving stormwater that enter surface waterways can cause erosion issues.

Stormwater can also impact water infrastructure. Leaves and other debris can be carried into storm drains and pipes, which can clog stormwater systems. In areas where stormwater systems are combined with wastewater systems (combined sewers), flooding events can lead to combined sewer overflows (CSOs). CSOs present a heightened health threat as sewage can flood urban areas and waterways. Underground stormwater and wastewater pipes are also vulnerable to damage by seismic events.

In Region 3, most local building codes and stormwater management plans emphasize use of centralized storm sewer systems to manage stormwater. Requirements for stormwater mitigation vary in Region 3. Low impact development (LID) mitigation strategies can alleviate or lighten the burden to a jurisdiction's storm sewer system by allowing water to percolate through soil onsite or detaining water so water enters the storm sewer system at lower volumes, at lower speed, and at lower temperatures. Most cities in Region 3 use the State of Oregon Residential Specialty Code, which does not address the issue of stormwater mitigation on new or existing construction. However, some cities, such as Eugene, require LID stormwater mitigation strategies in their building code. Promoting and requiring decentralized LID stormwater management strategies could help reduce the burden of new development on storm sewer systems, and increase a community's resilience to many types of hazard events.

Infrastructure Trends and Issues

Physical infrastructure is critical for everyday operations and is essential following a disaster. Lack or poor condition of infrastructure can negatively affect a community's ability to cope with, respond to, and recover from a hazard event. Diversity, redundancy, and consistent maintenance of infrastructure systems help create system resiliency (Meadows, 2008).

Roads, bridges, railroads, and airports are vulnerable to natural hazards. Failures of this infrastructure can be devastating to the economy and health of the region's residents. Bridges are particularly vulnerable to seismic events. Forty-four percent of all state-owned bridges in the region that have been identified as distressed or deficient are within Lane County. Railroads are sensitive to icing from winter storms. The second largest airport in the Oregon is in Region 3, along with several smaller airports and helipads.

The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards. The majority of power in the region is generated hydroelectrically and there are 16 power-generating facilities in the Mid/Southern Willamette Valley. The majority of dams are in Marion and Yamhill Counties. The three major dams are Detroit, Carmen-Smith, and Lookout Point. Roughly 14% (53) of all dams in the region are either Significant or High Threat Potential. Liquid Natural Gas is transported through the region via the Williams Northwest Pipeline that runs through Marion, Linn, and Lane Counties.

Decentralization and redundancy in the region’s telecommunication systems can help boost the area’s ability to communicate before, during, and after a disaster event. It is important to note that broadband and mobile telephone services do not cover many rural areas of the region that are distant from major transportation corridors. This may present a communication challenge in the wake of a hazard event. Encouraging residents to keep AM/FM radios available for emergency situations could help increase the capacity for communicating important messages throughout the region.

Water systems in the region are particularly vulnerable to hazard events because they tend to be centralized and lacking in system redundancies. Furthermore, because most drinking water is sourced from surface water, the region is at risk of high levels of pollutants entering waterways such as through combined sewers that overflow during high-water events. Older, centralized infrastructure in storm and wastewater infrastructure creates vulnerability in the system during flood events. The City of Eugene employs decentralized, low-impact development (LID) stormwater systems to better manage high-precipitation events.

Built Environment

Development Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's program is 19 land use goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards (DLCD website, http://www.oregon.gov/).

Settlement Patterns

The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people or an "urban cluster" of at least 2,500 people (but less than 50,000). Wheeler County does not meet either definition; therefore all of its population is considered rural even though the county has incorporated cities.

Regionally, between 2000 and 2010, urban areas in the Mid/Southern Willamette Valley have grown comparably to other urban areas statewide, with the greatest increases in population occurring in Linn, Polk, and Yamhill Counties. Benton is the only county in the region to experience a more even distribution of population growth in both urban and rural areas, roughly 9%. The most extreme shifts between urban and rural areas occurred in Yamhill County — 28% increase in urban populations and a 10.8% decrease in rural populations.

The percent growth of housing units in urban areas between 2000 and 2010 is almost 4 times that in rural areas. Linn, Polk, and Yamhill Counties have had the greatest increases in urban housing. Rural housing has increased by almost 16% in Benton County.

Unsurprisingly, populations tend to cluster around major road corridors and waterways. This holds true for the major cities of Eugene, Albany, Corvallis, and Salem and for the cities of Portland Metro area.

Table 2-197. Urban and Rural Populations in Region 3

	Urban			Rural		
	2000	2010	% Change	2000	2010	% Change
Oregon	2,694,144	3,104,382	15.2%	727,255	726,692	-0.1%
Region 3	738,040	850,560	15.2%	198,347	193,337	-2.5%
Benton	63,378	69,521	9.7%	14,775	16,058	8.7%
Lane	260,514	290,084	11.4%	62,445	61,631	-1.3%
Linn	65,349	79,759	22.1%	37,720	36,913	-2.1%
Marion	241,260	274,046	13.6%	43,574	41,289	-5.2%
Polk	47,672	60,378	26.7%	14,708	15,025	2.2%
Yamhill	59,867	76,772	28.2%	25,125	22,421	-10.8%

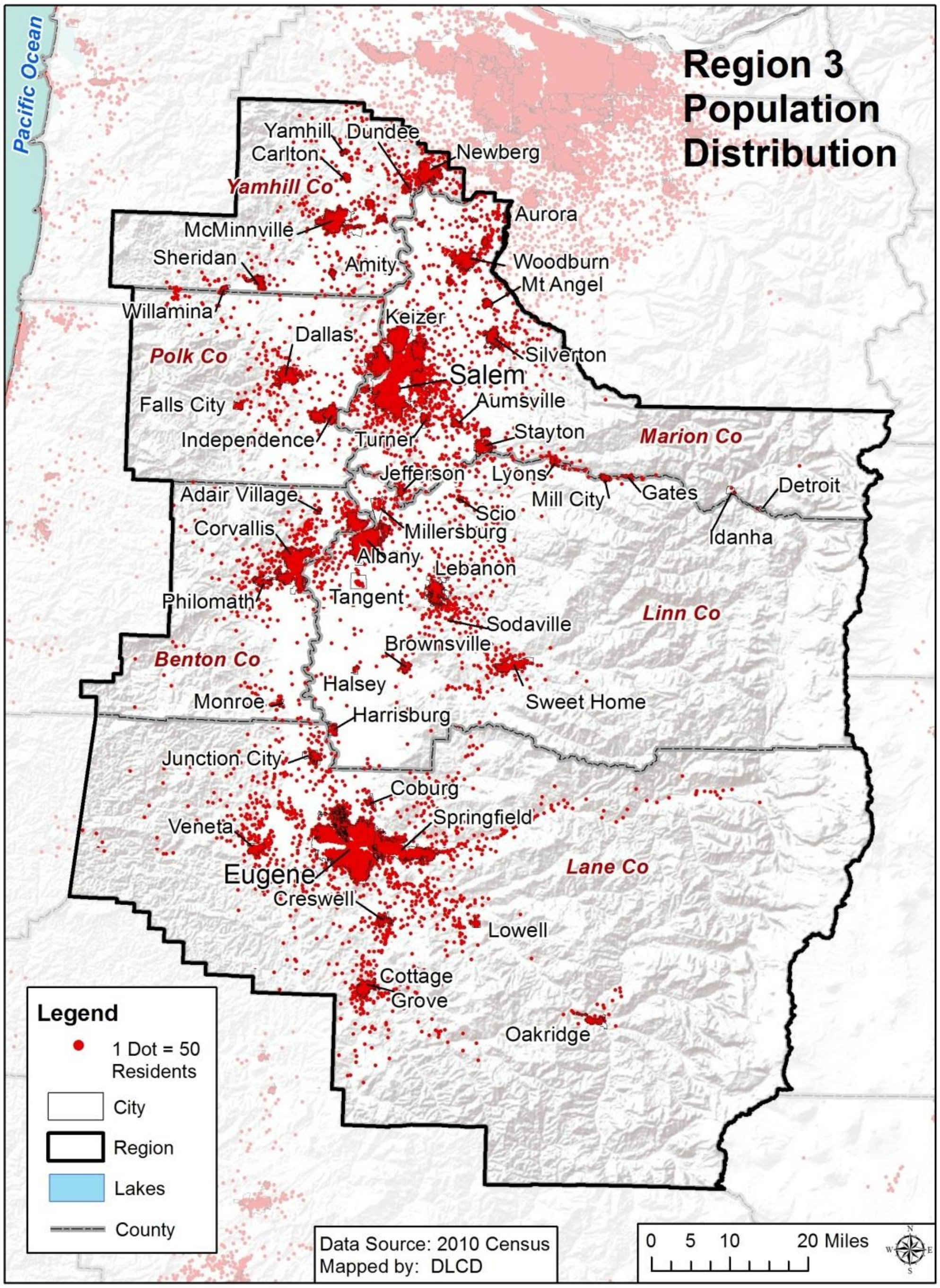
Source: U.S. Census Bureau. 2000 Decennial Census, Table P002 and 2010 Decennial Census, Table P2

Table 2-198. Urban and Rural Housing Units in Region 3

	Urban			Rural		
	2000	2010	% Change	2000	2010	% Change
Oregon	1,131,574	1,328,268	17.4%	321,135	347,294	8.1%
Region 3	298,306	348,148	16.7%	78,046	81,390	4.3%
Benton	26,115	29,459	12.8%	5,865	6,786	15.7%
Lane	112,750	128,267	13.8%	26,196	27,845	6.3%
Linn	27,712	33,467	20.8%	14,809	15,354	3.7%
Marion	91,846	104,590	13.9%	16,328	16,358	0.2%
Polk	18,851	24,204	28.4%	5,610	6,098	8.7%
Yamhill	21,032	28,161	33.9%	9,238	8,949	-3.1%

Source: U.S. Census Bureau. 2000 Decennial Census, Table H002 and 2010 Decennial Census, Table H2

Figure 2-126. Region 3 Population Distribution



Source: U.S. Census, 2012

Land Use and Development Patterns (Lettman, 2011)

Similar to Region 2, Region 3 overall has a larger percentage of private land (58%) than federal land (40%), with most of the federal holdings ranging up the slopes of the Cascades. However, the northern portion is dominated by agricultural activities, while the southern end has a much larger share of BLM and Forest Service timberland. As a result, Polk County, for example, is mostly privately owned, while just 42% of Lane County (minus the coastal portion) is in private hands.

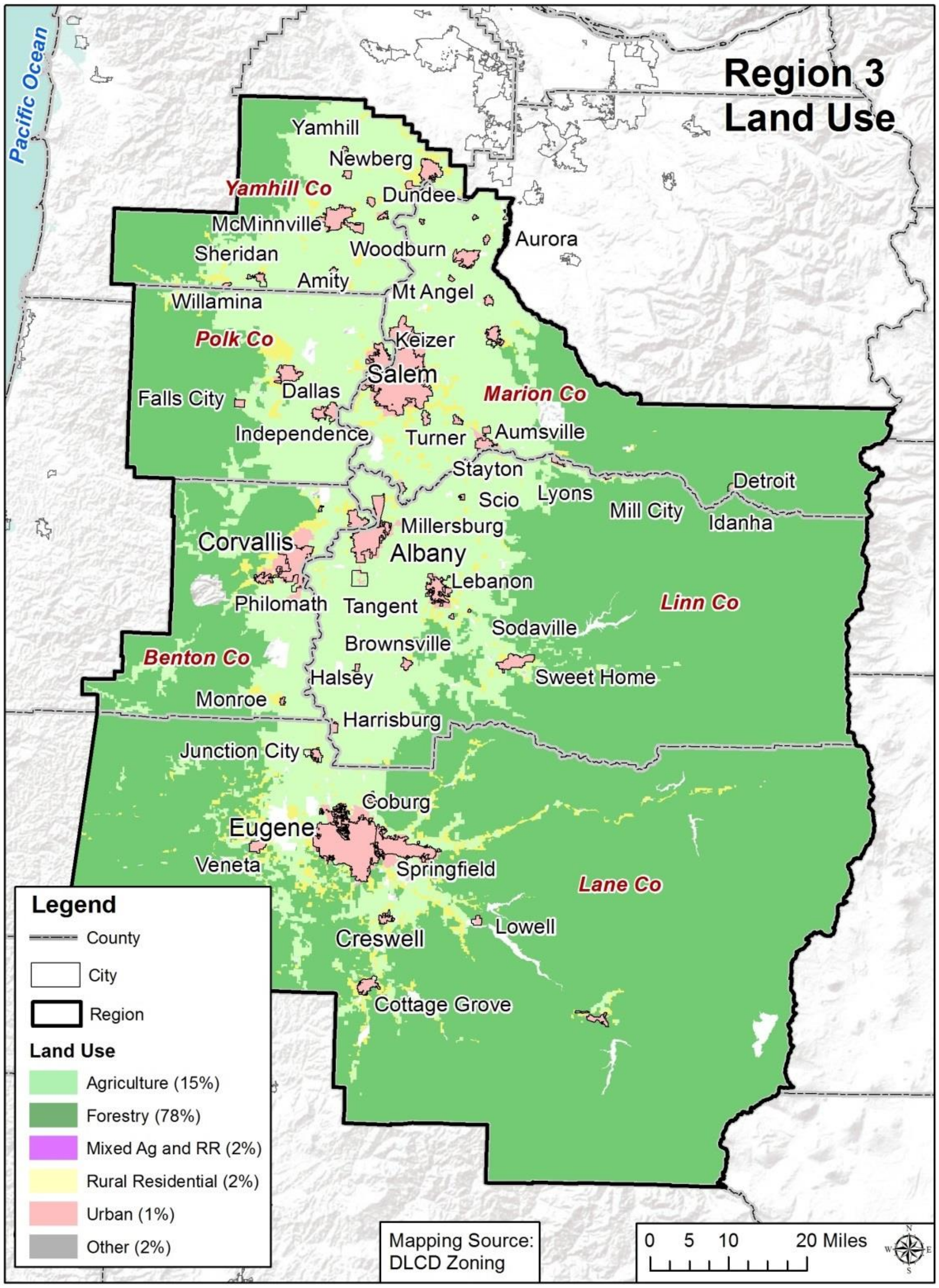
The South Willamette Region is a land of contrasts, with urban areas nestled within productive farmland, bordered by the Cascade and Coast Range timberlands. I-5 runs the length of the region, and this area's economy is shaped by the transportation system. With 61 incorporated communities in the region, there is continued pressure on area ecosystems from population growth, land use conversion, and altered habitat, fire regimes, and floodplain development.

Oregon Department of Forestry data shows that in the 25-year period between 1984 and 2009, approximately 147,000 acres of farm and range land in the state transitioned from land use classes more conducive to commercial farm or forest practices into more developed land classes. Almost half of all farm land conversion occurred in central Oregon, while nearly one quarter took place in the Metro area and one quarter in the general area of Region 3 (Lettman, 2011).

This region of the state is often subject to major flooding events, and communities have experienced major floods in 1861, 1890, 1945, 1956, 1964, 1996, and 2011. Generally, they have responded by keeping their flood ordinances current as well as going beyond minimum standards. For example, Corvallis, Albany, and Benton County integrate natural hazard information into their Comprehensive Plan, assuring that proper planning, such as determining if enough buildable land is available for future growth, and policies that regulate and prohibit development in natural hazard areas, will help minimize the extent of damage from future hazard events.

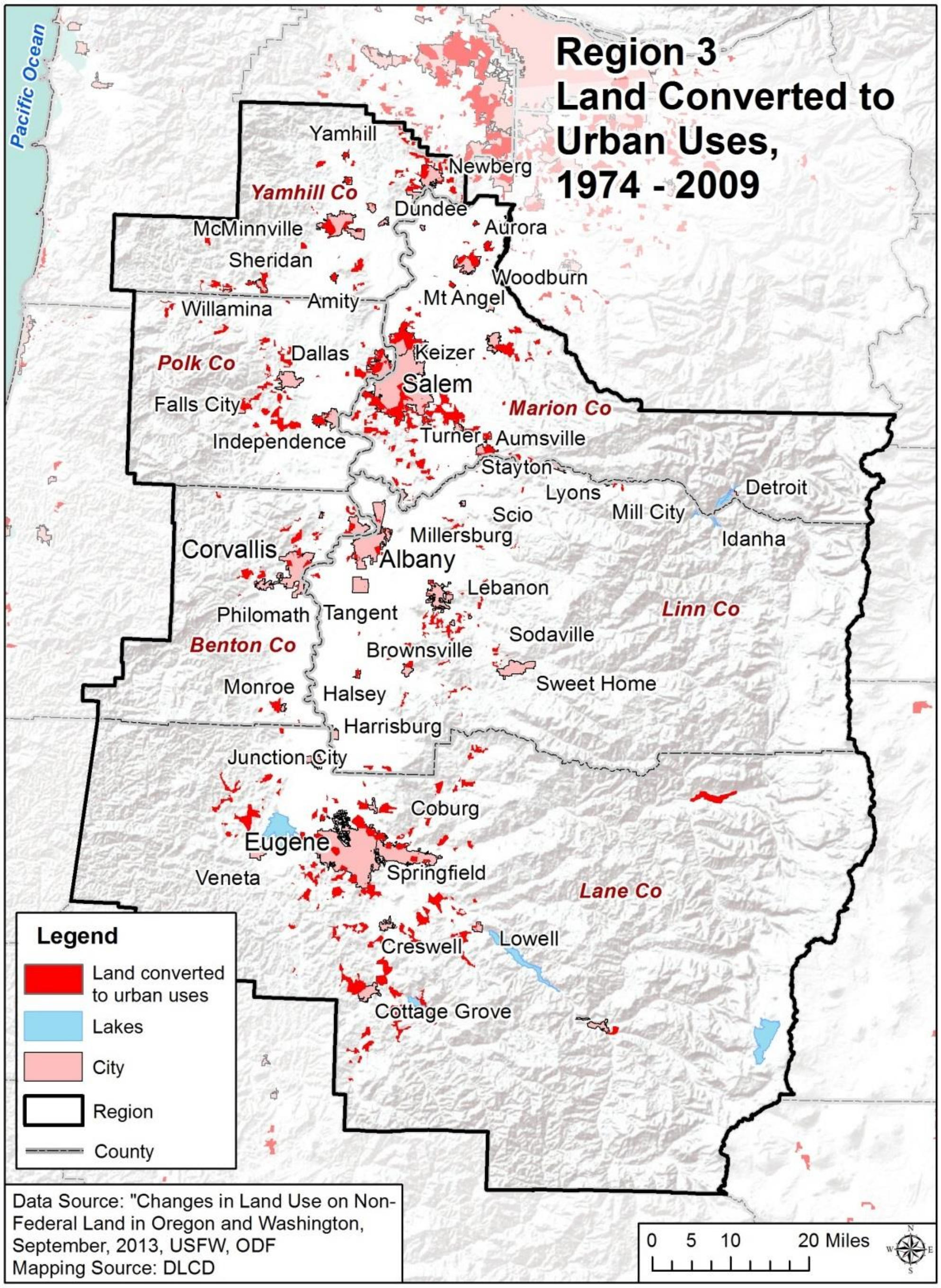
The Eugene-Springfield area is the second largest metropolitan area in Oregon, but expansion options are restricted by potential landslide and flood hazard areas. These communities are doing what they can to accommodate growth inside existing UGBs while minimizing encroachment into known hazard areas. One strategy they are using is to allow increased intensity of development outside of hazard areas, reducing the need to develop within them. For example, Eugene minimizes residential development on steep slopes by requiring larger lot sizes, and using floodplain areas as parks and open spaces. Overall, Eugene's average density has increased, and the mix of housing types is shifting toward more multi-family (DLCD, internal communication, 2014).

Figure 2-127. Region 3 Land Use



Source: DLCD, Statewide Zoning

Figure 2-128. Region 3 Land Use Converted to Urban Uses, 1974–2009



Source: Land Use Change on Non-Federal Land in Oregon and Washington, September, 2013, USFS, ODF

Housing

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. The majority of the region's housing stock is single-family homes. Mobile residences make up 9.0% of Region 3's housing overall, but Linn and Yamhill Counties have a higher share of mobile homes. In natural hazard events such as earthquakes and floods, mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of OES, 1997).

Table 2-199. Housing Profile for Region 3, 2012

	Total Housing Units	Single Family		Multi-Family		Mobile Homes	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	1,140,319	68.1%	460,852	27.5%	139,768	8.4%
Region 3	429,137	293,734	68.4%	95,559	22.3%	38,706	9.0%
Benton	36,301	22,684	62.5%	11,150	30.7%	2,425	6.7%
Lane	155,815	105,847	67.9%	35,331	22.7%	14,024	9.0%
Linn	48,718	34,022	69.8%	8,375	17.2%	6,170	12.7%
Marion	121,057	82,176	67.9%	28,506	23.5%	10,213	8.4%
Polk	30,190	21,922	72.6%	6,004	19.9%	2,198	7.3%
Yamhill	37,056	27,083	73.1%	6,193	16.7%	3,676	9.9%

Note: The percentages listed above do not reflect the number of structures that are built within special flood hazard areas or that are at risk of seismic damage.

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25024

Aside from location and type of housing, the year structures were built (**Table 2-200**) has implications for level of vulnerability to natural hazards. Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for the Cascadia earthquake fault (Judson, 2012). Therefore, homes built before 1994 are more vulnerable to seismic events.

Also in the 1970s, FEMA began assisting communities with floodplain mapping as part of administering 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. Regionally 35.6% of the housing stock was built prior to 1970, before the implementation of floodplain management ordinances. Just under one third of the region's housing stock was built after 1990 and the codification of seismic building standards. Only 10% of homes in Polk and Yamhill Counties were built after 1990 and current seismic building standards.

Table 2-200. Age of Housing Stock in Region 3, 2012

	Total Housing Units	Pre 1970		1970 to 1989		1990 or later	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	609,062	36.4%	518,569	31.0%	545,962	32.6%
Region 3	429,137	152,697	35.6%	140,380	32.7%	136,060	31.7%
Benton	36,301	12,887	35.5%	11,830	32.6%	11,584	31.9%
Lane	155,815	60,365	38.7%	51,825	33.3%	43,625	28.0%
Linn	48,718	18,207	37.4%	15,542	31.9%	14,969	30.7%
Marion	121,057	40,769	33.7%	42,155	34.8%	38,133	31.5%
Polk	30,190	9,365	31.0%	8,401	27.8%	12,424	41.2%
Yamhill	37,056	11,104	30.0%	10,627	28.7%	15,325	41.4%

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25034

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.

Table 2-201 shows the initial and current FIRM effective dates for Region 3 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, Flood section.

Table 2-201. Community Flood Map History in Region 3

	Initial FIRM	Current FIRM
Benton County	August 5, 1986	June 2, 2011
Albany	*see Linn County*	*see Linn County*
Corvallis	Jan. 3, 1985	June 2, 2011
Monroe	Sep. 26, 1975	June 2, 2011
Philomath	June 15, 1982	June 2, 2011
Lane County	Dec. 18, 1985	June 2, 1999
Coburg	Jan. 6, 1985	June 2, 1999 (M)
Cottage Grove	Nov. 15, 1985	June 2, 1999
Creswell	Sep. 18, 1985	June 2, 1999
Dunes City	Mar. 24, 1981	June 2, 1999 (M)
Eugene	Sep. 29, 1986	June 2, 1999
Florence	May 17, 1982	June 2, 1999
Junction City	June 15, 1982	June 2, 1999
Lowell	June 2, 1999	June 2, 1999 (M)
Oakridge	June 3, 1986	June 2, 1999
Springfield	Sep. 27, 1985	June 2, 1999
Veneta	Feb. 1, 1984	June 2, 1999
Westfir	Aug. 19, 1985	June 2, 1999
Linn County	Sep. 29, 1986	Sep. 29, 2010
Albany	April 3, 1985	Sep. 29, 2010
Brownsville	Aug. 17, 1981	Sep. 29, 2010
Halsey	Sep. 29, 2010	Sep. 29, 2010
Harrisburg	Feb. 3, 1982	Sep. 29, 2010
Idanha	Mar. 1, 1979	Sep. 29, 2010
Lebanon	July 2, 1981	Sep. 29, 2010
Lyons	Dec. 15, 1981	Sep. 29, 2010
Mill City	Mar. 1, 1979	Sep. 29, 2010
Millersburg	June 15, 1982	Sep. 29, 2010
Scio	Aug. 1, 1984	Sep. 29, 2010
Sweet Home	Mar. 1, 1982	Sep. 29, 2010
Tangent	May 17, 1982	Sep. 29, 2010
Waterloo	Sep. 29, 2010	Sep. 29, 2010
Marion County	Aug. 15, 1979	Jan. 2, 2003
Aumsville	Mar. 1, 1979	Jan. 19, 2000
Aurora	June 5, 1979	**Jan.** 19, 2000
Detroit	June 30, 1976	Jan. 19, 2000
Gates	Dec. 4, 1979	Jan. 19, 2000
Gervais	June 30, 1976	June 30, 1976
Hubbard	Feb. 5, 1986	Jan. 19, 2000
Jefferson	Mar. 1, 1979	Jan. 19, 2000
Keizer	May 1, 1985	Jan. 19, 2000
Mt. Angel	Jan.19, 2000	Jan. 19, 2000
Salem	June 15, 1979	Jan. 2, 2003
Scotts Mills	Mar. 1, 1979	Jan. 19, 2000
Silverton	Mar. 1, 1979	Jan. 19, 2000
St. Paul	Jan. 19, 2000	Jan. 19, 2000
Stayton	Mar. 1, 1979	Jan. 19, 2000
Turner	Apr. 2, 1979	Jan. 19, 2000
Woodburn	Mar. 1, 1979	Jan. 19, 2000
Polk County	Feb. 15, 1978	Dec. 19, 2006
Dallas	Apr. 5, 1988	Dec. 19, 2006
Falls City	July 7, 1981	Dec. 19, 2006
Independence	Apr. 5, 1988	Dec. 19, 2006
Monmouth	Apr. 5, 1988	Dec. 19, 2006
Salem	*see Marion County*	*see Marion County*
Yamhill County	Sep. 30, 1983	Mar. 2, 2010
Amity	Dec. 1, 1981	Mar. 2, 2010
Carlton	June 30, 1976	Mar. 2, 2010
Dayton	June 1, 1982	Mar. 2, 2010
Dundee	Mar. 1, 1982	Mar. 2, 2010
Lafayette	June 15, 1982	Mar. 2, 2010
McMinnville	Dec. 1, 1982	Mar. 2, 2010
Newberg	Mar. 1, 1982	Mar. 2, 2010
Sheridan	Aug. 1, 1990	Mar. 2, 2010
Willamina	Mar. 15, 1982	Mar. 2, 2010
Yamhill, City	Mar. 1, 1982	Mar. 2, 2010

(M) = no elevation determined; all Zone A, C, and X.

Source: Federal Emergency Management Agency, Community Status Book Report

State-Owned/Leased and Critical/Essential Facilities

In 2014 the Department of Geology and Mineral Industries updated the 2012 Oregon NHMP inventory and analysis of state-owned/leased facilities and critical/essential facilities. Results from this report relative to Region 3 can be found in **Table 2-202**. The region contains 58.3% of the total value of state-owned/leased critical/essential facilities. Many of the facilities are associated with the universities in Eugene and Corvallis and with state offices in Salem.

Table 2-202. Value of State-Owned/Leased Critical and Essential Facilities in Region 3

	Total Property Value (State Facilities)	Percent State Total
Oregon	$7,339,087,023	100%
Region 3	$4,277,900,069	58.3%
Benton	$1,093,373,557	14.9%
Lane	$283,280,825	3.9%
Linn	$75,555,783	1.0%
Marion	$2,771,586,104	37.8%
Polk	$37,996,619	0.5%
Yamhill	$16,107,182	0.2%

Source: DOGAMI

Built Environment Trends and Issues

The trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. Region 3 is largely an urban county with urban development focused around the major cities along I-5. Urban areas in Linn, Polk, and Yamhill are growing at a higher rate than the state, while Benton County’s rural population is growing at a higher rate. The region has a slightly higher percentage of mobile homes than the state — the highest percentage being in Linn County 12.7%. Over one third of all homes in Polk and Yamhill Counties were built before 1970 and floodplain management standards. Furthermore, almost two thirds of the region’s homes were built before 1990 and seismic building standards. All of the region’s FIRMs have been modernized or updated.

2.3.3.3 Hazards and Vulnerability

Droughts

Characteristics

Droughts are not common in Region 3. In 1992, the Governor declared a drought for all 36 counties in Oregon. However, since 1992, no Governor-declared droughts have occurred in this region. Nonetheless, a dry winter or spring can have an effect on water supplies within the Mid/Southern Willamette Valley. In March 2014, the Natural Resources Conservation Service's (NRCS) data showed snowpack for the Willamette Basin at 47% of average, and noted that water users should expect below normal stream flows during the summer months. NRCS data shows snowpack peaked at 30–60% of typical peak levels and melted out up to four weeks early. Precipitation in May helped boost water conditions. By June, the major reservoirs in the basin were storing at their average volumes. Although conditions were dry for much of the summer in Region 3, there was no state drought declaration, unlike many parts of Oregon in 2014.

Historic Drought Events

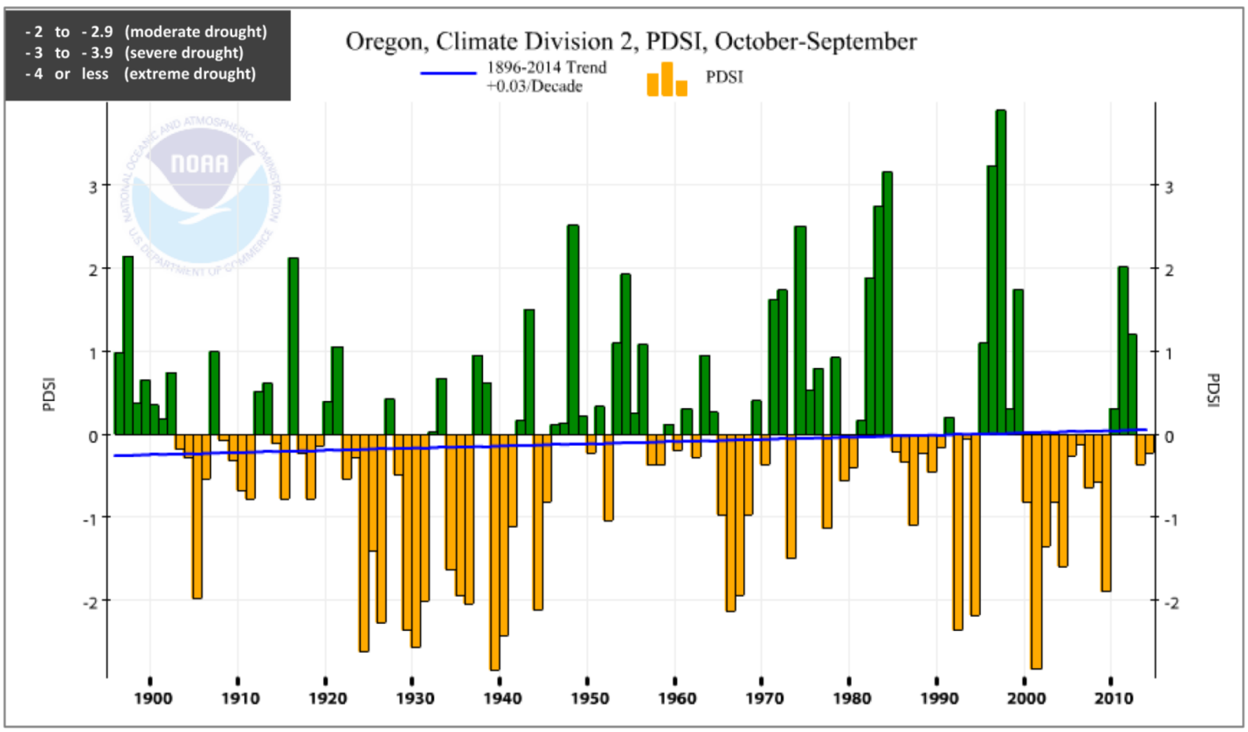
Table 2-203. Historic Droughts in Region 3

Date	Location	Description
1923-1924	statewide	prolonged statewide drought that caused major problems for agriculture
1928-1930	Regions 1–3, 5–7	moderate to severe drought affected much of the state; the worst years in Region 2 were 1928–1930, which initiated an era of many drier than normal years
1938-1939	statewide	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country; Water Year 1939 was one of the more significant drought years in during that period
1991-1992	statewide, especially Regions 1–4, 8	1992 fell toward the end of a generally dry period, which caused problems throughout the state; the 1992 drought was most intense in eastern Oregon, with severe drought occurring in Region 1
2000-2001	Regions 2–4, 6, 7	the driest water year on record in the Willamette Valley (NOAA Climate Division 2); warmer than normal temperatures combined with dry conditions

Sources: Taylor and Hatton (1999); Oregon Secretary of State's Archives Division. 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.

Historical drought information can also be obtained from the National Climatic Data Center, which provides climate data showing wet and dry conditions, using the Palmer Drought Severity Index (PDSI) that dates back to 1895. The Palmer Index is not the best indicator of water availability for Oregon as it does not account for snow or ice (delayed runoff), but it has the advantage of providing the most complete, long-term record. Figure 2-129 shows years where drought or dry conditions affected the Willamette Valley (Climate Division 2). Based on this index, Water Years 1939 and 2001 were the driest years with values of -2.84 and -2.83, respectively. These moderate-type drought years have occurred more than a dozen times during this record.

Figure 2-129. Palmer Drought Severity Index for Region 3



Source: National Climatic Data Center, http://www.ncdc.noaa.gov/cag/

Although not shown here, drought data from Climate Division 4, “the High Cascades,” could also be analyzed to show a broader picture of drought impacts in Hazard Regions 2 and 3.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 3 will experience drought is shown in **Table 2-204**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-204. Local Probability Assessment of Drought in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	M	H	—	—	—	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

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

Based on limited data, there is a low probability of drought occurring in this region.

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

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to drought is shown in **Table 2-205**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-205. Local Probability Assessment of Drought in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	L	M	—	—	—	M

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Oregon has yet to undertake a comprehensive, statewide analysis to identify which communities are most vulnerable to drought. However, based on a review of Governor-declared drought declarations since 1992, Region 3 could be considered less vulnerable to drought impacts than many other parts of the state.

Although long-term drought conditions are uncommon in the mid-Willamette Valley, a dry winter or spring could affect many communities and water users throughout the Basin. Recreation, particularly at the reservoirs owned and operated by the U.S. Army Corps of Engineers, contributes greatly to the valley’s economy. Communities, such as Detroit in Marion County, can be economically impacted by low reservoir levels. The Willamette Valley is also home to one of the most productive and diverse agricultural regions in the United States.

Earthquakes

Characteristics

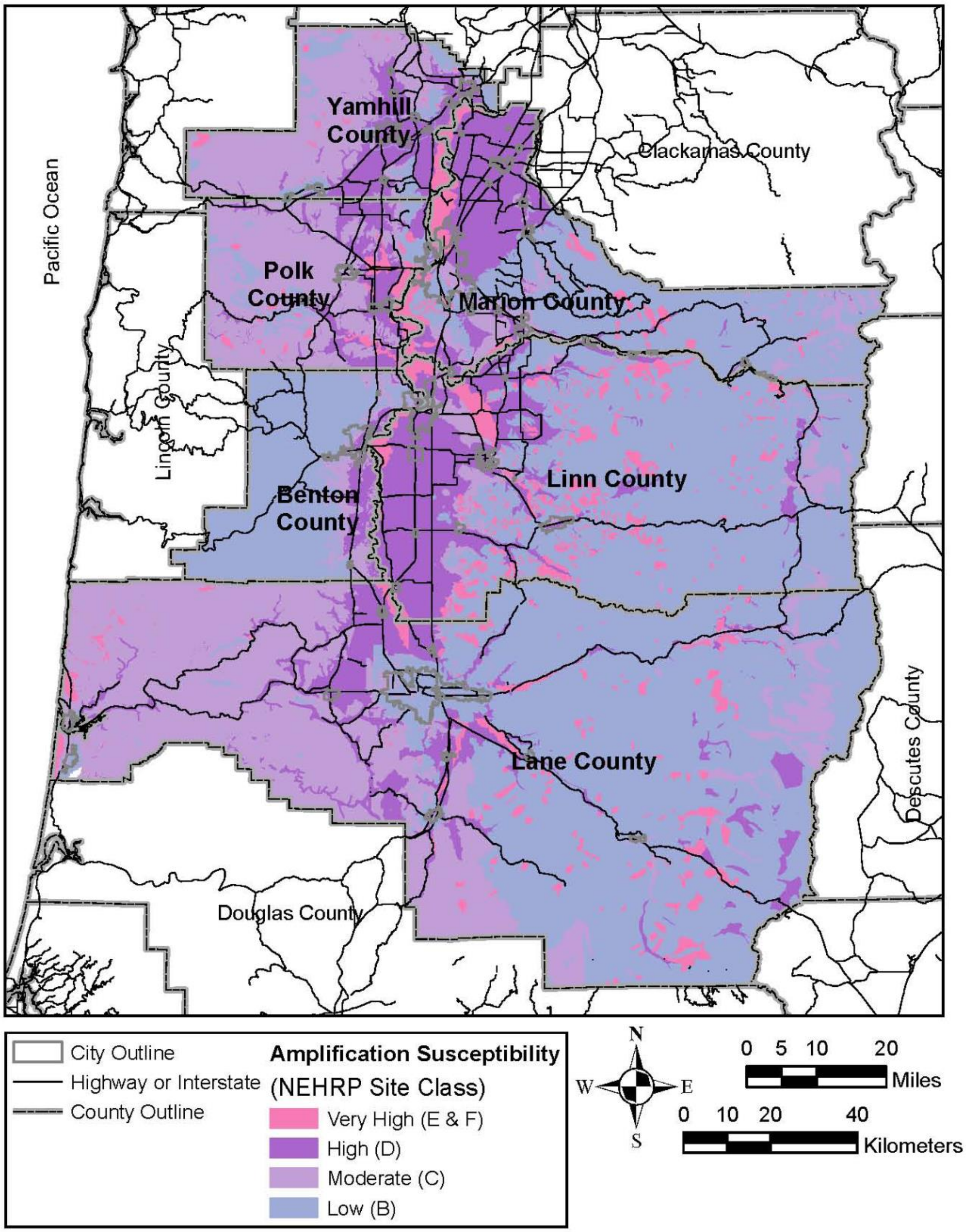
The geographic position of Region 3 makes it susceptible to earthquakes from four sources: (a) the off-shore Cascadia Fault Zone, (b) deep intra-plate events within the subducting Juan de Fuca plate, (c) shallow crustal events within the North America Plate, and (d) earthquakes associated with renewed volcanic activity.

Region 3 has experienced a few historic earthquakes centered in the region. In addition, the region has been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered outside the area. All considered, there is good reason to believe that the most devastating future earthquakes would probably originate along shallow crustal faults in the region and along the Cascadia Fault Zone. Deep-seated intra-plate events have been discovered by scientists in the region's historic and pre-historic record, as occurred near Olympia, Washington in 1949 and 2001, could generate magnitudes as large as M7.5.

Earthquakes produced through volcanic activity could possibly reach magnitudes of 5.5. The 1980 Mount St. Helens eruption was preceded by a magnitude 5.1 earthquake. Despite the fact that Cascade volcanoes are some distance away from the major population centers in Region 3, earthquake shaking and secondary earthquake-related hazards such as lahars could cause major damage to these centers.

Earthquake-associated hazards include severe ground shaking, liquefaction of fine-grained soils, and landsliding. The severity of these effects depend on several factors, including the distance from the earthquake source, the ability of soil and rock to conduct seismic energy, and the degree and composition of slope materials. As seismic waves travel through bedrock, some energy propagates through surface soils to the ground surface. Soil deposits can either deamplify or amplify the shaking based on the characteristics of the deposit. This phenomenon is generally referred to as ground shaking amplification (GSA). **Figure 2-130** displays the areas in Region 3 with greater and lesser ground shaking amplification hazard.

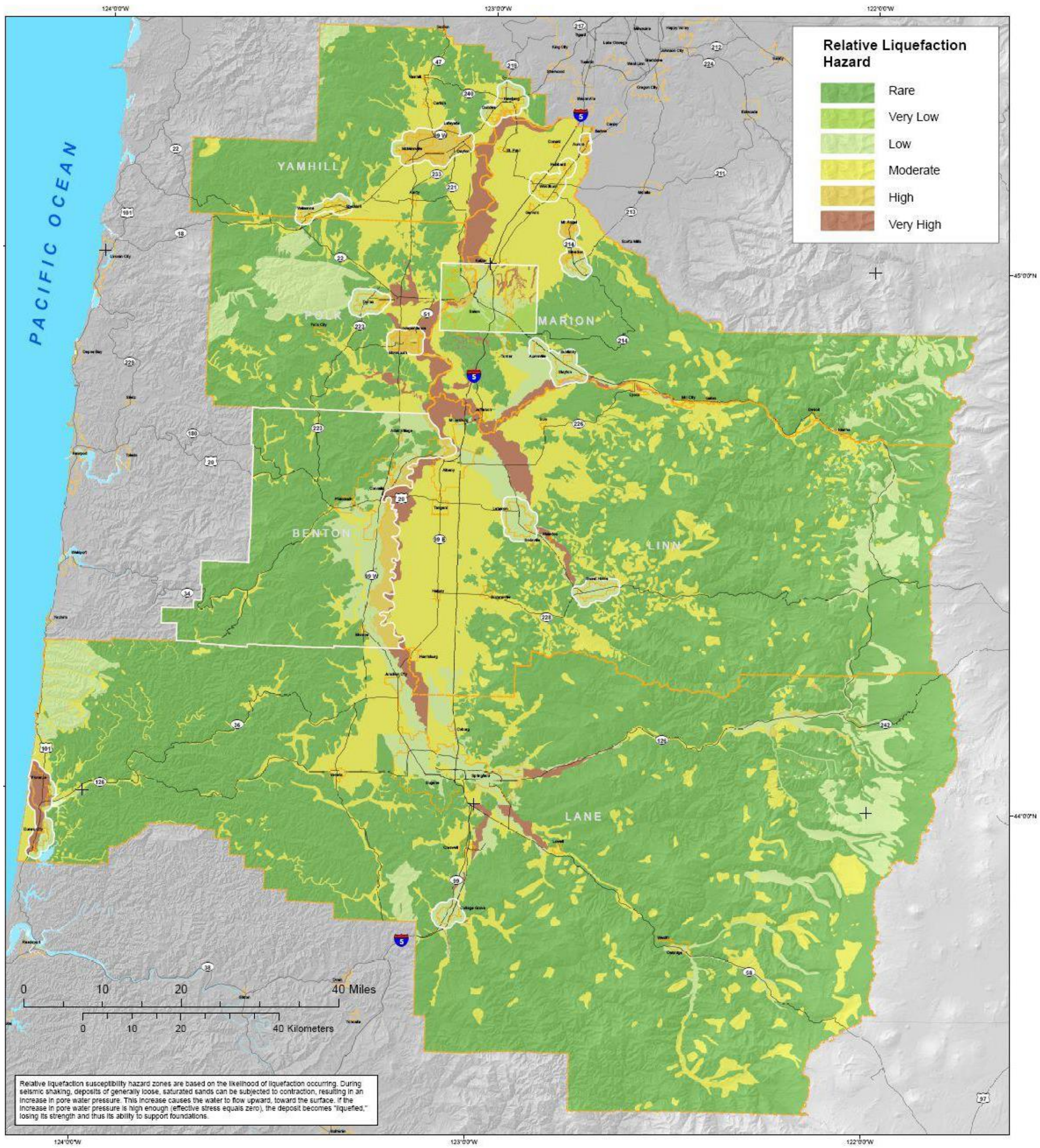
Figure 2-130. Amplification Susceptibility for Region 3



Source: Burns et al. (2008)

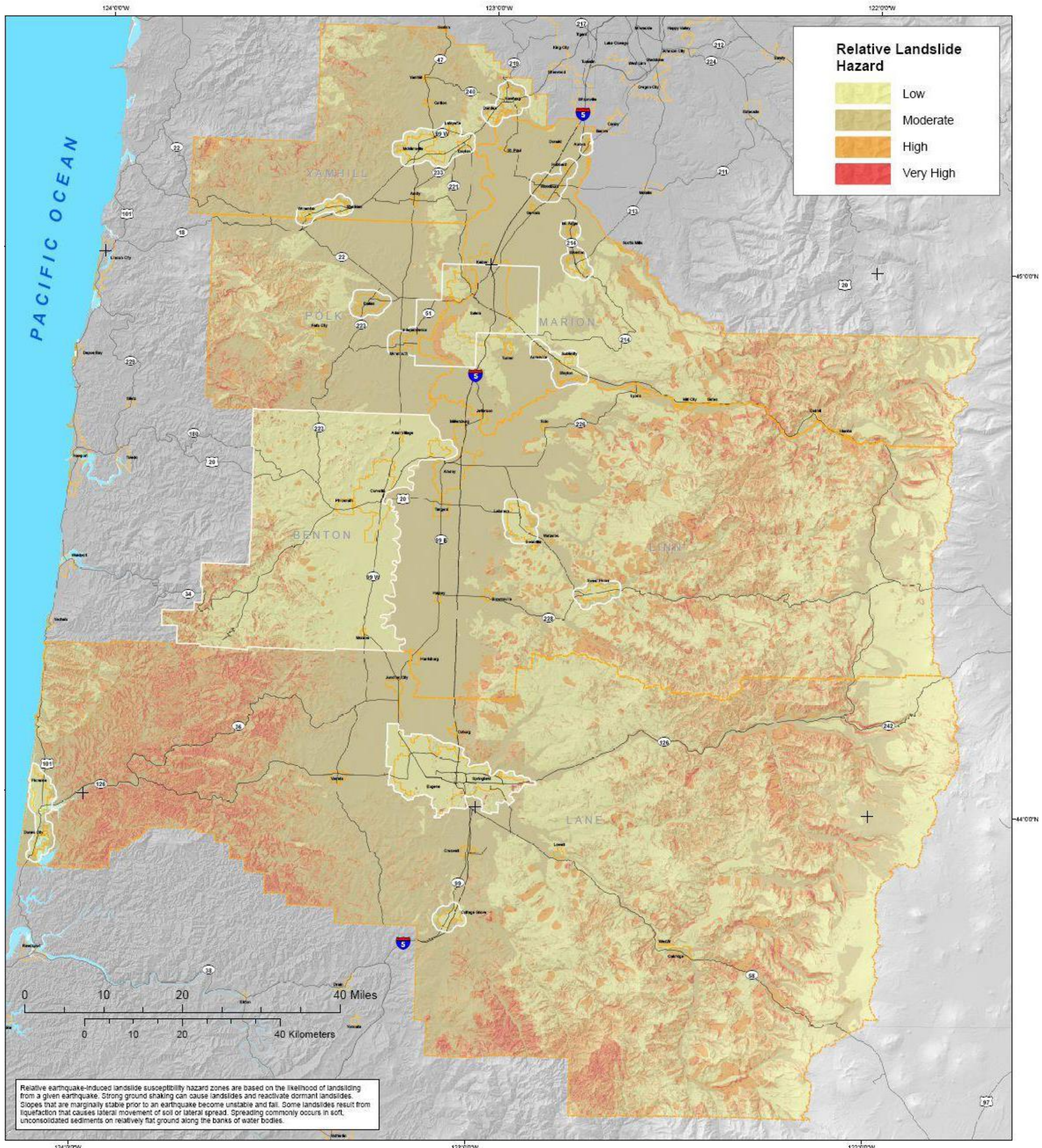
During seismic shaking, deposits of loose saturated sands can be subjected to contraction resulting in an increase in pore water pressure. If the increase in pore water pressure is high enough, the deposit becomes “liquefied,” losing its strength and thus its ability to hold and support loads. [Figure 2-131](#) displays the areas in the region with greater and lesser liquefaction hazard.

Figure 2-131. Relative Liquefaction Hazard for Region 3



Source: Burns et al. (2008)

Figure 2-132. Earthquake Induced Landslide Hazards for Region 3



Source: Burns et al. (2008)

Historic Earthquake Events

Table 2-206. Significant Earthquakes Affecting Region 3

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

*BCE: Before Common Era.

Sources: Wong and Bolt (1995)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 3 will experience earthquakes is shown in **Table 2-207**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-207. Local Probability Assessment of Earthquakes in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	M	L	H	H	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

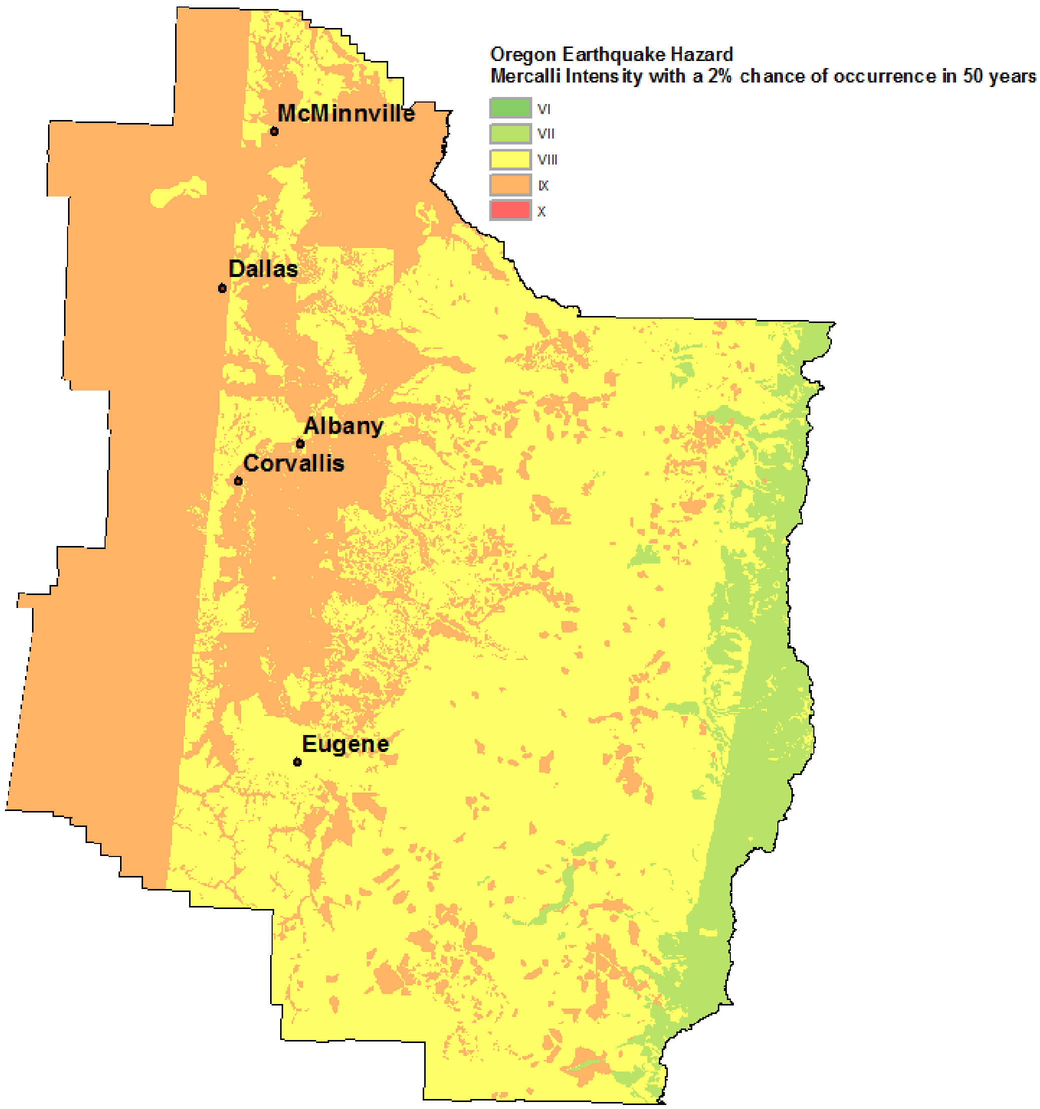
State Assessment

The probability of damaging earthquakes varies widely across the state. In Region 3 the hazard is dominated by Cascadia subduction earthquakes originating from a single fault with a well-understood recurrence history.

The probabilistic earthquake hazard for Region 3 is depicted in **Figure 2-133**. This map shows the expected level of earthquake damage that has a 2% chance of occurring in the next 50 years. The map is based on the 2008 USGS National Seismic Hazard Map and has been adjusted to account for the effects of soils following the methods of Madin and Burns (2013). In this case, the strength of shaking calculated as peak ground acceleration and peak ground velocity is expressed as Mercalli intensity, which describes the effects of shaking on people and structures. This map incorporates all that is known about the probabilities of earthquake on all Oregon faults, including the Cascadia Subduction Zone.

The Cascadia subduction zone is responsible for most of the hazard shown in **Figure 2-133**. The paleoseismic record includes 18 magnitude 8.8–9.1 megathrust earthquakes in the last 10,000 years that affected the entire subduction zone. The return period for the largest earthquakes is 530 years, and the probability of the next such event occurring in the next 50 years ranges from 7 to 12%. An additional 10 to 20 smaller, magnitude 8.3–8.5, earthquakes affected only the southern half of Oregon and northern California. The average return period for these is about 240 years, and the probability of a small or large subduction earthquake occurring in the next 50 years is 37–43%.

Figure 2-133. Probabilistic Earthquake Hazard in Region 3



Color zones show the maximum level of earthquake shaking and damage (Mercalli Intensity Scale) expected with a 2% chance of occurrence in the next 50 years. A simplified explanation of the Mercalli levels is:

VI	Felt by all, weak buildings cracked;
VII	Chimneys break, weak buildings damaged, better buildings cracked;
VIII	Partial collapse of weak buildings, unsecured wood frame houses move;
IX	Collapse and severe damage to weak buildings, damage to wood-frame structures; and
X	Poorly built structures destroyed, heavy damage in well-built structures.

Source: Madin and Burns (2013)

Vulnerability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the region's vulnerability to earthquakes is shown in **Table 2-208**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-208. Local Vulnerability Assessment of Earthquakes in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	H	M	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Region 3 is especially vulnerable to earthquake hazards because much of the area is susceptible to earthquake-induced landslides, liquefaction, and strong ground shaking.

Of the 15 counties in the state with the highest expected damages and losses based on the 500 year model, the following counties are located in Region 3:

- Lane,
- Marion,
- Benton,
- Linn, and
- Yamhill.

DOGAMI also developed two earthquake loss models for Oregon based on the two most likely sources of seismic events: (a) the Cascadia Subduction Zone (CSZ), and (b) combined crustal events (500-year model). Both models use Hazus, a software program developed by the Federal Emergency Management Agency (FEMA) as a means of determining potential losses from earthquakes. The CSZ event is based on a potential M8.5 earthquake generated off the Oregon coast. The model does not take into account a tsunami, which probably would develop from such an event. The 500-year crustal model does not look at a single earthquake (as in the CSZ model); it encompasses many faults. Neither model takes unreinforced masonry buildings into consideration.

DOGAMI investigators caution that the models contain a high degree of uncertainty and should be used only for general planning and policy making purposes. Despite their limitations, the models do provide some approximate estimates of damage and are useful to understand the relative relationships between the counties.

Table 2-209, **Table 2-210**, **Table 2-211**, and **Table 2-212** show estimated losses in each county, including building collapse potential and damages based on three model scenarios.

Table 2-209. Building Collapse Potential in Region 3

County	Level of Collapse Potential			
	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Benton	13	5	22	3
Lane*	126	69	68	8
Linn	74	15	30	23
Marion	94	34	88	30
Polk	13	11	17	4
Yamhill	30	20	22	5

*Does not include the Lane County coastal communities of Deadwood, Florence, Mapleton, and Swisshome, which are addressed in the Region 1 Profile.

Source: Lewis (2007)

Table 2-210. Estimated Losses in Region 3 from a M9 CSZ and Local Crustal Event

County	Building Value (Billions)	Total Building Related Losses from an M9.0 CSZ Event (Billions)	Total Building Related Losses from a Crustal Earthquake (Billions)
Benton	$4.85	$1.1	$0.8
Lane	$21.055	$5.0	$3.4
Linn	$5.669	$1.2	$1.3
Marion	$15.86	$2.6	$3.9
Polk	$3.467	$0.6	$0.4
Yamhill	$4.597	$1.2	$1.5

Source: Burns et al. (2008)

Table 2-211. Estimated Losses in Region 3 Associated with an M8.5-9.0 Subduction Event

Category	Benton	Lane	Linn	Marion	Polk	Yamhill
Injuries (5 pm time period)	1,356	3,945	1,049	2,492	678	1190
Deaths (5 pm time period)	96	264	67	157	43	74
Displaced Households	2,375	7,633	2,563	5,787	1,822	3,082
Economic losses for buildings	$1,049.51 m	$4,652 m	$1,150.68 m	$2,604.95m	$624.43 m	$1198.48 m
Operational after Day 1						
Fire station	100%	100%	100%	100%	100%	100%
Police Station	100%	100%	100%	100%	100%	100%
Schools	91%	100%	100%	99%	100%	98%
Bridges	91%	84%	100%	89%	82%	85%
Economic loss to infrastructure						
Highways	$ 33.5 m	$211 m	$4.4 m	$127.7 m	$59.4 m	$60.2 m
Airports	$0 m	$13.3 m	$23.10 m	$13 m	$14 m	$21.4 m
Communications	$0 m	$0.33 m	$0.07 m	$0.03 m	$0.05 m	$0.03 m
Debris generated (thousands of tons)	0	2,000	0	1,000	0	0

Source: Burns et al. (2008)

Table 2-212. Estimated Losses in Region 3 Associated with an Arbitrary M6.5-6.9 Crustal Event

Mitigation Factors	Benton	Lane	Linn	Marion	Polk	Yamhill
Injuries (5 pm time period)	557	1,821	993	3,249	321	1,178
Deaths (5 pm time period)	33	96	59	189	18	67
Displaced households	1,755	7,716	3,683	10,701	1,412	4,256
Economic losses from buildings	$762.25 m	$3,351.03 m	$1,315.72 m	$3979.57 m	$409.43 m	$1,525.35 m
Operational the day after the event: Fire station Police Station Schools Bridges	75% 75% 91% 100%	100% 91% 99% 97%	77% 40% 70% 91%	61% 65% 74% 86%	100% 100% 100% 93%	50% 64% 68% 89%
Economic losses to infrastructure: Highways Airports Communications	$18.7 m $19.3 m $ 0.24 m	$106 m $16 m $0.63 m	$129.70 m $38.3 m $0.11 m	$271.5 m $38 m $0.18 m	$35.7 m $11 m $0.05 m	$71.3 m $43.9 m $0.10 m
Debris generated (in thousands of tons)	0	1,000	0	1,000	0	0

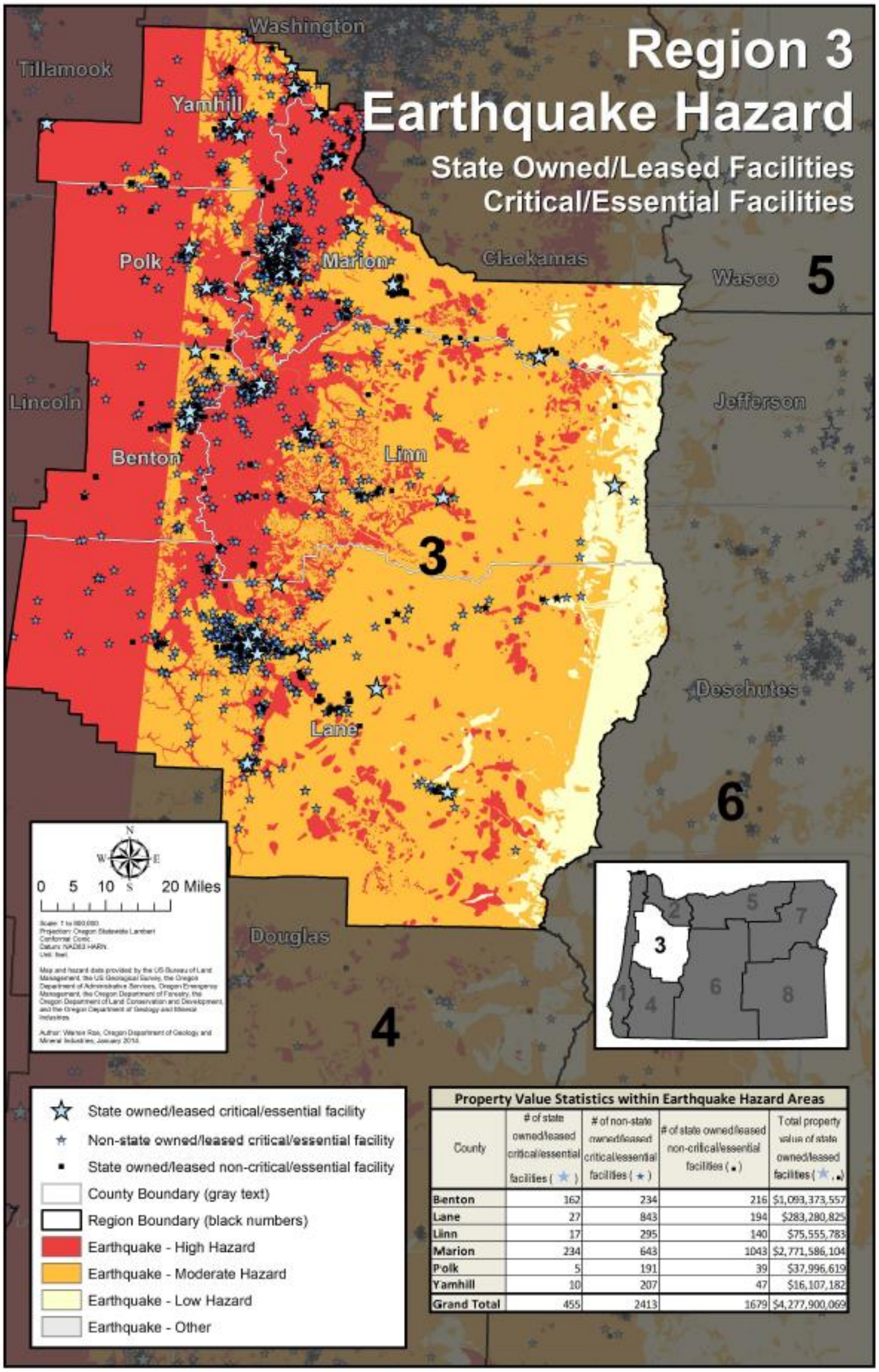
Source: Burns et al. (2008)

State-Owned/Leased Facilities and Critical/Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of 5,693 state facilities evaluated, 2,134 totaling roughly $4.3 billion worth of property are located in an earthquake hazard zone in Region 3 (**Figure 2-134**). Among the 1,141 state critical/essential facilities, 455 are in an earthquake hazard zone in Region 2. Additionally, 2,413 non-state critical/essential facilities in Region 2 are located in an earthquake hazard zone.

Figure 2-134. State-Owned/Leased Facilities and Critical/Essential Facilities in an Earthquake Zone in Region 3



Property Value Statistics within Earthquake Hazard Areas

County	# of state owned/leased critical/essential facilities	# of non-state owned/leased critical/essential facilities	# of state owned/leased non-critical/essential facilities	Total property value of state owned/leased facilities
Benton	162	234	216	$1,093,373,557
Lane	27	843	194	$283,280,825
Linn	17	295	140	$75,555,783
Marion	234	643	1043	$2,771,586,104
Polk	5	191	39	$37,996,619
Yamhill	10	207	47	$16,107,182
Grand Total	455	2413	1679	$4,277,900,069

Source: DOGAMI

SEISMIC LIFELINES

"Seismic lifelines" are the state highways ODOT has identified as most able to serve response and rescue operations, reaching the most people and best supporting economic recovery. The process, methodology, and criteria used to identify them are described in **Section 2.2.2.6, Seismic Transportation Lifeline Vulnerabilities**, and the full report can be accessed at **Appendix 9.1.13**, *Statewide Loss Estimates: Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification* (OSLR). According to that report, seismic lifelines in Region 3 have the following vulnerabilities.

Regional delineations for this Plan and for the OSLR are slightly different. Regions in the OSLR that correspond to Region 3 include sections of the Valley and Cascades Geographic Zones.

VALLEY GEOGRAPHIC ZONE (OLSR). The Valley Geographic Zone generally consists of two or three north-south routes through the Willamette Valley and a variety of east-west connectors between those routes. The entire area is likely to experience sustained ground shaking, with many roadways in areas subject to landslide and rockfall or liquefaction. Seismic lifeline routes that provide redundant north-south movement were designated.

The Tier 1 system in the Valley Geographic Zone consists of the following corridors:

- I-5,
- OR-99W from I-5 to OR-18 near Dayton,
- OR-18 from OR-99W near Dayton to McMinnville, and
- OR-22 from I-5 to OR-99E in Salem.

The Tier 2 system in the Valley Geographic Zone consists of the following corridors:

- US-26 from OR-47 to OR-217,
- OR-99W from McMinnville to Junction City,
- OR-99 from Junction City to I-5 in Eugene,
- OR-99E from Oregon City to I-5 in Salem, and
- OR-214 in Woodburn from I-5 to OR-99E.

The Tier 3 system in the Valley Geographic Zone consists of the following corridors:

- OR-219 from Newberg to Woodburn,
- OR-99E in Salem from I-5 to OR-22,
- OR-22 from OR-99W to Salem, and
- OR-34 from Corvallis to I-5.

Region 3 includes the central area of the Cascades Geographic Zone. These routes connect the highly seismically impacted western portion of the state to the less seismically impacted central portion of the state. The Tier 1 system in this region consists of OR-58. The Tier 2 system in the Cascades Geographic Zone in Region 3 consists of OR-22 from Salem to Santiam Junction and US-20 from Santiam Junction to Bend. There are no corridors designated as Tier 3 in the Region 3 Cascades Geographic Zone.

Regional Impact.

- Ground shaking: In Region 3, ground shaking will be of a magnitude and duration to cause property damage, possibly severe. Unreinforced structures, roadbeds, and bridges will be damaged to varying extents, and there will be damaged areas on lifelines that will be impassable without at least temporary repairs.
- Landslides and rockfall: Many rural and some developed area roadways in Region 3 are cut into or along landslide-prone features. A major seismic event will increase landslide and rockfall activities and may reactivate ancient slides that are currently inactive.
- Liquefaction: Structures in wetland, alluvial and other saturated areas may be subject to liquefaction damage; the total area of such impacts will vary with the extent of saturated soils at the time of the event.

Regional Loss Estimates. Highway-related losses include disconnection from supplies and replacement inventory, and the loss of tourists and other customers who must travel to do business with affected businesses.

Most Vulnerable Jurisdictions. Benton, Lane, Linn, Marion, Polk, and Yamhill Counties are generally equally vulnerable to ground shaking from a CSZ event. Each county has some steep roads in rural and developed areas that may experience landslides. All three have some transportation facilities along river beds or crossing rivers that may be vulnerable to liquefaction.

Floods

Characteristics

Region 3 has a lengthy flood history. Notable floods affecting Region 3 are shown in **Table 2-213**. **Table 2-214** describes flood sources for each of the counties in the region. Additionally, sheet flooding occurs on agricultural land. Because this occurs far from a source river or stream, however, such flood areas are not depicted on federal Flood Insurance Rate Maps.

Most of the serious flooding experienced in Region 3 occurs in December and January. These events are usually associated with La Niña conditions, which result in prolonged rain and rapid snowmelt on saturated or frozen ground. This sudden influx of water causes rivers to swell, forcing tributary streams to back up and flood communities.

Region 3 is protected by several flood control dams.

A very large 1964 flood was a result of unusually intense precipitation on frozen topsoil, augmented by snowmelt in the mountains and valley. Without upstream regulation, the 1964 flood would have been the largest flood of the 20th century, with a peak discharge of 320,000 cubic feet per second (cfs) at the Albany gage. However, upstream regulation reduced the peak discharge to 186,000 cfs.

The unincorporated areas of Region 3 are nearly all agricultural lands or timberlands. Flood damage in those areas would be limited to farm crops, farm buildings and residences, and erosion of croplands.

Historic Flood Events

Table 2-213. Significant Historic Floods Affecting Region 3

Date	Location	Characteristics	Type of Flood
Dec. 1861	Willamette Basin and coastal rivers	preceded by two weeks of heavy rain; every town on the Willamette was flooded or washed away; 635,000 cfs at Portland	rain on snow; snow melt
Feb. 1890	Willamette Basin and coastal rivers	second largest known flood in the Willamette Basin; almost every large bridge washed downstream	rain on snow
Dec. 1937	western Oregon	flooding followed heavy rains; considerable highway flooding; landslides	rain on snow
Jan. 1953	western Oregon	widespread flooding in western Oregon accompanied by windstorm	rain on snow
Dec. 1964-Jan. 1965	Willamette Basin	record flooding throughout Willamette Basin; two intense storms; near-record early season snow depths; largest flood in Oregon since dam construction on upper Willamette (1940s–50s; $34 million in damages	rain on snow
Jan. 1974	western Oregon	flooding followed heavy wet snow and freezing rain; nine counties received Disaster Declaration	rain on snow
Dec. 1978	western Oregon	intense heavy rain, snowmelt, saturated ground; one fatality in Region 3 (Benton County)	rain on snow
Feb. 1986	entire state	severe statewide flooding; rain and melting snow; numerous homes flooded and highways closed	snow melt
Feb. 1987	western Oregon	Willamette River and tributaries; mudslides; damaged highways and homes	rain on snow
Feb. 1996	entire state	deep snow pack, warm temperatures, record-breaking rains; flooding, landslides, power-outages (FEMA-1099-DR-Oregon)	rain on snow
Nov. 1996	entire state	record-breaking precipitation; local flooding/landslides (FEMA-1149-DR-Oregon)	rain on snow
Dec. 2005	Polk, Marion, Linn, Lane and Benton Counties	heavy rains causing rivers to crest above flood stage in Polk, Marion, Linn, Lane, and Benton Counties, as well as other counties in the Willamette Valley	riverine
Jan. 2006	Willamette Valley	heavy rains caused many rivers to crest above flood stage in the Willamette Valley, causing road closures and damage to agricultural lands	riverine
Dec. 2007	Yamhill	South Yamhill River flooded near McMinnville, causing damage to roads and bridges, 120 homes in Sheridan along with a few businesses and churches, and causing minor damage in Willamina; total county-wide damage estimates at $9.6 million	riverine
Dec. 2007	Polk	major flooding in Suver and other areas in Polk County; total losses equal $1 million for entire county	riverine
Jan. 2012	Polk, Marion, Yamhill, Lincoln, Benton, Linn and Lane Counties	heavy rain and wind; ice (DR-4055); flooding in the Willamette Valley; 130 homes and seven businesses were damaged in the City of Turner; 29 streets were closed in the City of Salem; the state motor pool lost 150 vehicles and thousands of gallons of fuel; Thomas Creek in the City of Scio overtopped, damaging several buildings	

Sources: Taylor and Hatton (1999); National Climatic Data Center Storm Events, located at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms

Table 2-214. Principal Riverine Flood Sources by County in Region 3

Benton	Lane	Linn	Marion	Polk	Yamhill
Willamette River, N. Fork Alsea, and tributaries, especially:	Willamette River and tributaries, especially:	Willamette River and tributaries, especially:	Willamette River and tributaries, especially:	Willamette River and tributaries, especially:	Willamette River and tributaries, especially:
Marys River	Amazon Creek	Calapooia River	Santiam River	S. Yamhill River	Yamhill River
Newton Creek	Berkshire Slough	Santiam (N and S)	Pudding River	Ash Creek (all forks)	Yamhill Creek
Mill Race	Blue River	Thomas Creek	Battle Creek	Agency Creek	Baker Creek
Frazier Creek	Cedar Creek	Ames Creek	Butte Creek	Ellendale Creek	Chehalem Creek
Soap Creek	Coast Fork	Oak Creek	Beaver Creek	Gibson Creek	Cozine Creek
Oak Creek	Dedrick Slough	Peters Ditch	Claggett Creek	Rickreall Creek	Hess Creek
Jackson Creek	Fall Creek	Truax Creek	Croisan Creek	Rock Creek	Palmer Creek
	Long Tom River		Gibson Creek	Rowell Creek	
	McKenzie River		Lake Labish Creek		
	Mohawk River		Mill Creek		
	Oxley Slough		Pringle Creek		
	Row River		Senecal Creek		
	Salmon Creek		Silver Creek		
	Silk Creek		Shelton Ditch		

Sources: FEMA, Benton County Flood Insurance Study (FIS), Aug. 15, 1996; FEMA, Lane County FIS, June 2, 1999; FEMA, Linn County FIS, Sept. 29, 1986; FEMA, Marion County FIS, July 13, 2001; FEMA, Polk County FIS, Dec. 19, 1995; FEMA, Yamhill County FIS, Sept. 30, 1983

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 3 will experience flooding is shown in **Table 2-215**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-215. Local Probability Assessment of Flood in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	H	H	H	H	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The Federal Emergency Management Agency (FEMA) has mapped most flood-prone streams in Oregon. The maps depict the 1% flood (100-year) upon which the National Flood Insurance Program is based. All of the Region 2 counties have Flood Insurance Rate Maps (FIRM); however, some of the maps are based on old modeling and could be outdated. The FIRM maps were issued at the following times:

- Benton, June 6, 2011;
- Lane, June 2, 1999;
- Linn, September 29, 2010;
- Marion, January 19, 2000;
- Polk, December 19, 2006; and
- Yamhill, March 2, 2010.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to flooding is shown in **Table 2-216**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-216. Local Vulnerability Assessment of Flood in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	M	H	H	M	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The Oregon Department of Land Conservation and Development (DLCD) created a countywide flood vulnerability index by compiling data from NOAA's Storm Events Database and from FEMA's National Flood Insurance Program. Data were calculated statewide for the period 1978 through 2013 for five input datasets: number of events, structure and crop damage estimates in dollars and NFIP claims number and dollar amounts. The mean and standard deviation were calculated for each input. Then each county was assigned a score ranging from 0 to 3 for each of these inputs according to **Table 2-217**.

Table 2-217. Scoring for Vulnerability Index

Score	Description
3	county data point is greater than 2.5 times standard deviation for the input data set
2	county data point is greater than 1.5 times standard deviation for the input data set
1	county data point is within standard deviation
0	no data reported

Source: DLCD

DLCD summed the scores for each of the five inputs to create a county-by-county vulnerability index. The maximum possible score is 15. A score over 6 indicates that at least one variable significantly exceeds average values.

All of the Counties in Region 3 received the same flood vulnerability score of 5, with the exception of Lane County which received a score of 6. Lane County's higher score is because a portion of Lane County is in Region 1, which is the region most vulnerable to flood. Many of the losses that caused Lane County's higher score are in Region 1. A score of 5 indicates that overall the counties in this region are moderately vulnerable to damaging floods. Nevertheless, the State is aware of several particularly vulnerable areas within these counties, including the cities of Sheridan and Scio, and parts of Salem and Eugene-Springfield (the most populous cities in Region 3).

FEMA has identified 46 Repetitive Loss properties in Region 3, four of which are Severe Repetitive Loss properties. This region has the third most repetitive flood losses of the Oregon NHMP Natural Hazard Regions, reflecting its downstream location in or near the Willamette Valley, often flat topography, and population density.

Table 2-218. Flood Severe/Repetitive Losses and Community Rating System Communities by County in Region 3

County	RL	SRL	Number of CRS Communities per County
Benton	6		1
*Lane	14	1	2
** Linn	8	1	1
Marion	12	2	3
Polk	2		1
Yamhill	4		1
Totals	**46**	**4**	**9**

*Includes non-coastal sections of Lane County.

**Albany is a CRS community located in both Benton and Linn Counties. For the purposes of this table, Albany is counted as being in Linn County.

Source: FEMA NFIP BureauNet, http://bsa.nfipstat.fema.gov/, accessed 12/1/2014

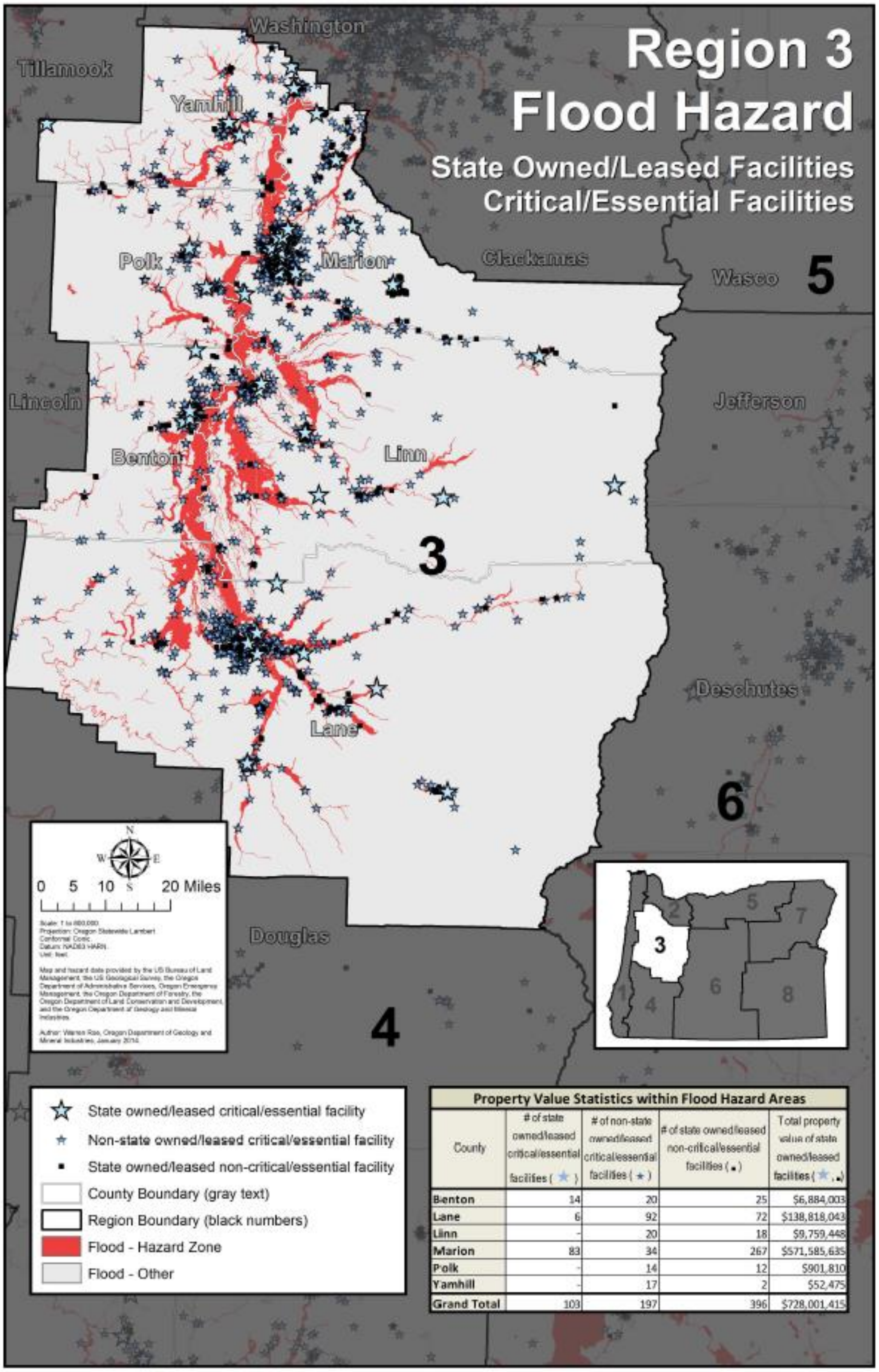
Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS), which results in reduced flood insurance costs. Benton, Lane, Marion, and Polk Counties participate in CRS, as do the cities of Albany, Corvallis, Eugene, Salem, and Sheridan.

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of the 5,693 state facilities evaluated, 28 are currently located within a flood hazard zone in Region 3 and have an estimated total value of $13 million (**Figure 2-135**). Of these, one is identified as a critical or essential facility. An additional 90 non-state-owned/leased critical or essential facilities are located in a flood hazard zone in Region 3.

Figure 2-135. State-Owned/Leased Facilities and Critical/Essential Facilities in a Flood Zone in Region 3



Property Value Statistics within Flood Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Benton	14	20	25	$6,884,003
Lane	6	92	72	$138,818,043
Linn	-	20	18	$9,759,448
Marion	83	34	267	$571,585,635
Polk	-	14	12	$901,810
Yamhill	-	17	2	$52,475
Grand Total	103	197	396	$728,001,415

Source: DOGAMI

Landslides

Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. In general, the Coast Range and Cascade Mountains have a very high incidence of landslides. For example, the Vineyard Mountain area near Corvallis, which is in the Coast Range foothills, experienced at least half a dozen landslides during the January 2009 storm. On occasion, major landslides sever major transportation routes such as U.S. or state highways and rail lines, causing temporary but significant economic damage.

Historic Landslide Events

Table 2-219. Historic Landslides in Region 3

Date	Location	Incident
Aug. 1957	near Westfir, Oregon	rock slide; fatalities: two workers
Feb. 1996		FEMA-1099-DR-Oregon; heavy rains and rapidly melting snow contributed to hundreds of landslides/debris flows across the state; many on clear cuts that damaged logging roads
Nov. 1996	Lane and Douglas Counties	FEMA-1149-DR-Oregon; heavy rain triggered mudslides (Lane and Douglas Counties); fatalities: eight; injuries: several (Douglas County)

Sources: Taylor and Hatton (1999); Oregon Department of Transportation Emergency Operations Plan, October 7, 2002

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 3 will experience landslides is shown in **Table 2-220**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-220. Local Probability Assessment of Landslides in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	M	M	—	—	—	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Landslides are found in every county in Oregon. There is a 100% probability of landslides occurring in this region in the future. Although we do not know exactly where and when they will occur, they are more likely to happen in the general areas where landslides have occurred in the past. Also, they will likely occur during heavy rainfall events or during a future earthquake.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to landslides is shown in **Table 2-221**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-221. Local Vulnerability Assessment of Landslides in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	L	L	—	—	—	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

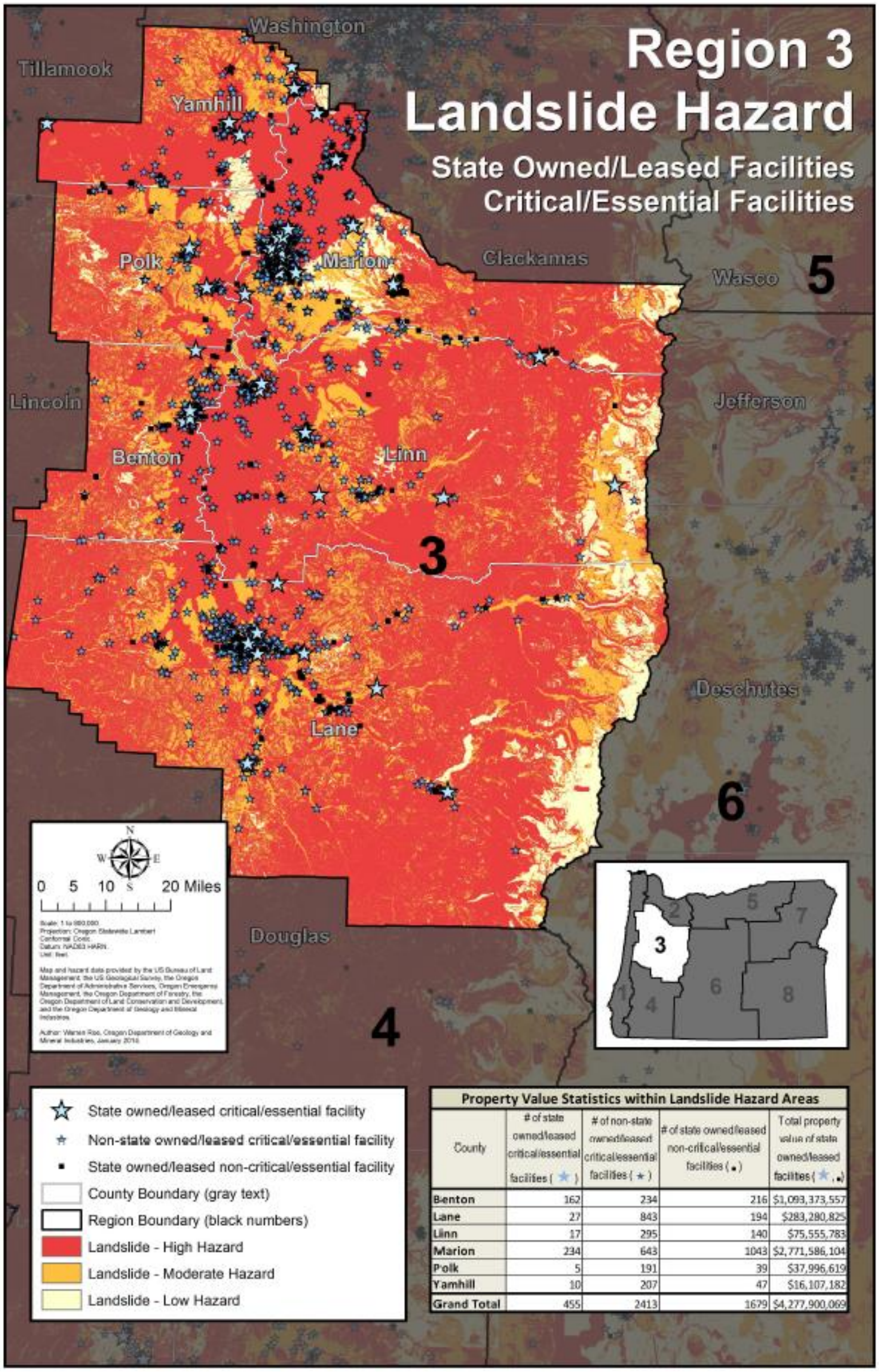
Many of the communities in this region are vulnerable to landslides; for example, the cities of Salem, Corvallis, and Eugene all have moderate exposure to landslides. As previously mentioned, the Vineyard Mountain area near Corvallis had landslides during the January 2009 storm. Many of these landslides caused significant damage to homes, roads, and the environment.

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 2,134 are located within a landslide hazard zone in Region 3, totaling roughly $4.2 billion (**Figure 2-136**). This includes 455 critical or essential facilities. An additional 2,413 non-state-owned critical or essential facilities are located within a landslide hazard zone in Region 4.

Figure 2-136. State-Owned/Leased Facilities and Critical/essential facilities in a Landslide Zone in Region 3



Property Value Statistics within Landslide Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (•)	Total property value of state owned/leased facilities (★, •)
Benton	162	234	216	$1,093,373,557
Lane	27	843	194	$283,280,825
Linn	17	295	140	$75,555,783
Marion	234	643	1043	$2,771,586,104
Polk	5	191	39	$37,996,619
Yamhill	10	207	47	$16,107,182
Grand Total	455	2413	1679	$4,277,900,069

Source: DOGAMI

Volcanoes

Characteristics

The eastern boundaries of Lane, Linn, and Marion Counties coincide with the crest of the Cascade Mountains. Volcanic activity in the Cascades will continue, but questions regarding how, to what extent, and when remain unanswered. Most volcano-associated hazards are local (e.g., explosions, debris, lava, and pyroclastic flows). However, lahars can travel considerable distances downstream, and wind-borne ash can blanket areas many miles from the source.

Historic Volcanic Events

Table 2-222. Historic Volcanic Events Affecting Region 3

Date	Location	Description
about 10,000 to <7,700 YBP	cones south of Mount Jefferson; Forked Butte and South Cinder Peak	lava flows
about 4,000 to 3,000 YBP	Sand Mountain, central Cascades	lava flows and cinder cones in Sand Mountain field
about 3,000 to 1,500 YBP	Belknap Volcano, central Cascades	lava flows, tephra
about 2,000 YBP	South Sister Volcano	rhyolite lava flow
about 1,300 YBP	Blue Lake Crater, central Cascades	spatter cones and tephra

Note: YBP is years before present.

Source: U.S. Geological Survey, Cascades Volcano Observatory: http://volcanoes.usgs.gov/observatories/cvo/
Scott et al. (2001); Walder et al. (1999)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 3 will experience volcanic activity is shown in **Table 2-223**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-223. Local Probability Assessment of Volcanic Activity in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	M	L	H	L	L	—

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Region 3 communities are closest to the Three Sisters and Mount Jefferson. Middle and South Sisters are the most active of the group. Because geologic history is fragmentary for these volcanoes, the probability of future explosive eruptions is difficult to estimate. Only two explosive episodes have occurred at the South Sister since the end of the ice age (about 12,000 years ago). Given the fragmentary record, the annual probability of the South and Middle Sister entering a new period of eruptive activity has been estimated from 1 in several thousand to 1 in 10,000 (Schilling et al., 1997). Similar difficulties complicate predictions of future eruptions at Mount Jefferson. There have been four episodes of lava flow eruptions around Mount Jefferson since the end of the Ice Age (about 12,000 years ago). Such a frequency suggests an annual probability of lava flow eruptions of 1 in 4,000 to 1 in 3,000 (Walder et al., 1999).

Table 2-224 provides further information about probability of volcanic eruptions in Region 3.

Table 2-224. Probability of Volcano-Related Hazards in Region 3

Volcano-Related Hazards	Benton	Lane	Linn	Marion	Polk	Yamhill	Remarks
Volcanic ash (annual probability of 1 cm or more accumulation from eruptions throughout the Cascade Range)	1 in 1,000 to 1 in 5,000	1 in 1,000	1 in 1,000	1 in 1,000	1 in 1,000 to 1 in 5,000	1 in 1,000 to 1 in 5,000	Sherrod et al. (1997)
Lahar	no risk	source: Three Sisters McKenzie River: 3 scenarios: source to Thurston	Source: Mt. Jefferson S. Santiam R. from Mt. Jefferson to Detroit	source: Mt. Jefferson, N. and S. Santiam rivers from Mt. Jefferson to Detroit	no risk	no risk	if the Detroit Lake dam is breached, lahars could reach Mill City, Lyons, and Stayton in Marion County: Walder et al. (1999) (maps); Lane County: Scott et al. (2001) (map)
Lava flow	no risk	source: Three Sisters immediate vicinity	Source: Mt. Jefferson Immediate vicinity	source: Mt. Jefferson immediate vicinity	no risk	no risk	Mt. Jefferson: Walder et al. (1999) (maps); Three Sisters: Scott et al. (2001) (maps)
Debris flow / avalanche	no risk	source: Three Sisters Proximity	Source: Mt. Jefferson Proximity	source: Mt. Jefferson proximity	no risk	no risk	Mt. Jefferson: Walder et al. (1999) (maps); Three Sisters: Scott et al. (2001) (maps)
Pyroclastic flow	no risk	source: Three Sisters Proximity	Source: Mt. Jefferson Pamelia and Minto Creeks	source: Mt. Jefferson Whitewater Cr and S. Fork Santiam	no risk	no risk	Mt. Jefferson: Walder et al. (1999) (maps); Three Sisters: Scott et al. (2001) (maps)

Sources: Sherrod et al. (1997), Walder et al. (1999), Scott et al. (2001)

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to volcanic activity is shown in **Table 2-225**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-225. Local Vulnerability Assessment of Volcanic Activity in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	L	M	H	M	M	—

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

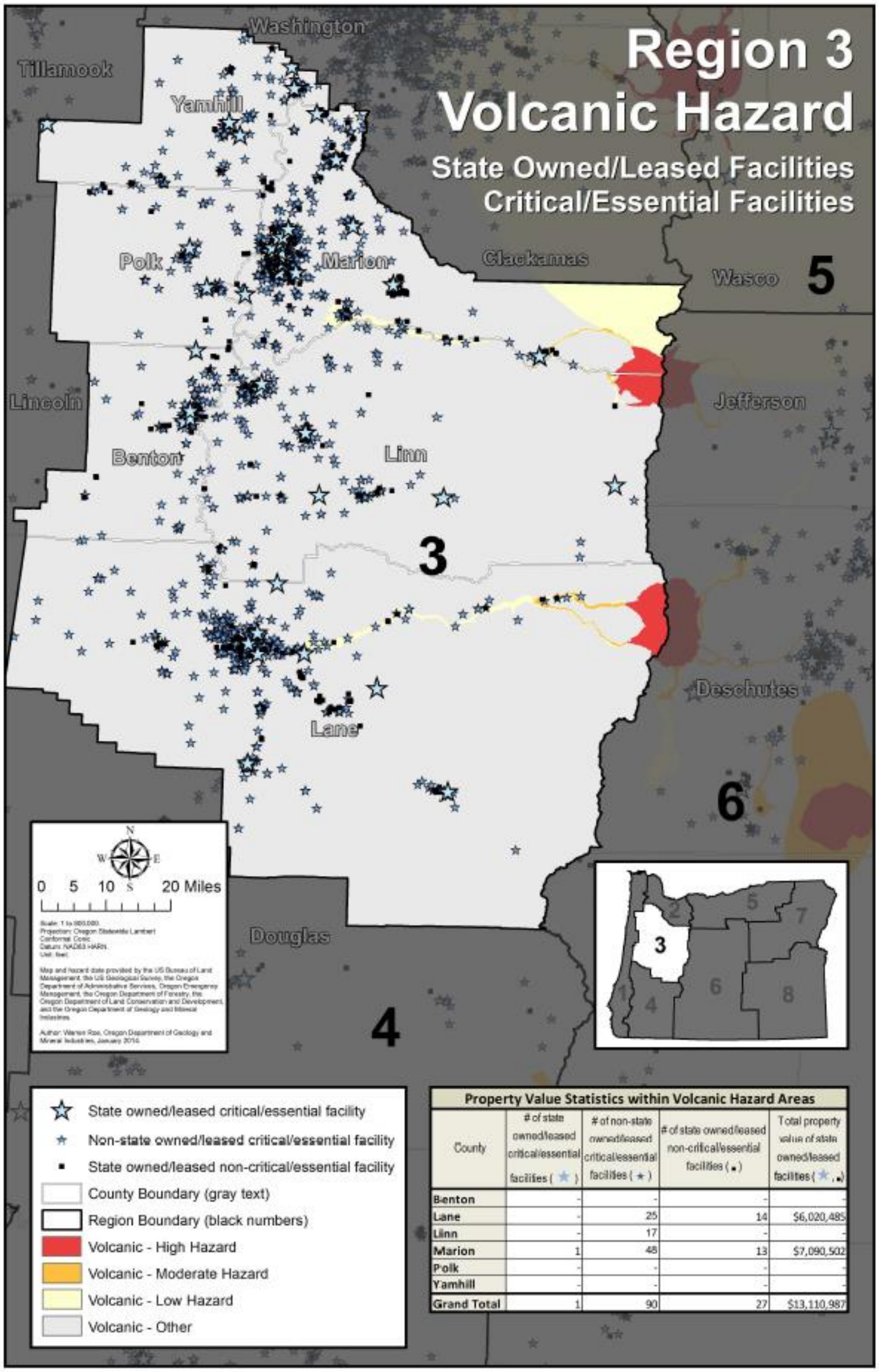
The U.S. Geological Survey has addressed volcanic hazards at Mount Jefferson (Walder et al., 1999) and the Three Sisters (Scott et al., 2001). These reports include maps depicting the areas at greatest risk. Lane, Linn, and Marion Counties are at risk and should consider the impact of volcano-related activity, such as lahars, on small mountain communities, dams, reservoirs, energy-generating facilities, and highways. These counties also should consider probable impacts on the local economy (e.g., wood products and recreation). There is virtually no risk from volcanoes in Benton, Polk, and Yamhill Counties, although normal prevailing winds could shift and carry ash into those areas.

STATE-OWNED/LEASED FACILITIES AND CRITICAL AND ESSENTIAL FACILITIES

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 28 are located within a volcanic hazard area in Region 3, totaling over $13 million in property value. Of those, one is a critical or essential facility. There are 90 non-state-owned/leased critical or essential facilities located within a volcanic hazard zone in Region 3 (**Figure 2-137**).

Figure 2-137. State-Owned/Leased Facilities and Critical/Essential Facilities in a Volcanic Hazard Zone in Region 3



Property Value Statistics within Volcanic Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilites (★, ▪)
Benton	-	-	-	-
Lane	-	25	14	$6,020,485
Linn	-	17	-	-
Marion	1	48	13	$7,090,502
Polk	-	-	-	-
Yamhill	-	-	-	-
Grand Total	1	90	27	$13,110,987

Source: DOGAMI

Wildfires

Characteristics

Forests in this region are quite productive due to the mild temperatures, amount of precipitation, and deep, rich, fertile soils. Historically, this landscape was dominated by oak woodland and savanna with an understory consisting of grasses and forbs. These landscapes tended to burn on a regular basis with low intensity surface fires. This area was also heavily influenced by the Kalapuya Indians. The Kalapuyas frequently burned this area to make the landscape more favorable to elk and deer, which they hunted for food. As Euro-Americans moved in, native tribes moved on. Without prescribed burns, conifer trees have established and have overtopped the oak trees. The understory has changed from grasses and forbs to an understory with more woody shrubs and dead and downed wood. These forests are similar to those of the Oregon Coast Range and have historic fire return intervals of 150-300 years. These fires also tend to be large, stand-replacing fires, rather than the low-intensity, frequent fires of the oak woodland forest type.

Because wildland fires are being effectively suppressed, the patterns and characteristics of fires are changing. Vegetation that historically would have been minimized by frequent fires has become more dominant. Over time, some species have also become more susceptible to disease and insect damage, which leads to an increase in mortality. The resulting accumulation of dead wood and debris creates the types of fuels that promote intense, rapidly spreading fires.

Historic Wildfire Events

Table 2-226. Historic Wildfires Affecting Region 3

Year	Name of Fire	Counties	Acres Burned	Remarks
1853	Nestucca	Tillamook/Yamhill	320,000	
1849	Siletz	Lincoln/Polk	800,000	
1865	Silverton	Marion	988,000	
1933	Tillamook	Tillamook, Yamhill	240,000	Human caused. Between 1933 and 1951, the Tillamook forest burned every 6 years. Fires followed drought conditions. Total Tillamook Burn: 350,000 acres (George Taylor, *The Oregon Weather Book*, p.202)
1966	Oxbow	Lane	44,000	
1972	Yamhill	Yamhill		
1977		Yamhill		west of Carlton
1987	Shady Lane	Polk		
2002		Lane		four people were injured

Note: This list is representative of a lengthy wildfire history. There have been many fires, named and unnamed. Statistics differ, depending on the source.

Source: Brian Ballou, August 2002, A Short History of Oregon Wildfires, Oregon Department of Forestry, unpublished; Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to wildfire is shown in **Table 2-227**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-227. Local Probability Assessment of Wildfire in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	H	H	H	M	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Wildfire always has been a part of the ecosystems in Oregon, sometimes with devastating effects. Some of the state's most devastating wildfires have been in counties within Region 3 (e.g., Marion, Polk, and Yamhill). Wildfire results from natural causes (e.g., lightning strikes), mechanical failure (Oxbow Fire), or human activity (unattended campfire, debris burning, or arson).

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to wildfire is shown in **Table 2-228**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-228. Local Vulnerability Assessment of Wildfire in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	M	M	M	M	M	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Wildfire risk is generally low to moderate in Region 3. Jurisdictions most vulnerable to wildfire are the result of a dispersed population in close proximity to abundant vegetative fuels. These forestlands contain extensive fuels composed of flammable grasses, brush, slash and timber.

Table 2-229. Wildland-Urban Interface Communities in Region 3

Benton	Lane (Non-Coastal)	Linn	Marion	Polk	Yamhill
Adair Village	Bohemia City	Albany	Breitenbush	Airlie	Grand Ronde Agency
Alpine	Coburg	Brownsville	Detroit	Buell	McMinnville
Alsea	Cottage Grove	Clear Lake Resort	Gates	Dallas	Midway
Bellfountain	Creswell	Harrisburg	Idanha	Falls City	Orchard View
Blodgett	Dexter	Lebanon	Jefferson	Fort Hill	Willamina
Corvallis	Dorena	Marion Forks	Lyons	Grand Ronde	
Dawson	Eugene	Mill City	Marion	Pedee	
Glenbrook	London Springs	New Idanha	Mehama		
Kings Valley	Lorane	Scio	Salem		
Lewisburg	Lower McKenzie	Sweet Home East	Scotts Mills		
Monroe	Lower Willamette	Sweet Home West	Silverton		
Philomath	Marcola		Stayton		
Summit	Pleasant Hill				
Wren	Springfield				
	Upper McKenzie				
	Upper Willamette				
	Waldon				
	West Valley				

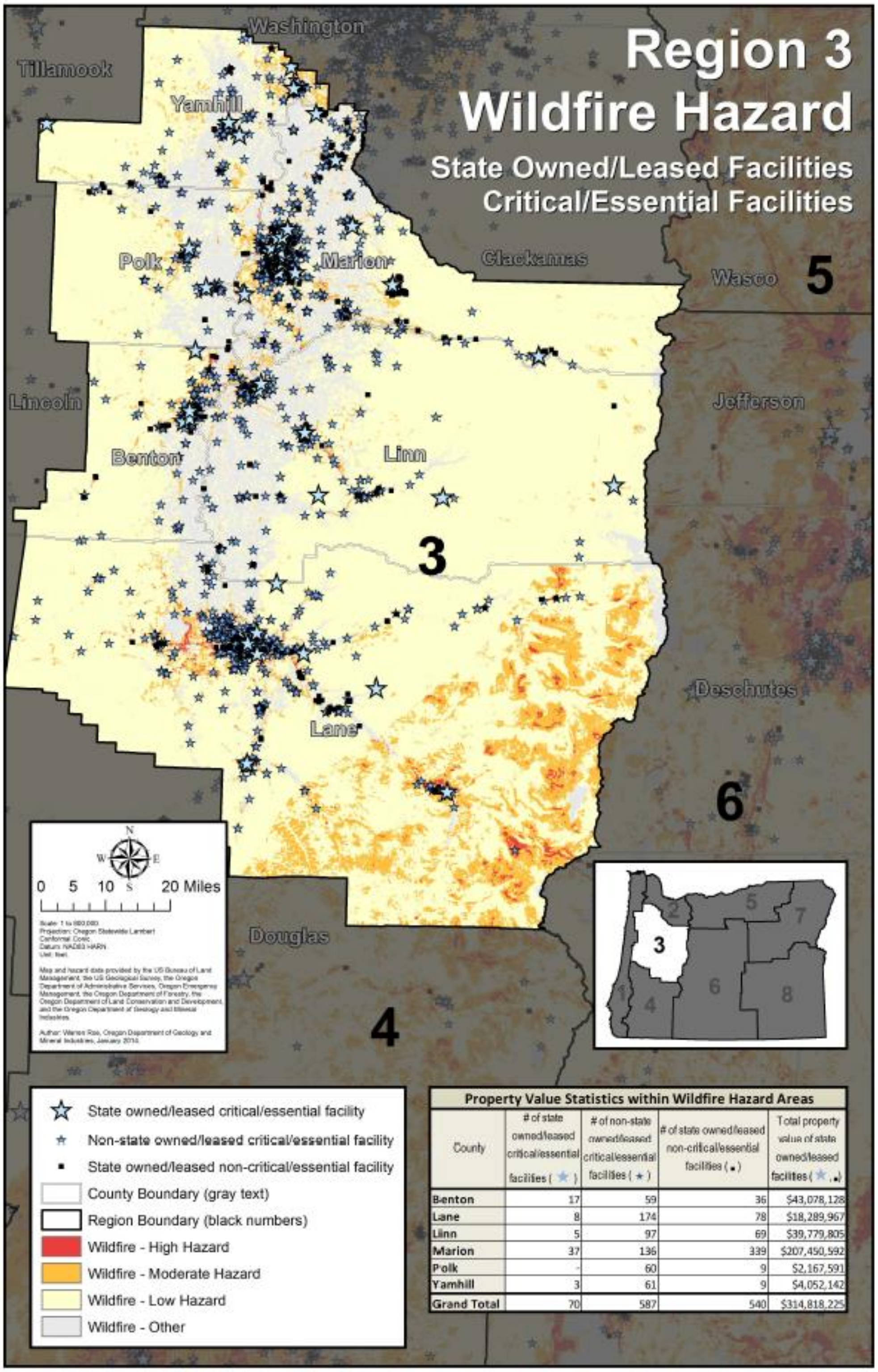
Source: Oregon Dept. of Forestry Statewide Forest Assessment, September 2006

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 610 are within a wildfire hazard zone in Region 3 and total roughly $315 million in value (**Figure 2-138**). Among state-owned/leased critical or essential facilities, 70 are located in a wildfire hazard zone in Region 3. An additional 587 non-state-owned/leased critical or essential facilities are also located in a wildfire hazard zone in Region 3.

Figure 2-138. State-Owned/Leased Facilities and Critical/Essential Facilities in a Wildfire Hazard Zone in Region 3



Property Value Statistics within Wildfire Hazard Areas

County	# of state owned/leased critical/essential facilities	# of non-state owned/leased critical/essential facilities	# of state owned/leased non-critical/essential facilities	Total property value of state owned/leased facilities
Benton	17	59	36	$43,078,128
Lane	8	174	78	$18,289,967
Linn	5	97	69	$39,779,805
Marion	37	136	339	$207,450,592
Polk	-	60	9	$2,167,591
Yamhill	3	61	9	$4,052,142
Grand Total	70	587	540	$314,818,225

Source: DOGAMI

Windstorms

Characteristics

High winds are not uncommon in the Willamette Valley. A majority of the destructive surface winds in the region are from the southwest, similar to Region 2. The much more frequent and widespread strong winds from the southwest are associated with storms moving onto the coast from the Pacific Ocean. If the winds are from the west, they may be stronger on the coast than in the interior valleys because of the north-south orientation of the Coast Range and Cascades. These mountain ranges obstruct and slow down the westerly surface winds. The most destructive winds are those which blow from the south, parallel to the major mountain ranges. The Columbus Day Storm of 1962 was a classic example of such a storm, and its effects were so devastating that it has become the benchmark from which other windstorms in Oregon are measured. The storm caused significant damage in Region 3.

In addition to windstorms, tornadoes have been recorded in Region 3 since 1887. The storms have occurred during all seasons, as described in **Table 2-230**. Fortunately, damage has been slight, and has mostly affected individual farm buildings, orchards, telephone poles and trees.

Historic Windstorm Events

Table 2-230. Historic Windstorms Affecting Region 3

Date	Location	Description
Apr. 1931	western Oregon	unofficial wind speeds reported at 78 mph; damage to fruit orchards and timber
Nov. 10-11, 1951	statewide	widespread damage; transmission and utility lines; Wind speed 40-60 mph; gusts 75-80 mph
Dec. 1951	statewide	wind speed 60 mph in Willamette Valley; 75-mph gusts; damage to buildings and utility lines
Dec. 1955	statewide	wind speeds 55-65 mph with 69-mph gusts; considerable damage to buildings and utility lines
Nov. 1958	statewide	wind speeds at 51 mph with 71-mph gusts; every major highway blocked by fallen trees
Oct. 1962	statewide	Columbus Day Storm; Oregon's most destructive storm to date; 116-mph winds in Willamette Valley; estimated 84 houses destroyed, with 5,000 severely damaged; total damage estimated at $170 million
Mar. 1971	most of Oregon	greatest damage in Willamette Valley; homes and power lines destroyed by falling trees; destruction to timber in Lane County
Nov. 1981	most of Oregon	highest winds since Oct. 1962; wind speed 71 mph in Salem; marinas, airports, and bridges severely damaged
Jan. 1990	statewide	heavy rain with winds exceeding 75 mph; significant damage; one fatality
Dec. 1995	statewide	followed path of Columbus Day Storm; wind speeds 62 mph in Willamette Valley; damage to trees (saturated soil a factor) and homes (FEMA-1107-DR-Oregon)
Nov. 1997	western Oregon	wind speed 52 mph in Willamette Valley; trees uprooted; considerable damage to small airports
Feb. 2002	western Oregon	strongest storm to strike western Oregon in several years; many downed power lines (trees); damage to buildings; water supply problems (lack of power); estimated damage costs: $6.14 million (FEMA-1405-DR-Oregon)
July 2003	Marion County	$15,000 in property damage
Dec. 2004	Marion, Lane, and Polk Counties	$6,250 in property damage — property damage estimate includes counties outside of Region 3
Dec. 2005	Mario and Linn Counties	$3,000 in property damage
Apr. 2004	Lane County	$5,000 in property damage
Jan. 2005	Linn and Marion Counties	windstorms cause $6,000 of damage in Linn and Marion Counties; a storm total of $15,000 in damages spread out among, Linn, Marion, Clackamas, Multnomah, and Washington Counties
Jan. 2006	Yamhill, Marion, and Polk Counties	wind storm with winds up to 58 mph causes a total of $500,000 in damages spread out over all four counties and includes Clackamas, Columbia, Washington, and Multnomah Counties as well
Feb. 2006	Linn, Marion, Lane, Benton, Polk, and Yamhill Counties	wind storms with gusts up to 77 mph cause $227,000 in damages in Linn, Lane, Marion, Benton, Polk, and Yamhill Counties; storm causes damages in region 2 and region 1 as well for a total storm damage of $575,000
May 2006	Lane County	$5,000 in property damage in Eugene, approximately 13,000 customers out of power
May 2007	Marion County	hail storm causes $5,000 in damages
Mar. 2008	Marion County	heavy winds measured at 40 mph cause $15,000 in damage near Woodburn

Sources: Taylor and Hatton (1999); FEMA-1405-DR-OR: February 7, 2002, Hazard Mitigation Team Survey Report, Severe Windstorm in Western Oregon; Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [online database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org

U.S. Department of Commerce. National Climatic Data Center. Available from http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms

Table 2-231. Recorded Tornadoes in Region 3

Date	County	Damage Description
Jan. 1887	Lane	fences damaged; livestock losses; trees uprooted
Nov. 1925	Polk	buildings, barns, and fruit trees damaged
Feb. 1926	Polk	house and trees damaged
Sep. 1938	Linn	observed in Brownsville; no damage
Dec. 1951	Lane	barn destroyed
Jan. 1953	Benton	observed; no damage
Mar. 1960	Marion	several farms damaged near Aumsville; trees uprooted
May 1971	Yamhill	house and barn damaged near McMinnville
Aug. 1975	Lane	metal building destroyed near Eugene
Aug. 1978	Yamhill	minor damage near Amity
Apr. 1984	Yamhill	barn roof destroyed
May 1984	Lane	barn and shelter damaged near Junction City
Nov. 1989	Lane	telephone poles and trees uprooted near Eugene
Nov. 1991	Marion	barn damaged near Silverton
Sep. 2007	Linn	a tornado rated at F0 near Albany and Lebanon causes $20,000 in damage to buildings and $22,000 to crops
Dec. 2010	Marion	a tornado rated at F2 damaged 50 buildings in the community of Aumsville, causing a total of $1.2 million in property damage
June 2013	Yamhill	tornado took ¼ mile path through town, some structural damage

Sources: Taylor and Hatton (1999, pp. 130-137); U.S. Department of Commerce. National Climatic Data Center. Available from http://www.ncdc.noaa.gov/stormevents/

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 3 will experience windstorms is shown in **Table 2-232**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-232. Local Probability Assessment of Windstorms in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	H	H	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The 100-year event for a windstorm in Region 3 is 1-minute average winds of 75 mph. A 50-year event has average winds of 68 mph. A 25-year event has average winds speeds of 60 mph.

Vulnerability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the region's vulnerability that to windstorms is shown in **Table 2-233**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-233. Local Vulnerability Assessment of Windstorms in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	M	M	M	H	H	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Many buildings, utilities, and transportation systems within Region 3 are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It also is 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. Benton, Lane, Marion, and Polk Counties are listed by PUC as being most vulnerable to wind damage in this region.

Fallen trees are especially troublesome. They can block roads and rails for long periods, which can affect emergency operations. In addition, uprooted or shattered trees can down power and other 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. Many roofs have been destroyed by uprooted ancient trees growing next to a house. In some situations, strategic pruning may be the answer. Prudent counties will work with utility companies to identify problem areas and establish a tree maintenance and removal program.

Bridges, which may be closed during periods of high wind, are an additional consideration.

Winter Storms

Characteristics

Severe winter weather in Region 3 is characterized by extreme cold, snow, ice, and sleet. Although such conditions may be expected in the Cascade Mountains and eastern Oregon, they are considered to be unusual in the Willamette Valley. Some Region 3 communities are unprepared, financially and otherwise, to handle severe winter storms. There are more moderate annual winter storms in the region; severe winter storms occur approximately every 4 years in the Valley. Severe weather conditions do not last long in Region 3, and winter-preparedness is a moderate priority.

Historic Winter Storm Events

Table 2-234. Severe Winter Storms in Region 3

Date	Location	Description
Dec. 1861	statewide	snowfall varied between 1 and 3 feet; did not leave Willamette Valley floor until late February
Dec. 1864	Willamette Valley and Columbia Basin	heavy snowfall; Albany (Linn County) received 16 inches in one day
Jan. 1916	statewide	two snow storms, each totaling 5 inches or more
Dec. 1919	Corvallis (Benton County	Corvallis received 22 inches of snow and set an all-time low temperature record of 14 °F
Jan.- Feb. 1937	statewide	heavy snow throughout the Willamette Valley; Dallas (Polk County) had 24 inches; Salem (Marion County) had 25 inches
Jan. 1950	statewide	heaviest snowfall since 1890; many highway closures; considerable property damage
Jan. 1956	western Oregon	packed snow became ice; many automobile accidents throughout the region
Mar. 1960	statewide	snowfall: 3–12 inches, depending on location; more than 100 snow-related accidents in Marion County
Jan. 1969	statewide	Lane County surpassed old snowfall record; Eugene (Lane County) had a total snow depth of 47 inches; three to $4 million in property damage
Jan. 1980	statewide	a series of storms bringing snow, ice, wind, and freezing rain; six fatalities
Feb. 1985	statewide	western valleys received 2–4 inches of snow; massive power failures (tree limbs broke power lines)
Dec. 1985	Willamette Valley	heavy snowfall throughout valley
Mar. 1988	statewide	strong winds and heavy snow
Feb. 1989	statewide	heavy snowfall and record low temperatures; Salem (Marion County) received 9 inches
Feb. 1990	statewide	average snowfall from one storm about 4 inches (Willamette Valley)
Dec. 1992	western Oregon	heavy snow; interstate highway closed
Feb. 1993	western Oregon	record snowfall at Salem airport
Winter 1998-99	statewide	series of storms; one of the snowiest winters in Oregon history
Dec. 2003 -Jan. 2004	statewide	wet snow blanketed highways in the Willamette Valley, causing power lines and trees to topple; Oregon 34 east of Philomath was closed for 30 hours January 5 and 6 while crews removed trees; Presidential disaster declaration for 30 of Oregon's 36 counties
Jan.-Feb. 2008	Marion County	a series of vigorous winter storms brought record setting snow accumulation to Detroit, Oregon; three dozen Oregon National Guard personnel were called in to help with snow removal in Detroit and Idanha; the towns received over 12 feet of snow in several weeks

Source: Taylor and Hatton (1999); unknown sources

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 3 will experience winter storms is shown in **Table 2-235**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-235. Local Probability Assessment of Winter Storms in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	H	H	H	H	—	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Winter storms occur annually in Region 3. On the basis of historical data, severe winter storms could occur about every 4 years in this region. We can expect to have continued annual storm events in this region. However, there are no solid statistical data available upon which to base these judgments. There is no statewide program to study the past, present, and potential impacts of winter storms in the state of Oregon at this time.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to winter storms is shown in **Table 2-236**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-236. Local Vulnerability Assessment of Winter Storms in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	M	H	H	H	—	H

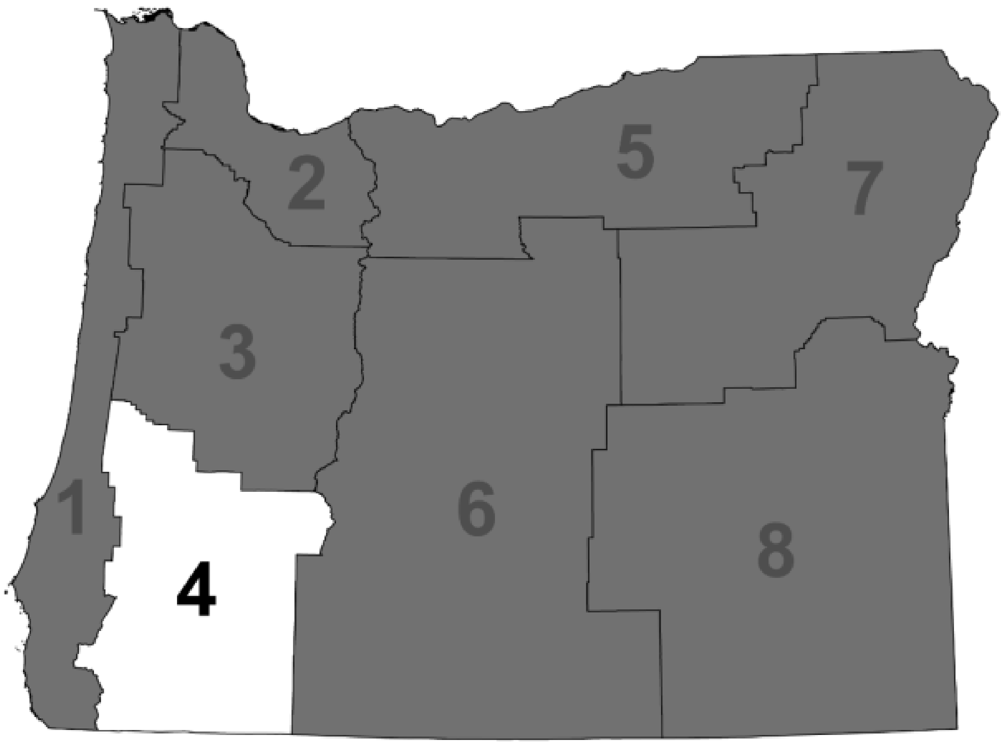
Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The I-5 corridor through this region is key to intermodal transportation; severe winter storms can have an adverse impact on the economy if the interstate has to be closed for any extended period of time.

2.3.4 Region 4: Southwest Oregon

*Douglas (non-coastal), Jackson, and Josephine Counties



*Note: The coastal portion of Douglas County is within Region 1. Where data are available for the coastal areas of Douglas County, the data are provided within the Region 1 profile; otherwise, countywide datasets are reported in this profile.

2.3.4.1 Summary

Regional Profile

The region's demographic, economic, infrastructure and development patterns indicate that some populations, structures and places may be more vulnerable to certain natural hazards than others. Mitigation efforts directed at these vulnerabilities may help boost the area's ability to bounce back after a natural disaster.

Social vulnerability across the region is driven by low median household incomes and a high proportion of senior citizens. There are several indicators of vulnerability at the county level, including: high numbers of tourists in Jackson County; a large share of seniors with disabilities in Douglas County; homelessness on the rise in Jackson and Josephine Counties; fewer college degrees in Douglas and Josephine Counties; and increases in poverty in Douglas and Jackson Counties.

Region 4 was hit particularly hard by the financial crisis that began in 2007 and continues to suffer from significantly low job recovery rates and below average wages. There are few key industries and employment sectors in Southwest Oregon. The area is particularly vulnerable during winter months when there are fewer employment opportunities.

Transportation networks across the state are vulnerable to seismic events. Following a CSZ earthquake, access along I-5 may be limited due to bridge collapse. Roughly 18% of the state-owned bridges in Southwest Oregon are distressed.

Energy facilities and conveyance systems in the region help support the regional economy and are vulnerable to damage and service disruptions due to natural hazard events. The region has multiple dams, hydroelectric and biomass power-generation facilities that service the state. Of the state-owned dams in the region, 28 have High Threat Potential and 42 have Significant Threat Potential. Natural gas pipelines run through Josephine and Douglas Counties and are vulnerable to seismic activity.

Older centralized water infrastructure is vulnerable to pollution and flooding, which can have implications for public health and water quality. During high-water events, the region's drinking water is vulnerable to high levels of pollutants entering waterways through combined sewer overflows (CSOs). Medford is the only city in the region that requires low impact development (LID) stormwater mitigation strategies in its development code.

Region 4 is developing at about half the rate of the state. The majority of growth is occurring in cities along I-5, particularly within Jackson County. Mobile homes comprise significant share of housing units and are inherently vulnerable to natural hazards. Roughly two thirds of homes in this region were built prior to current seismic building standards, making them especially vulnerable.

Hazards and Vulnerability

Region 4 is affected by eight of the state's 11 natural hazards. Coastal hazards, dust storms, and tsunamis do not directly impact this region.

Droughts: Droughts can affect commerce, agriculture, fisheries, and overall quality of life in all three counties. Jackson and Josephine Counties were declared federal primary natural disaster areas by the U.S. Department of Agriculture in 2013.

Earthquakes: Four types of earthquakes affect Region 4 (a)shallow crustal events, (b) deep intra-plate events within the subducting Juan de Fuca plate, (c) the offshore Cascadia Subduction Zone (CSZ) Fault, and (d) earthquakes associated with renewed volcanic activity. The CSZ is the chief earthquake hazard for Southwest Oregon. The region is particularly vulnerable due to the large area susceptible to earthquake-induced landslide, liquefaction, and ground shaking. In a 500-year model for a CSZ event or combined crustal events, all three of the region's counties rank among the top 15 counties with the highest expected earthquake damages and losses. The state's seismic lifelines along Interstate-5 and east-west routes that connect the region to the rest of the state are highly vulnerable to seismic events. There are 434 state-owned/leased facilities, valued at over $164.4 million, within this region's earthquake hazard zone. Of these, 34 are critical/essential facilities. An additional 1,069 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Floods: Floods affect Southwest Oregon in the form of riverine flooding often preceded by rapid snow melt and heavy rain. All of the region's counties are considered moderately vulnerable to flooding. There are 18 repetitive flood loss properties in Region 4. There are 102 state-owned/leased facilities, valued at approximately $45.4 million, located in the region's flood hazard zone. Of these, four are considered critical/essential facilities. An additional 80 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Landslides: Landslides can occur throughout the region, though more tend to occur in areas with steeper slopes, weaker geology, and higher annual precipitation. Rain-induced landslides can occur during winter months. Earthquakes can trigger landslides in the region. Vulnerability is increased in populated areas – such as in the Cities of Ashland and Medford – and in the Klamath Mountains. There are 434 state-owned/leased facilities, valued at over $164.4 million, located in this hazard zone in Region 4. Of these, 34 are critical/essential facilities. An additional 1,069 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Volcanoes: Volcanic activity may occur within the eastern areas of the region's counties that coincide with the crest of the Cascade mountain range. Particular areas of vulnerability include Crater Lake, upper reaches of the Umpqua and Clearwater Rivers, and the OR-62 corridor. Most volcanic activity is considered local. However, lahars and ashfall can travel many miles and small mountain communities, dams, reservoirs, energy-generating facilities, and highways may be vulnerable. There are no state-owned/leased facilities and no critical/essential facilities located in a volcanic hazard zone within Region 4.

Wildfires: In Southwest Oregon the combination of proximity of communities to wildland areas; high summer temperatures; rugged terrain; and likelihood of summer thunderstorm activity contribute to the region's vulnerability to wildfire. Wildfires are most common during the late summer. Based on data from the 2013 West Wide Wildfire Risk Assessment, in Region 4 Douglas and Jackson Counties have a high percentage of wildland acres in the Fire Risk, Wildland Development Areas, Fire Effects, or Fire Threat categories, making them especially vulnerable. Other areas of vulnerability are within wildland-urban interface communities. There are 198 state-owned/leased facilities located in this region's wildfire hazard zone, with a value of approximately $44 million. Of these, 11 are identified as critical/essential facilities. An additional 408 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Windstorms: Windstorms can occur when Pacific Ocean winds travel inland in a northeasterly direction. These storms generally impact the region's buildings, utilities, tree-lined roads, transmission lines, residential parcels, and transportation systems along open areas such as grasslands and farmland.

Winter Storms: Cold weather and high precipitation impact the region annually. Severe winter storms can shut down the I-5 corridor passage through the Siskiyou Mountains, which can adversely impact the economy regionally and statewide.

Climate Change

The most reliable information on climate change to date is at the state level. The state information indicates that hazards projected to be impacted by climate change in Region 4 include drought, wildfire, flooding, and landslides. Climate models project warmer drier summers and a decline in mean summer precipitation for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, all eight regions are expected to be affected by increased incidences of drought and wildfire. In addition, flooding and landslides are projected to occur more frequently throughout western Oregon. An increase in extreme precipitation is projected for some areas in Region 4 and could result in a greater risk of flooding characterized by increased magnitude and shorter return intervals in certain basins. Landslides in Oregon are strongly correlated with rainfall, so increased rainfall — particularly extreme events — will likely trigger more landslides. While winter storms and windstorms affect Region 4, there is little research on how climate change influences these hazards in the Pacific Northwest. For more information on climate drivers and the projected impacts of climate change in Oregon, see the section **Introduction to Climate Change**.

2.3.4.2 Profile

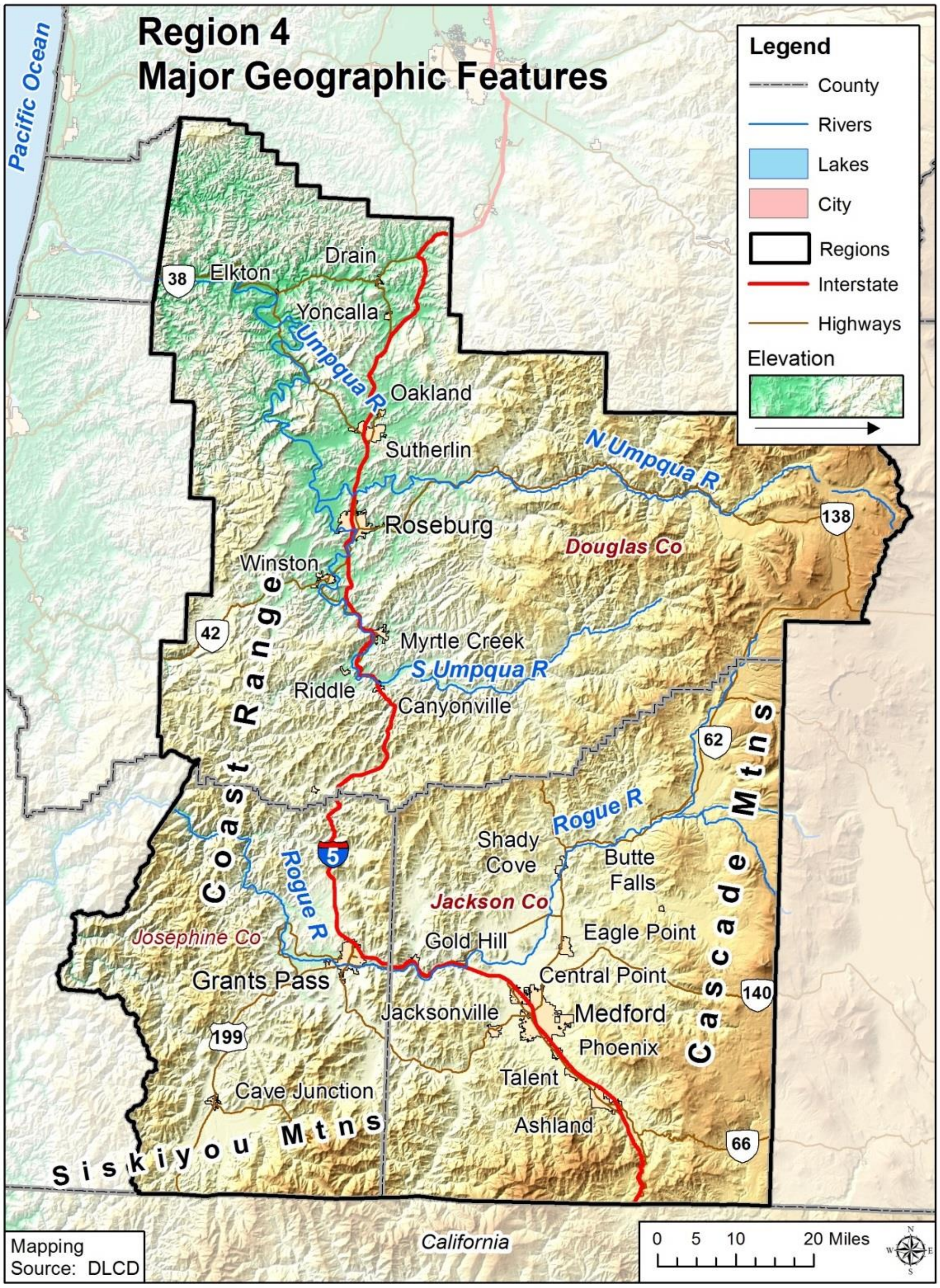
Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

Natural Environment

Geography

Southwestern Oregon is approximately 9,461 square miles in size, and includes Douglas (non-coastal), Jackson, and Josephine Counties. Mountain ranges and watersheds shape the region's topography. Region 4 begins at the Cascades in the east, and extends to the Klamath Mountains and Coast Range in the west. It extends from the Rogue-Umpqua Divide in the North to the Siskiyou Mountains at the California border in the south. Three rivers shape the region's main watersheds: the Umpqua River, the Rogue River, and the Illinois River (Downing, 2012).

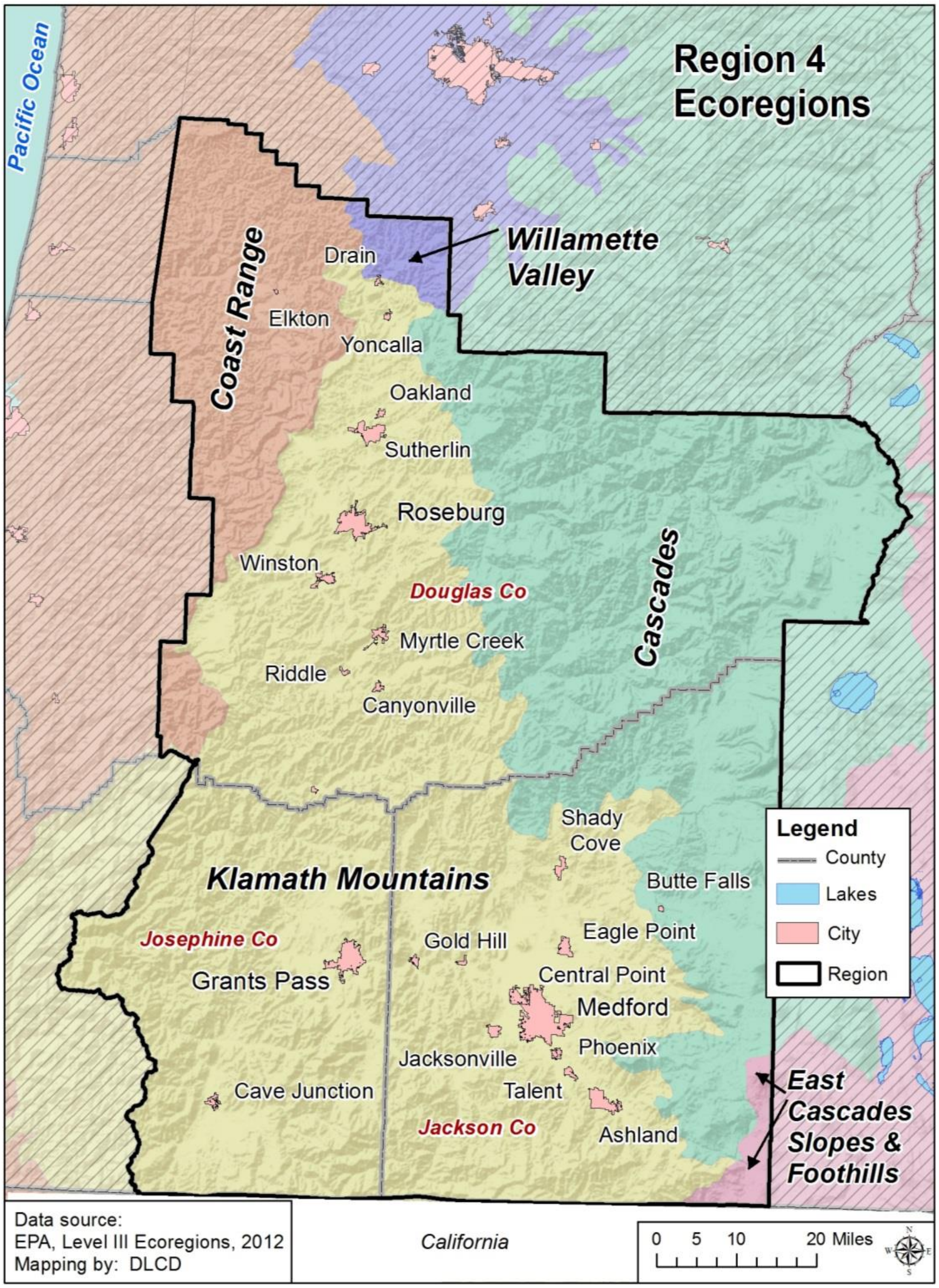
Figure 2-139. Region 4 Major Geographic Features



Source: Department of Land Conservation and Development, 2014

The U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Region 4 is composed of three ecoregions: the Cascades, the Klamath Mountains, and the Coast Range (**Figure 2-140**).

Figure 2-140. Region 4 Ecoregions



Cascades: This ecoregion is underlain by volcanic soils. Naturally occurring mixed conifer forests have given way to predominantly Douglas fir forests that are managed for commercial logging. Logging activities have put a strain on the ecological health of streams in the area (Ecoregions of Oregon, http://www.epa.gov/wed). Waterways in the steeper valleys support threatened cold-water salmonids including Chinook salmon, steelhead, and bull trout. Streams, lakes, reservoirs, rivers, and glacial lakes at higher elevations are key sources of water (Ecoregions of Oregon, http://www.epa.gov/wed).

Coast Range: The east slope of the Coast Range is located within Region 4. Sedimentary soils in this ecoregion are prone to failure following clearcuts, which may be of concern as the commercial Douglas fir forests located here are highly productive commercial logging areas. Landslides can impact the safety of nearby infrastructure and health of the region's waterways. The ecoregion's sedimentary soils can create more concerns for stream sedimentation than areas with volcanic soils (Ecoregions of Oregon, http://www.epa.gov/wed).

Klamath Mountains: A mixture of conifer and hardwood forests covers the Klamath Mountains ecoregion. A mosaic of soil types including sedimentary, granitic, metamorphic, and extrusive rocks underlies these forests. More extensive areas of hardwood and broadleaf evergreen canopies are evident in this ecoregion than in the Cascade Mountains ecoregion. Oregon white oak savannahs and woodlands, both habitat types that have been threatened by Douglas fir encroachment and human development, are present in foothills areas. This ecoregion has a dry, Mediterranean climate, which is prone to long summer droughts. The ecoregion's water quality and habitat continue to be negatively impacted by mine tailings (Ecoregions of Oregon, http://www.epa.gov/wed).

Climate

Climate refers to the temperatures, weather patterns, and precipitation in the region. This section covers historic climate information only. For estimated future climate conditions and possible impacts refer to the **State Risk Assessment** for statewide projections.

Region 4's diverse ecoregions have varying climatic conditions. Precipitation generally occurs in the winter months. Wet winters and dry summers influence risk to droughts, floods, landslides, wildfires, and winter storms. When considering the climate, snowfall should also be taken into account. Flooding can be a direct result of rain-on-snow events. Likewise, the amount of snowpack in a region can also impact the ability of communities to cope with drought. **Table 2-237** shows mean annual precipitation and temperatures for the three ecoregions in Region 4 (Ecoregions of Oregon, http://www.epa.gov/wed). Variations in temperature and precipitation vary widely by sub-ecoregion and microclimates. For more detailed and locally relevant climate data refer to the Oregon Climate Service.

Table 2-237. Average Precipitation and Temperature Ranges in Region 4 Ecoregions

Ecoregion	Mean Annual Precipitation Range (inches)	Mean Temperature Range (°F) January min/max	Mean Temperature Range (°F) July min/max
Cascades*	45–140	16/45	38/85
Klamath Mountains*	20–130	24/50	49/89
Coast Range	60–130	32/48	48/78
Willamette Valley	45–60	32/46	50/80
Eastern Cascades slopes and foothills	25–40	20/34	47/82

*Data have been generalized from all the sub-ecoregions of the ecoregion in Region 4.

Source: Thorson et al. (2003)

Demography

Population

Population forecasts are an indicator of future development needs and trends. Community demographics may indicate where specific vulnerabilities may be present in the aftermath of a natural hazard (Cutter et al., 2003). If a population is forecast to increase substantially, a community's capacity to provide adequate housing stock, services, or resources for all populations after a disaster may be stressed or compromised.

From 2000 to 2013 Region 4 as a whole has grown 3.1% less than the state overall. Jackson County has grown the most. By 2020, counties in Region 4 are projected to grow at about the same rate as the state overall.

Table 2-238. Population Estimate and Forecast for Region 4

Ecoregion	Mean Annual Rainfall (inches)	Mean Temperature (°F) January min/max	Mean Temperature (°F) July min/max
Cascades*	45-120	26/45	44/85
Klamath Mountains*	25-70	28/49	50/87
Coast Range	60-130	32/48	48/78

Source: Population Research Center, Portland State University, 2013; U.S. Census Bureau, 2010 Decennial Census. Table DP-1; Office of Economic Analysis, Long-Term Oregon State's County Population Forecast, 2010-2050, 2013

Tourists

Tourists are not counted in population statistics; and are therefore considered separately in this analysis. Tourism activities in Region 4 are largely centered on touring (traveling to experience scenic beauty, history, and culture), special events, and outdoor activities (Longwoods Travel USA, 2011b). The average travel party contains 3.1 persons and 68% of their trips originate from Oregon or California. In this region, the average trip length is 4.2 nights (Longwoods Travel USA, 2011b). More than half the tourists in this region visit Jackson County. In 2013, most visitors in Region 4 lodged in private homes.

Difficulty locating or accounting for travelers increases their vulnerability in the event of a natural disaster. Furthermore, tourists are often unfamiliar with evacuation routes, communication outlets, or even the type of hazard that may occur (MDC Consultants, n.d.). Targeting natural hazard mitigation outreach efforts to places where tourists lodge can help increase awareness and minimize the vulnerability of this population.

Table 2-239. Annual Visitor Estimates in Person Nights in Region 4

	2011		2012		2013	
	Number	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Region 4	8,860	—	9,088	—	9,348	—
Douglas	2,321	100%	2,341	100%	2,394	100%
Hotel/Motel	534	23.0%	533	22.8%	553	23.1%
Private Home	1,083	46.7%	1,091	46.6%	1,112	46.4%
Other	704	30.3%	717	30.6%	729	30.5%
Jackson	4,788	100%	4,952	100%	5,102	100%
Hotel/Motel	1,449	30.3%	1,517	30.6%	1,613	31.6%
Private Home	2,580	53.9%	2,665	53.8%	2,706	53.0%
Other	759	15.9%	770	15.5%	783	15.3%
Josephine	1,751	100%	1,795	100%	1,852	100%
Hotel/Motel	435	24.8%	448	25.0%	483	26.1%
Private Home	1,041	59.5%	1,066	59.4%	1,084	58.5%
Other	275	15.7%	281	15.7%	285	15.4%

Source: Dean Runyan Associates (2014)

Persons with Disabilities

Disabilities appear in many forms. While some disabilities may be easily identified, others may be less perceptible. Disabled populations, while difficult to identify and measure, are disproportionately affected during disasters (Cutter et al., 2003). About 4% more people in Region 4 identify as having a disability than do people throughout the state. Most people reporting a disability in Region 4 reside in Douglas County — over 20% of its population. About 43% of Douglas County's seniors (65 and older) are disabled. Local natural hazard mitigation plans should specifically target outreach programs toward helping disabled residents better prepare for and recover from hazard events.

Table 2-240. People with a Disability by Age Groups in Region 4, 2012

	Total Population*	With a Disability (Total Population)		Under 18 Years with a Disability		65 Years and Over with a Disability	
	Estimate	**Estimate**	**Percent**	**Estimate**	**Percent****	**Estimate**	**Percent****
Oregon	3,796,881	511,297	13.5%	39,439	4.6%	200,374	37.8%
Region 4	390,890	68,927	17.6%	4,429	5.3%	30,069	39.5%
Douglas	106,680	22,852	21.4%	1,531	7.0%	9,710	43.3%
Jackson	202,450	32,259	15.9%	2,333	5.3%	13,651	38.2%
Josephine	81,760	13,816	16.9%	565	3.4%	6,708	37.2%

*Total population does not include institutionalized population.

**Percent of age group.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Homeless Population

Population estimates of the homeless in Oregon are performed each January. These are rough estimates and can fluctuate with many factors, including the economy or season. The overwhelming majority of homeless are either single adult males or families with children. Communities located along major transportation corridors, such as I-5, tend to have higher concentrations of homeless people (Thomas et al., 2008). Over the 3-year period between 2009 and 2011 the homeless population has been gradually increasing in Jackson and Josephine Counties.

Extra attention is needed to care for and serve homeless communities. Some homeless people choose to remain hidden or anonymous, making it especially difficult to mitigate harm to them from natural hazard events. Accessible shelter and social services are key emergency considerations for the homeless community.

Table 2-241. Homeless Population Estimate for Region 4

	2000	2013	Percent Change (2000 to 2013)	2020 Projected	Percent Change (2013 to 2020)
Oregon	3,421,399	3,919,020	14.5%	4,252,100	8.5%
Region 4	357,394	397,975	11.4%	430,346	8.1%
Douglas	100,399	108,850	8.4%	116,113	6.7%
Jackson	181,269	206,310	13.8%	223,458	8.3%
Josephine	75,726	82,815	9.4%	90,776	9.6%

Source: Oregon Point in Time Homeless Count, Oregon Housing and Community Services
http://www.oregon.gov/ohcs/pages/ra_point_in_time_homeless_count.aspx

Gender

The gender breakdown in Region 4 (roughly 50:50) is similar to that of the state (U.S. Census Bureau, n.d.). 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 (Cutter et al., 2003).

Age

Region 4 has a 5.5% greater share of seniors than the state average. Senior citizens may require special consideration due to sensitivity to heat and cold, reliance upon transportation to obtain medication, and comparative difficulty in making home modifications that reduce risk to hazards. In addition, the elderly may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to the elderly (Morrow, 1999).

The percentage of children is slightly lower than the statewide average. Special considerations should be given to young children, schools, and parents during the natural hazard mitigation process. Young children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities. Parents may lose time from work and money when their children’s childcare facilities and schools are impacted by disasters (Cutter et al., 2003).

Table 2-242. Population by Vulnerable Age Groups, in Region 4, 2012

	Total Population	Under 18 Years Old		65 Years and Older	
	Estimate	Estimate	Percent	Estimate	Percent
Oregon	3,836,628	864,243	22.5%	540,527	14.1%
Region 4	393,640	83,166	21.1%	77,314	19.6%
Douglas	107,391	21,870	20.4%	22,733	21.2%
Jackson	203,613	44,437	21.8%	36,177	17.8%
Josephine	82,636	16,859	20.4%	18,404	22.3%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP05

Language

A majority of the region's population speaks English very well. Conversely, compared to state numbers, roughly 3–5% more of the region's population does not speak English very well. Hazard mitigation outreach materials used to communicate with and plan for this community should take into consideration their language needs.

Table 2-243. English Usage in Region 4, 2012

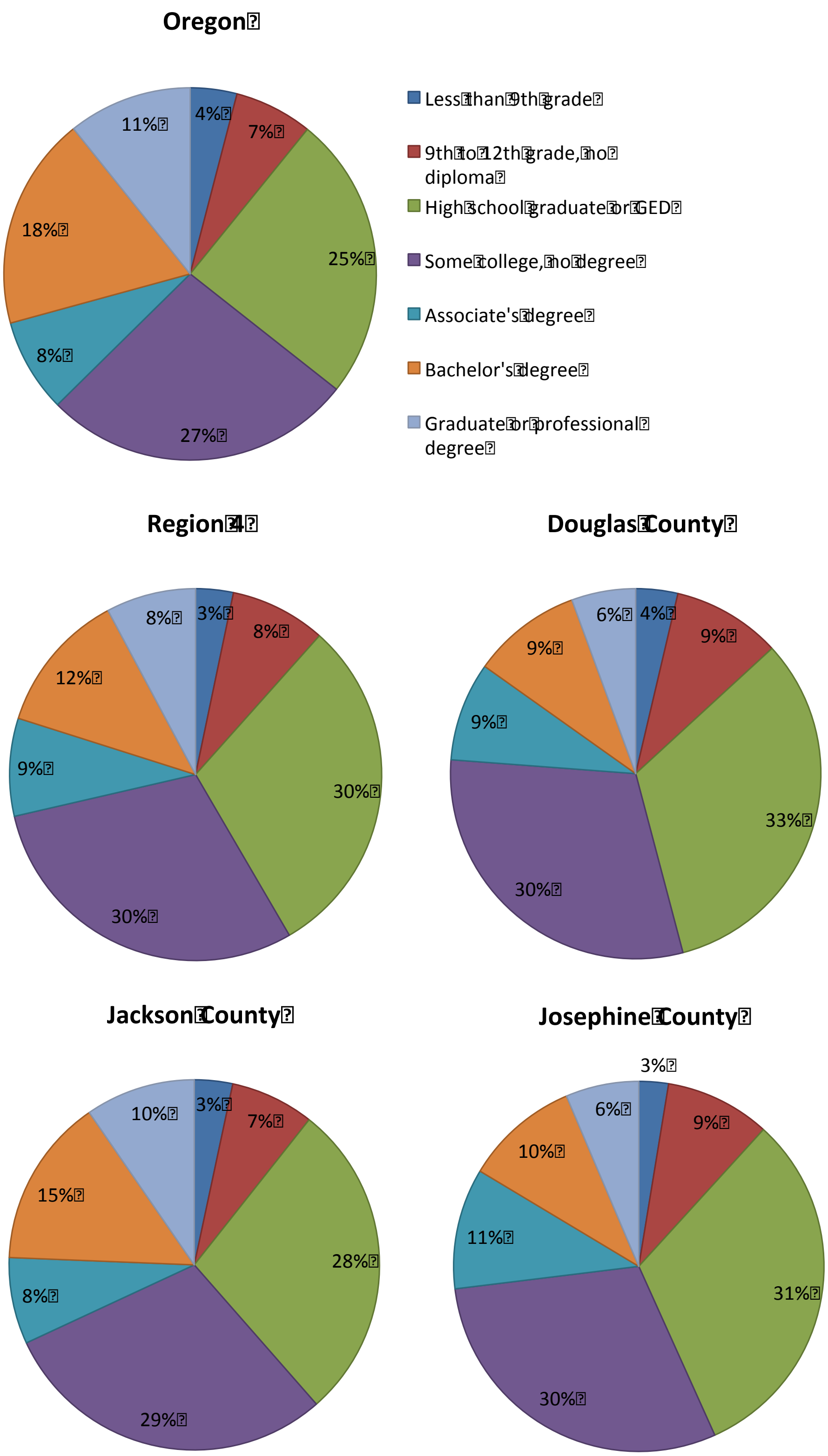
	Speak English "Very Well"		Speak English Less Than "Very Well"	
	Estimate	Percent	Estimate	Percent
Oregon	3,376,744	93.8%	224,905	6.2%
Region 4	362,946	97.6%	9,058	2.4%
Douglas	100,869	99.0%	1,037	1.0%
Jackson	184,577	96.3%	7,095	3.7%
Josephine	77,500	98.8%	926	1.2%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Education Level

Studies (Cutter et al., 2003) show that education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings. Furthermore, education can influence a person's and community's ability to understand warning information and to access resources before and after a natural disaster. In Southwestern Oregon, 5% more of the population has a high school degree or GED compared to state percentages. In Josephine and Douglas Counties, the share of bachelor's degrees is roughly 8% lower than the state average. Five percent fewer persons have a graduate or professional degree than the state average.

Figure 2-141. Educational Attainment in Region 4, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Income

The impact of a disaster in terms of loss and the ability to recover varies among population groups. "The causes of social vulnerability are explained by the underlying social conditions that are often quite remote from the initiating hazard or disaster event" (Cutter, 2006, p. 76). Historically, 80% of the disaster burden falls on the public. Of this number, a disproportionate burden is placed upon those living in poverty. People living in poverty are more likely to be isolated, are less likely to have the savings to rebuild after a disaster, and are less likely to have access to transportation and medical care.

The financial crisis that began in 2007 significantly affected Region 4. Across the region, median household incomes were below statewide numbers in 2009 and dropped roughly 8% by 2012. About 7% of households in Southwest Oregon earn less than $35,000 per year. Jackson County has the highest percent of its households earning more than $75,000 per year.

Table 2-244. Median Household Income in Region 4

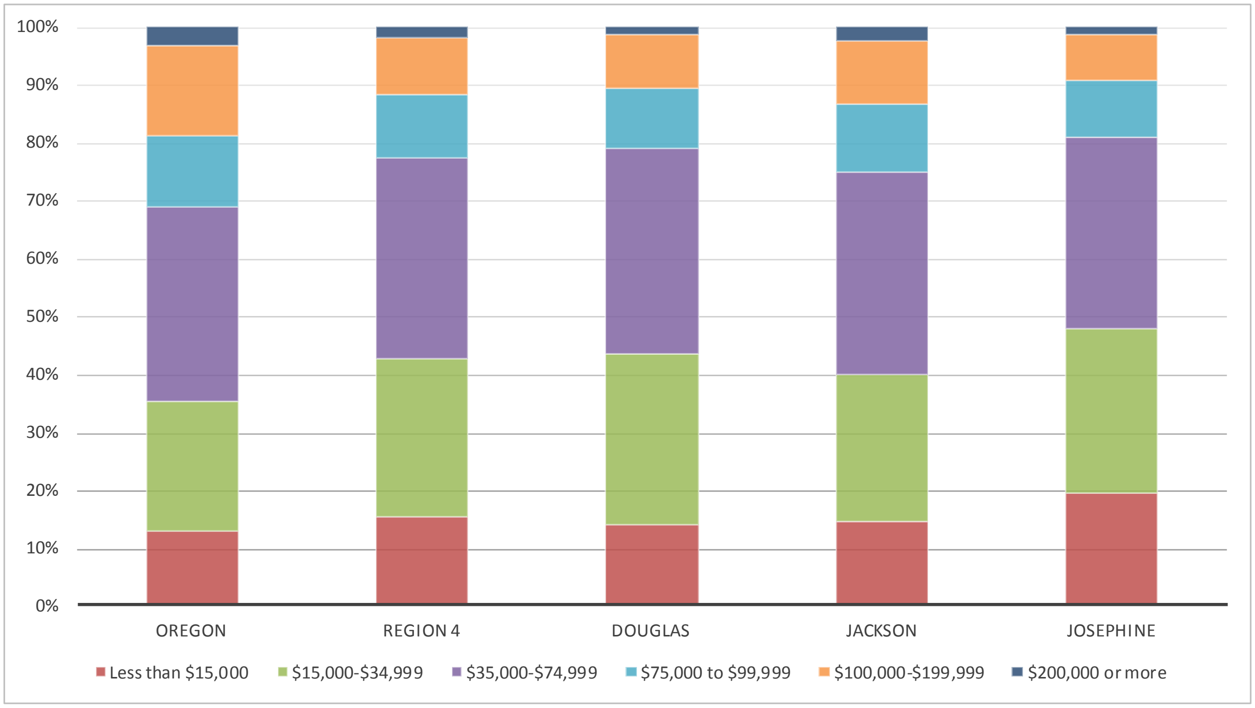
	2009	2012	Percent Change
Oregon	$52,474	$50,036	-4.6%
Region 4	N/A	N/A	N/A
Douglas	$43,154	$40,096	-7.1%
Jackson	$47,773	$43,664	-8.6%
Josephine	$40,085	$36,699	-8.4%

Note: 2009 dollars are adjusted for 2012 using Bureau of Labor Statistics' Consumer Price Index Inflation Calculator.

N/A = data not aggregated at the regional level.

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates. Table DP03.

Figure 2-142. Median Household Income Distribution in Region 4, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP03

Since 2009, about 7% more of the region's population has entered into poverty. Josephine County has the highest percentage of its population living in poverty — 20% of individuals and close to 31% of its children. Notably, Douglas County saw an increase in overall poverty of roughly 35%, and an almost 40% increase among its children.

Table 2-245. Poverty Rates in Region 4, 2012

	Total Population in Poverty			Children Under 18 in Poverty		
	Number	Percent	Percent Change*	Number	Percent	Percent Change*
Oregon	584,059	15.5%	17.7%	175,303	20.6%	17.6%
Region 4	68,524	17.6%	24.4%	21,063	25.7%	23.9%
Douglas	18,877	17.8%	34.5%	5,956	27.7%	39.5%
Jackson	33,346	16.6%	22.5%	10,032	22.9%	22.0%
Josephine	16,301	20.0%	18.0%	5,075	30.8%	12.6%

*Percent change since 2009

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates, Table S1701

Low-income populations require special consideration when mitigating loss to a natural hazard. Often, those who earn less have little to no savings and other assets to withstand economic setbacks. When a natural disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the natural disaster. To reduce the compounded loss incurred by low-income populations post-disaster, mitigation actions need to be specially tailored to ensure safety nets are in place to provide further support to those with fewer personal resources (Cutter et al., 2003).

Housing Tenure

Wealth can increase the ability to recover following a natural disaster (Cutter et al., 2003), and homeownership, versus renting, is often linked to having more wealth. Renters often do not have personal financial resources or insurance to help recover post-disaster. On the other hand, renters tend to be more mobile and have fewer assets at risk. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable due to natural disaster events.

Collectively, counties in Region 4 have a slightly greater home-ownership rate compared to the state overall. Douglas County has the highest share of its households being owner occupied. Jackson County has the greatest percent of its population renting. Douglas County has the greatest percentage of vacant properties. Compared to the state overall, there is a smaller share of seasonal and recreational homes in Southwest Oregon (U.S. Census Bureau, 2008–2012 American Community Survey, Table DP04 and Table B25004).

Table 2-246. Housing Tenure in Region 4, 2012

	Total Occupied Units	Owner Occupied		Renter Occupied		Vacant^	
		Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	945,824	62.5%	566,894	37.5%	105,417	6.3%
Region 4	161,421	104,869	65.0%	56,552	35.0%	12,416	7.0%
Douglas	43,678	30,362	69.5%	13,316	30.5%	4,258	8.7%
Jackson	83,370	51,646	61.9%	31,724	38.1%	5,534	6.1%
Josephine	34,373	22,861	66.5%	11,512	33.5%	2,624	6.9%

^ = Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

Source: U.S. Census Bureau, 2008–2012 American Community Survey, 5-Year Estimates, Table DP04 and Table B25004.

Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households. Region 4 is predominantly composed of family households. All three counties have a lower share of family households with children compared to the state.

Table 2-247. Family vs. Non-family Households in Region 4, 2012

	Total Households	Family Households		Nonfamily Households		Householder Living Alone	
	Estimate	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	964,274	63.7%	548,444	36.3%	421,620	27.9%
Region 4	161,421	105,456	65.3%	55,965	34.7%	45,352	28.1%
Douglas	43,678	29,279	67.0%	14,399	33.0%	11,609	26.6%
Jackson	83,370	53,966	64.7%	29,404	35.3%	23,426	28.1%
Josephine	34,373	22,211	64.6%	12,162	35.4%	10,317	30.0%

Source: U.S. Census Bureau, 2008–2012 American Community Survey, 5-Year Estimates, Table DP04

Table 2-248. Family Households with Children by Head of Household in Region 4, 2012

	Family Households with Children		Single Parent (Male)		Single Parent (Female)		Married Couple with Children	
	Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	415,538	27.5%	35,855	2.4%	93,575	6.2%	286,108	18.9%
Region 4	38,994	24.2%	4,285	2.7%	10,089	6.3%	24,620	15.3%
Douglas	9,556	21.9%	939	2.1%	2,619	6.0%	5,998	13.7%
Jackson	21,617	25.9%	2,241	2.7%	5,579	6.7%	13,797	16.5%
Josephine	7,821	22.8%	1,105	3.2%	1,891	5.5%	4,825	14.0%

Note: The table shows the percent of total households represented by each family household structure category.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Social and Demographic Trends

The social and demographic analysis shows that Region 4 is particularly vulnerable during a hazard event in the following categories:

- High numbers of tourists visit Jackson County.
- A high percentage of the senior population in Douglas County has a disability.
- The homeless population in Jackson and Josephine Counties is increasing.
- The region has a higher share of seniors than the state overall.
- In each county 3–5% more of the population does not speak English very well.
- A smaller share of the population has a college degree, especially in Douglas and Josephine Counties.
- Median household incomes are significantly lower than the state's.
- There has been a greater increase in the share of population living in poverty, including children, in Douglas and Jackson Counties, than in the state overall.

Economy

Economic characteristics include the financial resources present and revenue generated in the community to achieve a higher quality of life. Employment characteristics, income equality, employment, and industry sectors 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 employment sectors, workforce, resources, and infrastructure are interconnected in the existing economic picture.

Employment

Employment status and salary level may impact the resilience of individuals and families in the face of disasters as well as their ability to mitigate for natural hazards (Cutter et al., 2003). Since the end of the financial crisis that began in 2007, job recovery in Region 4 has lagged behind state's average. As of May 2013 Douglas County has recovered only 17% of jobs lost in the recession while 65% of jobs statewide have been recovered. Similarly, job recovery in Jackson County has occurred disproportionately in low-wage jobs. Regionally, unemployment rates have been declining steadily since 2009, but remain 2.4% higher than statewide averages. Jackson County has the largest labor force in the region and the lowest unemployment rate. Notably, average salaries in Southwest Oregon are 18% to 29% lower than the statewide average.

Table 2-249. Unemployment Rates in Region 4 2009-2013

	2009	2010	2011	2012	2013	Change (2009-2013)
Oregon	11.1%	10.8%	9.7%	8.8%	7.7%	-3.4%
Region 4	13.7%	13.4%	12.4%	11.5%	10.1%	-3.6%
Douglas	15.5%	14.7%	13.4%	12.3%	10.8%	-4.6%
Jackson	12.6%	12.6%	11.8%	11.0%	9.5%	-3.1%
Josephine	14.3%	14.2%	12.8%	12.1%	10.9%	-3.4%

Source: Oregon Employment Department, 2014

"The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster" (Cutter et al., 2003). Retail trade and tourism employment ebb and flow seasonally. The winter months tend to see the lowest employment rates due to less tourism and fewer employment opportunities in outdoor industries such as construction and agriculture (Tauer, 2014). Therefore, during winter months the region's economic vulnerability to a hazard event is heightened.

Table 2-250. Employment and Unemployment Rates in Region 4, 2013

	Civilian Labor Force	Employed Workers		Unemployed	
	Total	Total	Percent	Total	Percent
Oregon	1,924,604	1,775,890	92.3%	148,714	7.7%
Region 4	173,595	156,059	89.9%	17,536	10.1%
Douglas	43,207	38,531	89.2%	4,676	10.8%
Jackson	97,698	88,405	90.5%	9,293	9.5%
Josephine	32,690	29,123	89.1%	3,567	10.9%

Source: Oregon Employment Department, 2014

Table 2-251. Employment and Payroll in Region 4, 2013

	Employees	Average Pay	Percent State Average
Oregon	1,679,364	$45,010	100%
Region 4	135,543	$35,647	79.2%
Douglas	34,651	$35,382	78.6%
Jackson	78,171	$36,873	81.9%
Josephine	22,721	$31,831	70.7%

Source: Oregon Employment Department, 2014

Employment Sectors and Key Industries

In 2012 the five major employment sectors in Region 4 were: (a) Trade, Transportation, and Utilities; (b) Government; (c) Education and Health Services; (d) Leisure and Hospitality; and (e) Manufacturing. **Table 2-252** shows the distribution of total employment across all sectors. Wood products have historically been the main industry within the manufacturing sector in Region 4. In recent years, however, employment in wood products manufacturing has declined, and there has been an increase in food products manufacturing in Jackson and Josephine Counties (Oregon Employment Department, 2012; Employment Projections by Industry and Occupation: 2010–2020 Oregon and Regional Summary, retrieved Feb 19, 2014 from http://www.qualityinfo.org). Lumber and wood products continue to be one of the largest employment sectors in Douglas County, employing 10% of the private sector. Douglas County contains nearly 2.8 million acres in commercial forestland and is the second largest producer of timber in the state (Oregon Employment Department, n.d., Region 6 overview, retrieved Feb. 19, 2014, from http://www.qualityinfo.org/).

Table 2-252. Covered Employment by Sector in Region 4, 2013

		Douglas County		Jackson County		Josephine County	
Industry	**Region 4**	**Employment**	**Percent**	**Employment**	**Percent**	**Employment**	**Percent**
Total All Ownerships	135,546	34,651	100%	78,171	100%	22,724	100%
Total Private Coverage	113,739	26,920	77.7%	67,111	85.9%	19,708	86.7%
Natural Resources & Mining	4,309	1,635	4.7%	2,257	2.9%	417	1.8%
Construction	4,855	1,026	3.0%	3,092	4.0%	737	3.2%
Manufacturing	13,866	4,401	12.7%	7,052	9.0%	2,413	10.6%
Trade, Transportation & Utilities	28,735	6,289	18.1%	17,505	22.4%	4,941	21.7%
Information	2,001	266	0.8%	1,473	1.9%	262	1.2%
Financial Activities	5,152	1,068	3.1%	3,078	3.9%	1,006	4.4%
Professional & Business Services	11,716	3,281	9.5%	6,515	8.3%	1,920	8.4%
Education & Health Services	22,388	4,495	13.0%	13,681	17.5%	4,212	18.5%
Leisure & Hospitality	15,341	3,159	9.1%	9,505	12.2%	2,677	11.8%
Other Services	5,351	1,297	3.7%	2,935	3.8%	1,119	4.9%
Private Non-Classified	22	(c)	—	18	0.0%	(c)	—
Total All Government	21,807	7,731	22.3%	11,060	14.1%	3,016	13.3%
Federal Government	3,292	1,363	3.9%	1,681	2.2%	248	1.1%
State Government	4,101	1,021	2.9%	2,321	3.0%	759	3.3%
Local Government	14,414	5,347	15.4%	7,058	9.0%	2,009	8.8%

Note: (c) = confidential, information not provided by Oregon Employment Department to prevent identifying specific businesses.

Source: Oregon Employment Department, 2013

Each industry faces distinct vulnerabilities to natural hazards. Identifying key industries in the region enables communities to target mitigation activities toward those industries' specific sensitivities. Each of the primary private employment sectors has sensitivity to natural hazards, as follows.

Trade, Transportation, and Utilities: Retail Trade is the largest employment subsector within the Trade, Transportation, and Utilities sector. Retail Trade is vulnerable to disruptions in the disposable income of regional residents and to disruptions in the transportation system. Residents' discretionary spending diminishes after natural disasters as spending priorities tend to focus on essential items. Disruption of the transportation system could sever connectivity of people and retail hubs. Retail businesses are concentrated in the larger cities of the region and are most numerous in Jackson County.

Education and Health Services: The Health and Social Assistance industries play important roles in emergency response in the event of a disaster. The importance of the health care and social assistance sector is underscored in Region 4 because of the region's increasing numbers of retirees. Health care is a relatively stable revenue sector regionally with an abundant distribution of businesses primarily serving a local population.

Leisure and Hospitality: This sector primarily serves regional residents with disposable income and tourists. The behavior of both of these social groups would be disrupted by a natural disaster. Regional residents may have less disposable income and tourists may choose not to visit a region with unstable infrastructure.

Manufacturing: This sector is highly dependent upon transportation networks in order to access supplies and send finished products to outside markets. For these reasons the manufacturing sector may be susceptible to disruptions in transportation infrastructure. However, manufacturers are not dependent on local markets for sales, which may contribute to the economic resilience of this sector. Within the region, manufacturers are primarily based in Douglas and Jackson counties. The timber manufacturing industry is particularly vulnerable to droughts, landslides, and wildfires.

Revenue by Sector

In 2007 Trade (Retail and Wholesale), Manufacturing, and Healthcare and Social Assistance were the highest revenue grossing industries in Region 4. (Note that revenue data from the 2012 Economic Census will not be released prior to the publication of this Plan.) Combined, these three industries generated over $12.7 billion (86% of total revenue) for the region (**Table 2-253**).

Table 2-253. Revenue of Top Industries (in Thousands of Dollars) in Region 4, 2007

	Total Revenue (in Thousands)	Trade (Retail and Wholesale)	Manufacturing	Health Care and Social Assistance
Oregon	$277,017,733	44.4%	24.1%	7.3%
Region 4	$14,823,762	44.9%	27.1%	13.8%
Douglas	$3,708,424	31.5%	40.6%	13.8%
Jackson	$8,949,774	49.9%	22.8%	13.1%
Josephine	$2,165,564	47.3%	21.8%	16.5%

Source: U.S. Census, Economic Census. 2007, Table ECO700A1

Sectors anticipated to be major employers in the future warrant special attention, especially in the hazard mitigation planning process so workforces and employers can be more prepared to respond and adapt to needs that arise after a natural hazard event. According to the Oregon Employment Department, between 2012 and 2022, the largest job growth in Region 4 is expected to occur in the following sectors: (a) Education and Health Services; (b) Trade, Transportation, and Utilities (including retail trade); (c) Professional and Business Services; (d) Leisure and Hospitality; and (e) Manufacturing (Oregon Employment Department, 2014).

Identifying sectors with a large number of businesses and targeting mitigation strategies to support those sectors, can help the region's resiliency. The Trade, Transportation, and Utilities sector includes the most businesses in the region. The Other Services sector has the second most businesses. The Professional and Business Services sector, Education and Health Services sector, Leisure and Hospitality sector round out the top five sectors in Southwestern Oregon (Oregon Employment Department, 2012). While many of these are small businesses, employing fewer than 20 employees, collectively they represent 68% of the business units in the region. Due to their small size and large collective share of the economy, these businesses are particularly sensitive to temporary decreases in demand, such as may occur following a natural hazard event.

Economic Trends and Issues

Current and anticipated financial conditions of a community are strong determinants of community resilience, since a strong and diverse economic base increases the ability of individuals, families, and communities to absorb impacts of a disaster and recover more quickly. The economic analysis shows that Region 4 is particularly vulnerable during a hazard event due to the following characteristics:

- Significantly high unemployment rates in Douglas and Josephine Counties;
- Lower regional wages — 71% to 82% of state average salaries; and
- An economy heavily dependent on a few key industries.

Considering the high regional unemployment and an economy heavily dependent on a few key industries, Region 4 may experience greater difficulty recovering after a disaster than a region with a more diverse economic base. Supporting the growth of dominant industries and employment sectors, as well as emerging sectors identified in this analysis, could help the region become more resilient to economic downturns that often follow a hazard event (Stahl et al., 2000).

Infrastructure

Transportation

Roads

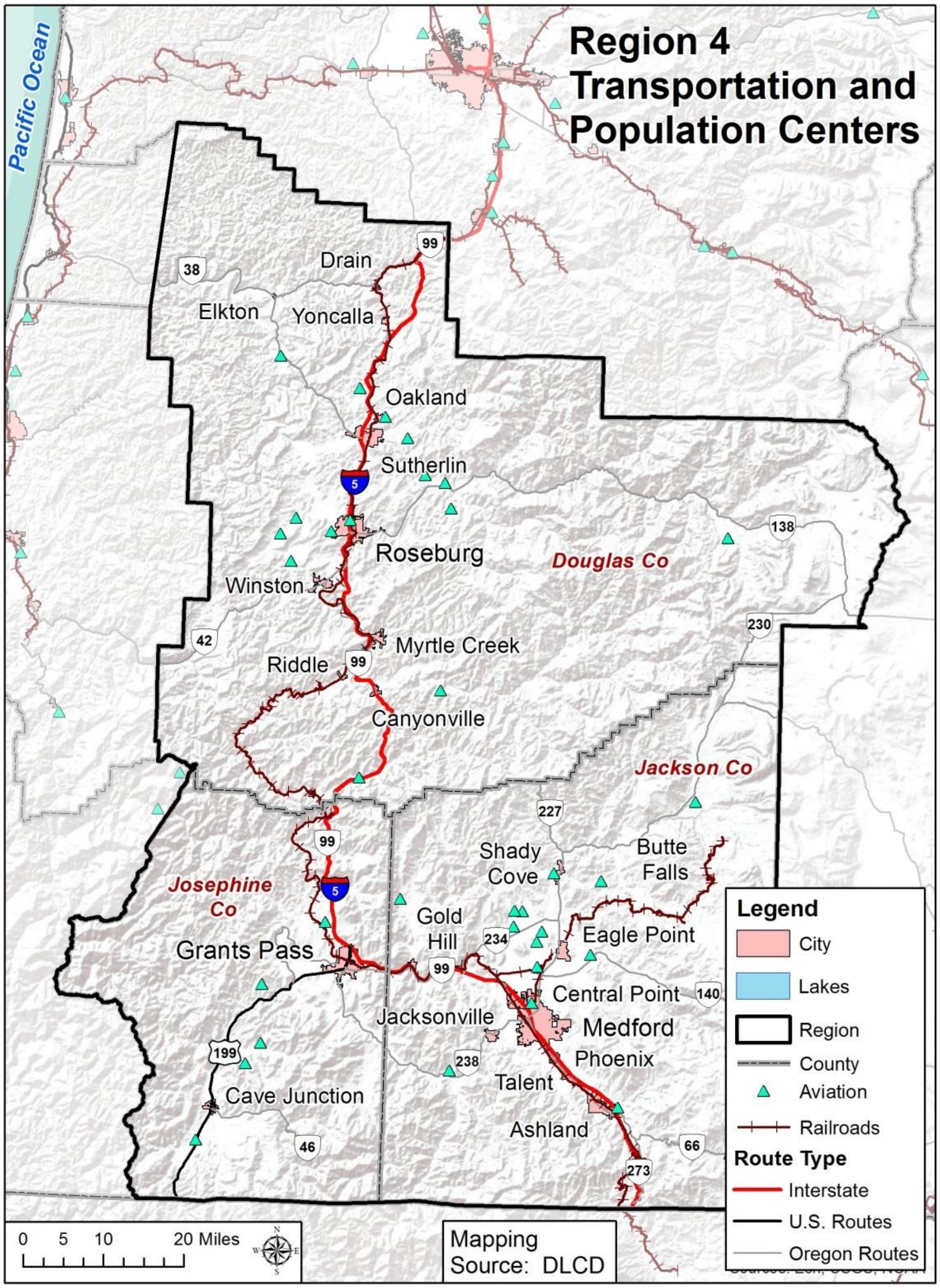
The largest population bases in Region 4 — the Cities of Ashland, Grants Pass, Medford, and Roseburg — are located along I-5. I-5 runs north-south through Region 4 and is the main passage for automobiles and trucks traveling along the West Coast.

Region 4’s growing population centers bring more workers, automobiles and trucks onto roads. A high percentage of workers driving alone to work coupled with interstate and international freight movement on the I-5 corridor create additional stresses on transportation systems. Some of these include added maintenance, congestion, oversized loads, and traffic accidents.

Natural hazards and emergency events can further disrupt automobile traffic, create gridlock, and shut down local transit systems, making evacuation and other emergency operations difficult. Hazards such as localized flooding can render roads unusable. Likewise, a severe winter storm has the potential to disrupt the daily driving routine of thousands of people.

According to the Oregon Department of Transportation’s (ODOT’s) Seismic Lifeline Report (**Appendix 9.1.13**), the region has exposure to earthquakes, especially a Cascadia Subduction Zone event. Therefore, the seismic vulnerability of the region’s lifelines, including roadways and bridges, is an important issue. For information on ODOT’s Seismic Lifeline Report findings for Region 4 see **Seismic Lifelines**.

Figure 2-143. Region 4 Transportation and Population Centers



Source: Oregon Department of Land Conservation and Development, 2014

Bridges

Because of earthquake risk in Region 4, the seismic vulnerability of the region'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 region's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or are part of regional and local systems that are maintained by the region's counties and cities.

Table 2-254 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 (ODOT, 2012, 2013). About 18% of the region's ODOT bridges are distressed, compared to 22% for the state.

Table 2-254. Bridge Inventory for Region 4

	State Owned			County Owned			City Owned			Other Owned			Area Total			Historic
	Di	ST	%D*	De	ST	%D	De	ST	%D	De	ST	%D	D	T	%D	Covered
Oregon	610	2,718	22%	633	3,420	19%	160	614	26%	40	115	35%	1,443	6,769	21%	334
Region 4	64	362	18%	81	508	16%	14	56	25%	4	10	40%	163	905	18%	11
Douglas	28	174	18%	44	252	17%	6	23	26%	2	6	33%	80	440	18%	6
Jackson	24	128	21%	16	152	11%	8	32	25%	0	0	-	48	300	16%	4
Josephine	12	60	21%	21	104	20%	0	1	0%	2	4	50%	35	165	21%	1

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.

Source: ODOT (2012, 2013)

Railroads

Railroads that run through Region 4 support cargo and trade flows. The region's rail providers are the Central Oregon & Pacific and the White City Terminal Railroad. There is no passenger rail line through the region. The Central Oregon & Pacific Line follows I-5 through the region, then runs west through Lane County and loops back into Region 4 through Reedsport. The White City Terminal Railroad is a short spur off the Central Oregon & Pacific Line in Jackson County (Loy et al., 1976). Oregon's rail system is critical to the state's economy, energy, and food systems. Rail systems export lumber and wood products, pulp and paper, and other goods produced in Oregon and carry products from other states to and through Oregon by rail (Cambridge Systematics, 2014).

Rails are sensitive to icing from winter storms that can occur in Region 4. Disruptions in the rail system can result economic losses for the region. The potential for harm from rail accidents can also have serious implications for local communities, particularly if hazardous materials are involved.

Airports

Rogue Valley International-Medford Airport is the only commercial airport in the region and is the third busiest airport in Oregon (Federal Aviation Administration, 2012). The airport is owned, operated and administered by Jackson County Aviation Authority. It serves eight hubs and four air carriers with approximately 56 arriving and departing flights daily (Jackson County, Oregon, airport website, http://www.co.jackson.or.us/SectionIndex.asp?SectionID=5).

In the event of a natural disaster, public and private airports are important staging areas for emergency response activities. Public airport closures will impact the region's tourism industries, as well as the ability for people to leave the region by air. Businesses relying on air freight may also be impacted by airport closures.

Table 2-255. Public and Private Airports in Region 4

	Number of Airports by FAA Designation				
	Public Airport	Private Airport	Public Heliport	Private Heliport	Total
Region 4	10	26	0	13	49
Douglas	4	12	0	4	20
Jackson	4	11	0	7	22
Josephine	2	3	0	2	7

Source: FAA Airport Master Record (Form 5010), 2014

Energy

Electricity

Several power supply companies serve Region 4. The Bonneville Power Administration is the area's wholesale electricity distributor. The majority of the region is powered by PacifiCorp (Pacific Power and Light). The Coos-Curry Electric Cooperative and the Douglas Electric Cooperative serve portions of Douglas and Josephine Counties. The Umpqua Indian Utility Cooperative serves the Cow Creek Band of Umpqua Tribe of Indians, including the site of the Seven Feathers Casino Resort located in Douglas County north of Grants Pass and south of Roseburg.

Table 2-256 lists electric power-generating facilities within Region 4. The region has a total of eight power-generating facilities: three are hydroelectric power facilities, and five are categorized as “other” (primarily biomass). In total the power-generating facilities have the ability to produce up to 391 megawatts of electricity.

Table 2-256. Power Plants in Region 4

	Hydro-electric	Natural Gas	Wind	Coal	Other*	Total
Region 4	3	0	0	0	5	8
Douglas	1	0	0	0	3	4
Jackson	2	0	0	0	1	3
Josephine	0	0	0	0	1	1
Energy Production (MW)	**305**	**0**	**0**	**0**	**86**	**391**

* “Other” includes biomass, geothermal, landfill gas, solar, petroleum, and waste.

Source: Army Corps of Engineers; Biomass Power Association; Calpine Corporation; Eugene Water and Electric Board; Iberdola Renewables; Idaho Power Company; Klamath Energy LLC; Oregon Department of Energy; Owyhee Irrigation District; Form 10K Annual Report (2013), PacifiCorp; Form 10K Annual Report (2013), Portland General Electric; U.S. Geothermal, Inc.

Hydropower

The majority of electrical power in Region 4 is generated through hydropower. Dams for hydropower generation are primarily situated on the Applegate, Rogue, and Umpqua Rivers. Dams operated by the Bonneville Power Administration (BPA) provide hydro-generated electricity to the state’s consumer owned utilities. Major BPA dams in the region are located on the Applegate and Rogue Rivers.

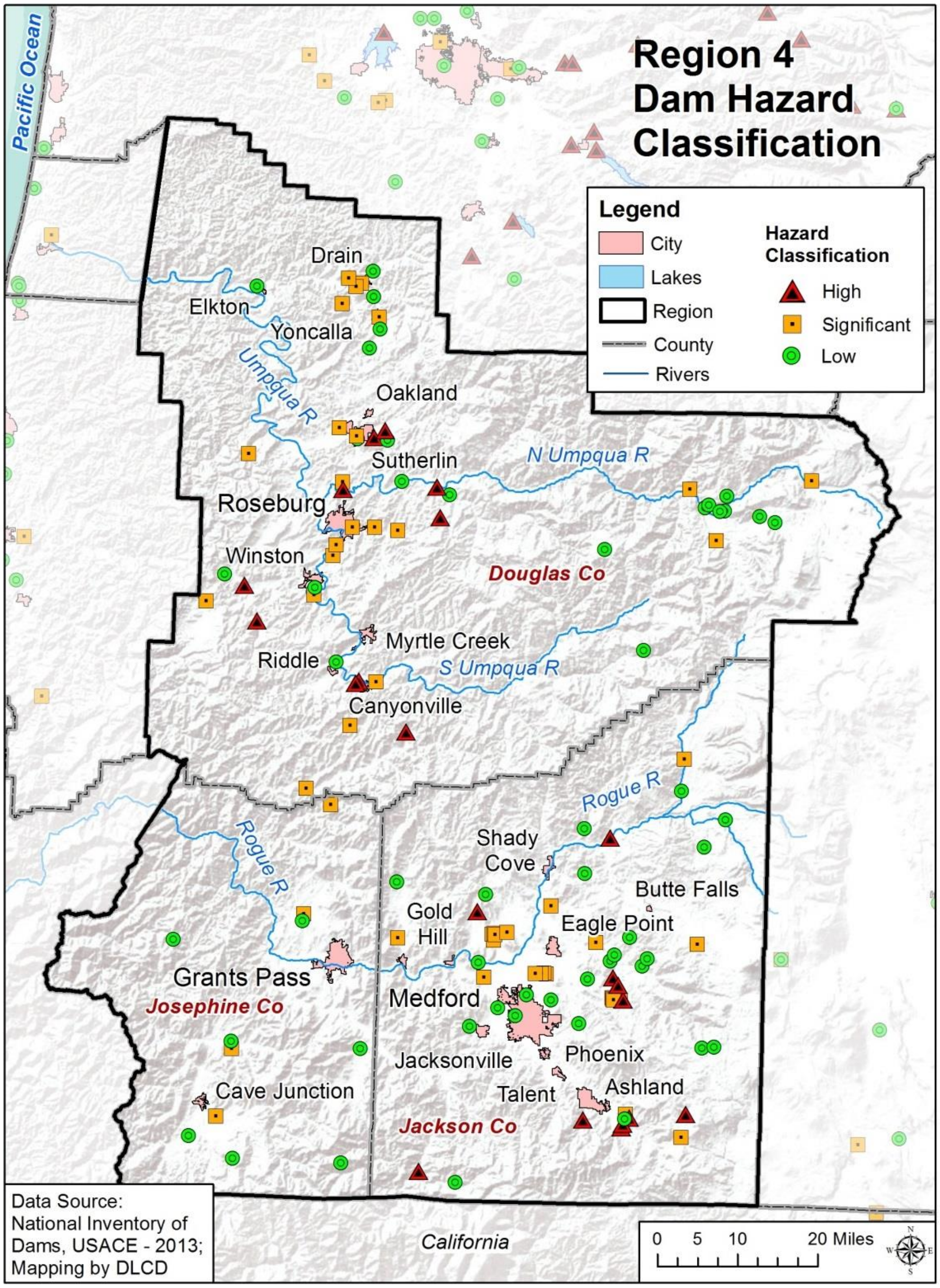
Minor dam failures can occur at any time. Most dam failures result in minor damage to structures and pose little or no risk to life safety. However, the potential for severe damage and fatalities does exist (major dam failures have occurred most recently near Hermiston, 2005, and Klamath Lake, 2006) (Association of Dam Safety Officials, n.d.). The Oregon Water Resources Department maintains an inventory of all large dams located in Oregon (using the National Inventory of Dams (NID) threat potential methodology). Table 2-257 lists the number of dams included in the inventory. The majority of dams in the region are located in Douglas and Jackson Counties. There are 28 High Threat Potential dams and 42 Significant Threat Potential dams in the region.

Table 2-257. Threat Potential of Dams in Region 4

	Threat Potential			
	High	Significant	Low	Total Dams
Region 4	28	42	113	183
Douglas	13	20	52	85
Jackson	14	19	42	75
Josephine	1	3	19	23

Source: Oregon Water Resources Department, Dam Inventory Query 2014

Figure 2-144. Region 4 Dam Hazard Classification

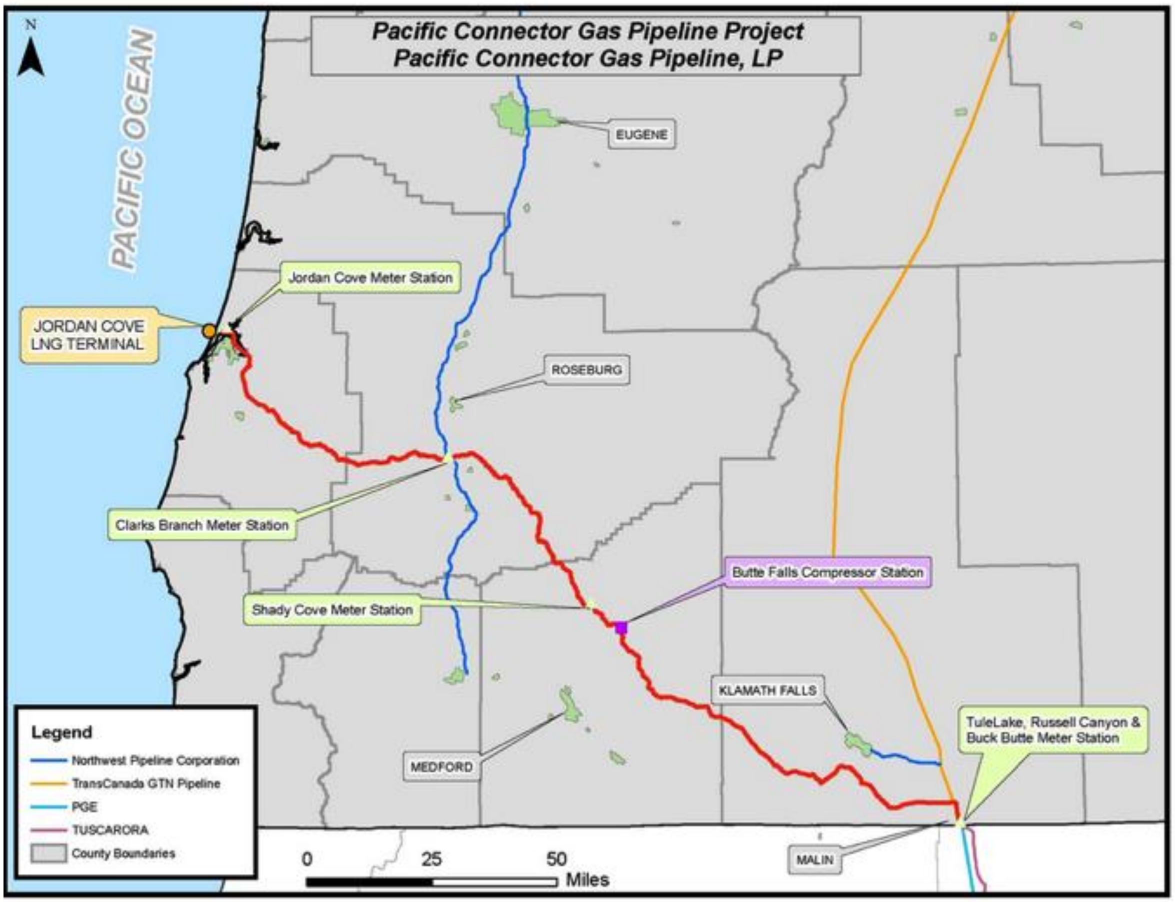


Source: National Inventory of Dams, USACE, 2013

Natural Gas

Although natural gas does not provide the most energy to the region, it does contribute a significant amount of energy to Pacific Power's portfolio. Liquefied natural gas (LNG) is transported via pipelines throughout the United States. Figure 2-145 shows existing LNG pipelines and the proposed Pacific Connector Gas Pipeline (in red) (Oregon Department of Environmental Quality, 2014). One pipeline, owned by the Northwest Pipeline Corporation, runs though Douglas and Josephine Counties. LNG pipelines, like other buried pipe infrastructure, are vulnerable to earthquakes and can cause danger to human life, safety, and environmental impacts in the case of a spill.

Figure 2-145. Liquefied Natural Gas Pipelines in Region 4



Source: Oregon Department of Environmental Quality, 2014

Utility Lifelines

Southwestern Oregon primarily receives oil and gas from Alaska by way of the Puget Sound through pipelines and tankers. The region is at the southern end of this pipeline network. Oil and gas are supplied by Northern California through a separate network. The electric, oil, and gas lifelines that run through the county are both municipally and privately owned (Loy et al., 1976). These utility lifelines may be vulnerable to severe, but infrequent natural hazards, such as earthquakes.

The network of electrical transmission lines running through Region 4 is operated by Pacific Power and Light and primarily facilitates local energy production and distribution (Loy et al., 1976). Most of the natural gas Oregon uses originates in Alberta, Canada. Avista Utilities owns the main natural gas transmission pipeline (Loy et al., 1976).

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio). Region 4 is part of the Southern Oregon Operational Area under The Oregon State Emergency Alert System Plan (Oregon Office of Emergency Management (2013), which also includes Coos, Curry, and Klamath Counties. There is a memorandum of understanding between these counties that facilitates the launching of emergency messages for counties by Jackson County. Counties in this area can launch emergency messages by contacting the Oregon Emergency Response System (OERS) which in turn creates emergency messages to communities statewide.

Beyond day-to-day operations, maintaining communication capabilities during disaster events and other emergency situations helps to keep citizens safe by keeping them informed of the situation's status, areas to avoid, and other procedural information. Additionally, responders depend on telecommunications infrastructure to be routed to sites where they are needed.

Television

Television serves as a major provider for local, regional, and national news and weather information and can play a vital role in emergency communications. The local primary stations identified as emergency messengers by the Oregon State Emergency Alert System Plan are:

- KOBI-TV Channel 5, Medford; and
- Channel 49, Grants Pass.

Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband service providers serve Region 4. Broadband technology including mobile wireless is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless, and mobile wireless. Internet service is becoming more readily available in the region with a greater number of providers and service types available within major communities and along major transportation corridors (I-5, US-199, etc.) (NTIA, n.d.). Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

Wireless providers sometimes offer free emergency mobile phones to those impacted by disasters, which can aid in communication when landlines and broadband service are unavailable.

Radio

Radio is readily available to those who live within Region 4 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Radio transmitters for the Southern Oregon Operational Area are (Oregon Office of Emergency Management, 2013):

- WWF-97, 162.475 MHZ, Ashland;
- WXL-85, 162.400 MHZ, Medford; and
- WXL-98, 162.550 MHZ, Roseburg.

Ham Radio

Amateur radio, or ham radio, is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). Region 4 is served by ARES District 5. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (Oregon Office of Emergency Management, n.d.). The official ham emergency station calls for Region 4 include (American Relay Radio League Oregon Chapter, www.arrloregon.org):

- Douglas County: K7AZW;
- Jackson County: K7VS; and
- Josephine County: none available at this time.

Water

Water infrastructure includes drinking water, stormwater, and wastewater systems. All of these systems possess some level of vulnerability to natural hazards that can have repercussions on human health, ecosystems, and industry.

Drinking Water

In Region 4 the majority of the municipal drinking water supply is obtained from surface water. In Jackson and Josephine Counties, the Rogue River provides municipal water supplies to most cities. The City of Cave Junction is an exception, obtaining water from the Illinois River. In Douglas County, most cities source their water from the Umpqua River and its tributaries.

Rural residents may get water from groundwater wells or surface water. Most rural residents in Douglas County use surface water sources for potable water. The majority of rural residents in Jackson and Josephine Counties use domestic wells outside of municipal boundaries. Areas with sedimentary and volcanic soils may be subject to high levels of arsenic, hydrogen sulfide, and fecal coliform bacteria, which can impact the safety of groundwater sources.

Surface sources for drinking water are vulnerable to pollutants caused by non-point sources and natural hazards. Non-point source pollution is a major threat to surface water quality, and may include stormwater runoff from roadways, agricultural operations, timber harvest, erosion, and sedimentation. Landslides, flood events, and earthquakes and resulting liquefaction can cause increased erosion and sedimentation in waterways. Acid mine drainage from the Formosa mine, a U.S. Environmental Protection Agency Superfund site, is another non-point source of pollution. Acid mine drainage threatens the health of Middle Creek in southern Douglas County, a tributary to the Umpqua River.

Underground water supplies and aging or outdated infrastructure — such as reservoirs, treatment facilities, and pump stations — can be severed during a seismic event. Rigid materials such as cast iron may snap under the pressure of liquefaction. More flexible materials such as polyvinyl chloride (PVC) and ductile iron may pull apart at joints under the same stresses. These types of infrastructure damages could result in a loss of water pressure in municipal water supply systems, limiting access to potable water. This can lead to unsanitary conditions that may threaten human health. Lack of water can also impact industry, such as the manufacturing sector. Moreover, if transportation infrastructure is impacted by a disaster event, repairs to water infrastructure will be delayed.

Stormwater and Wastewater

In urbanized areas severe precipitation events may cause flooding that leads to stormwater runoff. A non-point source of water pollution, stormwater runoff can adversely impact drinking water quality. It can also lead to environmental issues such as increasing surface water temperatures that can adversely affect habitat health. Furthermore, large volumes of fast-moving stormwater that enter surface waterways can cause erosion issues.

Stormwater can also impact water infrastructure. Leaves and other debris can be carried into storm drains and pipes, which can clog stormwater systems. In areas where stormwater systems are combined with wastewater systems (combined sewers), flooding events can lead to combined sewer overflows (CSOs). CSOs present a heightened health threat as sewage can flood urban areas and waterways. Underground stormwater and wastewater pipes are also vulnerable to damage by seismic events.

In Region 4, most local building codes and stormwater management plans emphasize use of centralized storm sewer systems to manage stormwater. Requirements for stormwater mitigation vary in Region 4. Low impact development (LID) mitigation strategies can alleviate or lighten the burden on a jurisdiction's storm sewer system by allowing water to percolate through soil onsite or detaining water so water enters the storm sewer system at lower volumes, at lower speeds, and at lower temperatures. While some jurisdictions in Region 4 refer to LID techniques in their stormwater management plans, Medford is the only city that requires LID stormwater mitigation strategies in its development code. Promoting and requiring decentralized LID stormwater management strategies could help reduce the burden of new development on storm sewer systems, and increase a community's resilience to many types of hazard events.

Infrastructure Trends and Issues

Physical infrastructure is critical for everyday operations and is essential following a disaster. Lack or poor condition of infrastructure can negatively affect a community's ability to cope with, respond to, and recover from a hazard event. Diversity, redundancy, and consistent maintenance of infrastructure systems help create system resiliency (Meadows, 2008).

Older and structurally unsound bridges in Region 4 compromise transportation systems. The effects of bridge and road failures on the economy and health of the Region's residents could be devastating. About 18% of the region's bridges owned by the state are distressed.

The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards. There are eight power-generating facilities in Southwest Oregon. Three are hydroelectric power facilities. The others are primarily biomass facilities. The major Bonneville Power Administration dams in the region are on the Applegate and Rogue Rivers. Of the state-owned dams in the region, 28 have High Threat Potential and 42 have Significant Threat Potential.

Buried natural gas transmission lines run through Douglas and Josephine Counties and are vulnerable to seismic activity.

Decentralization and redundancy in the region's telecommunication systems can help boost the area's ability to communicate before, during, and after a disaster event. It is important to note that broadband and mobile telephone services do not cover many rural areas of the region that are distant from major transportation corridors. This may present a communication challenge in the wake of a hazard event. Encouraging residents to keep AM/FM radios available for emergency situations could help increase the capacity for communicating important messages throughout the region.

Water systems in the region are particularly vulnerable to hazard events because they tend to be older, centralized, and lack system redundancies Drinking water is primarily sourced from surface water. The region is at risk in case of high levels of pollutants entering waterways through CSO's during high-water events. The implementation of decentralized low impact development (LID) stormwater systems can increase the region's capacity to better manage high-precipitation events. Medford is the only city that requires LID stormwater mitigation strategies in its development code.

Built Environment

Development Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's program is 19 land use goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards (Department of Land Conservation and Development, website: http://www.oregon.gov/http://www.oregon.gov/).

Settlement Patterns

The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people or an "urban cluster" of at least 2,500 people (but less than 50,000). Wheeler County does not meet either definition; therefore all of its population is considered rural even though the county has incorporated cities.

Between 2000 and 2010 urban populations in Region 4 have grown by about 14%; more than 4 times the percent growth in rural areas. Jackson and Josephine Counties are experiencing the most urban growth in people and housing. Growth in Douglas County is more evenly distributed between urban and rural areas. Unsurprisingly, populations tend to cluster around major road corridors and waterways. This holds true for the major cities of Ashland, Medford, Grants Pass and Roseburg.

Table 2-258. Urban and Rural Populations in Region 4

	Urban			Rural		
	2000	**2010**	**Percent Change**	**2000**	**2010**	**Percent Change**
Oregon	2,694,144	3,104,382	15.2%	727,255	726,692	-0.1%
Region 4	238,659	271,312	13.7%	118,735	122,274	3.0%
Douglas	58,411	63,332	8.4%	41,988	44,335	5.6%
Jackson	141,112	162,458	15.1%	40,157	40,748	1.5%
Josephine	39,136	45,522	16.3%	36,590	37,191	1.6%

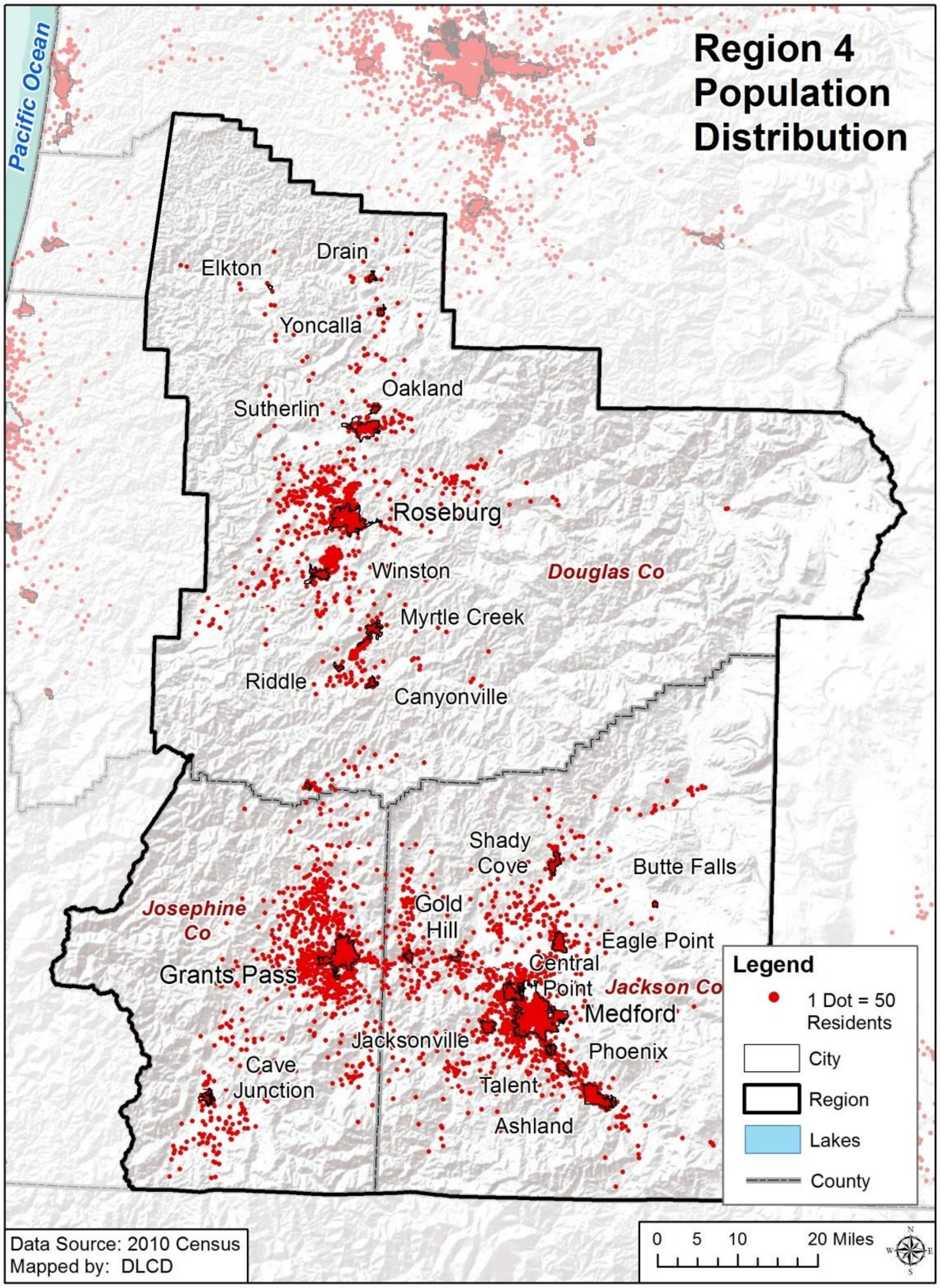
Source: U.S. Census Bureau. 2000 Decennial Census, Table P002 and 2010 Decennial Census, Table P2

Table 2-259. Urban and Rural Housing Units in Region 4

	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 4	101,546	121,709	19.9%	50,714	56,144	10.7%
Douglas	25,273	28,553	13.0%	18,011	20,362	13.1%
Jackson	59,255	72,470	22.3%	16,482	18,467	12.0%
Josephine	17,018	20,686	21.6%	16,221	17,315	6.7%

Source: U.S. Census Bureau. 2000 Decennial Census, Table H002 and 2010 Decennial Census, Table H2

Figure 2-146. Region 4 Population Distribution



Source: U.S. Census, 2012

Land Use and Development Patterns (Lettman, 2011)

Land use for Region 4 is dominated by forestry (78%), with the majority of land owned by the Federal Government. Agricultural activities (15%) are the second major land use, for primarily field crops, orchard and livestock.

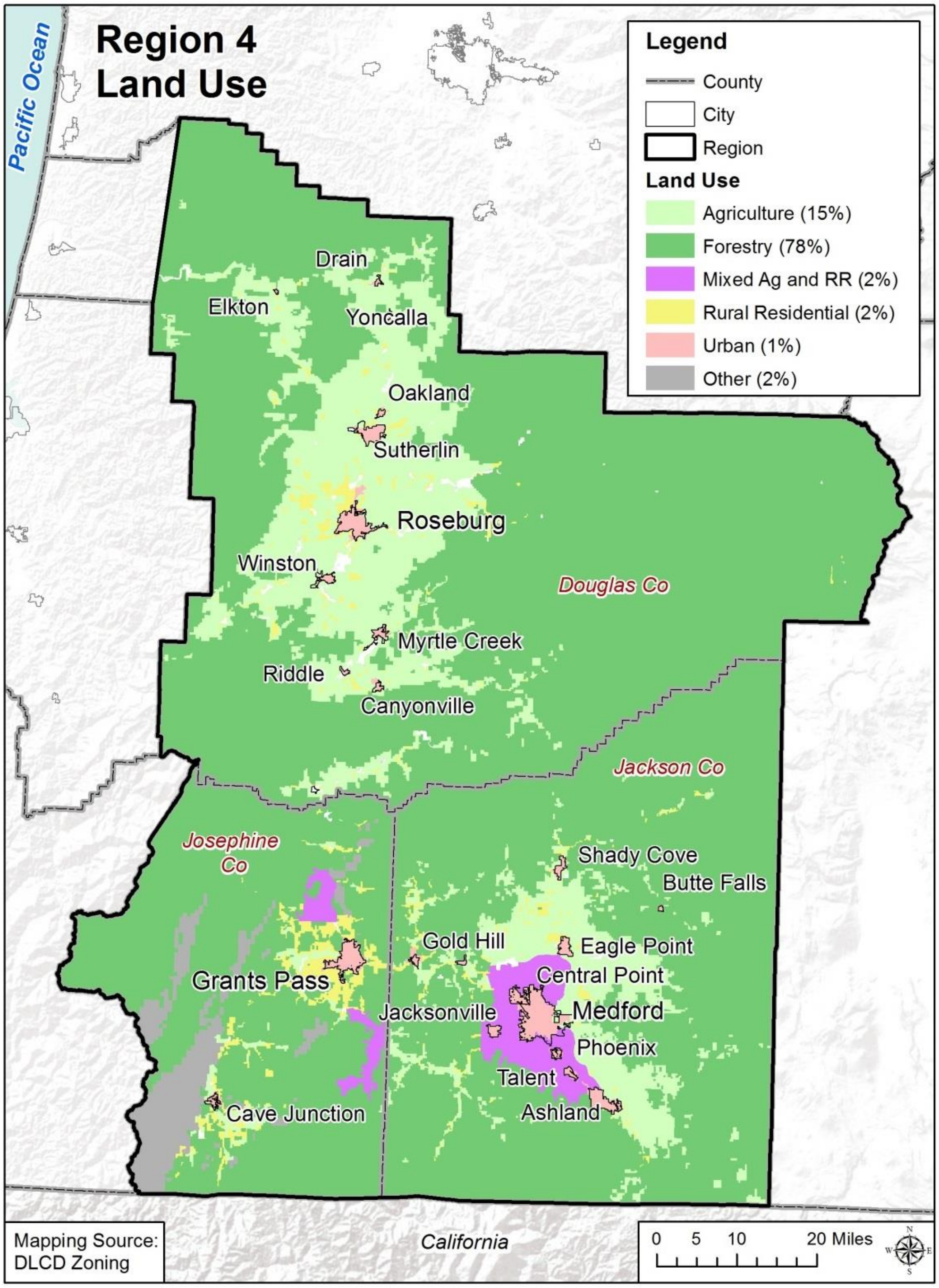
Under Oregon's land use system, each urban area is required to define an Urban Growth Boundary (UGB). Housing tracts, shopping malls, and other kinds of urban development are not allowed to sprawl past that boundary, while agricultural lands and open space outside a UGB are preserved. In Region 4, Roseburg has a significant area to the north along I-5 that can accommodate growth. Grants Pass has room to expand in several directions. Other communities, such as Medford, Central Point, and Jacksonville have little land reserved for urban expansion.

During the 25-year period between 1984 and 2009, Josephine County had a high rate of conversion of private land to developed uses. 14% of the county's 237,000 acres of private land in forest and agricultural uses was converted to low-density residential or urban uses — most of this change occurred between 1974 and 1984. However, the rates of conversion of private land in resource land uses to low-density residential or urban uses declined in the region and almost stopped between 2000 and 2009. Strong farm and forest land protections played a role in this decline. State statutes and rules establish standards for dwellings, uses and land divisions in rural areas to limit incompatible development and land fragmentation and to ensure that newly created farm and forest parcels remain commercially viable for farm and forest use (Lettman, 2011).

These changing land use development patterns and protections contribute to a slowing of the growth in the region's wildland-urban interface and other developed areas. While this does not necessarily lessen the wildfire risk in Region 4, it does provide the communities an opportunity to use tools such as the Josephine and Jackson County Integrated Fire Plans to reach vulnerable communities with wildfire risk assessment, outreach, and education.

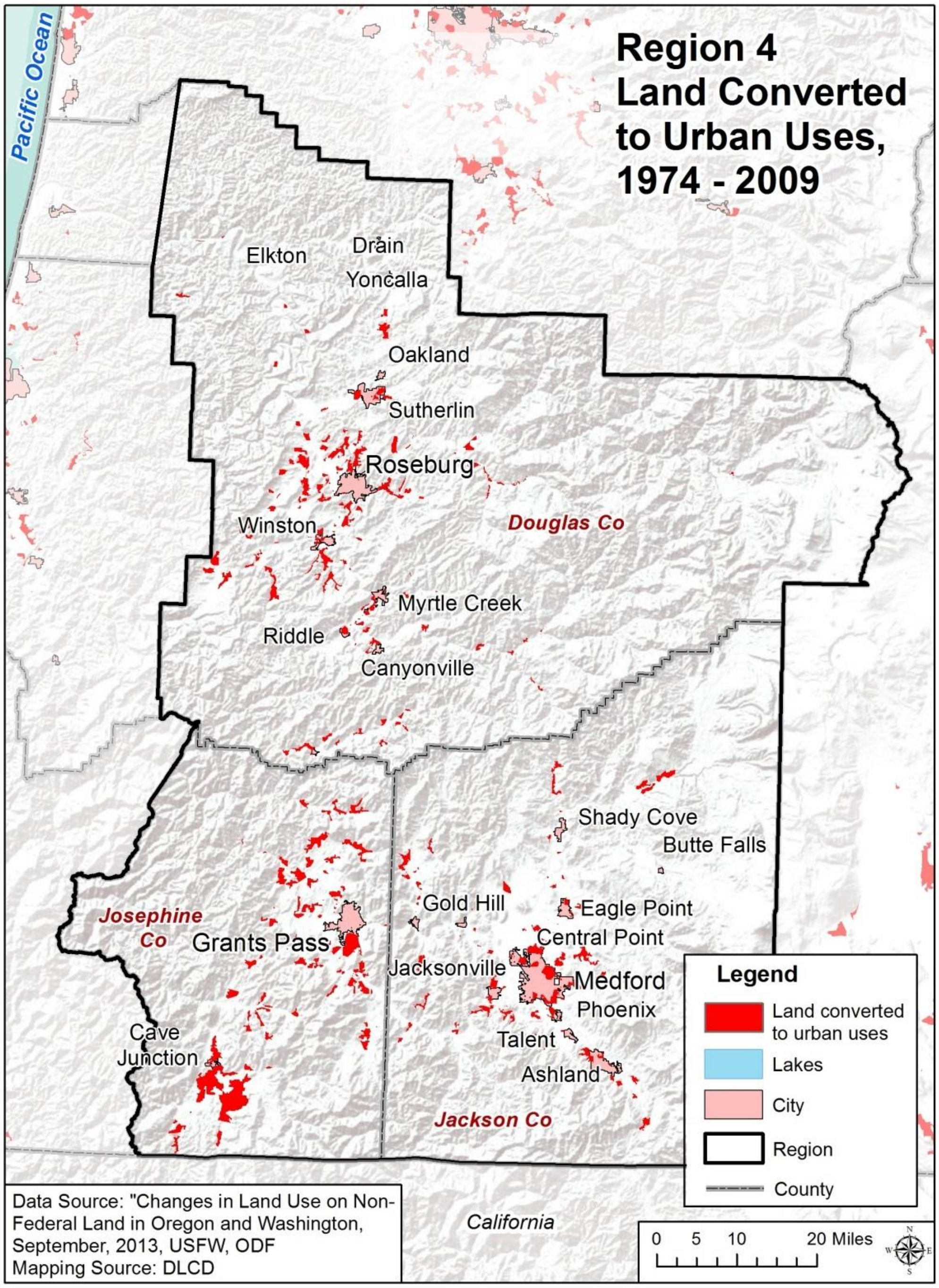
Regional problem solving activities are also addressing land use and development issues and how to guide growth. The "Greater Bear Creek Valley Regional Problem Solving Project" involves Jackson County and six cities in the Rogue Valley in guiding urban growth and development, while preserving priority farmland and floodplain.

Figure 2-147. Region 4 Land Use



Source: Department of Land Conservation and Development

Figure 2-148. Region 4 Land Converted to Urban Uses, 1974-2009



Source: Land Use Change on Non-Federal Land in Oregon and Washington, September, 2013, USFS, ODF

Housing

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. The majority of the region's housing stock is single-family homes. A significant portion of Douglas and Josephine Counties' housing stock is mobile homes. In natural hazard events such as earthquakes and floods, mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of OES, 1997).

Table 2-260. Housing Profile for Region 4, 2012

	Total Housing Units	Single Family		Multi-Family		Mobile Homes	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	1,140,319	68.1%	460,852	27.5%	139,768	8.4%
Region 4	177,544	124,002	69.8%	25,846	14.6%	26,540	14.9%
Douglas	48,775	33,820	69.3%	5,613	11.5%	8,820	18.1%
Jackson	90,814	63,378	69.8%	15,730	17.3%	11,469	12.6%
Josephine	37,955	26,804	70.6%	4,503	11.9%	6,251	16.5%

Note: The percentages listed above do not reflect the number of structures that are built within special flood hazard areas or that are at risk of seismic damage.

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, B25024

Aside from location and type of housing, the year structures were built (**Table 2-261**) has implications. Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for the Cascadia earthquake fault (Judson, 2012). Therefore, homes built before 1994 are more vulnerable to seismic events.

Also in the 1970s, FEMA began assisting communities with floodplain mapping as part of administering 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. Regionally 32% of the housing stock was built prior to 1970, before the implementation of floodplain management ordinances. More than one third of the region's housing stock was built after 1990 and the codification of seismic building standards. A larger share of housing in Jackson and Josephine Counties was built after 1990 than does Douglas County.

Table 2-261. Age of Housing Stock in Region 4, 2012

	Total Housing Units	Pre 1970		1970 to 1989		1990 or later	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	609,062	36.4%	518,569	31.0%	545,962	32.6%
Region 4	177,544	56,763	32.0%	59,336	33.4%	61,445	34.6%
Douglas	48,775	18,489	37.9%	16,749	34.3%	13,537	27.8%
Jackson	90,814	27,815	30.6%	28,322	31.2%	34,677	38.2%
Josephine	37,955	10,459	27.6%	14,265	37.6%	13,231	34.9%

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, B25034

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. **Table 2-262** shows the initial and current FIRM effective dates for Region 4 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, **Flood** section.

Table 2-262. Community Flood Map History in Region 4

	Initial FIRM	Current FIRM
Douglas County	December 15, 1978	February 17, 2010
Canyonville	November 1, 1978	February 17, 2010
Drain	August 1, 1979	February 17, 2010
Elkton	September 5, 1979	February 17, 2010
Glendale	September 29, 1978	February 17, 2010
Myrtle Creek	February 15, 1978	February 17, 2010
Oakland	June 19, 1985	February 17, 2010
Reedsport	April 3, 1984	February 17, 2010
Riddle	August 1, 1979	February 17, 2010
Roseburg	June 1, 1977	February 17, 2010
Sutherlin	February 17, 2010	February 17, 2010 (M)
Winston	December 31, 1974	February 17, 2010
Yoncalla	February 17, 2010	February 17, 2010 (M)
Jackson County	April 1, 1982	May 3, 2011
Ashland	June 1, 1981	May 3, 2011
Butte Falls	June 30, 1976	June 30, 1976 (M)
Central Point	September 30, 1980	May 3, 2011
Eagle Point	September 30, 1980	May 3, 2011
Gold Hill	September 17, 1980	May 3, 2011
Jacksonville	December 4, 1979	May 3, 2011
Medford	April 15, 1981	May 3, 2011
Phoenix	May 3, 1982	May 3, 2011
Rogue River	January 2, 1980	May 3, 2011
Shady Cove	September 30, 1980	May 3, 2011
Talent	February 1, 1980	May 3, 2011
Josephine County	June 1, 1982	December 3, 2009
Cave Junction	June 1, 1982	December 3, 2009
Grants Pass	April 15, 1981	December 3, 2009

(M) = no elevation determined; all Zone A, C, and X.

Source: Federal Emergency Management Agency, Community Status Book Report

State-Owned/Leased and Critical/Essential Facilities

In 2014 the Department of Geology and Mineral Industries updated the 2012 Oregon NHMP inventory and analysis of state-owned/leased facilities and critical/essential facilities. Results from this report relative to Region 4 can be found in **Table 2-263**. The region contains 2.2% of the total value of state-owned/leased critical/essential facilities.

Table 2-263. Value of State-Owned/Leased Critical and Essential Facilities in Region 4

	Total Property Value (State Facilities)	Percent State Total
Oregon	$7,339,087,023	100%
Region 4	$164,409,632	2.2%
Douglas	$66,660,507	0.9%
Jackson	$60,819,133	0.8%
Josephine	$36,929,992	0.5%

Source: The Department of Geology and Mineral Industries

Built Environment Trends and Issues

The trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. Region 3 is largely urban with development focused around the major cities along I-5 including Ashland, Medford, Grants Pass and Roseburg. Douglas County's urban population is growing at about half the state's rate. The region's housing stock is largely single-family homes. The region has about twice the percentage of mobile homes than the state, with Douglas County having the greatest share of mobile units and Jackson County having the greatest number of units overall. Over 38% of homes in Jackson County were built after 1990 to current seismic building standards. All of the region's FIRMs have been modernized or updated.

2.3.4.3 Hazards and Vulnerability

Droughts

Characteristics

In Region 4, drought conditions can affect commerce, agriculture, fisheries, and overall quality of life. All three counties in Region 4 experienced drought conditions in 1992, 1994, 2001 and 2002. The Governor has not issued a formal drought declaration in Region 4 since 2002. In August 2013, the U.S. Department of Agriculture declared Jackson and Josephine Counties, along with Klamath and Lake Counties in Region 6, as federal primary natural disaster areas due to damages and losses caused by recent drought.

The lack of snow in the basin forced the Mount Ashland Ski Resort to close the 2013-14 season on March 13, 2014. For the first time in its 50-year history, Mount Ashland did not open for skiing or snowboarding (http://www.mtashland.com/News.asp?NewsID=400). On March 19, 2014, the Jackson County Commission declared a local drought disaster and had plans to ask the state for assistance. USDA reports showed snowpack in the Rogue Basin at 31% of average. The NRCS reported that without significant spring rainfall, water users in the Rogue and Umpqua basins could anticipate a water shortage in summer 2014. In early May, the Governor issued a drought emergency declaration for Jackson County. Josephine County was declared a few weeks later. Communities, such as Ashland, did not plant any new trees or shrubs to help offset drought-related concerns, and also decided to move forward on a new water pipeline to bring Medford water to Ashland for potential emergency use during the late summer months.

Historic Drought Events

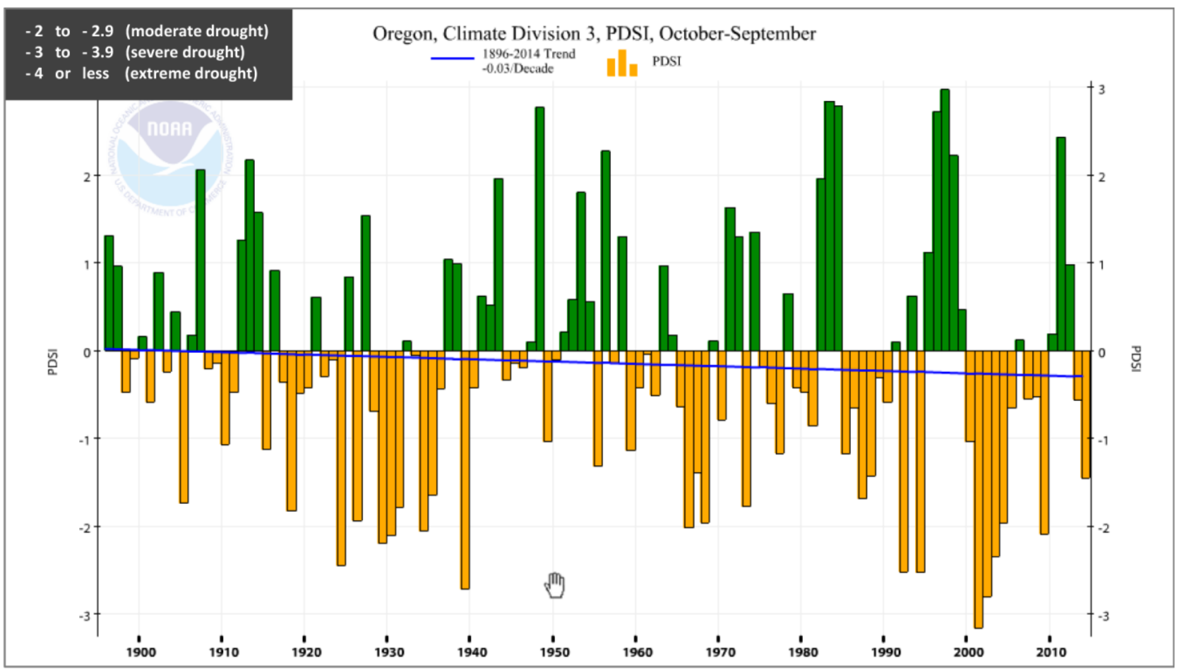
Table 2-264. Historic Droughts in Region 4

Date	Location	Description
1939	statewide	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country; water year 1939 was one of the more significant drought years in Region 4 during that period
1976-77	SW Oregon eastern Oregon	despite an insignificant PDSI value, the 1976-77 drought affected agriculture in Region 4; the water year was significantly drier than normal, but temperatures were near normal; the 1976-77 drought is included in this table because of the very large water year precipitation departures
1992	statewide	1992 fell toward the end of a generally dry period, which caused problems throughout the state
1994	SW Oregon eastern Oregon	In 1994, Governor's drought declaration covered 11 counties located within regions 4, 5, 6, 7, and 8
2001	SW Oregon eastern Oregon	Governor-declared drought in effect for all counties in Region 4 during 2001 as well as most counties in Regions 5, 6, 7, and 8
2002	coast; SW Oregon eastern Oregon	2001 Drought Declaration still in effect; five additional counties declared
2014	Regions 4, 6, 7, 8	Governor has declared drought in 10 counties in Oregon, including Region 4's Josephine and Jackson Counties

Sources: Taylor and Hatton (1999); Oregon Secretary of State's Archives Division. 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.

Hazard Region 4, which encompasses Jackson, Josephine, and Douglas Counties, is prone to frequent droughts. Historic drought information can be obtained from the National Climatic Data Center, which provides climate data showing wet and dry conditions, using the Palmer Drought Severity Index (PDSI) that dates back to 1895. The Palmer Index is not the best indicator of water availability for Oregon because it does not account for snow or ice (delayed runoff), however, it has the advantage of providing the most complete, long-term record. During this record, the index shows that the southwestern valley experienced an extreme drought on one occasion (2001) and moderate drought on several occasions in the 1920s and 1930s, the early 1990s, the early 2000s and again in 2009 (**Figure 2-149**). Water Year 2014 has been a very dry for this area as well, with reservoir levels well below normal. The snowpack in this region peaked significantly below normal and set many record lows for snowpack levels at long term monitoring sites.

Figure 2-149. Palmer Drought Severity Index for Region 4



Source: National Climatic Data Center, http://www.ncdc.noaa.gov/cag/

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the probability that Region 4 will experience drought is shown in **Table 2-265**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-265. Local Probability Assessment of Drought in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	—	M	—

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

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

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

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to drought is shown in **Table 2-266**. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-266. Local Vulnerability Assessment of Drought in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	—	M	—

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Oregon has not undertaken a comprehensive statewide analysis to identify which communities are most vulnerable to drought. However, based on a review of Governor drought declarations since 1992, Region 4 is vulnerable to drought-related impacts. All three counties — Douglas, Josephine, and Jackson — have each received 4 drought declarations since 1992. These occurred in 1992, 1994, 2001, and 2002.

Earthquakes

Characteristics

The geographic position of this region makes it susceptible to earthquakes from four sources: (a) the off-shore Cascadia Fault Zone, (b) deep intra-plate events within the subducting Juan de Fuca plate, (c) shallow crustal events within the North America Plate, and (d) earthquakes associated with renewed volcanic activity.

This part of Oregon has experienced no historic earthquakes of any significance that were centered in the region. However, the region has been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered outside the area. All considered, there is good reason to believe that the most devastating future earthquakes would probably originate along shallow crustal faults in the region and along the Cascadia Fault Zone. The magnitude 7.3 deep-seated intraplate event centered near Brookings in 1873 was probably felt throughout Southwest Oregon. There have been no known intraplate events in the region's history or pre-history. The 1993 Klamath Falls earthquake was felt in the region, but no damage was reported.

Earthquakes produced through volcanic activity could possibly reach magnitudes of 5.5. The 1980 Mount St. Helens eruption was preceded by a magnitude 5.1 earthquake. Despite the fact that Cascade volcanoes are some distance away from the major population centers in Region 2, earthquake shaking and secondary earthquake-related hazards such as lahars could cause major damage to these centers.

Historic Earthquake Events

Table 2-267. Significant Earthquakes Affecting Region 4

Date	Location	Magnitude (M)	Remarks
Approximate Years: 1400 BCE*, 1050 BCE, 600 BCE, 400, 750, 900	offshore, Cascadia Subduction Zone	probably 8-9	based on studies of earthquake and tsunami at Willapa Bay, Washington; these are the mid-points of the age ranges for these six events
Jan. 1700	offshore, Cascadia Subduction Zone	approximately 9.0	generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Nov. 1873	Brookings area	7.3	chimneys fell at Port Orford, Grants Pass, and Jacksonville; no aftershocks; origin probably Gorda block of the Juan de Fuca plate; intraplate event
Apr. 14, 1920	Fort Klamath, Oregon	5.0	three shocks felt at Fort Klamath; center: probably in the vicinity of Crater Lake
Mar. 1993	Scotts Mills	5.6	$28 million in damage; damage to homes, schools, businesses, state buildings (Salem); crustal event (FEMA-985-DR-Oregon)
Sep. 1993	Klamath Falls	5.9 to 6.0	two earthquakes causing two deaths and extensive damage; $7.5 million in damage to homes, commercial, and government buildings; crustal event (FEMA-1004-DR-Oregon)

*BCE: Before Common Era.
Source: Wong and Bolt (1995)

Probability and Vulnerability

As stated in the **State Risk Assessment**, section, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 4 will experience earthquakes is shown in **Table 2-268**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-268. Local Probability Assessment of Earthquake in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	M	M	M

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

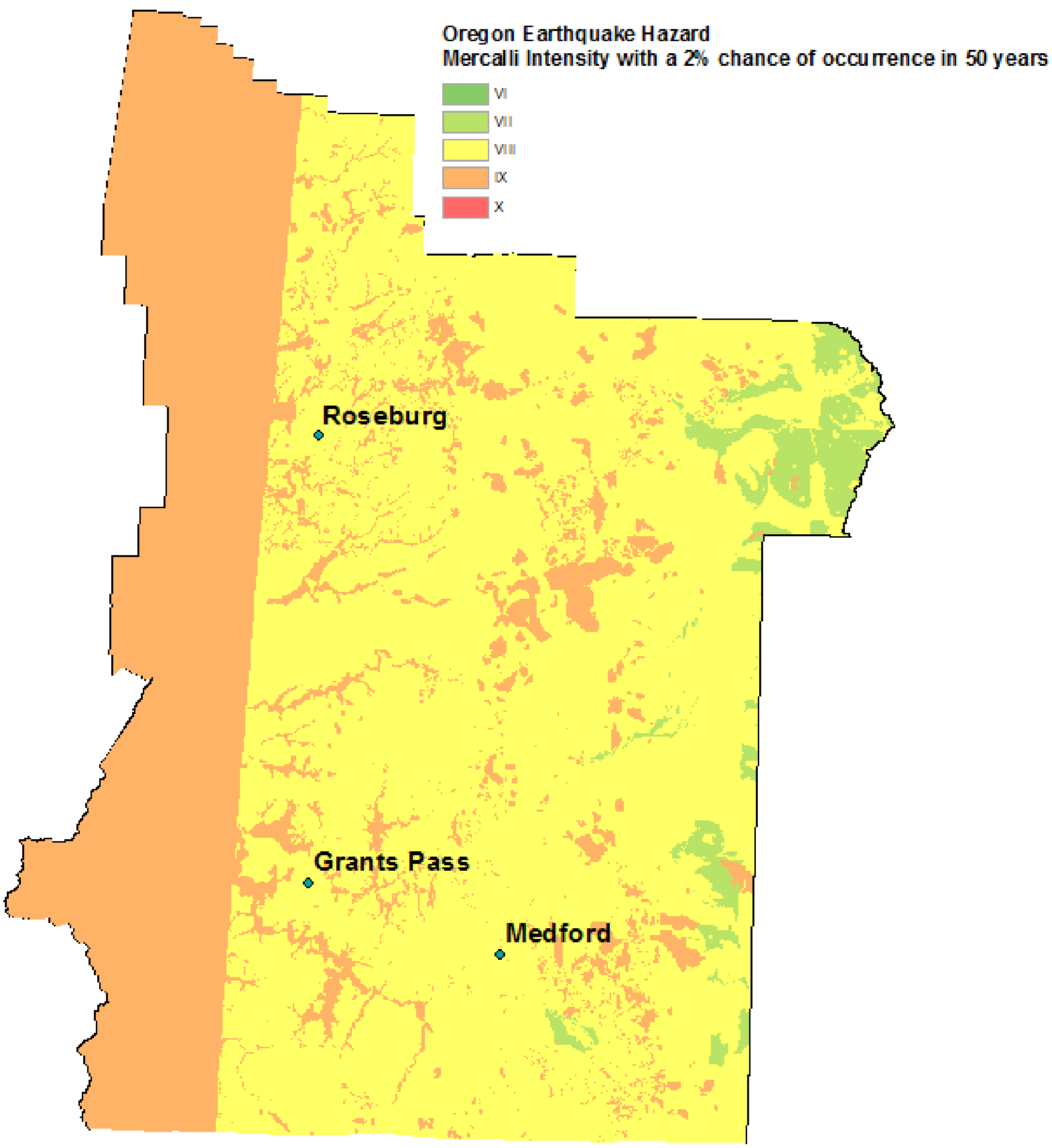
State Assessment

The probability of damaging earthquakes varies widely across the state. In Region 4 the hazard is dominated by Cascadia subduction earthquakes originating from a single fault with a well-understood recurrence history.

The probabilistic earthquake hazard for Region 4 is depicted in **Figure 2-150**. This map shows the expected level of earthquake damage that has a 2% chance of occurring in the next 50 years. The map is based on the 2008 USGS National Seismic Hazard Map and has been adjusted to account for the effects of soils following the methods of Madin and Burns (2013). In this case, the strength of shaking calculated as peak ground acceleration and peak ground velocity is expressed as Mercalli intensity, which describes the effects of shaking on people and structures. This map incorporates all that is known about the probabilities of earthquake on all Oregon faults, including the Cascadia Subduction Zone (CSZ).

For Oregon west of the crest of the Cascades, the CSZ is responsible for most of the hazard shown in **Figure 2-150**. The paleoseismic record includes 18 magnitude 8.8–9.1 megathrust earthquakes in the last 10,000 years that affected the entire subduction zone. The return period for the largest earthquakes is 530 years, and the probability of the next such event occurring in the next 50 years ranges from 7 to 12%. An additional 10–20 smaller, magnitude 8.3–8.5, earthquakes affected only the southern half of Oregon and northern California. The average return period for these is about 240 years, and the probability of a small or large subduction earthquake occurring in the next 50 years is 37-43%

Figure 2-150. Probabilistic Earthquake Hazard in Region 4



Color zones show the maximum level of earthquake shaking and damage (Mercalli Intensity Scale) expected with a 2% chance of occurrence in the next 50 years. A simplified explanation of the Mercalli levels is:

VI	Felt by all, weak buildings cracked;
VII	Chimneys break, weak buildings damaged, better buildings cracked;
VIII	Partial collapse of weak buildings, unsecured wood frame houses move;
IX	Collapse and severe damage to weak buildings, damage to wood-frame structures; and
X	Poorly built structures destroyed, heavy damage in well-built structures.

Source: Madin and Burns (2013)

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to earthquakes is shown in **Table 2-269**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-269. Local Vulnerability Assessment of Earthquake in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	M	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Region 4 is especially vulnerable to earthquake hazards because much of the area is susceptible to earthquake-induced landslides, liquefaction, or strong ground shaking. Based on DOGAMI's projected loss estimates to either a CSZ event or to combined crustal events using a 500-year model, all three counties in Region 4 are among the top 15 counties in the state projected to experience the greatest losses and damages.

In 2007, DOGAMI (Lewis, 2007) 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 a total of 3,349 buildings, giving each 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 (Lewis, 2007). 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 prioritize buildings for further study. **Table 2-270** shows the number of buildings surveyed in each county with their respective rankings.

Table 2-270. Building Collapse Potential in Region 4

Region 4 Counties	Level of Collapse Potential			
	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Douglas*	74	45	40	10
Jackson	139	13	87	22
Josephine	37	15	16	1

*Does not include the Douglas County coastal communities of Gardiner, Reedsport, and Winchester Bay.

Source: Lewis (2007)

The Oregon Department of Geology and Mineral Industries (DOGAMI) has also developed two earthquake loss models for Oregon based on the two most likely sources of seismic events: (a) a Cascadia Subduction Zone (CSZ) 8.5 event, and (b) combined crustal events (using a 500-year

Model). Loss and damage estimates based on these models are founds in Table 2-271 and Table 2-272. For more information on these models, see the State Risk Assessment section.

Table 2-271. Projected Dollar Losses in Region 4, Based on an M8.5 Subduction Event and a 500-Year Model

Region 4 Counties	Economic Base Loss in Thousands (1999)	Greatest Absolute Loss in Thousands (1999) From an 8.5 CSZ Event	Greatest Absolute Loss in Thousands (1999) from a 500-Year (Crustal) Event
Douglas	$4,631,000	$275,000	$546,000
Jackson	$7,829,000	$538,000	$1,191,000
Josephine	$3,240,000	$593,000	$848,000

Source: Wang and Clark (1999)

Table 2-272. Estimated Damages and Losses in Region 4 Associated with Two Earthquake Models

	M8.5 CSZ Event			500-Year Model[1]		
Damage/Loss Type	**Douglas**	**Jackson**	**Josephine**	**Douglas**	**Jackson**	**Josephine**
Injuries	151	428	418	294	930	585
Deaths	2	8	7	4	18	11
Displaced households	255	650	573	534	1,458	872
Economic losses for buildings[2]	$275 m	$538 m	$593 m	$546 m	$1.2 b	$847 m
Operational the “day after” the event[3]:						
Fire stations	66%	75%	22%	N/A	N/A	N/A
Police stations	57%	62%	45%	N/A	N/A	N/A
Schools	44%	70%	34%	N/A	N/A	N/A
Bridges	74%	84%	73%	N/A	N/A	N/A
Economic losses to:						
Highways	$43 m	$10 m	$16 m	$69 m	$34 m	$29 m
Airports	$5 m	$2 m	$5 m	$9 m	$8 m	$10 m
Communications	$7 m	$2 m	$4 m	$12 m	$9 m	$8 m
Debris generated (thousands of tons)	222	434	476	411	889	614

Notes:

[1]Every part of Oregon is subject to earthquakes. The 500-year model is an attempt to quantify the risk across the state. The estimate does not represent a single earthquake. Instead, the 500-year model includes 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. More and higher magnitude earthquakes than used in this model may occur (DOGAMI, 1999).

[2]There are numerous unreinforced masonry structures (URMs) in Oregon, the currently available default building data does not include any URMs. Thus, the reported damage and loss estimates may seriously under-represent the actual threat” (Wang, 1998, p. 5)

[3]Because the 500-year model includes several earthquakes, the number of facilities operational the “day after” cannot be calculated.

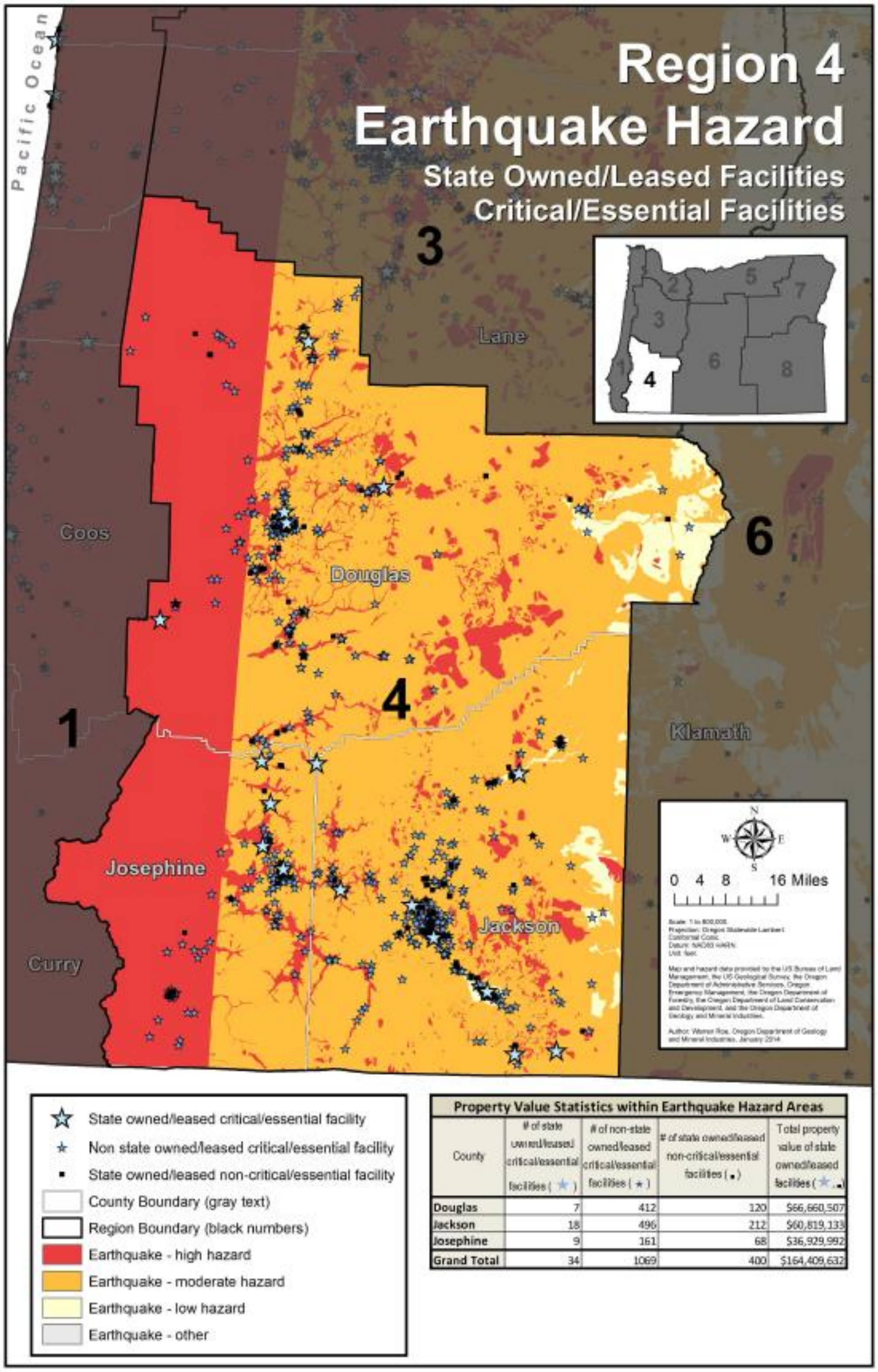
Source: Wang and Clark (1999)

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information

Of 5,693 state facilities evaluated, 434 totaling $164.4 million worth of property fall into an earthquake hazard zone in Region 4 (**Figure 2-151**). Among the 1,141 critical or essential state facilities, 34 are in an earthquake hazard zone in Region 4. Additionally, 1,069 non-state-owned/leased critical or essential facilities in Region 4 are located in an earthquake hazard zone.

Figure 2-151. State-Owned/Leased Facilities and Critical/Essential Facilities in an Earthquake Zone in Region 4



Property Value Statistics within Earthquake Hazard Areas

County	# of state owned/leased critical/essential facilities	# of non-state owned/leased critical/essential facilities	# of state owned/leased non-critical/essential facilities	Total property value of state owned/leased facilities
Douglas	7	412	120	$66,660,507
Jackson	18	496	212	$60,819,133
Josephine	9	161	68	$36,929,992
Grand Total	34	1069	400	$164,409,632

Source: DOGAMI

SEISMIC LIFELINES

"Seismic lifelines" are the state highways ODOT has identified as most able to serve response and rescue operations, reaching the most people and best supporting economic recovery. The process, methodology, and criteria used to identify them are described in **Section 2.2.2.6, Seismic Transportation Lifeline Vulnerabilities**, and the full report can be accessed at **Appendix 9.1.13**, *Statewide Loss Estimates: Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification* (OSLR). According to that report, seismic lifelines in Region 4 have the following vulnerabilities.

The following geographic zones identified in the OSLR are located within Region 4:

- *South I-5 Geographic Zone:* Region 4 is primarily in this geographic zone where the only recommended seismic lifeline is I-5 from Eugene to the California border. The entire area is likely to experience sustained ground shaking, with many roadways in areas subject to landslide and rockfall or liquefaction. All of I-5 in this zone was designated a Tier 1 route (highest priority roadway) due to its importance in the region and the lack of alternate corridors.
- *Cascades Geographic Zone:* Region 4 also includes the southerly portion of the Cascades Geographic Zone. The only seismic lifeline in this area is the Tier 2 route (second highest priority roadway) on OR-140 from Medford to US-97 in Klamath County, the southernmost route that can also serve as a connection from Medford to the Klamath Falls area in a seismic event. OR-140 is a mountain road that has risks related to dam failure, landslide, and rockfall and also runs through some high-water-table areas.
- *Coastal Geographic Zone:* Region 4 includes a Tier 3 lifeline (third highest priority) in the Coastal Zone: US-199 from I-5 to the Oregon-California border, connecting with US-101 near Crescent City, California. US-199 has a high risk of rockfall approaching its western end and also runs closely along a riverbed so may be vulnerable to liquefaction damage.

REGIONAL IMPACT. Routes in Region 4 are vulnerable to ground shaking, landslides, rockfall, and liquefaction.

- Ground Shaking: In Region 4 ground shaking will be the most significant vulnerability in populated areas. Unreinforced structures, roadbeds, and bridges will be damaged to varying extents from either a CSZ or Klamath Falls event.
- Landslides and Rockfall: Many roadways in the foothills within and around the valley include landslide prone features. A major seismic event will increase landslide and rockfall activities and may reactivate ancient slides that are currently inactive.
- Liquefaction: Structures in wetland, alluvial and other saturated areas, including the many Umpqua and Rogue River crossings, may be subject to liquefaction damage; the total area of such impacts will vary with the extent of saturated soils at the time of the event.

REGIONAL LOSS ESTIMATES. Economic losses caused by a CSZ event were not calculated for the specific zones of study or for specific highway facilities. The economic loss assessment statewide considered only the losses directly due to highway closures, so for example, it does not include productivity losses due to business site damage. The highway-related losses include disconnection from supplies and replacement inventory and the loss of tourists and other customers who must travel to do business with affected businesses.

Most Vulnerable Jurisdictions. Inland Douglas, Jackson, and Josephine Counties are generally equally vulnerable to ground shaking from a CSZ event. A Klamath Falls event has the potential to affect Ashland and Jackson County more that it would Josephine or Douglas County. All three counties have steep rural areas and to some extent steep developed areas that may experience landslides. All three have some transportation facilities along river beds or river crossings that may be vulnerable to liquefaction. The biggest risk is from a CSZ event with an epicenter off the southern Oregon coast.

Floods

Characteristics

A number of large floods have been recorded in Southwest Oregon, many of which were very destructive. Recurrence is virtually assured, since some areas at risk are rapidly urbanizing. This region has the distinction of having two major rivers – the Umpqua and Rogue Rivers – that have their origins in the Cascade Mountains and continue to flow through the Coast Range to the Pacific Ocean. Their headwaters receive an abundance of mountain snow. At lower elevations they may receive runoff from intense Pacific storms, which are not uncommon in western Oregon. A combination of rapidly melting snow and intense rain can produce disastrous flood conditions. **Table 2-273** lists some significant floods that affected southwest Oregon communities. **Table 2-274** includes tributary streams that also have produced disastrous floods.

The physical beauty of the area has attracted a large number of people to various stream valleys, where they are placed at risk despite National Flood Insurance Program (NFIP) requirements. This is somewhat offset by Oregon's land use program, which generally prohibits the subdivision of farm and forestland for residential purposes.

Historic Flood Events

Table 2-273. Significant Historic Flood Events Affecting Region 4

Date	Location	Characteristics	Type of Flood
Mar. 1931	western Oregon	wet, mild weather; bridges and homes destroyed	rain on snow
Oct. 1950	southwest Oregon	severe flooding in Region 4; six fatalities; bridges and roads destroyed	rain on snow
Jan. 1962	western Oregon	heavy rain (3-4 inches in Rogue Valley); 84 people evacuated; great loss of farmland	rain on snow
Dec. 1964	entire state	infamous 1964 flood that has become an Oregon benchmark; record flows on Rogue and Umpqua Rivers	rain on snow
Jan. 1974	western Oregon	series of storms with mild temperatures; large snowmelt with rapid runoff	rain on snow
Jan. 1986	entire state	significant flooding in western Oregon attributable to warm, intense rain	snow melt
Jan. 1990	western Oregon	significant flooding in western Oregon	rain on snow
Nov. 1996	entire state	tropical air mass; intense rain; landslides; power outages (FEMA-1149-DR-Oregon)	rain on snow
Dec. 1996	entire state	mild weather continues; severe flooding in Ashland; FEMA declaration (FEMA-1160-DR-Oregon)	rain on snow
Dec. 2005	Douglas, Jackson and Josephine Counties	$2,840,000; damage estimate includes areas outside of Region 4	
June 2006	Jackson	heavy rain brought flash flooding to Jacksonville, but no reported damages	riverine
Aug. 2007	Jackson	heavy rains caused flash flooding near Ashland, no major estimated damages	riverine
Nov. 2012	Jackson	heavy rains resulted in at least 4 NFIP losses in the area around Central Point	riverine
Jan. 2012	Douglas	heavy rains resulted in at least two NFIP losses in the Roseburg areas	riverine

Source: Taylor and Hatton (1999); Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org; 2014 BureauNet; National Climatic Data Center, Storm Events, available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvnt~Storms

Table 2-274. Principal Flood Sources by County in Region 4

Douglas (Non-Coastal)	Jackson	Josephine
North and South Umpqua Rivers and tributaries	Rogue River and tributaries	Rogue River and tributaries
Tributaries: Scholfield Creek Deer Creek North and South Myrtle Creeks Cow Creek Newton Creek	Tributaries: Jump Off Joe Creek Louse Creek Waters Creek Applegate River Slate Creek Murphy Creek Illinois Creek East and West Forks of the Illinois River Deer Creek	Tributaries: Lazy Creek Larson Creek Griffin Creek Pleasant Creek Foots Creek Little Butte Creek Lone Pine Creek Lassen Creek Crooked Creek Daisy Creek Evans Creek Wagner Creek Ashland Creek Colman Creek Clay Creek Bear Creek

Sources: FEMA, April 21, 1999, Douglas County Flood Insurance Study (FIS); and FEMA, May 15, 2002, Jackson County FIS; and FEMA, Sept 27, 1991, Josephine County FIS

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 4 will experience flooding is shown in **Table 2-275**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-275. Local Probability Assessment of Flood in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	H	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

The Federal Emergency Management Agency (FEMA) has mapped most flood-prone streams in Oregon. The maps depict the 1% flood (100-year) upon which the National Flood Insurance Program is based. All of the Region 4 counties have digital Flood Insurance Rate Maps (FIRM); however, most of the modeling used to compile these maps is old and could be outdated. The effective FIRM maps are:

- Douglas, February 2010;
- Jackson, May 2011; and
- Josephine, December 2009.

Damaging floods occur approximately every 10-15 years.

According to the Draft Jackson County Hazard Mitigation Plan (2012) the most significant of the FEMA-determined floodplains and floodways surround the Rogue River, Bear Creek, Ashland Creek and Applegate River. Properties in and near the floodplains in the cities of Rogue River and Shady Cove are subject to frequent flooding events (http://www.co.jackson.or.us/Page.asp?NavID=3903, accessed 3/21/2014). The Rogue and Applegate Rivers also are sources of flooding in Josephine County, along with Slate Creek and the Illinois River. Rogue River flooding affects the City of Grants Pass and Illinois River flooding affects the City of Cave Junction (http://www.oregonriskmap.com/index.php/county-profiles/county-profiles/143-example-county-profile-template-sp-23168, accessed 3/21/2014).

In Douglas County the highest stream flows in the Umpqua River basin usually occur during November through March as a result of heavy winter rains augmented by snowmelt. Most of the flooding occurs in the valley areas of the South Umpqua and Umpqua Rivers, although the tributary streams of Cow Creek, Calapooya Creek, and Elk Creek also have extensive flood plains. Most of the land subject to flooding along the South Umpqua River is below Days Creek. Because these valleys are the most densely populated and intensively developed in Douglas County, the principal flood problems occur along this stream. Flood potential also exists along the Umpqua River between Elkton and the confluence of the North and South Umpqua Rivers. In the Glendale-Azalea valley of Cow Creek, much bank erosion and channel shifting occurs during floods (http://www.oregonriskmap.com/index.php/county-profiles/county-profiles/142-douglas, accessed 3/21/2014).

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the region's vulnerability to flooding is shown in **Table 2-276**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-276. Local Vulnerability Assessment of Flood in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	H	M	M

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

The Oregon Department of Land Conservation and Development (DLCD) created a countywide flood vulnerability index by compiling data from NOAA's Storm Events Database and from FEMA's National Flood Insurance Program. Data were calculated statewide for the period 1978 through 2013 for five input datasets: number of events, structure and crop damage estimates in dollars and NFIP claims number and dollar amounts. The mean and standard deviation were calculated for each input. Then, each county was assigned a score ranging from 0 to 3 for each of these inputs according to **Table 2-277**.

Table 2-277. Scoring for Vulnerability Index

Score	Description
3	county data point is greater than 2.5 times standard deviation for the input data set
2	county data point is greater than 1.5 times standard deviation for the input data set
1	county data point is within standard deviation
0	no data reported

Source: DLCD

DLCD summed the scores for each of the five inputs to create a county-by-county vulnerability index. The maximum possible score is 15. A score over 6 indicates that at least one variable significantly exceeds average values.

Each county in Region 4 received a flood vulnerability score of 6, which is about average. A portion of Douglas County is in Region 1, but the vulnerability scoring process could only calculate scores countywide.

Josephine and Jackson County's Hazard Mitigation Plans report flood hazard probability is high but vulnerability as moderate. No explanation of these results was provided (http://www.co.jackson.or.us/Page.asp?NavID=3903, accessed 3/21/2014; http://jocosheriff.us/your-sheriffs-office/emergency-management/nhmp, accessed 3/21/2014)., Douglas County cited insufficient information to estimate countywide vulnerability (http://www.co.jackson.or.us/Page.asp?NavID=3903, accessed 3/21/2014).

FEMA has identified 18 Repetitive Loss properties in Region 4, none of which are Severe Repetitive Loss properties.

Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS), which results in reduced flood insurance costs. Douglas and Jackson Counties participate in CRS, as do the cities of Ashland, Central Point, Grants Pass, Medford, Rogue River, Roseburg, and Talent.

Table 2-278. Flood Severe/Repetitive Losses and Community Rating System Communities by County in Region 4

County	RL	SRL	# of CRS Communities per County
*Douglas	6	—	2
Jackson	7	—	6
Josephine	5	—	1
Totals	**18**	**0**	**9**

*Includes non-coastal sections of Douglas County

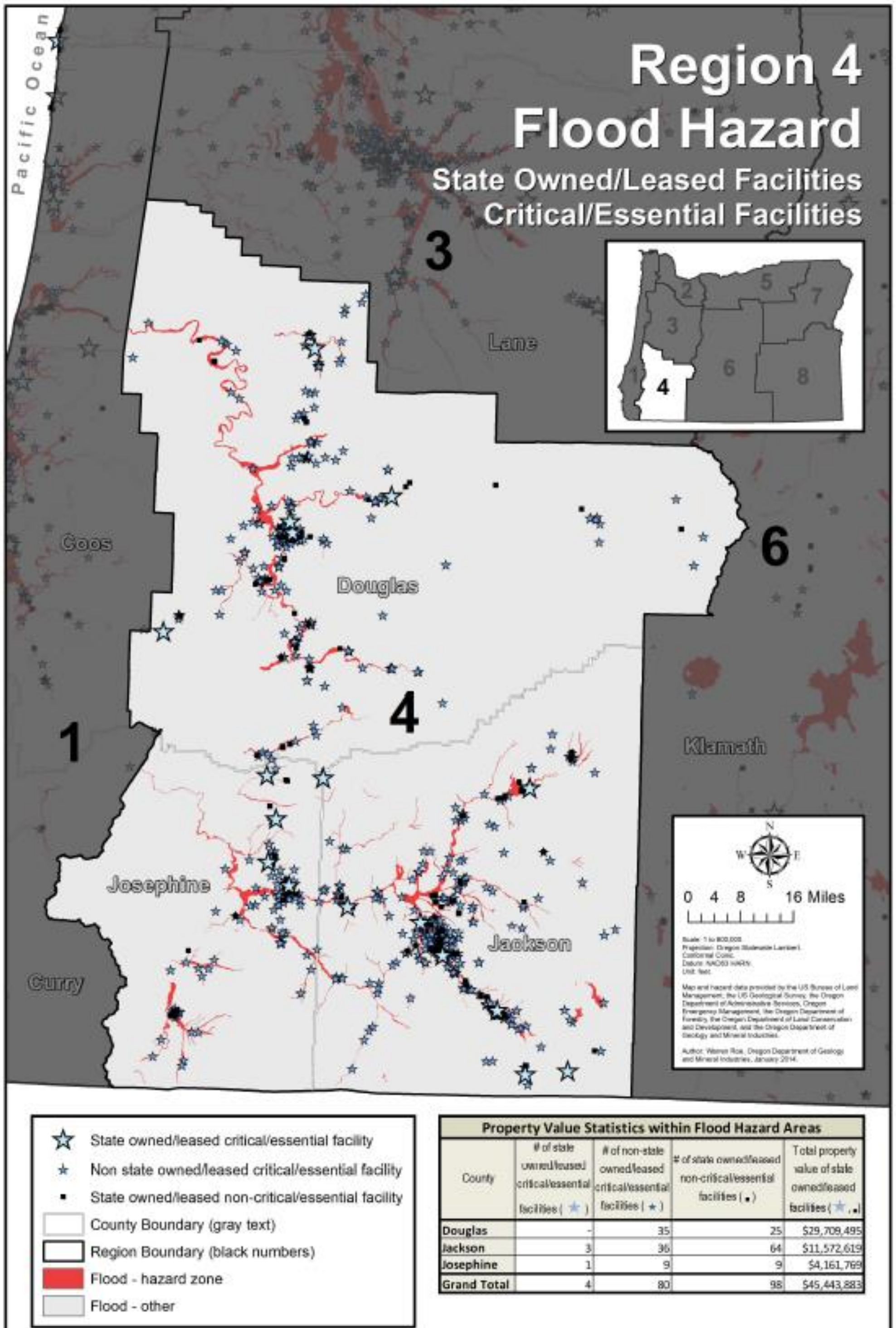
Source: FEMA NFIP BureauNet, http://bsa.nfipstat.fema.gov/, accessed 12/1/2014

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of the 5,693 state facilities evaluated, 102 are currently located within a flood hazard zone in Region 4 and have an estimated total value of $45.4 million (**Figure 2-152**). Of these, four are identified as a critical or essential facility. An additional 80 non-state-owned/leased critical or essential facilities are located in a flood hazard zone in Region 4.

Figure 2-152. State-Owned/Leased Facilities and Critical/Essential Facilities in a Flood Zone in Region 4



Property Value Statistics within Flood Hazard Areas

County	# of state owned/leased critical/essential facilities	# of non-state owned/leased critical/essential facilities	# of state owned/leased non-critical/essential facilities	Total property value of state owned/leased facilities
Douglas	-	35	25	$29,709,495
Jackson	3	36	64	$11,572,619
Josephine	1	9	9	$4,161,769
Grand Total	4	80	98	$45,443,883

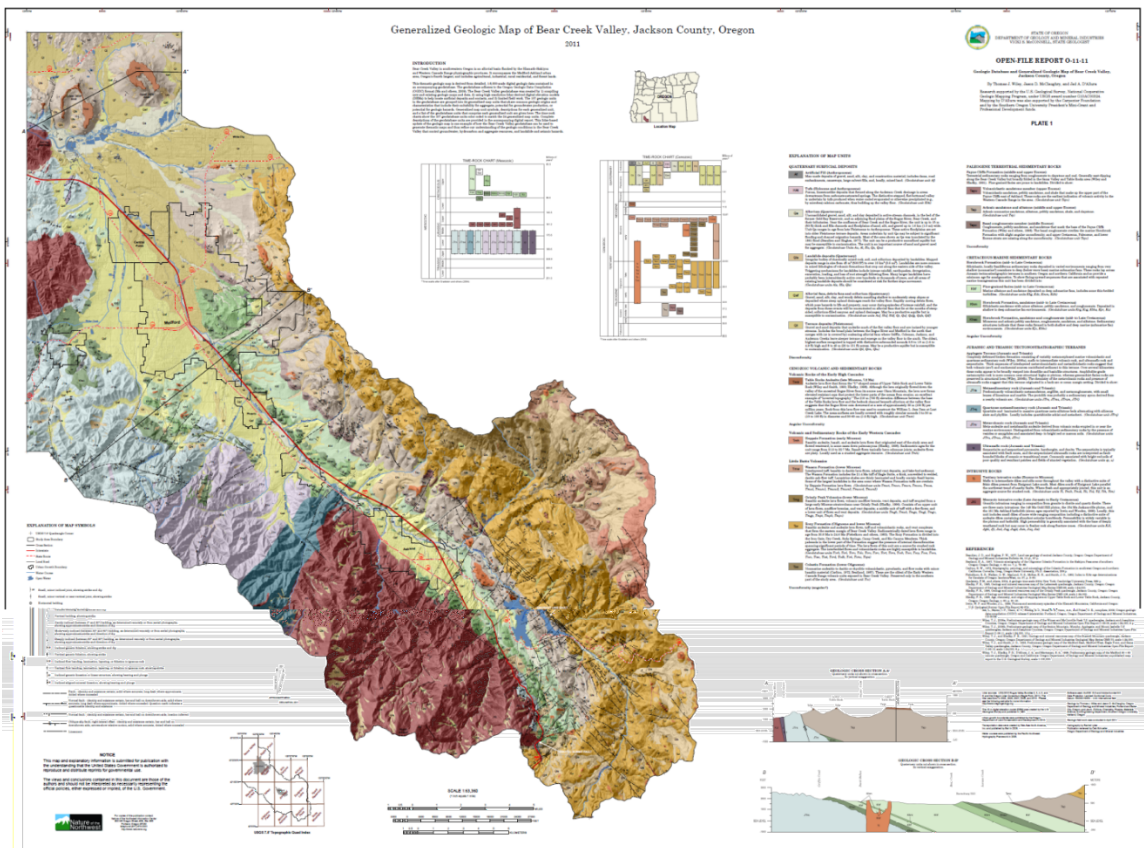
Source: DOGAMI

Landslides

Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. In general, the Klamath Mountains have a high incidence of landslides. On occasion, major landslides sever major transportation routes such as U.S. or state highways and rail lines, causing temporary but significant economic damage. For example, new geologic mapping of the Medford area found 1,734 landslide, debris fan, and colluvium deposits indicating a high level of hazard in this small area (**Figure 2-153**).

Figure 2-153. Generalized Geologic Map of Bear Creek Valley, Jackson County, Oregon



Source: Wiley et al. (2011)

Historic Landslide Events

Table 2-279. Historic Landslide Events in Region 4

Date	Location	Incident
Jan. 1974	near Canyonville, Oregon	nine employees working in a telephone building were killed when the building was pushed by a mudslide into Canyon Creek
Feb. 1996		heavy rains and rapidly melting snow contributed to hundreds of landslides / debris flows across the state; many occurred on clear cuts that damaged logging roads
Nov. 1996	Lane and Douglas Counties	heavy rain triggered mudslides (Lane and Douglas Counties); eight fatalities and several injuries (Douglas County)

Source: Taylor and Hatton (1999)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 4 will experience landslides is shown in **Table 2-280**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-280. Local Probability Assessment of Landslide in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	H	H	—

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Landslides are found in every county in Oregon. There is a 100% probability of landslides occurring in this region in the future. Although we do not know exactly where and when they will occur, they are more likely to happen in the general areas where landslides have occurred in the past. Also, they will likely occur during heavy rainfall events or during a future earthquake.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to landslides is shown in **Table 2-281**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-281. Local Vulnerability Assessment of Landslides in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	M	L	—

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

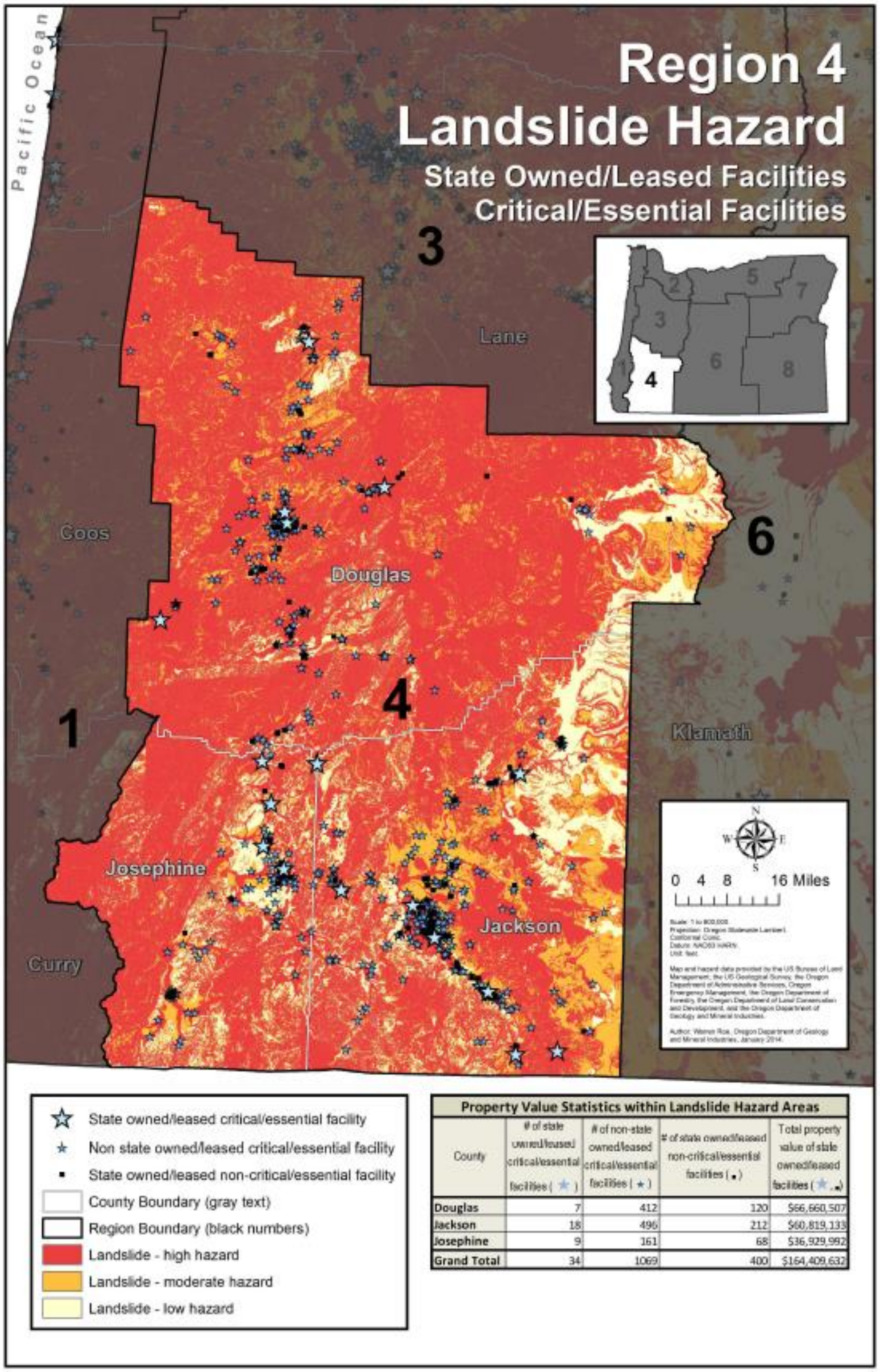
Many of the communities in this region are vulnerable to landslides; for example, the city of Medford and Ashland have a moderate exposure to landslides.

STATE-OWNED/LEASED FACILITIES AND CRITICAL AND ESSENTIAL FACILITIES

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of the 5,693 state facilities evaluated, 434 are located within landslide hazard areas in Region 4, totaling roughly $164.4 million (**Figure 2-154**). This includes 34 critical or essential facilities. An additional 1,069 critical or essential facilities not owned/leased by the state are located within a landslide hazard zone in Region 4.

Figure 2-154. State-Owned/Leased Facilities and Critical/Essential Facilities in a Landslide Hazard Zone in Region 4



Property Value Statistics within Landslide Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Douglas	7	412	120	$66,660,507
Jackson	18	496	212	$60,819,133
Josephine	9	161	68	$36,929,992
Grand Total	34	1069	400	$164,409,632

Source: DOGAMI

Volcanoes

Characteristics

The eastern boundaries of Douglas and Jackson Counties coincide with the crest of the Cascade Mountains, a volcanic range. The Cascade Mountains are still active as has been demonstrated by Mount St. Helens in Washington State. Volcanic activity in the Cascades will continue, but questions regarding how, to what extent, and when, remain. Both Douglas and Jackson Counties are at some risk from volcano-associated hazards however remote. Josephine County is west of the Cascade Mountains and is not subject to the same risks.

Southwest Oregon communities are close to several prominent volcanic peaks, one of which is a national park (Crater Lake). The other peaks include Mount Bailey (elevation 8,363 ft), Mount Thielsen (9,182 ft), and Mount McLaughlin (9,495 ft). Of the three, Crater Lake (6,178 ft) may pose the greatest risk. It is a caldera and the remnant of a mountain (Mount Mazama) that probably had an elevation between 10,800 and 12,000 ft. The massive eruption, which produced the caldera, took place about 7,700 years ago. The long history at Mount Mazama strongly suggests that this volcanic center will be active in the future (Bacon et al., 1997). The presence of the lake means that any future eruption likely will be violent; there are many examples of explosive activity brought about by magma coming into contact with water.

Douglas and Jackson Counties should consider the impact of volcano-related activity on small mountain communities, tourist attractions (e.g., Crater Lake) dams, reservoirs, and highways. These counties also should consider probable impacts on the local economy (e.g., wood products, tourism, and recreation).

Historic Volcanic Events

Table 2-282. Historic Volcanic Events in Region 4

Date	Location	Description
about 7,780 to 15,000 YBP	Cinnamon Butte, southern Cascades	basaltic scoria cone and lava flows
about 7,700 YBP	Crater Lake Caldera	formation of Crater Lake caldera, pyroclastic flows, widespread ashfall

Note: YBP is years before present.

Sources: U.S. Geological Survey, Cascades Volcano Observatory: http://volcanoes.usgs.gov/observatories/cvo/; Bacon et al. (1997)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 4 will experience volcanic hazards is shown in **Table 2-283**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-283. Local Probability Assessment of Volcanic Activity in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	—	L	—

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

There is virtually no risk from volcanoes in Josephine County, other than the possibility of ashfall. Ashfall could come from several sources in the Cascade Range, including Mount Shasta in California or Crater Lake in Oregon. The probability of ashfall totaling 1 cm or more in Josephine County, from any Cascade volcano, is about 1 in 10,000.

Douglas and Jackson Counties are at greater risk of volcanic hazards. The probability of a 1 cm or greater ashfall varies from 1 in 5,000 to 1 in 10,000 (Sherrod et al., 1997).

Based on the total number of eruptive episodes in the past 100,000 years, the average recurrence interval in the Crater Lake area is about 10,000 years. The annual probability of an eruption then, is about 1 in 10,000; the 30-year probability is about 1 in 330 (Bacon et al., 1997). The probability of an event is summarized in **Table 2-284** for each of the counties in Region 4.

Table 2-284. Probability of Volcano-Related Activity in Region 4

Volcano-Related Hazard	Douglas	Josephine	Jackson	Remarks
Volcanic ash (annual probability of 1 cm or more accumulation from eruptions throughout the Cascade Range)	1 in 5,000 to 1 in 10,000	1 in 10,000	1 in 5,000 to 1 in 10,000	Sherrod et al. (1997)
Lahar	Source: Crater Lake	no risk	Source: Crater Lake	Bacon et al. (1997)
Lava flow	no risk	no risk	no risk	Bacon et al. (1997)
Debris flow / avalanche	no risk	no risk	Source: Crater Lake	Bacon et al. (1997)
Pyroclastic flow	Source: Crater Lake	no data available	Source: Crater Lake	Bacon et al. (1997)

Sources: Sherrod et al. (1997); Bacon et al. (1997)

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to volcanic hazards is shown in **Table 2-285**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-285. Local Vulnerability Assessment of Volcanic Activity in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	—	L	—

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

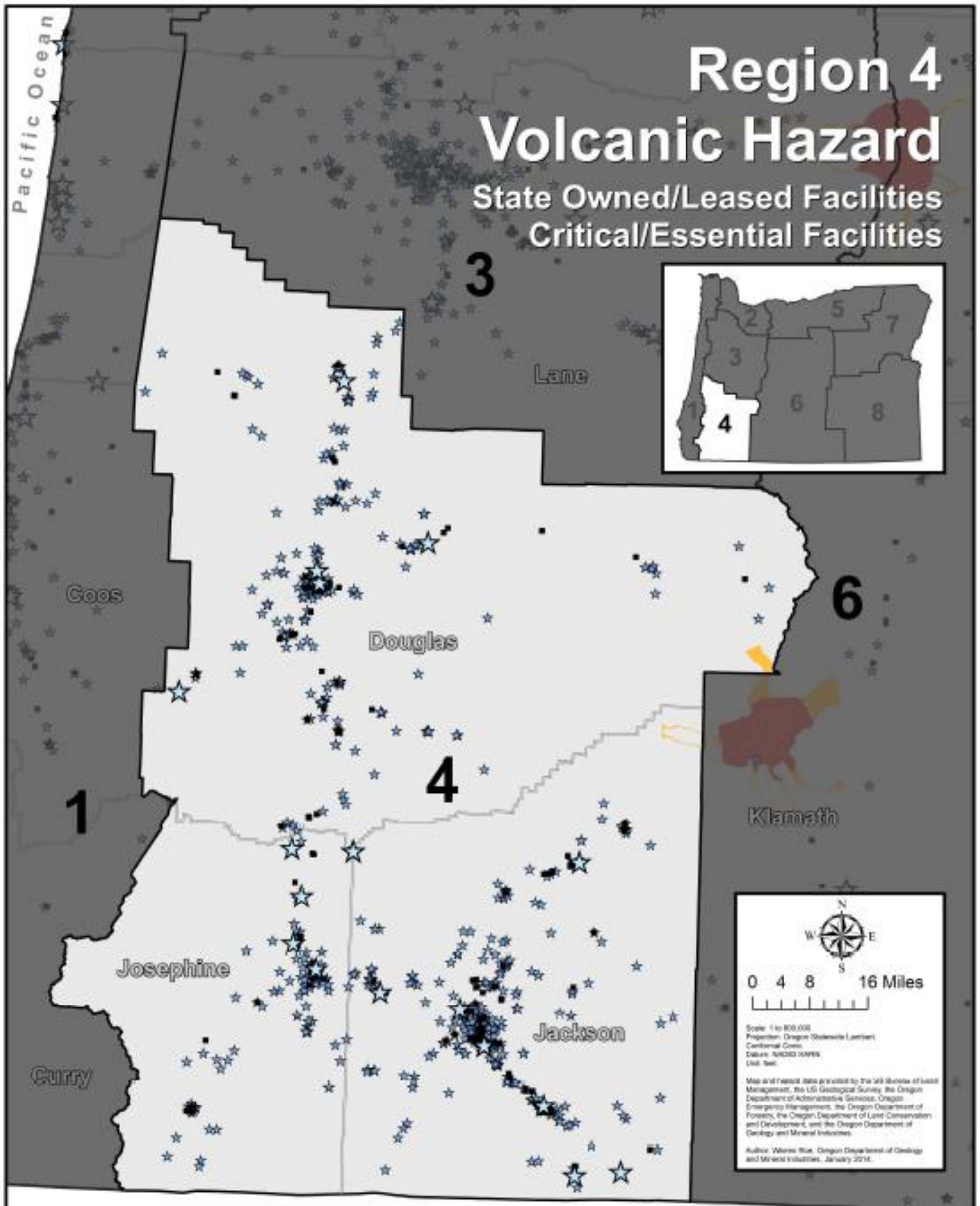
The U.S. Geological Survey has addressed volcanic hazards in the Crater Lake region (Bacon et al., 1997). This report includes maps depicting the areas at greatest risk. The park itself is in the greatest risk category. In Douglas County, the upper reaches of the Umpqua and Clearwater rivers are subject to volcano-associated hazards, as is the OR-62 corridor in Jackson County (Bacon et al., 1997; http://pubs.usgs.gov/of/1997/0487/). There is virtually no risk from volcanoes in Josephine County, other than the possibility of ashfall.

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. (See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, none are located within a volcanic hazard area in Region 4. Furthermore, there are no non-state-owned/leased critical or essential facilities located within a volcanic hazard zone in Region 4 (**Figure 2-155**).

Figure 2-155. State-Owned/Leased Facilities and Critical/Essential Facilities in a Volcanic Activity Hazard Zone in Region 4



Property Value Statistics within Volcanic Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★ , ▪)
Douglas	-	-	-	-
Jackson	-	-	-	-
Josephine	-	-	-	-
Grand Total	0	0	0	50

Source: DOGAMI

Wildfires

Characteristics

While the residents in Region 4 enjoy moderate winters, during the summer residents can expect long drought periods, low humidity with temperatures that sometimes exceed 100 °F, and frequent lightning storms. Some landscapes are affected by autumn east winds that occur when stable air pushes across a mountain range and then descends on the leeward side. The air becomes warmer and drier as it descends and can lead to increased, sometimes extreme, fire behavior in lower lee-side locations.

Summers in Region 4 bring perfect weather conditions for extreme wildfires. Lightning strikes are frequent during the summer months, and the numerous strikes have the potential to ignite numerous fires.

Fire exclusion in Region 4 has created vegetation and fuel conditions for large and catastrophic fires that are more difficult to suppress than smaller fires. Throughout the watersheds, forests present a continuous fuel supply both vertically, in small, thin trees and dead branches (*ladder fuels*), and horizontally, in an abundance of dead and downed material. When a fire gets started in such a forest, the dead branches, sticks, twigs, and other material increase fire intensity and, with ladder fuels present, provide great opportunity for the fire to reach the forest canopy, resulting in a stand-killing crown fire. These conditions also affect the means in which prescribed fire and fuels treatment are applied to the landscape.

Current climate conditions, especially in drought years, influence the frequency, intensity, duration, and extent of fire. Summers are dry and lightning prone because a Pacific coast high-pressure system typically blocks precipitation for much of the season. In the upper elevations, where temperatures are low and rainfall is high, fires are less frequent than in the valleys. Larger climatic factors such as long-term global variations related to El Niño or to sunspot cycles also influence fire regimes, but this influence is confounded by local climatic variations, recent land management activities, and burns.

Historic Wildfire Events

Table 2-286 describes some of the more noteworthy fires in Oregon's history.

Table 2-286. Historic Wildfires in Region 4

Year	Name of Fire	County	Acres Burned	Remarks
1951	Hubbard Creek, Russell Creek, Vincent Creek Fires	Douglas	16,094	the Hubbard Creek Fire burned 15,774 acres and destroyed 18 homes; the Russell Creek Fire burned 350 acres and killed one person; the Vincent Creek Fire burned 23,000 acres near Scottsburg
1966	Oxbow Fire	Douglas	43,368	the Oxbow Fire killed one person
1987	Bland Mountain	Douglas	10,300	near Canyonville; 14 structures lost, 2 people killed
1992	E. Evans Creek	Jackson	10,135	four structures lost
1994	Hull Mountain	Jackson	8,000	one life and 44 structures were lost; the fire was an act of arson
1994	Sprignett Butte	Jackson	1,631	arson
2000	Antioch road	Jackson	376	
2002	Squires Peak/Wall Creek	Jackson	3,125	
2002	Timbered Rock	Jackson	27,111	
2002	Biscuit	Curry, Josephine	500,000	estimated to be one of Oregon's largest in recorded history, the Biscuit Fire encompassed most of the Kalmiopsis Wilderness
2003	Cove Road	Jackson	700	3 miles east of Ashland
2004	Bland Mtn. #2	Douglas	4,700	two homes lost
2008	Doubleday	Jackson	1,244	threatened Butte Falls
2010	Oak Knoll Fire	Jackson County	< 100	Oak Knoll Fire in Ashland destroyed 11 homes in less than 45 minutes
2013	Douglas Complex	Douglas, Josephine, Wasco, Grant	48,324	combined with fires in Region 5, 6, and 7, the most acres burned in since 1951 on lands protected by the Oregon Department of Forestry
2013	Brimstone	Josephine	2,377	part of southern Oregon fire storm that included the Douglas Complex above
2013	Big Windy	Josephine	26,725	part of southern Oregon fire storm that included Brimstone and Douglas Complex; one firefighter death

Source: 2013 Fire Statistics, Oregon Department of Forestry

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 4 will experience wildfire is shown in **Table 2-287**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-287. Local Probability Assessment of Wildfire in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	H	H	H

Source: Oregon Office of Emergency Management, 2013, County Hazard Analysis Scores

State Assessment

Hot and dry summers combined with frequent lightning events, rugged terrain, and an abundance of fuels makes Region 4 a hotbed of fire activity. Historically, some of Region 4's largest fires have been caused by human activity. While lightning-caused fires accounted for nearly 70% of the fires in 2013, the 10-year average for lightning-caused fires is closer to 25%.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to wildfire is shown in **Table 2-288**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-288. Local Vulnerability Assessment of Wildfire in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	H	M	M

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Region 4 is one of the state's regions most susceptible to wildfire. Based on data from the 2013 West Wide Wildfire Risk Assessment, all counties in Region 4 have a high percentage of wildland acres subject to Fire Risk, Wildland Development Areas, Fire Effects, or Fire Threat, making them especially vulnerable. Note: WWRA data does not differentiate between coastal and non-coastal Douglas County. Therefore, all of Douglas County is considered most vulnerable to wildfire.

Douglas, Josephine, and Jackson Counties are made up of several smaller communities that lie within the wildland-urban interface and have a distinct vulnerability to wildfire given their proximity to forestland, high summer temperatures, rugged terrain, and likelihood of summer thunderstorm activity. The human element is a factor as well with several populations intermixed in wildland areas. Arson continues to be a concern in this part of the state as well as the high number of fires caused by debris burning and equipment use.

Table 2-289. Region 4 Wildland-Urban Interface Communities

Douglas		Jackson	Josephine
Azalea	Lelomo Lake	Antelope Creek	Galice
Camas Valley	Lookingglass	Applegate	Grants Pass
Canyonville	Myrtle Creek	Ashland	Illinois Valley
Curtin	Oakland	Butte Falls	Merlin
Days Creek	Rice Hill	Colestin	Murphy
Diamond Lake	Riddle	Crow Foot	Oregon Caves
Dillard	Roseburg	Elk Creek	Selma
Dixonville	Steamboat	Gold Hill	Sunny Valley
Drain	Sutherlin	Green Springs	Wilderville
Dry Creek	Tenmile	Jacksonville	Williams
Elkton	Tiller	Lake Creek	Wolf Creek
Fair Oaks	Toketee	Medford	
Glenbrook	Tri City	Prospect	
Glendale	Umpqua	Rogue River	
Glide	Union Gap	Sams Valley	
Green Acres	Wilber	Shady Cove	
Winston	Wolf Creek	Trail	
Yoncalla		Union Creek	
		Upper Applegate	
		Wimer	

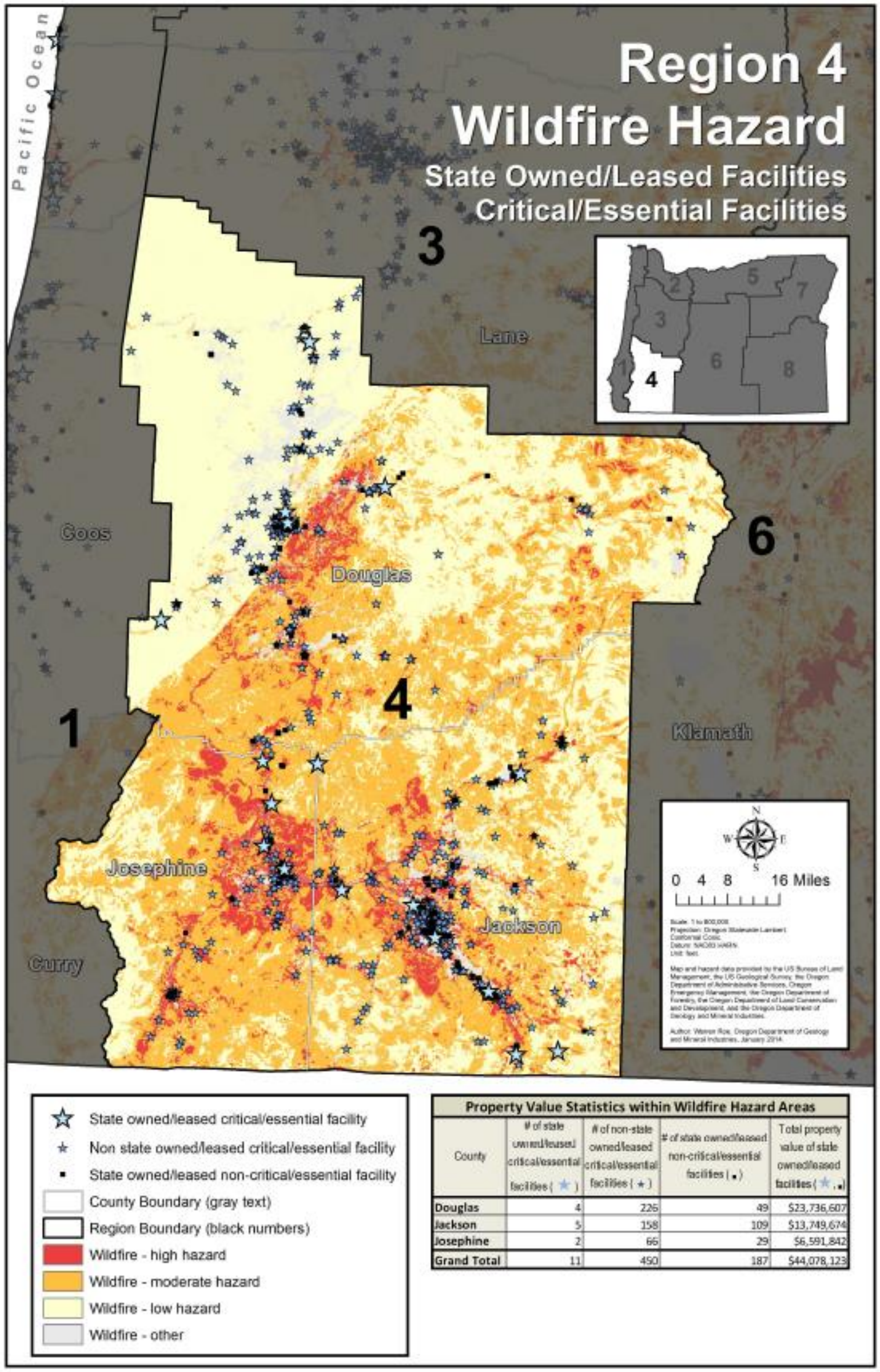
Source: ODF Statewide Forest Assessment September, 2006

STATE-OWNED/LEASED FACILITIES AND CRITICAL AND ESSENTIAL FACILITIES

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 198 are within a wildfire hazard zone in Region 4 and total about $44 million in value (**Figure 2-156**). Among state-owned/leased critical or essential facilities, 11 have a wildfire hazard in any category. An additional 408 non-state-owned/leased critical or essential facilities are located in Region 4.

Figure 2-156. State-Owned/Leased Facilities and Critical/Essential Facilities in a Wildfire Zone in Region 4



Property Value Statistics within Wildfire Hazard Areas				
County	# of state owned/leased critical/essential facilities	# of non-state owned/leased critical/essential facilities	# of state owned/leased non-critical/essential facilities	Total property value of state owned/leased facilities
Douglas	4	226	49	$23,736,607
Jackson	5	158	109	$13,749,674
Josephine	2	66	29	$6,591,842
Grand Total	11	450	187	$44,078,123

Source: DOGAMI

Windstorms

Characteristics

Extreme winds (other than tornadoes) are experienced in all of Oregon's eight regions. A majority of the destructive surface winds in Oregon are from the southwest. Under certain conditions, very strong east winds may occur, but these usually are limited to small areas in the vicinity of the Columbia River Gorge or other low mountain passes. The much more frequent and widespread strong winds from the southwest are associated with storms moving onto the coast from the Pacific Ocean. If the winds are from the west, they may be stronger on the coast than in the interior valleys because of the north-south orientation of the Coast Range and Cascades. These mountain ranges obstruct and slow down the westerly surface winds. The most destructive winds are those which blow from the south, parallel to the major mountain ranges. The Columbus Day Storm of 1962 was a classic example of such a storm, and its effects were so devastating that it has become the benchmark from which other windstorms in Oregon are measured. The storm caused significant damage in Region 4.

Tornadoes have not been recorded in Jackson, Josephine, or central Douglas Counties.

Historic Windstorm Events

Table 2-290. Historic Windstorms in Region 4

Date	Affected Area	Characteristics
Apr. 1931	western Oregon	unofficial wind speeds reported at 78 mph; damage to fruit orchards and timber
Nov. 10-11, 1951	statewide	widespread damage; transmission and utility lines; wind speed 40–60 mph; gusts 75–80 mph
Dec. 1951	statewide	wind speed 60 mph in Willamette Valley; 75-mph gusts; damage to buildings and utility lines
Dec. 1955	statewide	wind speeds 55–65 mph with 69-mph gusts; considerable damage to buildings and utility lines
Nov. 1958	statewide	wind speeds at 51 mph with 71-mph gusts; every major highway blocked by fallen trees
Oct. 1962	statewide	Columbus Day Storm; Oregon's most destructive storm to date; 116 mph winds in Willamette Valley; estimated 84 houses destroyed, with 5,000 severely damaged; total damage estimated at $170 million
Mar. 1971	most of Oregon	greatest damage in Willamette Valley; homes and power lines destroyed by falling trees; destruction to timber in Lane County
Nov. 1981	most of Oregon	highest winds since Oct. 1962; wind speed 71-mph in Salem; marinas, airports, and bridges severely damaged
Jan. 1990	statewide	heavy rain with winds exceeding 75 mph; significant damage; one fatality
Dec. 1995	statewide	followed path of Columbus Day Storm; wind speeds 62 mph in Willamette Valley; damage to trees (saturated soil a factor) and homes
Nov. 1997	western Oregon	wind speed 52 mph in Willamette Valley; trees uprooted; considerable damage to small airports
Feb. 2002	western Oregon	strongest storm to strike western Oregon in several years; many downed power lines (trees); damage to buildings; water supply problems (lack of power); estimated damage costs: $6.14 million
Feb. 2004	Jackson County	heavy winds caused $4,000 in damages in Jackson County
Dec. 2006	Douglas and Josephine Counties	high winds up to 90 mph caused $150,000 in damages in Douglas and Josephine; the storm also impacted Coos and Curry Counties for a storm damage total of $300,000
July 2007	Josephine and Jackson Counties	severe thunderstorms with winds up to 60 mph down numerous trees damaging vehicles and trailers; $100,000 in damage in Jackson County; lightning struck the steeple of a church in Josephine County, causing $60,000 in damages

Sources: Taylor and Hatton (1999); Hazard Mitigation Team Survey Report, Severe Windstorm in Western Oregon, February 7, 2002 (FEMA-1405-DR-OR); Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org ; National Climatic Data Center, Storm Events, http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 4 will experience windstorms is shown in **Table 2-291**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-291. Local Probability Assessment of Windstorm in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	H	H	H

Source: Oregon Office of Emergency Management, 2013, County Hazard Analysis Scores

State Assessment

The 100-year event in Region 4 consists of 1-minute average winds of 80 mph. A 50-year event is 70 mph. A 25-year event has average winds of 60 mph.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to windstorms is shown in **Table 2-292**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-292. Local Vulnerability Assessment of Windstorm in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	M	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Many buildings, utilities, and transportation systems within Region 4 are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It also is 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 and can affect emergency operations. In addition, uprooted 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. Many roofs have been destroyed by uprooted ancient trees growing next to a house. In some situations, strategic pruning may be the answer. Prudent counties will work with utility companies to identify problem areas and establish a tree maintenance and removal program.

Winter Storms

Characteristics

Severe winter weather in Region 4 can be characterized by extreme cold, snow, ice, and sleet. In higher elevations such as the lower Cascade Range and the Siskiyou Mountains and passes, moderate to heavy snowfall is expected on an annual basis. Some Region 4 communities are unprepared, financially and otherwise, for the impact of severe winter storms. An historical summary of extreme winter conditions in this region is shown in **Table 2-293**.

Historic Winter Storm Events

Table 2-293. Severe Winter Storms in Region 4

Date	Location	Characteristics
Dec. 1861	statewide	snow covered entire Pacific Northwest 1–3 feet
Jan. 1916	statewide	two snow storms, each totaling 5 inches or more
Jan. 1932	SW Oregon mountains	Crater Lake record snowfall: 879 inches
Jan.- Feb. 1937	statewide	heavy snow throughout state
Jan. 1950	statewide	heaviest snowfall since 1890; highway closures; considerable property damage
Jan. 1951	Crater Lake, Oregon	new annual record snowfall at Crater Lake
Jan. 1956	western Oregon	packed snow became ice; automobile accidents throughout region
Mar. 1960	statewide	snowfall: 3–12 inches; over 100 accidents in Marion County
Jan. 1969	statewide	Lane County surpassed old snowfall record; 47 inches in Eugene ; $3 to $4 million in property damage
Jan. 1980	statewide	a series of storms bringing snow, ice, wind, and freezing rain; six fatalities
Feb. 1985	statewide	2-4 inches of snow in western valleys; massive power failures (tree limbs broke power lines)
Feb. 1986	Cascades, Oregon	heavy snowfall
Mar. 1988	statewide	strong winds and heavy snow
Feb. 1989	statewide	heavy snowfall and record low temperatures
Nov. 1989	Siskiyou, Oregon	unusually heavy snowfall
Dec. 1992	western Oregon	heavy snow; interstate highway closed
Feb. 1993	western Oregon	record snowfall at Salem airport
Winter 1998-1999	statewide	series of storms; one of the snowiest winters in Oregon history
Winter 2003-2004	statewide	most significant winter storm in several years brought snowfall to most of Oregon; largest snowstorm in the Siskiyou Pass (Jackson County) in a quarter century; shut down I- 5

Source: Taylor and Hatton (1999)

Source: Oregon Department of Transportation, 2008. *State Natural Hazards Mitigation Plan*, Winter Storm chapter.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 4 will experience winter storms is shown in **Table 2-294**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-294. Local Probability Assessment of Winter Storms in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	H	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Winter storms occur annually in Region 4. On the basis of historical data, severe winter storms could occur about every 4 years in this region. We can expect to have continued annual storm events in this region. However, there are no solid statistical data available upon which to base these judgments. There is no statewide program to study the past, present, and potential impacts of winter storms in the state of Oregon at this time. Higher elevations through the Siskiyou Mountains and the Cascade Range are expected to have higher annual snowfall amounts and this is planned for at the state and local level.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to winter storms is shown in **Table 2-295**. See the State Risk Assessment for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-295. Local Vulnerability Assessment of Winter Storms in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	H	H	H

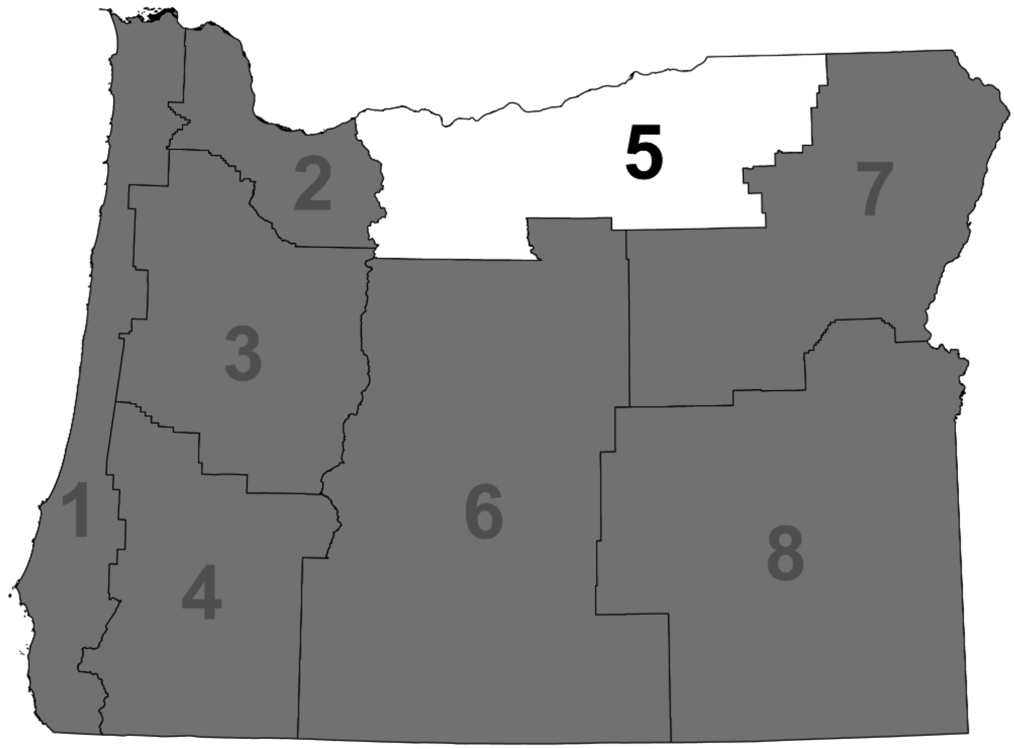
Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

All three counties in Region 4 are impacted by severe winter storms. The I-5 corridor passes through the Siskiyou Mountains in this region and is key to intermodal transportation. As well as the link to California and commodity flow. Severe winter storms can shut down this vital link for extended periods and can have a direct adverse impact on Oregon's economy.

2.3.5 Region 5: Mid-Columbia Region

Gilliam, Hood River, Morrow, Sherman, Umatilla, and Wasco Counties



2.3.5.1 Summary

Regional Profile

The region's demographic, economic, infrastructure and development patterns indicate that some populations, structures and places may be more vulnerable to certain natural hazards than others. Mitigation efforts directed at these vulnerabilities may help boost the area's ability to bounce back after a natural disaster.

Across the region, social vulnerability is driven by fewer college degrees and high numbers of housing rentals and vacancies. At the county level the numbers of disabled persons in Gilliam; homeless people in Wasco and Umatilla; children in Hood River, Morrow, and Umatilla; seniors in Gilliam and Sherman; and people who do not speak English very well in Hood River and Umatilla are notable.

Overall, Region 5 has been rebounding from the financial crisis that began in 2007. Economic vulnerability is driven by high unemployment rates in Morrow and Umatilla Counties and low wages in Morrow and Hood River Counties.

Interstate-84, two rail yards, Amtrak lines, three ports, and one commercial airport support the economy and daily operations in Region 5. These integral transportation systems are susceptible to many natural hazards. Damage or interruption to the services these systems provide could be devastating to the region and state.

There are 31 power-generating facilities in the Mid-Columbia Region, including hydroelectric, natural gas, wind, and coal facilities. Liquid natural gas pipelines run through Gilliam, Morrow, and Umatilla Counties. Four additional wind facilities are proposed for the region. The diverse energy and drinking water systems here help reduce the area's vulnerability to damage and disruptions in service that can happen during a natural hazard event.

Surface water, wells, and springs supply local drinking water. These systems are vulnerable to non-point source pollution, erosion, and sedimentation that can adversely impact water quality. Rigid, buried infrastructure is vulnerable to seismic activity.

Region 5 is largely rural, with urban development occurring in communities along I-84 in Hood River County. Mobile homes, which are inherently more vulnerable to natural hazards, make up a significant share of the region's housing units. Over 80% of homes in Gilliam and Sherman Counties were built before 1990 and current seismic building standards. With the exception of Morrow and Umatilla Counties, none of the region's FIRMs have been modernized or updated — leaving this region's flood maps less up to date as other areas of the state.

Hazards and Vulnerability

Region 5 is affected by nine of the 11 natural hazards that affect Oregon communities. Coastal hazards and tsunamis do not directly impact this region.

Droughts: Droughts are common in Region 5, particularly within Gilliam, Morrow, and Sherman Counties. Agricultural industries in the region are vulnerable to scarcity of water supplies during drought events.

Dust Storms: Strong winds can carry fine silt, sand, and clay particles into the air. These storms can travel hundreds of miles at speeds of at least 25 miles per hour and can reach heights of over 10,000 feet. Dust storms are most common over the areas of dry land that are prevalent within this region. Dust storms affect the region annually, during summer months and periods of drought. Morrow and Umatilla Counties are the counties most vulnerable to dust storms in the state.

Earthquakes: Over all, the region is moderately vulnerable to three types of earthquakes: (a) shallow crustal events, (b) deep intra-plate events within the subducting Juan de Fuca plate, and (c) the offshore Cascadia Subduction Zone (CSZ) Fault. Primary vulnerabilities are due to shallow crustal and intraplate earthquakes that cause earthquake-induced landslides in the Cascades, ground shaking, and liquefaction. A CSZ event will affect markets to east upon which communities in Region 5. There are 411 state-owned/leased facilities, valued at over $528 million, in the earthquake hazard zone in this region. Of these, 76 are critical/essential facilities. An additional 1,446 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Floods: Rain-on-snow events during unseasonably warm winters create disastrous riverine flooding events in the Mid-Columbia Region. Flash floods associated with summer thunderstorms are also exceptionally damaging. All of the region's counties are considered moderately vulnerable to flooding. There are 265 state-owned/leased facilities, valued at approximately $6 million, located in the region's flood hazard zone. Of these, three are considered critical/essential facilities. An additional 35 non-state-owned/leased critical/essential facilities are located in this hazard zone.

Landslides: Landslides can occur throughout the region, though more tend to occur in areas with steeper slopes, weaker geology, and higher annual precipitation. Rain-induced landslides can occur during winter months. Earthquakes can trigger landslides at any time. Vulnerability is increased in populated areas within the Columbia River Gorge, along the I-84 corridor and in the Cascade Mountains. There are 631 state-owned/leased facilities, valued at over $744 million, located in this hazard zone in Region 5. Of these, 121 are critical/essential facilities. An additional 1,541 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Volcanoes: There are several active and potentially active volcanoes in the Cascade Range along the western border of the Mid-Columbia Region. Areas particularly vulnerable to volcanic activity include the Cities of Parkdale and Hood River near Mount Hood, and communities along the White River in Wasco County. Though most volcanic activity is considered local, lahars and ashfall can travel many miles, impacting small mountain communities, dams, reservoirs, energy-generating facilities, and highways. There are 321 state-owned/leased facilities, valued at approximately $259 million, located in a volcanic hazard zone in this region. Of these, 59 are critical/essential facilities. An additional 1,377 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Wildfires: This region has unique geographic features, weather characteristics, a history of unmanaged fuels, and an expanding wildland-urban interface that contribute to the region's susceptibility to wildfire. The majority of the forestlands in Region 5 are historically prone to wildfire. Summer weather patterns can produce lightning storms that start many fires. Based on data from the 2013 West Wide Wildfire Risk Assessment, in Region 5, Umatilla and Wasco

Counties have high percentages of wildland acres subject to Fire Risk, Wildland Development Areas, Fire Effects, or Fire Threat, making them especially vulnerable. Other areas of vulnerability are within wildland-urban interface communities. There are 239 state-owned/leased facilities, valued at approximately $81.5 million, located in this region's wildfire hazard zone. Of these, 23 are identified as critical/essential facilities. An additional 1,072 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Windstorms: High winds within Region 5 in the Columbia River Gorge are legendary, sometimes reaching 80 miles per hour. Windstorms generally impact the region's buildings, utilities, tree-lined roads, transmission lines, residential parcels, and transportation systems along open areas such as grasslands and farmland. Special building codes in this region require tie downs for mobile homes within 30 miles of the Columbia River. The most vulnerable communities are those near the Columbia Gorge within Gilliam, Hood River, Morro, and Sherman Counties.

Winter Storms: Frigid air emanating from the Wallowa Mountains and traveling through the Columbia River Gorge bring winter storms to this region annually. Though winter storms have the potential to affect the entire region, particularly along the I-84 corridor, the area is known for cold winters so residents and visitors are usually prepared for these storms.

Climate Change

The most reliable information on climate change to date is at the state level. The state information indicates that hazards projected to be impacted by climate change in Region 5 include drought and wildfire. Climate models project warmer drier summers and a decline in mean summer precipitation for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, all eight regions are expected to be affected by an increased incidence of drought and wildfire. An increase in drought could result in the increased incidence of dust storms, though no current research is available on the direct effects of future climate conditions on the incidence of dust storms. While winter storms and windstorms affect Region 5, there is little research on how climate change influences these hazards in the Pacific Northwest. For more information on climate drivers and the projected impacts of climate change in Oregon, see the section, **Introduction to Climate Change**.

2.3.5.2 Profile

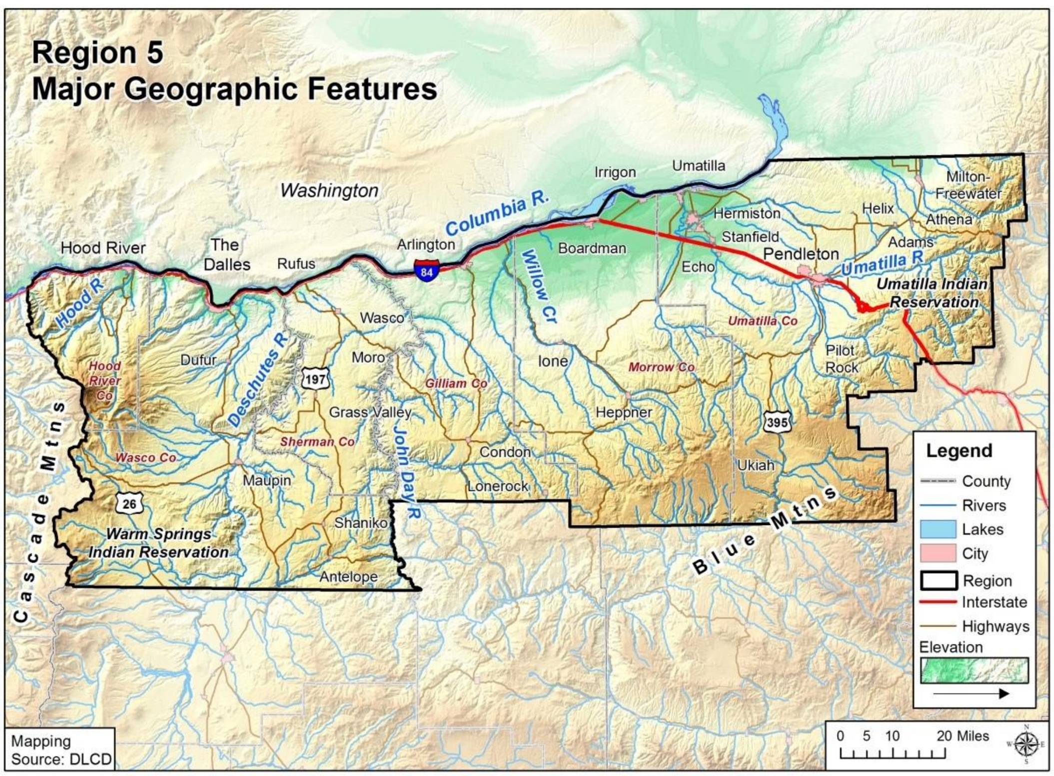
Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

Natural Environment

Geography

Oregon's Mid-Columbia Region is approximately 10,178 square miles in size and includes Gilliam, Hood River, Morrow, Sherman, Umatilla, and Wasco Counties. The Columbia River and the eastern slope of the Cascades shape the region's topography. Region 5 begins at the Cascades crest in the west and extends east to the Idaho border. The region's northern border is the Columbia River and extends to the northern ridges of the Blue Mountains in the south. The region's major watershed is the Columbia River with all smaller water bodies feeding it as it flows west into the Pacific Ocean. The region supports crop farming as well as livestock grazing.

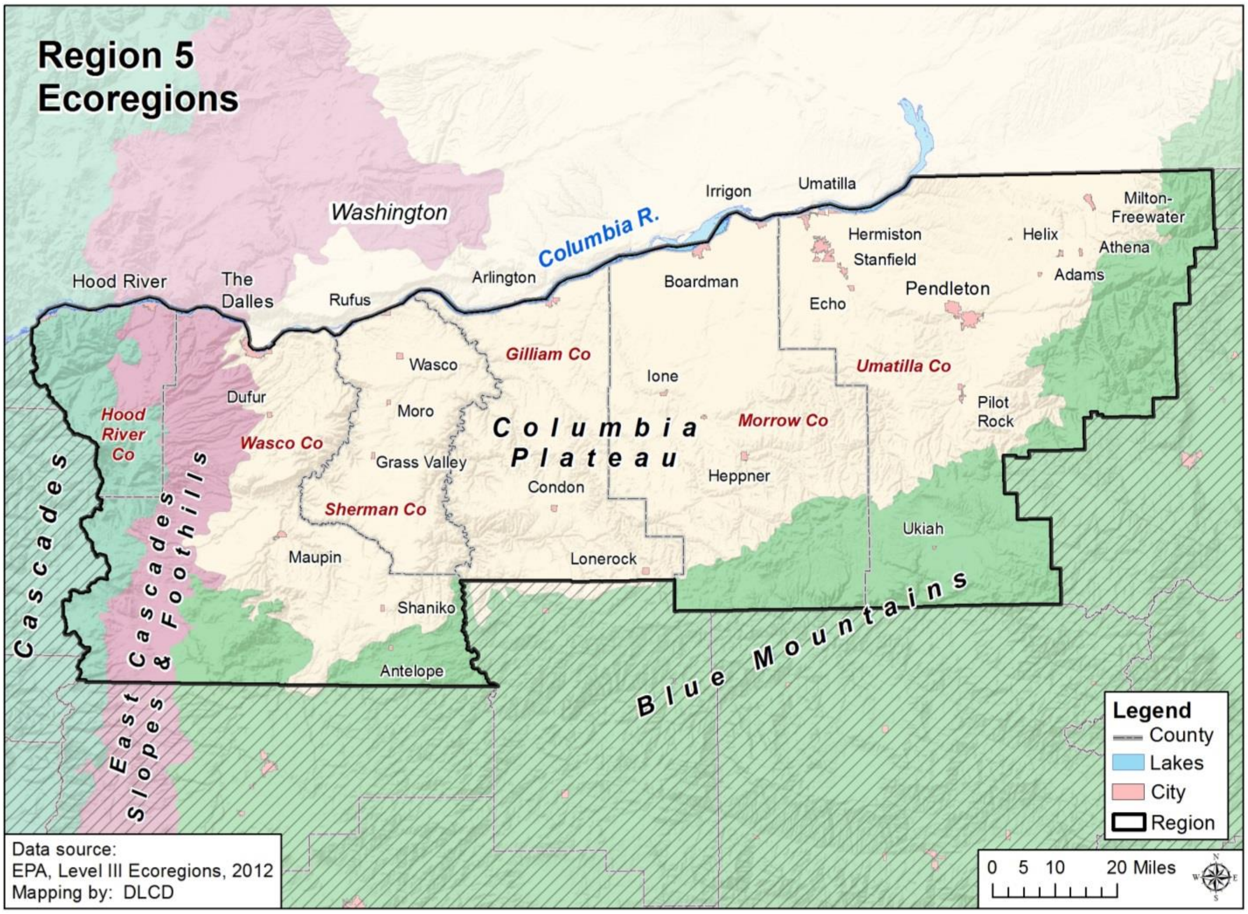
Figure 2-157. Region 5 Major Geographic Features



Source: Department of Land Conservation and Development, 2014

The U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Region 5 is composed of four ecoregions: the Cascades, the Eastern Cascades Slope and Foothills, the Blue Mountains and, predominantly, the Columbia Plateau (**Figure 2-158**).

Figure 2-158. Region 5 Ecoregions



Blue Mountains: This ecoregion is complex and diverse, with many sub-ecoregions with unique conditions. In general, the Blue Mountains areas of Region 5 have a dry continental climate with marine intrusions because of proximity to the Columbia Gorge. While much of the Blue Mountains are underlain with volcanic rock, land in the Wallowa and Elkhorn Mountain ranges is composed of granitic intrusives, deep sea sediments, and metamorphic rocks. Grazing, logging, and fire suppression regimes have altered land cover throughout the region where juniper woodlands have given way to sagebrush grasslands and grand fir forests have given way to spruce fir forests. Other forests in the region predominantly have either a Douglas fir or ponderosa pine canopy. Ponderosa forests tend toward sparsely vegetated understories. The ecoregion's Douglas fir forests tend toward dense shrub understories, making them more difficult to log. Some high meadows also exist within the Blue Mountains in Region 5 and unchannelized streams tend toward a meandering nature within wide floodplains, moving dynamically through the landscape. Riparian areas of the region have a diverse palette of understory shrubs with black cottonwoods, grand firs, and alders in the canopy layer (Thorson et al., 2003).

Cascades: This ecoregion is underlain by volcanic soils. Naturally occurring mixed conifer forests have given way to predominantly Douglas fir forests that are managed for commercial logging. Logging activities have put a strain on the ecological health of streams in the area (Thorson et al., 2003). Waterways in the steeper valleys support threatened cold-water salmonids including Chinook salmon, steelhead, and bull trout. Streams, lakes, reservoirs, rivers, and glacial lakes at higher elevations are key sources of water. Large volcanic peaks, glaciers and year-round snowfields punctuate the alpine and subalpine areas of the ecoregion (Thorson et al., 2003).

Columbia Plateau: The Columbia River has shaped this arid, sagebrush steppe. This ecoregion is underlain by basaltic bedrock up to two miles deep. Naturally occurring wheatgrass, sagebrush, sage grass and other drought-tolerant plants have given way to crop farming and grazing. Higher elevation areas support Douglas fir and ponderosa pine forests while narrow canyons provide habitat for riparian species such as white alders and mock orange. Deep loess soil deposits cover some areas, making them more agriculturally productive than areas with spare soils (Thorson et al., 2003).

Eastern Cascades Slope and Foothills: The Region 5 section of this ecoregion is dominated by grand fir mixed forests in the uplands and mixed oak/conifer forests in the foothills. The Columbia River Gorge influences lower elevations with marine weather systems while the uplands are moister with richer soils. Because of its location in the rain shadow of the Cascades, the ecoregion often experiences dramatic temperature extremes and native plants are adapted to dry climates and frequent wildfires. Logging and recreation are common land uses throughout and rural residential development and agricultural uses can be found in the foothills (Thorson et al., 2003).

Climate

Climate refers to the temperatures, weather patterns, and precipitation in the region. This section covers historic climate information. For estimated future climate conditions and possible impacts refer to the **State Risk Assessment** for statewide projections.

Region 5 has diverse ecoregions with varying climatic conditions with the majority of the region’s land in Columbia Plateau. The Columbia Plateau’s arid climate supports a variety of agricultural activities, most notably wheat, barley, alfalfa, corn and potato production. The region is subject drought, floods, landslides, and wildfires. When considering the climate, snowfall should also be taken into account. Flooding can be a direct result of rain-on-snow events. Likewise, the amount of snowpack in a region can also impact the ability of communities to cope with drought. **Table 2-296** shows mean annual precipitation and temperatures for the three ecoregions in Region 5 (Thorson et al., 2003). Variations in temperature and precipitation vary widely by sub-ecoregion and microclimates. For more detailed and locally relevant climate data refer to the Oregon Climate Service.

Table 2-296. Average Precipitation and Temperature Ranges in Region 5 Ecoregions

Ecoregion	Mean Annual Precipitation Range (inches)	Mean Temperature Range (°F) January min/max	Mean Temperature Range (°F) July min/max
Cascades*	55–140	16/41	38/78
Eastern Cascades slopes and foothills*	16–55	16/40	40/82
Columbia Plateau*	7–25	24/41	52/89
Blue Mountains*	8–60	16/41	43/84

*Data have been generalized from all the sub-ecoregions of the ecoregion in Region 5.

Source: Thorson et al. (2003)

Demography

Population

Population forecasts are an indicator of future development needs and trends. Community demographics may indicate where specific vulnerabilities may be present in the aftermath of a natural hazard (Cutter et al., 2003). If a population is forecast to increase substantially, a community's capacity to provide adequate housing stock, services, or resources for all populations after a disaster may be stressed or compromised.

Overall, from 2000 to 2013 Region 5's growth rate is roughly 5% less than the state. The majority of the region's growth occurred in the largest cities and in Hood River, Umatilla, and Wasco Counties. Sherman was the only county in the region to decline in population. By 2020, all counties in Region 5, except Hood River County, are projected to grow at a rate less than the state overall.

Table 2-297. Population Estimate and Forecast for Region 5

	2000	2013	Percent Change (2000 to 2013)	2020 Projected	Percent Change (2013 to 2020)
Oregon	3,421,399	3,919,020	14.5%	4,252,100	8.5%
Region 5	129,594	142,150	9.7%	152,460	7.3%
Gilliam	1,915	1,945	1.6%	2,062	6.0%
Hood River	20,411	23,295	14.1%	25,628	10.0%
Morrow	10,995	11,425	3.9%	12,307	7.7%
Sherman	1,934	1,780	-8.0%	1,716	-3.6%
Umatilla	70,548	77,895	10.4%	83,359	7.0%
Wasco	23,791	25,810	8.5%	27,388	6.1%

Source: Population Research Center, Portland State University, 2013; U.S. Census Bureau, 2010 Decennial Census. Table DP-1; Office of Economic Analysis, Long-Term Oregon State's County Population Forecast, 2010-2050, 2013

Tourists

Tourists are not counted in population statistics and are therefore considered separately in this analysis. Tourism activities in Region 5 are largely centered on outdoor activities (hiking/backpacking, visiting national/state parks etc.), touring (traveling to experience scenic beauty, history and culture), and special events (such as fairs, festivals or sporting events) (Longwoods Travel USA, 2011e). Over 9% (2.5 million) of all overnight trips to Oregon included time within Region 5. (Data for Morrow and Umatilla Counties are not included in this count.) Two thirds of trips to the region occur between April and September, and the average travel party contains four persons. The average trip length is over four nights. (Data for Morrow and Umatilla Counties are not included in this count.) From 2011 to 2013, the majority of visitors to the Mid-Columbia Region lodged in hotels/motels or other accommodations.

Difficulty locating or accounting for travelers increases their vulnerability in the event of a natural disaster. Furthermore, tourists are often unfamiliar with evacuation routes, communication outlets, or even the type of hazard that may occur (MDC Consultants, n.d.). Targeting natural hazard mitigation outreach efforts to places where tourists lodge can help increase awareness and minimize the vulnerability of this population.

Table 2-298. Annual Visitor Estimates in Person Nights in Region 5

	2011		2012		2013	
	Number	Percent	Number	Percent	Number	Percent
Region 5	3,907	—	3,835	—	3,878	—
Gilliam and Sherman	149	100%	153	100%	142	100%
Hotel/Motel	50	33.6%	51	33.3%	40	28.2%
Private Home	36	24.2%	37	24.2%	36	25.4%
Other	63	42.3%	65	42.5%	66	46.5%
Hood River	819	100%	853	100%	850	100%
Hotel/Motel	367	44.8%	389	45.6%	386	45.4%
Private Home	284	34.7%	292	34.2%	289	34.0%
Other	168	20.5%	172	20.2%	175	20.6%
Morrow	252	100%	244	100%	261	100%
Hotel/Motel	77	30.6%	72	29.5%	82	31.4%
Private Home	114	45.2%	110	45.1%	116	44.4%
Other	61	24.2%	62	25.4%	63	24.1%
Umatilla	1,681	100%	1,588	100%	1,652	100%
Hotel/Motel	668	40%	597	38%	628	38%
Private Home	775	46%	748	47%	779	47%
Other	238	14%	243	15%	245	15%
Wasco	1,006	100%	997	100%	973	100%
Hotel/Motel	401	40%	380	24%	359	37%
Private Home	247	25%	250	16%	250	26%
Other	358	36%	367	23%	364	37%

Source: Oregon Travel Impacts: 1991–2013, April 2014. Dean Runyan Associates, http://www.deanrunyan.com/doc_library/ORImp.pdf

Persons with Disabilities

Disabilities appear in many forms. While some disabilities may be easily identified, others may be less perceptible. Disabled populations, while difficult to identify and measure, are disproportionately affected during disasters (Cutter et al., 2003). The same percentage of people in Region 5 identify as having a disability as do people throughout the state. Notably, roughly 22% of Gilliam County's population and half of its seniors (65 and older) report having a disability. Morrow and Umatilla Counties also have high percentages (over 40%) of seniors reporting a disability. Local natural hazard mitigation plans should specifically target outreach programs toward helping disabled residents better prepare for and recover from hazard events.

Table 2-299. People with a Disability by Age Groups in Region 5, 2012

	Total Population*	With a Disability (Total Population)		Under 18 Years with a Disability		65 Years and Over with a Disability	
	Estimate	Estimate	Percent	Estimate	Percent**	Estimate	Percent**
Oregon	3,796,881	511,297	13.5%	39,439	4.6%	200,374	37.8%
Region 5	133,922	18,074	13.5%	1,282	3.6%	7,355	39.6%
Gilliam	1,897	425	22.4%	21	5.8%	199	49.9%
Hood River	22,118	2,217	10.0%	140	2.4%	874	31.9%
Morrow	11,137	1,748	15.7%	163	5.1%	621	45.5%
Sherman	1,865	339	18.2%	19	4.8%	159	39.7%
Umatilla	72,178	9,710	13.5%	684	3.4%	3,990	42.5%
Wasco	24,727	3,635	14.7%	255	4.5%	1,512	35.1%

Note: *Total population does not include institutionalized population

Note: **Percent of age group

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Homeless Population

Population estimates of the homeless are performed in Oregon each January. These are rough estimates and can fluctuate with many factors, including the economy or season. The overwhelming majority of homeless are either single adult males or families with children. Communities located along major transportation corridors, such as I-84, tend to have higher concentrations of homeless people (Thomas et al., 2008). Throughout the region, with the exception of Gilliam and Sherman Counties, this population increased significantly from 2009 to 2010. The next year these numbers almost doubled in Wasco and Umatilla Counties, and decreased by half or more in Hood River and Morrow.

Extra attention is needed to care for and serve homeless communities. Some homeless people choose to remain hidden or anonymous, making it especially difficult to mitigate harm to them from natural hazard events. Accessible shelter and social services are key emergency considerations for the homeless community.

Table 2-300. Homeless Population Estimate for Region 5

	2009	2010	2011	3-Year Average
Oregon	17,122	19,208	22,116	19,482
Region 5	310	1,052	939	767
Gilliam	14	0	9	8
Hood River	18	482	284	261
Morrow	179	241	10	143
Sherman	5	0	N/A	3
Umatilla	61	104	235	133
Wasco	33	225	401	220

Source: Oregon Point in Time Homeless Count, Oregon Housing and Community Services. http://www.oregon.gov/ohcs/pages/ra_point_in_time_homeless_count.aspx

Gender

Region 5 has slightly more males than females (male, 51.1%; female, 48.9%), an inverse ratio to that of the state (Cutter et al., 2003). 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 (Cutter et al., 2003).

Age

More than one fifth of the population in Gilliam and Sherman are seniors. Senior citizens may require special consideration due to sensitivity to heat and cold, reliance upon transportation to obtain medication, and comparative difficulty in making home modifications that reduce risk to hazards. In addition, the elderly may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to the elderly (Morrow, 1999).

Children constitute over a quarter of the population in Hood River, Morrow, and Umatilla Counties. Special consideration should be given to young children, schools, and parents during the natural hazard mitigation process. Young children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities. Parents may lose time from work and money when their children's childcare facilities and schools are impacted by disasters (Cutter et al., 2003).

Table 2-301. Population by Vulnerable Age Groups, in Region 5, 2012

	Total Population	Under 18 Years Old		65 Years and Older	
	Estimate	Estimate	Percent	Estimate	Percent
Oregon	3,836,628	864,243	22.5%	540,527	14.1%
Region 5	138,081	35,502	25.7%	19,148	13.9%
Gilliam	1,904	361	19.0%	406	21.3%
Hood River	22,207	5,740	25.8%	2,799	12.6%
Morrow	11,146	3,173	28.5%	1,368	12.3%
Sherman	1,865	393	21.1%	401	21.5%
Umatilla	75,846	20,130	26.5%	9,685	12.8%
Wasco	25,113	5,705	22.7%	4,489	17.9%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP05

Language

There are considerably high percentages of the populations in Hood River and Morrow Counties who do not speak English "very well," roughly 18% and 14%, respectively. Outreach materials used to communicate with and plan for these populations should take into consideration language needs.

Table 2-302. English Usage in Region 5, 2012

	Speak English "Very Well"		Speak English Less Than "Very Well"	
	Estimate	Percent	Estimate	Percent
Oregon	3,376,744	93.8%	224,905	6.2%
Region 5	115,667	90.0%	12,842	10.0%
Gilliam	1,781	98.9%	20	1.1%
Hood River	17,134	82.5%	3,629	17.5%
Morrow	8,928	86.3%	1,422	13.7%
Sherman	1,695	96.7%	58	3.3%
Umatilla	64,574	91.9%	5,716	8.1%
Wasco	21,555	91.5%	1,997	8.5%

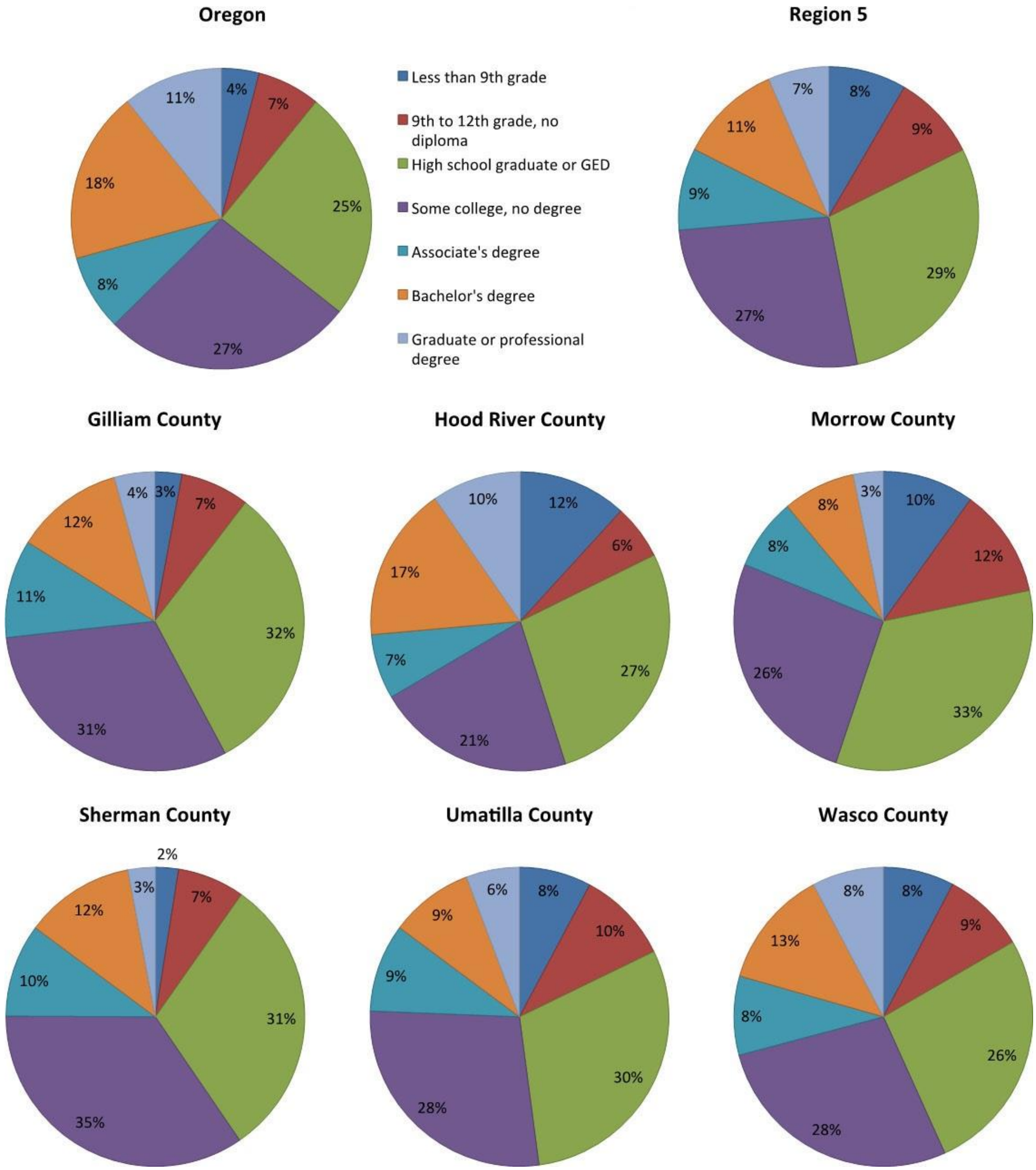
Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Education Level

Studies (Cutter et al., 2003) show that education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings. The region has a 7% lower rate of high school graduates (including GEDs) and a 12% lower rate of persons with a bachelor's degree compared to statewide percentages. Hood River County has the largest percentage population with a bachelor's degree or higher, while Morrow County has the lowest percentage.

Education can influence the ability to access resources, while lack of resources may constrain the ability to understand warning information (Cutter et al., 2003). Therefore, levels of education within the region should be considered when designing hazard outreach materials to local communities.

Figure 2-159. Educational Attainment in Region 5, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Income

The impact of a disaster in terms of loss and the ability to recover varies among population groups. "The causes of social vulnerability are explained by the underlying social conditions that are often quite remote from the initiating hazard or disaster event" (Cutter, 2006, p. 76). Historically, 80% of the disaster burden falls on the public. Of this number, a disproportionate burden is placed upon those living in poverty. People living in poverty are more likely to be isolated, are less likely to have the savings to rebuild after a disaster, and are less likely to have access to transportation and medical care.

The financial crisis that began in 2007 appears to have minimally affected Region 5's median household incomes. Contrary to statewide trends between 2009 and 2014, median household incomes increased in all counties in Region 5, except in Wasco County. Sherman County experienced the largest growth (almost 190%) in household income. In all but one county in the region, median household incomes are lower than the statewide average by $1,500-$6,400. The exception is Hood River County, in which households earn on average of $6,300 more than the statewide average.

Table 2-303. Median Household Income in Region 5

	2009	2012	Percent Change
Oregon	$52,474	$50,036	-4.6%
Region 5	N/A	N/A	N/A
Gilliam	$45,070	$45,833	1.7%
Hood River	$53,289	$56,355	5.8%
Morrow	$46,639	$48,457	3.9%
Sherman	$37,578	$44,583	18.6%
Umatilla	$48,404	$48,452	0.1%
Wasco	$44,206	$43,601	-1.4%

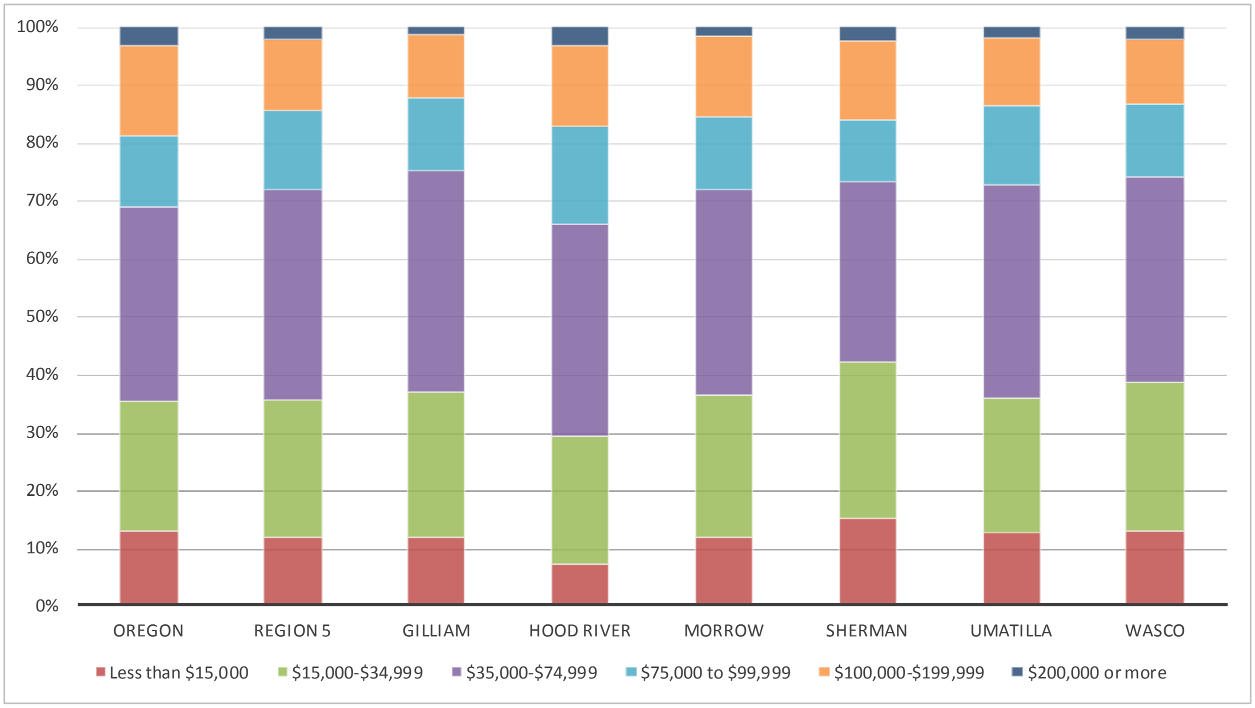
Note: 2009 dollars are adjusted for 2012 using Bureau of Labor Statistics' Consumer Price Index Inflation Calculator.

N/A = data not aggregated at the regional level.

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates. Table DP03.

The region has about the same household income distribution as the state as a whole. Within the region, Sherman County has the highest percentage of households (42.1%) earning less than $35,000 per year, while Hood River County has the highest percentage of households (34.2%) earning more than $75,000 per year. Just over one third of the region's households earn between $35,000 and $75,000 per year.

Figure 2-160. Median Household Income Distribution in Region 5, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP03

The share of the Mid-Columbia Region's individuals and children living in poverty is comparable to statewide numbers. Sherman and Wasco Counties have the highest percentages of their populations living in poverty. Gilliam and Wasco Counties have had the greatest increases in poverty rates. Conversely, poverty has been on the decline in Hood River and Morrow Counties. Child poverty rates have significantly increased by more than 25% in Sherman and Wasco Counties. Notably, 44% of children in Sherman County are living in poverty.

Table 2-304. Poverty Rates in Region 5, 2012

	Total Population in Poverty			Children Under 18 in Poverty		
	Number	Percent	Percent Change*	Number	Percent	Percent Change*
Oregon	584,059	15.5%	17.7%	175,303	20.6%	17.6%
Region 5	20,495	15.6%	8.1%	7,415	21.2%	13.1%
Gilliam	238	12.6%	36.0%	41	11.6%	2.5%
Hood River	2,235	10.1%	-6.3%	682	12.0%	-5.8%
Morrow	1,726	15.5%	-9.6%	723	22.9%	-8.6%
Sherman	413	22.4%	11.0%	165	44.1%	27.9%
Umatilla	11,149	15.5%	6.5%	4,451	22.4%	17.1%
Wasco	4,734	19.3%	29.5%	1,353	24.6%	25.9%

*Percent change since 2009

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates, Table S1701

Low-income populations require special consideration when mitigating loss to a natural hazard. Often, those who earn less have little to no savings and other assets to withstand economic setbacks. When a natural disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the natural disaster. To reduce the compounded loss incurred by low-income populations post-disaster, mitigation actions need to be specially tailored to ensure safety nets are in place to provide further support to those with fewer personal resources (Cutter et al., 2003).

Housing Tenure

Wealth can increase the ability to recover following a natural disaster (Cutter et al., 2003), and homeownership, versus renting, is often linked to having more wealth. Renters often do not have personal financial resources or insurance to help recover post-disaster. On the other hand, renters tend to be more mobile and have fewer assets at risk. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable due to natural disaster events.

Collectively, about one third of housing units in Region 5 are rentals. Morrow County has the highest percentage of owner-occupied units — 10% more than the regional average. Gilliam County has the highest percentage of rental units. The region has a roughly 3% higher vacancy rate than the state, with the highest percentage in Gilliam County (about 15%), and the highest number of units in Umatilla County (2,044). In addition, the region has a slightly higher percentage of seasonal or recreational homes than the state (U.S. Census Bureau, 2008–2012 American Community Survey, Table DP04 and Table B25004).

Table 2-305. Housing Tenure in Region 5, 2012

	Occupied Units	Owner-occupied		Renter-occupied		Vacant^	
		Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	945,824	62.5%	566,894	37.5%	105,417	6.3%
Region 5	50,034	33,156	66.3%	16,878	33.7%	4,346	9.5%
Gilliam	894	561	62.8%	333	37.2%	174	14.8%
Hood River	8,027	5,498	68.5%	2,529	31.5%	666	7.2%
Morrow	3,791	2,769	73.0%	1,022	27.0%	435	9.8%
Sherman	788	525	66.6%	263	33.4%	93	10.3%
Umatilla	26,786	17,391	64.9%	9,395	35.1%	2,044	6.9%
Wasco	9,748	6,412	65.8%	3,336	34.2%	934	8.2%

^ = Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04 and Table B25004.

Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households. Region 5 is predominantly composed of family households, and roughly one third of those have children. Similar to the state as a whole, more than twice as many single-parent households are headed by females than by males.

Table 2-306. Family vs. Non-family Households in Region 5, 2012

	Total Households	Family Households		Nonfamily Households		Householder Living Alone	
	Estimate	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	964,274	63.7%	548,444	36.3%	421,620	27.9%
Region 5	50,034	34,196	68.3%	15,838	31.7%	13,162	26.3%
Gilliam	894	543	60.7%	351	39.3%	321	35.9%
Hood River	8,027	5,341	66.5%	2,686	33.5%	2,100	26.2%
Morrow	3,791	2,737	72.2%	1,054	27.8%	874	23.1%
Sherman	788	476	60.4%	312	39.6%	254	32.2%
Umatilla	26,786	18,553	69.3%	8,233	30.7%	6,954	26.0%
Wasco	9,748	6,546	67.2%	3,202	32.8%	2,659	27.3%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Table 2-307. Family Households with Children by Head of Household in Region 5, 2012

	Family Households with Children		Single Parent (Male)		Single Parent (Female)		Married Couple with Children	
	Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	415,538	27.5%	35,855	2.4%	93,575	6.2%	286,108	18.9%
Region 5	15,236	30.5%	1,349	2.7%	3,665	7.3%	10,222	20.4%
Gilliam	185	20.7%	23	2.6%	46	5.1%	116	13.0%
Hood River	2,545	31.7%	150	1.9%	314	3.9%	2,081	25.9%
Morrow	1,335	35.2%	132	3.5%	323	8.5%	880	23.2%
Sherman	176	22.3%	10	1.3%	46	5.8%	120	15.2%
Umatilla	8,711	32.5%	880	3.3%	2,280	8.5%	5,551	20.7%
Wasco	2,284	23.4%	154	1.6%	656	6.7%	1,474	15.1%

Note: The table shows the percent of total households represented by each family household structure category.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Social and Demographic Trends

The social and demographic analysis shows that Region 1 is particularly vulnerable during a hazard event in the following ways:

- Almost a quarter of the population has a disability, including half the senior population, in Gilliam County.
- The homeless population in Wasco and Umatilla Counties has increased significantly.
- Children comprise over one quarter of the population in Hood River, Morrow, and Umatilla Counties.
- Over one fifth of the population in Gilliam and Sherman Counties are seniors.
- High numbers of people who do not speak English "very well" in Hood River and Umatilla Counties.
- The region has a lower share of people with a college degree then the state as a whole.
- Roughly one third of housing units are rentals.
- Gilliam and Sherman Counties have high vacancy rates.

Economy

Economic characteristics include the financial resources present and revenue generated in the community to achieve a higher quality of life. Employment characteristics, income equality, employment, and industry sectors 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 employment sectors, workforce, resources, and infrastructure are interconnected in the existing economic picture.

Employment

Employment status and salary level may impact the resilience of individuals and families in the face of disasters as well as their ability to mitigate against losses due to natural hazards (Cutter et al., 2003). "The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster" (Cutter et al., 2003). The region has made a broad recovery since the financial crisis that began in 2007, with an 11% increase in its labor force (Tauer, 2014). Regional unemployment rates have been declining steadily. Umatilla County has the largest labor force in the region and the highest unemployment rate. Average salaries are low, between 73% and 92% of the statewide average. (Data are for "Covered Employment," workers covered by state Unemployment Insurance [UI] laws and for civilian workers covered by the program of Unemployment Compensation for Federal Employees.) For example, the average salary in Morrow County is $41,352 and $31,215 in Hood River County.

Table 2-308. Unemployment Rates in Region 5, 2009-2013

	2009	2010	2011	2012	2013	Change (2009-2013)
Oregon	11.1%	10.8%	9.7%	8.8%	7.7%	-3.4%
Region 5	9.1%	9.4%	8.8%	8.1%	7.5%	-1.6%
Gilliam	6.8%	7.0%	7.5%	7.6%	6.9%	0.1%
Hood River	8.1%	8.3%	7.9%	7.1%	6.1%	-2.0%
Morrow	9.2%	9.4%	8.8%	8.3%	7.8%	-1.4%
Sherman	9.0%	9.9%	9.2%	8.7%	7.3%	-1.7%
Umatilla	9.6%	10.0%	9.2%	8.5%	8.1%	-1.5%
Wasco	8.9%	9.4%	8.6%	8.0%	7.1%	-1.9%

Source: Oregon Employment Department, 2014

Table 2-309. Employment and Unemployment Rates in Region 5, 2013

	Civilian Labor Force	Employed Workers		Unemployed	
	Total	Total	Percent	Total	Percent
Oregon	1,924,604	1,775,890	92.3%	148,714	7.7%
Region 5	74,367	68,801	92.5%	5,566	7.5%
Gilliam	1,050	978	93.1%	72	6.9%
Hood River	14,215	13,353	93.9%	862	6.1%
Morrow	5,339	4,923	92.2%	416	7.8%
Sherman	1,000	927	92.7%	73	7.3%
Umatilla	38,255	35,138	91.9%	3,117	8.1%
Wasco	14,508	13,482	92.9%	1,026	7.1%

Source: Oregon Employment Department, 2014

Table 2-310. Employment and Payroll in Region 5, 2013

	Employees	Average Pay	Percent State Average
Oregon	1,679,364	$45,010	100%
Region 5	60,049	$34,649	77.0%
Gilliam	746	$36,145	80.3%
Hood River	12,892	$31,215	69.4%
Morrow	4,805	$41,352	91.9%
Sherman	751	$38,746	86.1%
Umatilla	29,275	$35,594	79.1%
Wasco	11,580	$32,939	73.2%

Source: Oregon Employment Department, 2014

Employment Sectors and Key Industries

In 2013 the five major employment sectors in Region 5 were: (a) Government; (b) Trade, Transportation, and Utilities; (c) Natural Resources and Mining; (d) Education and Health Services; and (e) Manufacturing. Between 2012 and 2022, projected growth is expected to create a 9% increase in employment in the Columbia Basin, including Morrow and Umatilla Counties, and a 15% increase in employment in the Columbia Gorge Region, including Gilliam, Hood River, Sherman, and Wasco Counties (Oregon Employment Department, n.d.b).

Table 2-311. Covered Employment by Sector in Region 5, 2013

		Gilliam County		Hood River County		Morrow County	
Industry	**Region 5**	**Employment**	**Percent**	**Employment**	**Percent**	**Employment**	**Percent**
Total All Ownerships	60,049	746	100%	12,892	100%	4,805	100%
Total Private Coverage	80.6%	522	70.0%	11,661	90.5%	3,978	82.8%
Natural Resources & Mining	14.4%	43	5.8%	2,667	20.7%	1,062	22.1%
Construction	2.8%	51	6.8%	296	2.3%	129	2.7%
Manufacturing	11.3%	(c)	0.0%	1,362	10.6%	1,504	31.3%
Trade, Transportation & Utilities	18.1%	127	17.0%	1,905	14.8%	584	12.2%
Information	1.0%	(c)	0.0%	138	1.1%	70	1.5%
Financial Activities	2.2%	15	2.0%	226	1.8%	73	1.5%
Professional & Business Services	6.2%	134	18.0%	898	7.0%	210	4.4%
Education & Health Services	12.1%	55	7.4%	1,822	14.1%	152	3.2%
Leisure & Hospitality	9.8%	45	6.0%	2,008	15.6%	149	3.1%
Other Services	2.6%	33	4.4%	337	2.6%	45	0.9%
Private Non-Classified	0.0%	(c)	0.0%	2	0.0%	-	0.0%
Total All Government	19.4%	224	30.0%	1,231	9.5%	828	17.2%
Federal Government	1.8%	10	1.3%	107	0.8%	57	1.2%
State Government	4.0%	17	2.3%	118	0.9%	109	2.3%
Local Government	13.6%	198	26.5%	1,006	7.8%	662	13.8%

		Sherman County		Umatilla County		Wasco County	
Industry	**Region 5**	**Employment**	**Percent**	**Employment**	**Percent**	**Employment**	**Percent**
Total All Ownerships	60,049	751	100%	29,275	100%	11,580	100%
Total Private Coverage	80.6%	434	57.8%	22,284	76.1%	9,509	82.1%
Natural Resources & Mining	14.4%	13	1.7%	2,919	10.0%	1,950	16.8%
Construction	2.8%	(c)	0.0%	877	3.0%	300	2.6%
Manufacturing	11.3%	(c)	0.0%	3,235	11.1%	702	6.1%
Trade, Transportation & Utilities	18.1%	235	31.3%	6,079	20.8%	1,953	16.9%
Information	1.0%	-	0.0%	174	0.6%	194	1.7%
Financial Activities	2.2%	(c)	0.0%	687	2.3%	301	2.6%
Professional & Business Services	6.2%	12	1.6%	1,999	6.8%	478	4.1%
Education & Health Services	12.1%	14	1.9%	3,196	10.9%	2,055	17.7%
Leisure & Hospitality	9.8%	124	16.5%	2,376	8.1%	1,184	10.2%
Other Services	2.6%	19	2.5%	739	2.5%	392	3.4%
Private Non-Classified	0.0%	(c)	0.0%	4	0.0%	(c)	0.0%
Total All Government	19.4%	317	42.2%	6,991	23.9%	2,072	17.9%
Federal Government	1.8%	130	17.3%	511	1.7%	288	2.5%
State Government	4.0%	38	5.1%	1,761	6.0%	334	2.9%
Local Government	13.6%	149	19.8%	4,719	16.1%	1,450	12.5%

Note: (c) = confidential, information not provided by Oregon Employment Department to prevent identifying specific businesses.

Source: Oregon Employment Department, 2013

Each industry faces distinct vulnerabilities to natural hazards. Identifying key industries in the region enables communities to target mitigation activities toward those industries' specific sensitivities. Each of the primary private employment sectors has sensitivity to natural hazards, as follows.

Trade, Transportation, and Utilities: Retail Trade is the largest employment subsector within the Trade, Transportation, and Utilities sector. Retail Trade is vulnerable to disruptions in the disposable income of regional residents and to disruptions in the transportation system. Residents' discretionary spending diminishes after natural disasters as spending priorities tend to focus on essential items. Disruption of the transportation system could sever connectivity of people and retail hubs. Retail businesses are concentrated in the larger cities of the region.

Natural Resources and Mining: The primary industries within this sector regionally are largely crop and animal production. These industries tend to fluctuate seasonally and are vulnerable to a variety of natural hazards (winter storms, floods, etc.). In addition to the loss of farm production, wages could be lost due to natural disasters. In addition, these industries are dependent upon transportation systems that are vulnerable to disasters.

Education and Health Services: The industries in these sectors play important roles in emergency response in the event of a disaster. Health care is a relatively stable revenue sector regionally with an increasing distribution of businesses primarily serving a local and aging population.

Manufacturing: This sector is highly dependent upon transportation networks in order to access supplies and send finished products to outside markets. For these reasons the manufacturing sector may be susceptible to disruptions in transportation infrastructure. However, manufacturers are not dependent on local markets for sales, which may contribute to the economic resilience of this sector.

Revenue by Sector

In 2007 Trade (Retail and Wholesale), Manufacturing, and Healthcare and Social Assistance were the highest revenue grossing industries in Region 5. (Revenue data from the 2012 Economic Census will not be released prior to the publication of this Plan.) Combined, these three industries generated over $2.9 billion (83% total revenue) for the region (**Table 2-312**). Trade (Retail and Wholesale) is the largest grossing sector in all counties.

Note: Due to the small size and few industries in the region, data are withheld in several categories, especially manufacturing data, to avoid disclosing information on individual companies. Therefore, data are aggregated at the county level.

Table 2-312. Revenue of Top Industries (in Thousands of Dollars) in Region 5

	Total Revenue (in Thousands)	Trade (Retail and Wholesale)	Manufacturing	Health Care and Social Assistance
Oregon	$277,017,733	44.4%	24.1%	7.3%
Region 5	$3,447,733	61.7%	—	14.4%
Gilliam	$46,622	96.8%	—	—
Hood River	$1,047,637	49.4%	23.5%	10.3%
Morrow	$115,354	57.9%	D	9.7%

Sherman	$74,222	91.7%	—	0.3%
Umatilla	$1,545,252	67.8%	D	15.6%
Wasco	$618,646	61.7%	—	22.2%

Notes: D = Withheld to avoid disclosing data for individual companies; data are included in higher level totals, and "-" = data not provided.

Source: U.S. Census, Economic Census. 2007. Table EC0700A1

Sectors that are anticipated to be major employers in the future warrant special attention, especially in the hazard mitigation planning process so the workforce and employers can be more prepared to respond and adapt to needs that arise after a natural hazard event. According to the Oregon Employment Department, between 2012 and 2022 the largest job growth in Region 5 is expected to occur in the following sectors: (a) Education and Health Services; (b) Trade, Transportation, and Utilities (including retail trade); (c) Natural Resources and Mining; (d) Leisure and Hospitality; (e) Government; and (f) Manufacturing (Oregon Employment Department, 2014).

Identifying sectors with a large number of businesses and targeting mitigation strategies to support those sectors can help the region's resiliency. The Trade, Transportation, and Utilities sector includes the most businesses in Region 5. The Natural Resources and Mining sector has the second most businesses. Professional and Business Services, Education and Health Services, Leisure and Hospitality, and the Other Services round out the regions' top five sectors (Oregon Employment Department, 2012). While many of these are small businesses employing fewer than 20 employees, collectively they represent almost three fourths of the businesses in the region. Due to their small size and large collective share of the economy, these businesses are particularly sensitive to temporary decreases in demand such as may occur following a natural hazard event.

Economic Trends and Issues

Current and anticipated financial conditions of a community are strong determinants of community resilience, since a strong and diverse economic base increases the ability of individuals, families, and communities to absorb impacts of a disaster and recover more quickly. The Economic analysis shows that Region 5 is particularly vulnerable during a hazard event due to:

- Higher unemployment in Morrow and Umatilla Counties, and
- Significantly lower regional wages than the state as a whole in Hood River and Morrow Counties.

This region has largely rebounded from the financial crisis that began in 2007. Much of the region's growth in employment is spurred by the health care and construction industries, which are driven by an aging population and an increase in retiring baby boomers (Oregon Employment Department, n.d.b). Supporting the growth of dominant industries and employment sectors as well as emerging sectors identified in this analysis can help the region become more resilient to economic downturns that often follow a hazard event (Stahl et al., 2000).

Infrastructure

Transportation

Roads

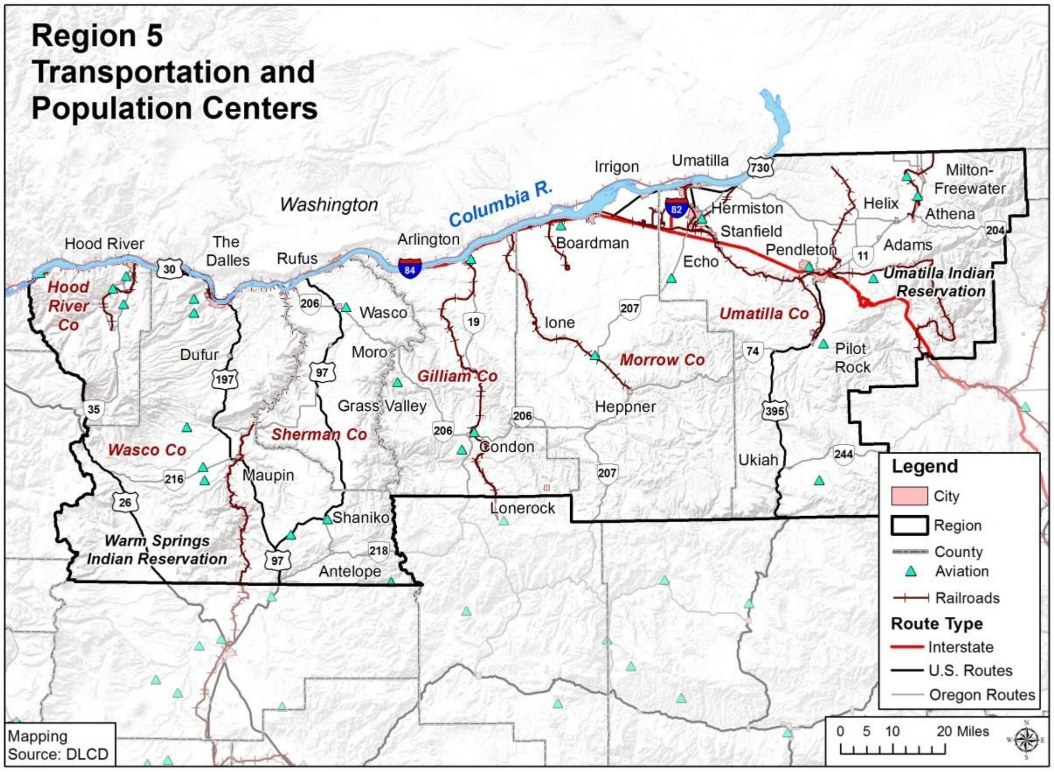
The largest population bases in Region 5 are located along the region's major freeways, I-84. I-84 is the main east-west passage for automobiles and trucks traveling between the northwest and states to the east.

Region 5's growing population centers bring more workers, automobiles and trucks onto roads. A high percentage of workers driving alone to work coupled with interstate and international freight movement on the I-84 corridor create additional stresses on transportation systems. Some of these stresses are added maintenance, congestion, oversized loads, and traffic accidents.

Natural hazards and emergency events can further disrupt automobile traffic, create gridlock, and shut down local transit systems, making evacuation and other emergency operations difficult. Hazards such as localized flooding can render roads unusable. Likewise, a severe winter storm has the potential to disrupt the daily driving routine of thousands of people.

According to the Oregon Department of Transportation's (ODOT's) Seismic Lifeline Report (**Appendix 9.1.13**), ground shaking from a CSZ event is not expected to cause damage to the region's major highways. The region has relatively low vulnerability to ground shaking from a CSZ event. However, connections to markets and services will likely be disrupted. For information on ODOT's Seismic Lifeline Report findings for Region 5, see **Seismic Lifelines**.

Figure 2-161. Region 5 Transportation and Population Centers



Source: Oregon Department of Transportation, 2014

Bridges

Because of earthquake risk in Region 5, the seismic vulnerability of the region'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 region's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or that are part of regional and local systems that are maintained by the region's counties and cities.

Table 2-313 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 (ODOT, 2012, 2013). The region has about the same percentage of bridges that are distressed or deficient (20%), as does the state.

Table 2-313. Bridge Inventory for Region 5

	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 5	31	123	25%	8	73	11%	2	13	15%	2	3	67%	43	215	20%	50
Gilliam	4	19	21%	2	16	13%	0	1	0%	0	0	—	6	36	17%	1
Hood River	16	45	33%	1	15	7%	0	0	—	2	2	100%	19	66	29%	8
Morrow	2	24	9%	3	33	9%	2	11	18%	0	1	0%	7	68	10%	3
Sherman	9	35	26%	2	9	22%	0	1	0%	0	0	—	11	45	24%	2
Umatilla	9	117	8%	37	168	22%	4	22	18%	0	0	—	50	299	17%	15
Wasco	11	51	26%	9	65	14%	1	5	20%	1	2	50%	22	115	19%	21

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.

Source: ODOT (2012, 2013)

Railroads

Railroads that run through Region 5 support cargo and trade flows. The region's major freight rail providers are the Union Pacific (UP) and the Burlington Northern-Santa Fe (BNSF) railroads. There are two major rail yards in the region — in The Dalles and Hinkle — operated by UP (Cambridge Systematics, 2014). The Hinkle Yard serves as UP's system yard and locomotive service and repair yard for Oregon and the greater northwest area (Cambridge Systematics, 2014).

Amtrak provides passenger rail service along the Columbia Gorge and eastward via the Empire Builder line.

Rails are sensitive to icing from winter storms that can occur in Region 5. Disruptions in the rail system can result economic losses for the region. The potential for harm from rail accidents can also have serious implications for local communities, particularly if hazardous materials are involved.

Airports

The Eastern Oregon Regional Airport is the only commercial airport in the region (City of Pendleton website, http://www.pendleton.or.us/pendleton-airport). It serves one passenger airline, SeaPort Airlines, providing service to Portland and North Bend (Portland International Airport, 2014).

In the event of a natural disaster, public and private airports are important staging areas for emergency response activities. Public airport closures will impact the region's tourism industries, as well as the ability for people to leave the region by air. Businesses relying on air freight may also be impacted by airport closures.

Table 2-314. Public and Private Airports in Region 5

	Number of Airports by FAA Designation				
	Public Airport	Private Airport	Public Helipad	Private Helipad	Total
Region 5	9	18	0	8	35
Gilliam	2	2	0	0	4
Hood River	2	2	0	1	5
Morrow	2	0	0	1	3
Sherman	1	0	0	0	1
Umatilla	2	6	0	5	13
Wasco	0	8	0	1	9

Source: FAA Airport Master Record (Form 5010), 2014

Ports

Oregon's ports have historically been used for timber transport, and commercial and recreational fishing. With the decline in the timber industry, ports have evolved to embrace economic development and tourism by offering industrial land and river, rail, road, and air infrastructure. There are three ports within Region 5: The Port of Cascade Locks, The Port of The Dalles, and the Port of Hood River. The Port of Cascade Locks includes industrial land, a marine park, and the Bridge of the Gods, and promotes recreation tourism (Port of Cascade Locks website, http://portofcascadelocks.org/http://portofcascadelocks.org/). The Port of Hood River encompasses industrial land, business parks, an expo center, the Hood River Marina and waterfront area, Hood River Airport, and the Hood River – White Salmon Bridge (Portland Hood River website, http://www.portofhoodriver.com/http://www.portofhoodriver.com/). The Port of The Dalles is approximately 425,000 square acres and covers the northern third of Wasco County. It contains industrial land and The Dalles Marina (Port of The Dalles website, http://www.portofthedalles.com/http://www.portofthedalles.com/).

Energy

Electricity

The region is served by several investor-owned, public, cooperative, and municipal utilities. The Bonneville Power Administration is the area's wholesale electricity distributor. Pacific Power and Light (Pacific Power) is the primary investor-owned utility company serving portions of Gilliam, Hood River, Morrow, Sherman, and Umatilla Counties. The region's electric cooperatives are: the Hood River Electric Cooperative (Hood River County), Wasco Electric Cooperative (Gilliam, Hood River, Sherman, Wasco), Columbia Basin Cooperative (Gilliam, Morrow, Umatilla), Umatilla Cooperative (Umatilla), Columbia Power Cooperative (Umatilla) and Central Electric Cooperative (Wasco). Two utility districts serve the region: City of Cascade Locks (Hood River) and Milton-Freewater (Umatilla). In addition, the Northern Wasco People's Utility District (Wasco) serves portions of the region.

The region has a total of 31 power-generating facilities: 4 hydroelectric power facilities, 3 natural gas power facilities, 23 wind power facilities, and 1 coal power facility. In total, the power-generating facilities have the ability to produce up to 11,227 megawatts (MW) of electricity. The region also includes four wind power facilities that are approved but not constructed. The wind power facilities will have the capacity to generate up to 1,205 MW of electricity (Oregon Department of Energy).

Table 2-315. Power Plants in Region 5

	Hydro-electric	Natural Gas	Wind	Coal	Other*	Total
Region 5	4	3	23	1	0	31
Gilliam	0	0	8**	0	0	8
Hood River	1	0	0	0	0	1
Morrow	0	1	3**	1	0	5
Sherman	1	0	7	0	0	8
Umatilla	1	2	5	0	0	8
Wasco	1	0	0	0	0	1
Energy Production (MW)	**6,458**	**1,265**	**3,044**	**460**	**0**	**11,227**

*“Other” includes biomass, geothermal, landfill gas, solar, petroleum, and waste

**There are four wind power facilities that are located in both Gilliam and Morrow Counties, this table places half of each facility in each county.

Source: Army Corps of Engineers; Biomass Power Association; Calpine Corporation; Eugene Water and Electric Board; Iberdola Renewables; Idaho Power Company; Klamath Energy LLC; Oregon Department of Energy; Owyhee Irrigation District; Form 10K Annual Report (2013), PacifiCorp; Form 10K Annual Report (2013), Portland General Electric; U.S. Geothermal, Inc.

Hydropower

The Bonneville Power Administration (BPA) provides hydro-generated electricity to the state’s consumer-owned utilities. The major BPA dams in the region are located on the Columbia River in communities of The Dalles, John Day, and McNary.

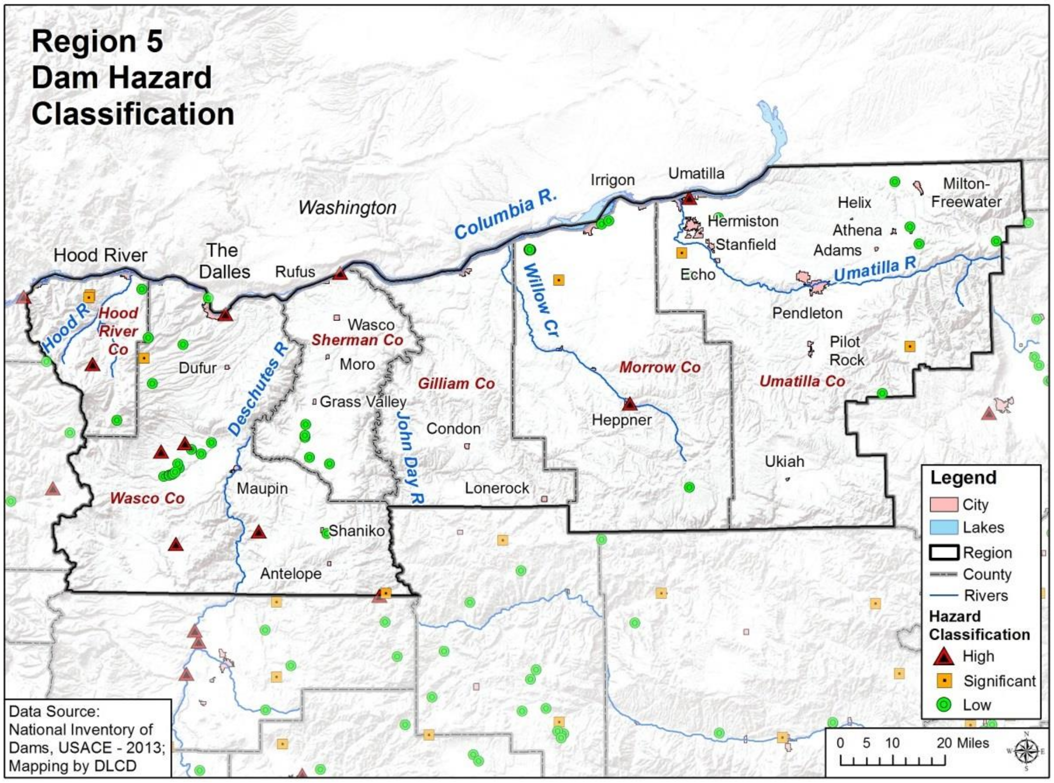
Minor dam failures can occur at any time. Most dam failures result in minor damage to structures and pose little or no risk to life safety. However, the potential for severe damage and fatalities does exist (major dam failures have occurred most recently near Hermiston, 2005, and Klamath Lake, 2006) (Association of Dam Safety Officials, n.d.). The Oregon Water Resources Department maintains an inventory of all large dams located in Oregon by using the National Inventory of Dams (NID) threat potential methodology. Table 2-316 lists the number of dams included in the inventory. The majority of dams in the region are located in Umatilla (19) and Wasco (30) Counties. There are 14 High Threat Potential dams and 6 Significant Threat Potential dams in the region.

Table 2-316. Threat Potential of Dams in Region 5

	Threat Potential			Total Dams
	High	Significant	Low	
Region 5	14	6	57	77
Gilliam	0	0	0	0
Hood River	1	2	8	11
Morrow	1	1	4	6
Sherman	1	0	10	11
Umatilla	3	3	13	19
Wasco	8	0	22	30

Source: Oregon Water Resources Department, Dam Inventory Query 2014

Figure 2-162. Region 5 Dam Hazard Classification

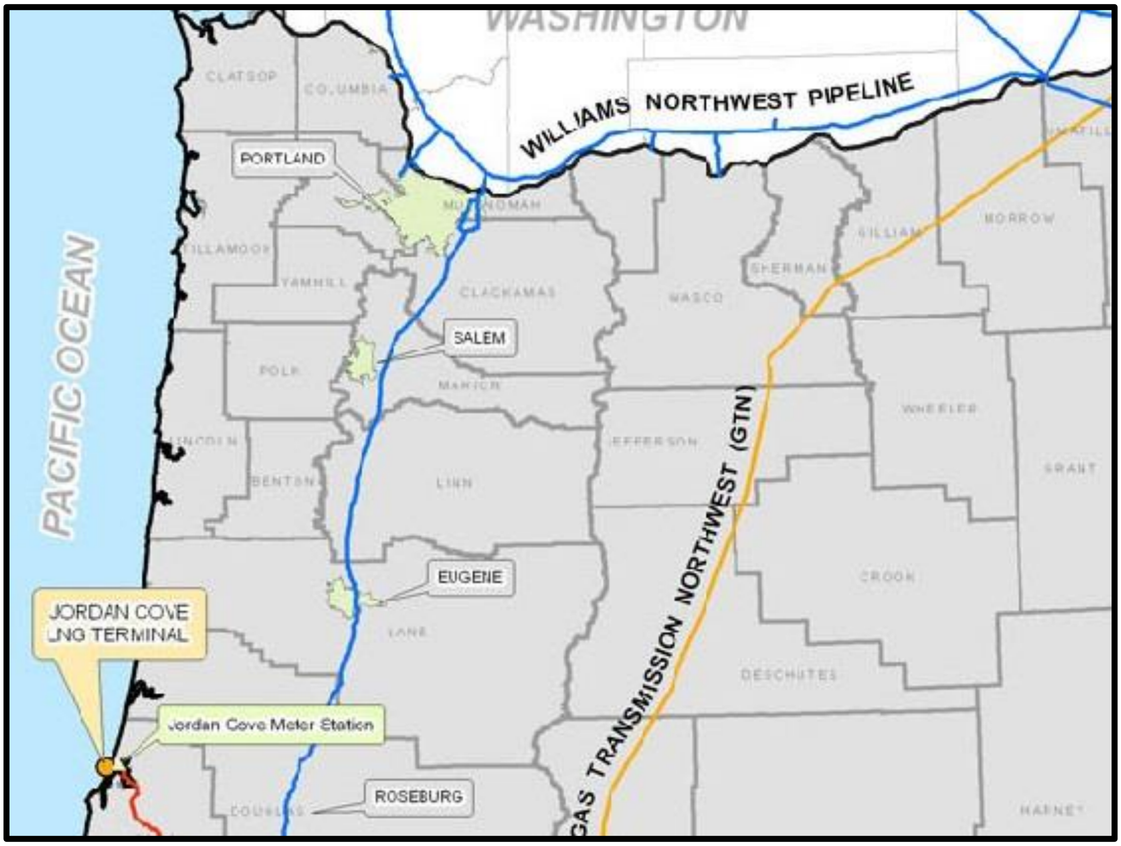


Source: National Inventory of Dams, USACE, 2013

Natural Gas

Although natural gas does not provide the most energy to the region, it does contribute a significant amount of energy to the region's energy portfolio. Liquefied natural gas (LNG) is transported via pipelines throughout the United States. **Figure 2-163** shows the Gas Transmission Northwest (GTN) line, which runs through Gilliam, Morrow, and Umatilla Counties (in green) (Pipelines International, 2009). LNG pipelines, like other buried pipe infrastructure, are vulnerable to earthquakes and can cause danger to human life and safety, as well as environmental impacts in the case of a spill.

Figure 2-163. Liquefied Natural Gas Pipelines in Region 5



Source: Oregon Department of Environmental Quality

Utility Lifelines

The Mid-Columbia region is an important thoroughfare for oil and gas pipelines and electrical transmission lines. The region is also a major producer of hydropower. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy. These lines may be vulnerable to severe, but infrequent natural hazards, such as earthquakes.

Communities in this region primarily receive oil and gas from Alaska by way of the Puget Sound through pipelines and tankers. The region is at the southern end of this pipeline network. Oil and gas are supplied by Northern California via a separate network. The electric, oil, and gas lifelines that run through the region are both municipally and privately owned (Loy et al., 1976).

The network of electrical transmission lines running through Region 5 is operated primarily by Pacific Power, regional electrical cooperatives, and Bonneville Power Administration (Loy et al., 1976). Most of the natural gas Oregon uses originates in Alberta, Canada. Avista Utilities owns the main natural gas transmission pipeline (Loy et al., 1976).

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio). Region 5 is part of the Columbia Gorge Operational Area (Hood River, Wasco, Sherman, Gilliam), Central Oregon Operational Area (Wheeler, Southern Wasco), and Eastern Oregon Operational Area (Morrow, Umatilla) under The Oregon State Emergency Alert System Plan (Oregon Office of Emergency Management, 2013). There is a memorandum of understanding between these counties that facilitates the launching of emergency messages. Counties in these areas can launch emergency messages by contacting the Oregon Emergency Response System (OERS), which in turn creates emergency messages to communities statewide.

Beyond day-to-day operations, maintaining communications capabilities during disaster events and other emergency situations helps to keep citizens safe by keeping them informed of the situation's status, areas to avoid, and other procedural information. Additionally, responders depend on telecommunications infrastructure to be routed to sites where they are needed.

Television

Television serves as a major provider for local, regional, and national news and weather information and can play a vital role in emergency communications. The Oregon State Emergency Alert System Plan does not identify a local primary station for emergency messages.

Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband service providers serve Region 5. Broadband technology including mobile wireless is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless, and mobile wireless. Internet service is readily available throughout most parts the region with a smaller number of providers and service types available in the southern parts of the region (south of I-84) (NTIA, n.d.). Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

Wireless providers sometimes offer free emergency mobile phones to those impacted by disasters, which can aid in communication when landlines and broadband service are unavailable.

Radio

Radio is readily available to those who live within Region 5 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Radio transmitters for the Columbia Gorge Operational Area are (Oregon Office of Emergency Management, 2013):

- KMSW-FM, 92.7 MHZ, The Dalles, 102.9 MHZ, Hood River;
- KHRV-FM, 90.1 MHZ, Hood River, OPB Radio Network; and
- KOTD, 89.7 MHZ, The Dalles, OPB Radio Network.

Ham Radio

Amateur radio, or ham radio, is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). Region 5 is served by ARES Districts 2 and 3. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (Oregon Office of Emergency Management, n.d.). The official ham emergency station calls for Region 5 include (American Relay Radio League Oregon Chapter, n.d., www.arrloregon.org):

- Gilliam County: W7ILD;
- Hood River County: K7VEW;
- Morrow County: N7ZHG;
- Sherman County: WB7PPK;
- Umatilla County: N7ZHG; and
- Wasco County: KF7LN.

Water

Water infrastructure includes drinking water, stormwater, and wastewater systems. All of these systems possess some level of vulnerability to natural hazards that can have repercussions on human health, ecosystems, and industry.

Drinking Water

The drinking water supply in Region 5 is drawn from a combination of surface, well, and spring sources. Surface water is drawn from rivers and smaller tributaries. In the eastern and western portions of the region these surface water sources are often backed up by groundwater that is drawn from an aquifer when surface water levels get low, especially in summer months. However, in the region’s central counties municipal wells drawing from the aquifer are primary sources with springs used as a backup where they are available. In this central part of the region water shortages in wells are increasing although flow levels tend to stay consistent throughout the year. Water quality in the region’s municipal supply is high. Chemical and fuel spills are a concern when surface waterways intersect with or parallel major roadways. Water quality could be threatened as older or damaged well infrastructure may not filter coliform and other bacteria as effectively as newer infrastructure.

Rural residents draw water from surface water, groundwater wells, or springs. Surface water is usually used for irrigation, and wells are used as backup source. Groundwater wells serve residential needs. In rural areas storage ponds or small dams are sometimes created on private land to provide additional on-site drinking water storage. Water quality for rural residents is primarily affected by nitrates from agricultural activities and by low flow levels, which can increase the density of pollutants.

Surface sources for drinking water are vulnerable to pollutants caused by non-point sources and natural hazards. An example of non-point source pollution is stormwater runoff from roadways, agricultural operations, timber harvest, erosion, and sedimentation. Landslides, flood events, earthquakes, and liquefaction can cause increased erosion and sedimentation in waterways.

Underground water supplies and aging or outdated infrastructure — such as reservoirs, treatment facilities, and pump stations — can be severed during a seismic event. Rigid materials such as cast iron may snap under the pressure of liquefaction. More flexible materials such as polyvinyl chloride (PVC) and ductile iron may pull apart at joints under the same stresses. These types of infrastructure damages could result in a loss of water pressure in municipal water supply systems, limiting access to potable water. This can lead to unsanitary conditions that may threaten human health. Lack of water can also impact industry, such as the manufacturing sector. Moreover, if transportation infrastructure is impacted by a disaster event, repairs to water infrastructure will be delayed.

Stormwater and Wastewater

In urbanized areas severe precipitation events may cause flooding that leads to stormwater runoff. A non-point source of water pollution, stormwater runoff can adversely impact drinking water quality. It can also lead to environmental issues such as increasing surface water temperatures, adversely affecting habitat health. Furthermore, fast-moving large volumes of stormwater entering surface waterways can cause flooding and erosion.

Stormwater can also impact water infrastructure. Leaves and other debris can be carried into storm drains and pipes, which can clog stormwater systems. In areas where stormwater systems are combined with wastewater systems (combined sewers), flooding events can lead to combined sewer overflows (CSOs). CSOs present a heightened health threat as sewage can flood urban areas and waterways. Underground stormwater and wastewater pipes are also vulnerable to damage by seismic events.

In Region 5, most municipal building codes and stormwater management plans (city and county) emphasize use of centralized storm sewer systems to manage stormwater. Requirements for stormwater mitigation vary in Region 5. Low impact development (LID) mitigation strategies can alleviate or lighten the burden on a jurisdiction's storm sewer system by allowing water to percolate through soil onsite or detaining water so water enters the storm sewer system at lower volumes, at lower speed, and at lower temperatures. The four largest municipalities in the region, Hood River, Hermiston, The Dalles and Pendleton, do not require LID strategies in their building codes. Promoting and requiring decentralized LID stormwater management strategies could help reduce the burden of new development on storm sewer systems and could increase a community's resilience to many types of hazard events.

Infrastructure Trends and Issues

Physical infrastructure is critical for everyday operations and is essential following a disaster. Lack or poor condition of infrastructure can negatively affect a community's ability to cope with, respond to, and recover from a hazard event. Diversity, redundancy, and consistent maintenance of infrastructure systems help create system resiliency (Meadows, 2008).

The effects of road, bridge, rail, and port failures could be devastating to the economy and public health in the Mid-Columbia Region. I-84 supports the main east-west passenger and freight transport and is subject to winter storms and wind storms. Rail systems are vulnerable to icy conditions in the Gorge. In Region 5, there are two rail yards that service the state and greater Northwest region. Amtrak provides passenger service through the Columbia River Gorge. Three ports and one commercial airport are economic engines for the region, providing for tourism and recreation and supporting business and industrial parks.

The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards. A diverse energy portfolio helps increase the area's ability to communicate and transport goods and emergency services after a hazard event. There are 31 power-generating facilities: four hydroelectric, three natural gas, 23 wind, and one coal facility. Four additional wind facilities have been proposed for this region. Three of BPA's large dams and hydroelectric projects are here on the Columbia River. LNG pipelines run through Gilliam, Morrow, and Umatilla Counties.

Decentralization and redundancy in the region's telecommunication systems can help boost the area's ability to communicate before, during, and after a disaster event. It is important to note that broadband and mobile telephone services may not cover rural areas of the region that are distant from I-84. This may present a communication challenge in the wake of a hazard event. Encouraging residents to keep AM/FM radios available for emergency situations could help increase the capacity for communicating important messages throughout the region.

Drinking water is sourced from surface water, wells, and springs. Water quality can be threatened by non-point source pollution from stormwater runoff and agricultural activities in the area. Erosion and sedimentation caused by natural hazard events could also threaten the water quality. In addition, outdated, damaged, or rigid buried water infrastructure is vulnerable to seismic activity. Though low impact development (LID) stormwater systems can increase the region's capacity to better manage high-precipitation events, no communities in this region require LID practices.

Built Environment

Development Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's program is 19 land use goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards (DLCD website, http://www.oregon.gov/http://www.oregon.gov/).

Settlement Patterns

The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people, or an "urban cluster" of at least 2,500 people (but less than 50,000). Gilliam and Sherman Counties do not meet either definition; therefore even though both counties contain incorporated cities, they are considered 100% rural.

Between 2000 and 2010, growth in the region's urban areas has been about 10% less than urban growth statewide. While Umatilla County has the greatest number of people and housing in urban areas, urban populations, and homes in Hood River County have grown considerably, by roughly 22% and 32%, respectively. Gilliam and Sherman Counties do not have urban populations and are also losing the greatest share of their rural populations. Rural homes have increased by almost 10% in Gilliam and Wasco Counties. The region's population is clustered around the I-84 corridor and the cities of Hood River, Pendleton, and The Dalles.

Table 2-317. Urban and Rural Populations in Region 5

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	2,694,144	3,104,382	15.2%	727,255	726,692	-0.1%
Region 5	79,500	87,442	10.0%	50,094	50,815	1.4%
Gilliam	0	0	—	1,915	1,871	-2.3%
Hood River	8,727	10,687	22.5%	11,684	11,659	-0.2%
Morrow	5,790	6,048	4.5%	5,205	5,125	-1.5%
Sherman	0	0	—	1,934	1,765	-8.7%
Umatilla	49,253	53,831	9.3%	21,295	22,058	3.6%
Wasco	15,730	16,876	7.3%	8,061	8,337	3.4%

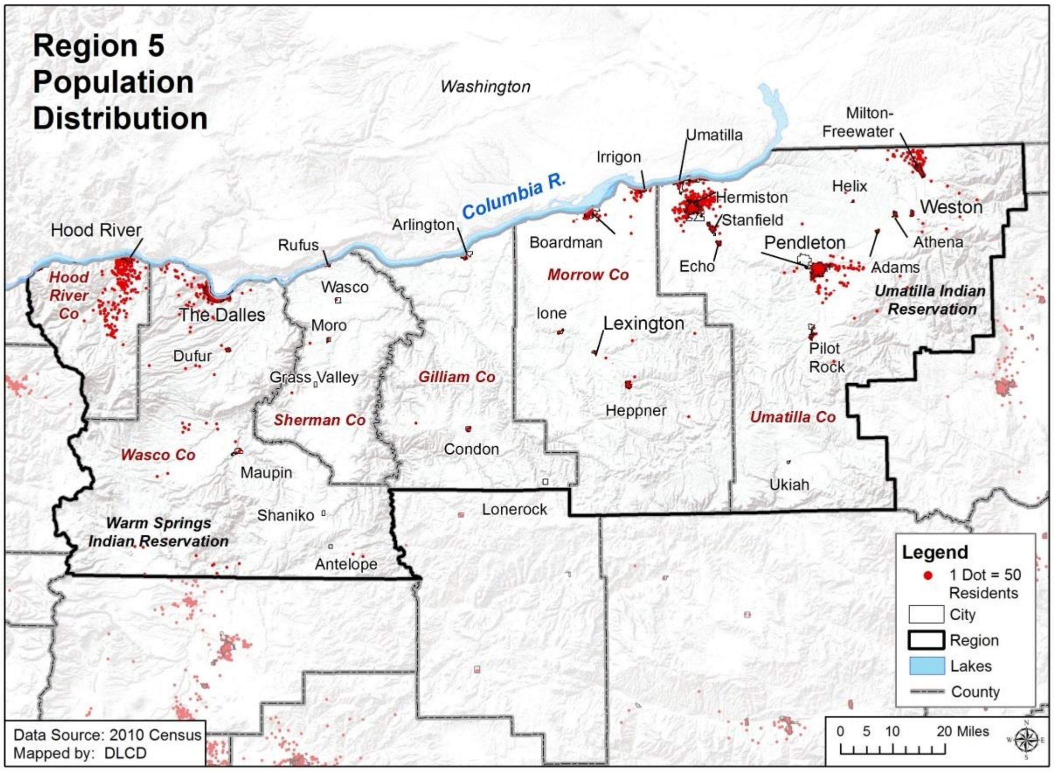
Source: U.S. Census Bureau. 2000 Decennial Census, Table P002 and 2010 Decennial Census, Table P2

Table 2-318. Urban and Rural Housing Units in Region 5

	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 5	31,453	34,811	10.7%	20,946	22,156	5.8%
Gilliam	0	0	—	1,043	1,156	10.8%
Hood River	3,681	4,870	32.3%	4,137	4,401	6.4%
Morrow	1,957	2,010	2.7%	2,319	2,432	4.9%
Sherman	0	0	—	935	918	-1.8%
Umatilla	19,124	20,755	8.5%	8,552	8,938	4.5%
Wasco	6,691	7,176	7.2%	3,960	4,311	8.9%

Source: U.S. Census Bureau. 2000 Decennial Census, Table H002 and 2010 Decennial Census, Table H2

Figure 2-164. Region 5 Population Distribution



Source: U.S. Census, 2012

Land Use and Development Patterns

Region 5 embraces the Columbia River Plateau, where land uses have traditionally been dominated by agriculture and beef cattle.

Over the past 40 years — since all counties and incorporated municipalities were required to prepare comprehensive land use plans in accordance with 19 statewide planning goals (the Land Conservation and Development Act in 1973) — little has changed in this region's land use. According to a study by the Department of Forestry, between 1974 and 2009 very little loss in the area of private land in forest, agricultural, and range uses occurred in Wasco, Gilliam, Sherman Counties. The study does note an exception in Morrow County between 1974 and 1984, where private owners converted an estimated 33,000 acres of land in wildland range use to agricultural use (Lettman, 2011).

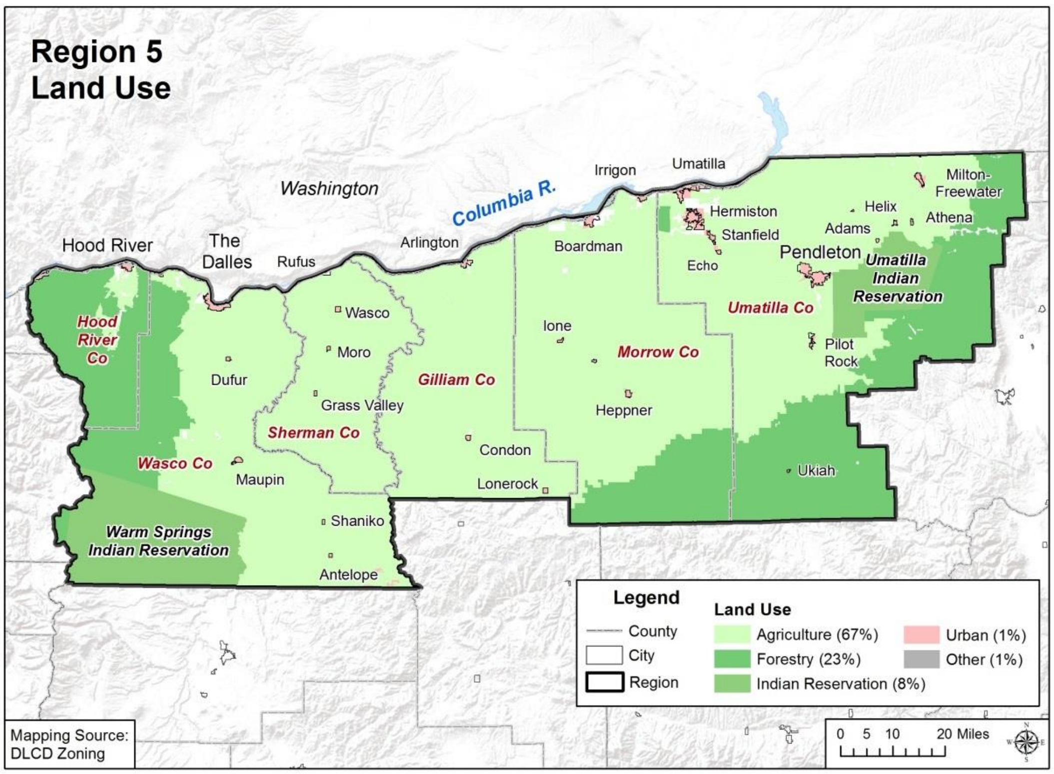
The community of Arlington (Gilliam County) has maintained a steady growth rate, and the Port of Morrow, 25 miles to the east in Umatilla County, remains the second busiest port in Oregon. Development can be limited in Region 5 along the Columbia River partly due to the geography. For example, buildable land in the community of Hood River is partly constrained by floodplains.

In the past few years, there has been significant growth in the development of wind farms. Shepherds Flat — located in both Morrow and Gilliam Counties — officially opened in 2012 and is one of the largest land-based wind farms in the world. Built entirely on private land, construction of nearly 100 miles of power lines and 85 miles of roads is expected on the 30-

square-mile project. Through the Mid-Columbia Region the potential effect of wind turbines, distribution lines, road building, and the region's changing viewshed is a developing conversation.

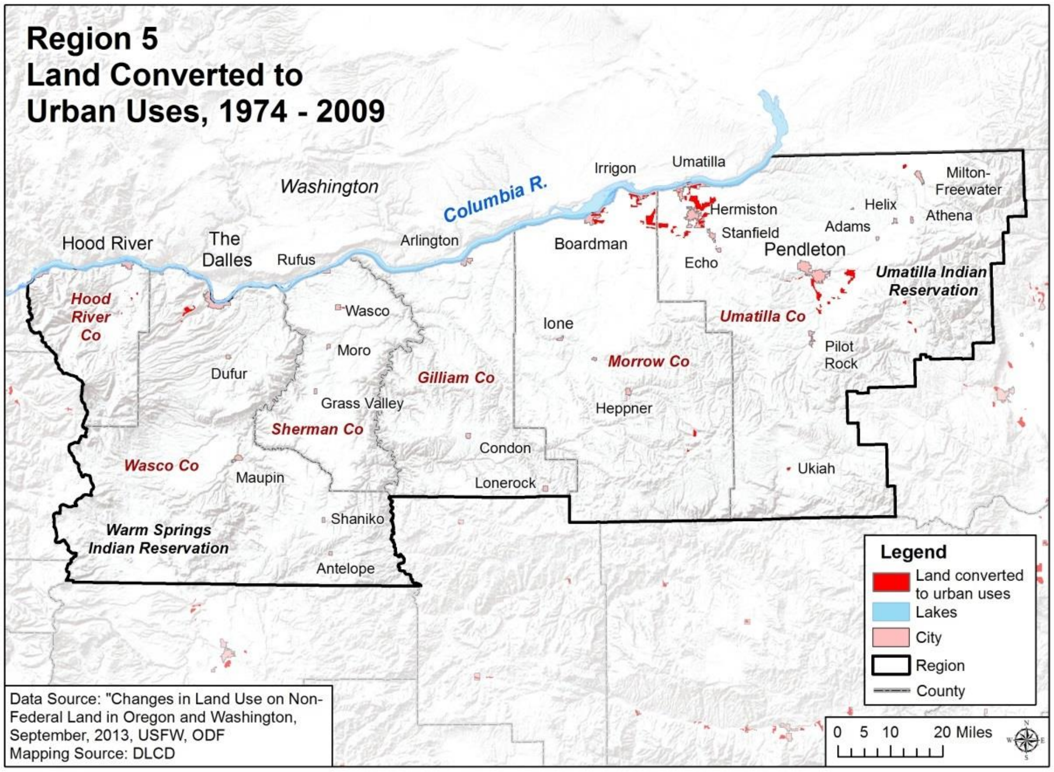
New FEMA floodplain mapping in Umatilla County in 2010 brought significant changes for the community of Milton-Freewater: the major levee along the Walla Walla River providing protection for much of the community was de-certified, effectively moving three quarters of the population into the NFIP regulatory floodplain. After some effort, the community approved a bond to repair the levee and new maps went into effect in 2013 reflecting that change.

Figure 2-165. Region 5 Land Use



Source: Department of Land Conservation and Development, 2014

Figure 2-166. Region 5 Land Converted to Urban Uses, 1974–2009



Source: Land Use Change on Non-Federal Land in Oregon and Washington, September, 2013, USFS, ODF

Housing

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. **Table 2-319** provides a breakdown by county of housing types (single, multi-family, and mobile home; note that the total housing units value includes boats, RVs, vans, etc. that are used as a residence. These homes are not included in the table as a separate category since they represent a small percentage of the overall housing profile.).

The data show that the majority (69.1%) of the region's housing stock is single-family homes. Multi-family housing represents a smaller portion (15.5%) of housing within the region. Umatilla County has nearly half of the region's supply of multi-family units (5,049). Mobile residences make up 15.1% of Region 5's housing (Umatilla County has the highest number of mobile homes, while almost one third of the total housing units in Morrow and Sherman Counties are mobile homes). In natural hazard events such as earthquakes and floods, mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of OES, 1997).

Table 2-319. Housing Profile for Region 5, 2012

	Total Housing Units	Single Family		Multi-Family		Mobile Homes	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	1,140,319	68.1%	460,852	27.5%	139,768	8.4%
Region 5	56,938	39,319	69.1%	8,808	15.5%	8,586	15.1%
Gilliam	1,173	827	70.5%	92	7.8%	248	21.1%
Hood River	9,280	7,116	76.7%	1,399	15.1%	765	8.2%
Morrow	4,448	2,690	60.5%	485	10.9%	1,245	28.0%
Sherman	900	589	65.4%	50	5.6%	254	28.2%
Umatilla	29,707	20,433	68.8%	5,049	17.0%	4,076	13.7%
Wasco	11,430	7,664	67.1%	1,733	15.2%	1,998	17.5%

Note: The percentages listed above do not reflect the number of structures that are built within special flood hazard areas or that are at risk of seismic damage.

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25024

Aside from location and type of housing, the year structures were built has implications (Table 2-320). Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for the Cascadia earthquake fault (Judson, 2012). Therefore, homes built before 1994 are more vulnerable to seismic events.

Also in the 1970s, FEMA began assisting communities with floodplain mapping as a part of administering 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. Table 2-320 illustrates the age of housing stock through 2012. Regionally, 44.5% of the housing stock was built prior to 1970, before the implementation of floodplain management ordinances (about 60% within Gilliam and Sherman Counties). Regionally, approximately 75% of the housing stock was built before 1990 and the codification of seismic building standards. Twenty-five percent of the region's housing stock was built after 1990.

Table 2-320. Age of Housing Stock in Region 5, 2012

	Total Housing Units	Pre 1970		1970 to 1989		1990 or Later	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	609,062	36.4%	518,569	31.0%	545,962	32.6%
Region 5	56,938	25,313	44.5%	16,881	29.6%	14,744	25.9%
Gilliam	1,173	706	60.2%	246	21.0%	221	18.8%
Hood River	9,280	4,078	43.9%	2,128	22.9%	3,074	33.1%
Morrow	4,448	1,259	28.3%	1,618	36.4%	1,571	35.3%
Sherman	900	551	61.2%	186	20.7%	163	18.1%
Umatilla	29,707	13,055	43.9%	9,556	32.2%	7,096	23.9%
Wasco	11,430	5,664	49.6%	3,147	27.5%	2,619	22.9%

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25034

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. **Table 2-321** shows the initial and current FIRM effective dates for Region 5 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, **Flood** section.

Table 2-321. Community Flood Map History in Region 5

	Initial FIRM	Current FIRM
Gilliam County	Sep. 24, 1984	Sep. 24, 1984 (M)
Arlington	Sep. 24, 1984	Sep. 24, 1984 (M)
Condon	Sep. 24, 1984	Sep. 24, 1984 (M)
Hood River	Sep. 24, 1984	Sep. 24, 1984 (M)
Cascade Locks	Sep. 24, 1984	Sep. 24, 1984 (M)
City of Hood River	Sep. 24, 1984	Sep. 24, 1984 (M)
Morrow County	Apr. 1, 1981	Dec. 18, 2007
Boardman	Dec. 18, 2007	Dec. 18, 2007 (M)
Heppner	Apr. 1, 1981	Dec. 18, 2007
Ione	Apr. 1, 1981	Dec. 18, 2007
Irrigon	Dec. 18, 2007	Dec. 18, 2007
Lexington	Apr.1, 1981	Dec. 18, 2007
Sherman County	Sep. 24, 1984	Sep. 24, 1984 (M)
Grass Valley	Sep. 24, 1984	Sep. 24, 1984 (M)
Rufus	Sep. 24, 1984	Sep. 24, 1984 (M)
City of Wasco	Sep. 15, 1989	Sep. 15, 1989
Umatilla County	June 15, 1978	Sep. 3, 2010
Adams	May 15, 1984	Sep. 3, 2010
Athena	July 16, 1984	Sep. 3, 2010
Echo	May 15, 1984	Sep. 3, 2010
Helix	June 1, 1984	Sep. 3, 2010
Hermiston	Oct. 28, 1977	Sep. 3, 2010
Milton-Freewater	Sep. 12, 1978	Sep. 3, 2010
Pendleton	Nov. 3, 1978	Sep. 3, 2010
Pilot Rock	Aug. 4, 1988	Sep. 3, 2010
Stanfield	Aug. 15, 1984	Sep. 3, 2010
Ukiah	Sep. 24, 1984	Sep. 3, 2010 (M)
City of Umatilla	Sep. 24, 1984	Sep. 3, 2010 (M)
Weston	Sep. 18, 1987	Sep. 3, 2010
Umatilla Indian Reservation	Sep. 3, 2010	Sep. 3, 2010
Wasco County	Sep. 24, 1984	Sep. 24, 1984 (M)
Dufur	Sep. 24, 1984	Sep. 24, 1984 (M)
Maupin	Sep. 24, 1984	Sep. 24, 1984 (M)
Mosier	Feb.17, 1989	Feb. 17, 1989
The Dalles	Sep. 24, 1984	Sep. 24, 1984 (M)
Warm Springs Reservation	See Jefferson County	See Jefferson County

(M) = no elevation determined; all Zone A, C, and X.

Note: The Umatilla and Warm Springs Indian reservation information is provided for reference only. The State of Oregon has no jurisdiction over tribal lands.

Source: Federal Emergency Management Agency, Community Status Book Report

State-Owned/Leased and Critical/Essential Facilities

In 2014 the Department of Geology and Mineral Industries updated the 2012 Oregon NHMP inventory and analysis of state-owned/leased facilities and critical/essential facilities. Results from this report relative to Region 5 are shown in **Table 2-322**. The region contains 10.1% of the total value of state-owned/leased critical/essential facilities.

Table 2-322. Value of State-Owned/Leased Critical and Essential Facilities in Region 5

	Total Property Value (State Facilities)	Percent State Total
Oregon	$7,339,087,023	100%
Region 5	$744,388,079	10.1%
Gilliam	$2,316,597	0.0%
Hood River	$16,806,289	0.2%
Morrow	$9,176,310	0.1%
Sherman	$1,153,185	0.0%
Umatilla	$665,356,499	9.1%
Wasco	$49,579,199	0.7%

Source: The Department of Geology and Mineral Industries

Built Environment Trends and Issues

The trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. Region 5 is largely rural with urban development focused along I-84 and around the population centers of Hood River, The Dalles and Pendleton. Hood River County has the fastest growing urban population in the region, while Gilliam and Sherman Counties are entirely rural and declining in population. The region’s housing stock is largely single-family homes. However, there is nearly double the state’s percentage of mobile homes. The regions housing stock is also older than that of the state. Over 80% of homes in Gilliam and Sherman Counties were built before 1990 and current seismic building standards. With the exception of Morrow and Umatilla Counties, none of the region’s FIRMs have been modernized or updated, leaving this region’s flood maps less up to date than those of other regions.

2.3.5.3 Hazards and Vulnerability

Droughts

Characteristics

Region 5 has experienced drought conditions on several occasions. Most recently, Gilliam and Morrow County had drought emergencies declared by the Governor in 2013. Region 5 is susceptible to drought impacts, particularly since this region is predominantly supported by an agriculturally based economy.

Historic Drought Events

Table 2-323. Historic Droughts in Region 5

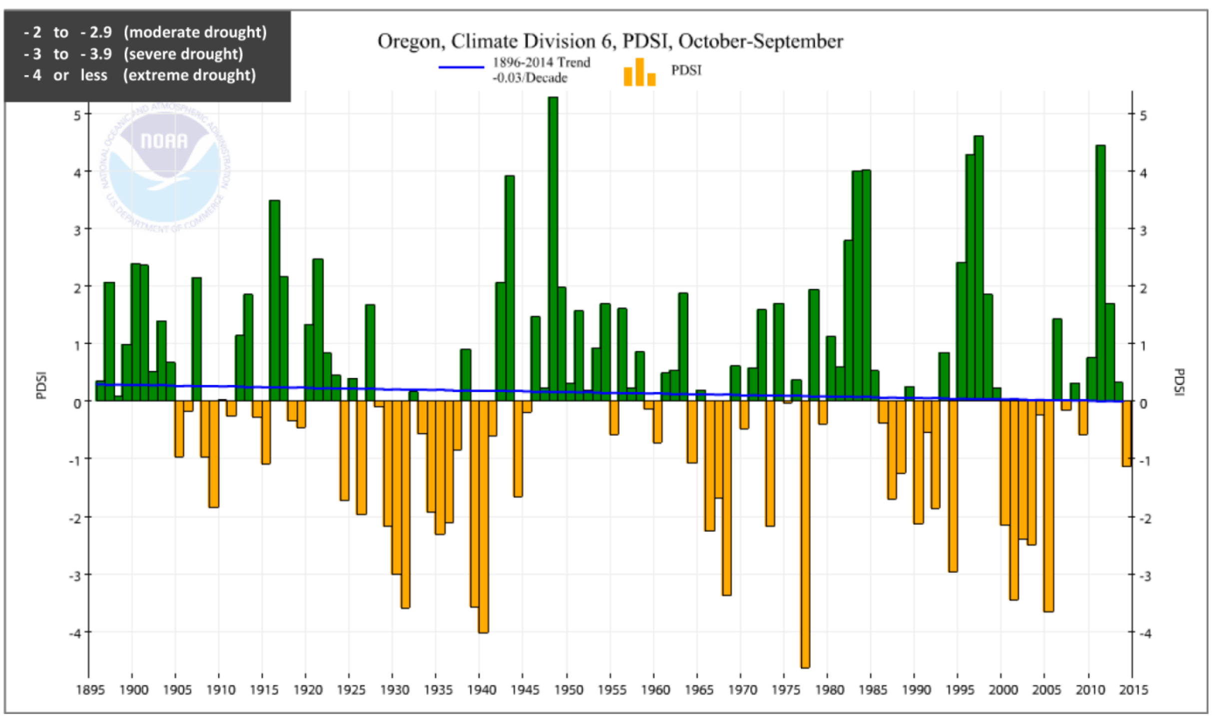
Water Year	Location	Description
1939	statewide 1938-1939, extreme drought in Region 5 in 1939-1940	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country
1977	Regions 4–8	the 1976-1977 drought was the most severe drought in the region with significant agricultural impacts
1994	Regions 4–8	in 1994 the Governor’s drought declaration covered 11 counties located within regions 4, 5, 6, 7, and 8
2001	Regions 4–8 (18 counties)	Governor declared drought in Hood River, Wasco, Sherman, Gilliam, and Morrow Counties
2002	Regions 1 and 4–8	2001 drought declaration still in effect; Governor declares 5 additional counties, including Umatilla County
2003	Regions 5–8	eight counties declared; for Region 5, this included Sherman County; Hood River, Wasco, Gilliam, Morrow, and Umatilla County drought declarations from 2001 and 2002 were in effect through June 23, 2003; other counties outside of Region 5 under a drought declaration included Wheeler and Crook County from Region 6; Baker, Union, and Wallowa from Region 7; and Malheur and Harney County from Region 8; the Klamath County (Region 6) 2001 drought declaration remained in effect through December 31, 2003
2004	eastern Oregon	Governor declared drought for Morrow County in Region 5; three other counties also declared in neighboring regions
2005	Regions 5–7	all six counties within Region 5 declared drought by the Governor, along with five counties in Region 6, and two counties in Region 7
2008	Region 5 only	Governor issued a drought declaration for Sherman and Gilliam Counties in September
2013	Regions 5–8	five counties affected statewide; for Region 5: Gilliam and Morrow; Region 6: Klamath County, Region 7: Baker County, and Region 8: Malheur County

Sources: Taylor Hatton 1999); Oregon Secretary of State’s Archives Division; 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

Historical drought information can also be obtained from the National Climatic Data Center, which provides climate data showing wet and dry conditions, using the Palmer Drought Severity Index (PDSI) that dates back to 1895. The Palmer Index is not the best indicator of water availability for Oregon because it does not account for snow or ice (delayed runoff); however, it has the advantage of providing the most complete, long-term record. [Figure 2-167](#) shows years where drought or dry conditions affected the Hazard Region 5, the north central area of Oregon (Climate Division 6).

Based on this index, there were two extreme drought years for this region: 1940 (- 4.02) and 1977 (- 4.63). During the 1930s, there were many moderate and severe drought years. 1968 was another severe drought year. The 1994 water year was nearly as severe, and the early 2000s experienced many moderate drought water years in the north central region.

Figure 2-167. Palmer Drought Severity Index for Region 5



Source: National Climatic Data Center, http://www.ncdc.noaa.gov/cag/

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the probability that Region 5 will experience drought is shown in **Table 2-324**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-324. Local Probability Assessment of Drought in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Probability	H	H	—	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

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

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to drought is depicted **Table 2-325**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-325. Local Vulnerability Assessment of Drought in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Vulnerability	H	H	—	M	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Oregon has not undertaken a comprehensive statewide analysis to identify which communities are most vulnerable to drought. However, based on a review of Governor drought declarations since 1992, Region 5 is vulnerable to drought-related impacts. Sherman, Gilliam, and Morrow have been under seven different drought declarations each since 1992.

Dust Storms

Characteristics

The characteristics of dust storms in Region 5 are well described in the State Risk Assessment, **Dust Storms** section. There is nothing about the dust storms in this region that differs from the general description, except to note that some of these storms in Morrow and Umatilla Counties in the past were possibly exacerbated by the agricultural practices at that time.

There are many examples of dust storms in this region. One of the most recent significant storms occurred on January 4, 2008. That morning, Oregon State Police responded to three semi-trailer trucks overturned on I-84 in Region 5, a day of blowing snow, dust, and debris that created near-zero visibility in some locations. The eastbound freeway lanes were closed near mile point 193 west of Pendleton because of high winds, crashes, and visibility issues in Morrow and Umatilla Counties. However, no injuries were reported related to the overturned vehicles between milepost 216 and 218 east of Pendleton. Five police patrol cars and two pickup trucks operated by troopers responding to the overturned vehicles received windshield and body damage from wind-blown rocks. Also that day, ODOT closed Oregon 11 between Pendleton and Milton-Freewater. Police reported several accidents there caused by low visibility, blowing dust and debris.

Historic Dust Storm Events

Table 2-326. Historic Dust Storms in Region 5

Date	Location	Description
May 1843[1]	Columbia Gorge	Rev. Gustavus Hines, who was traveling by canoe with a Dr. Davis in the Columbia Gorge, reported this storm
Feb. 1909	between Pendleton and Pilot Rock	"The dust storm (is) now blowing great holes in the ground wherever there are any plowed fields… sand and soil are being scooped up in vast quantities (and) deposited in large drifts… roads are being blocked… travelers were obliged to stop and wait until the blackness caused by the dust disappeared before they could tell where they were going." [2]
June 1912	Pendleton area	"The worst wind storm of the year… brought with it a great burden of dust (which) made it extremely disagreeable as well as harmful."
May 1975[3]	near Echo Junction	winds up to 45 mph blew dust from nearby plowed fields, resulting in a seven-car accident on a Friday afternoon in the eastbound lanes of I-80 (now I-84); four injured
Mar. 1976[4]	near Stanfield	18 vehicles piled-up in two separate accidents on I-80, now I-84; these accidents killed one and injured 20 people; they were caused by a dust storm (referred to in the press as a sand storm) that produced "near zero" visibility; one of the pileups was a fiery accident involving a loaded fuel tanker truck, two other trucks, and two cars; this dust storm also caused road closures both south and north of Hermiston and caused other accidents on OR-207 about 9 miles south of I-80 (84)
July 1979[5]	near Stanfield	this dust storm caused two deaths and six injuries in a freeway pileup on I-80 (I-84) very close to the location of the previous event; winds near 60 mph; some of the injured were hit as pedestrians while trying to assist those already injured or pinned in automobiles
Apr. 1996	near Hepner	"Strong winds in the Columbia Basin produced a dust storm near Hepner."[6]
June 1997	near Hermiston	"Highway 395 south of Hermiston was closed for a few hours when high wind and blowing dust reduced visibility to less than 50 feet. The dust is believed to have played a role in a minor accident on the highway." [7]
Sep. 1999[8]	Morrow and Umatilla Counties	blowing dust off wheat fields killed eight and injured more than twenty people in chain-reaction auto crashes
Sept. 2001	near Pendleton	blowing dust contributed to an eight vehicle accident on OR-11 10 miles northeast of Pendleton; windy conditions, combined with loose topsoil from a freshly plowed field, created blowing dust that locally reduced visibilities to less than 100 feet; a series of chain reaction collisions occurred as vehicles slowed as they entered into the area of low visibility; five minor injuries were reported according to the Oregon State Police[9]
Oct. 2003	Morrow and Umatilla Counties	"A dust storm lowered visibilities to less than a quarter mile along the foothills of the Blue Mountains… ODOT led traffic on Highway 11 from Milton-Freewater to Weston… one way at a time." This event also affected an area 11 miles southwest of Boardman. [10]
Mar. 2005	Morrow and Umatilla Counties	weather stations at 19 locations measured peak wind gusts from 45 to 64 mph; visibility restrictions down to near zero due to blowing dust occurred along I-84 between Boardman and Pendleton; extremely low visibilities led to road closures and multiple vehicle pileups; vehicles pulled off the road to avoid collisions. "On Highway 207 near Hermiston visibility was reduced to near zero due to blowing dust. The extremely low visibility contributed to a non-injury collision near the Boardman Bombing Range. In addition, four miles north of Heppner on State Route 207, blowing dust reduced visibilities to near zero." [11]
May 2006	near Boardman	"I came around the corner (to) a giant dust cloud that looked like a brown fog bank… within the cloud was regular lightning bolts." [12]

Date	Location	Description
Jan. 2008	Morrow and Umatilla Counties	ODOT closed the freeway's westbound lanes between Baker City and La Grande about noon because of blowing snow, dust, and debris that created near-zero visibility in the Ladd Canyon area east of La Grande; the eastbound freeway lanes were closed between mile point 193 west of Pendleton and Baker City because of high winds, crashes, and visibility issues; five patrol cars and two pickup trucks operated by troopers responding to overturned vehicles received windshield and body damage from wind-blown rocks; ODOT also closed Oregon 11 between Pendleton and Milton-Freewater; police reported several accidents caused by low visibility, blowing dust and debris
May 2010	Morrow and Umatilla Counties	"Blowing dust in the Columbia Basin reduced visibility to near zero around Stanfield, Pendleton, and between Lexington and Hermiston. The blowing dust caused traffic accidents with an injury near Stanfield on I-84." [13]
Sept. 2013[14]	Umatilla County	dust storms two weeks apart hit Weston

Sources:

(1) Diary of Rev. Gustavus Hines

(2) East Oregonian, February 3, 1909

(3) East Oregonian, May 24, 1975

(4) East Oregonian, March 24, 25, and 26, 1976, including articles titled "18 Vehicles Crash in Dust Storm; Woman Killed" and "Dust Problem Stymies Farmers"; Oregon Statesman, "Dust Storms Hit E. Oregon…", March 25, 1976

(5) Oregon Statesman, "2 Dead, 6 Injured in Freeway Accident; Dust Storm Blamed," July 11, 1979

(6) https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5556785

(7) https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5597478

(8) La Grande Observer, "State Gives Dust Storm Driving Advice," October 1, 1999 and "Report Blames Speed," November 20, 1999; Statesman Journal, "Six Die in 50-car Pileup on I-84: Dust Blinds Drivers on the Interstate near Pendleton," September 26, 1999, "Dust Brownout Led to Fatal Wrecks: Dry Weather and High Winds Created the Deadly Eastern Oregon Storm," September 27, 1999, and "Road Warnings Needed: Motorists Can Learn from Last Week's Fatal Dust Storm Collisions," October 5, 1999; Corvallis Gazette-Times, "Corvallis Couple Recovering from Highway Crash," September 27, 1999; Learning to Fly, April Henry; East Oregonian, Mitchell Zach; Associated Press news story dated September 26, 1999; also post-event documents of the Community Solutions Team (meeting minutes) and Oregon State Police

(9) https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5268728

(10) https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5372265 and https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5335873

(11) https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5439648 and https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5439653

(12) This is from a letter to the editor of The Dalles Chronical dated July 6, 2006; it conveys trucker Greg Jones' experience on a "run one night in May… to Hermiston."

(13) https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=222144

(14) Daily Mail, September 16, 2013; YouTube, Fredrik Anderson, September 12, 2013

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the probability that Region 5 will experience dust storms is shown in **Table 2-327**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-327. Local Probability Assessment of Dust Storms in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Probability	—	—	H	—	H	—

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Using history as a guide (nine significant storms in Region 5 over the past 40 years), the probability of dust storms occurring in Region 5 is high. These storms may be slightly less likely than in the past due to changes in agricultural practices, but changes in climate, ENSO cycles, and other natural factors may offset reductions in occurrence linked to farming.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to dust storm is shown in **Table 2-328**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-328. Local Vulnerability Assessment of Dust Storms in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Vulnerability	—	—	M	—	H	—

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Morrow and Umatilla Counties are not only the counties most vulnerable to dust storms in this region, but are also the most vulnerable in the State of Oregon. These two counties seem to be most vulnerable due to a combination of soil types, exposed soil due to farming, periodic high wind events, and big open areas that help dust storms to develop. Wasco County is also vulnerable in this region.

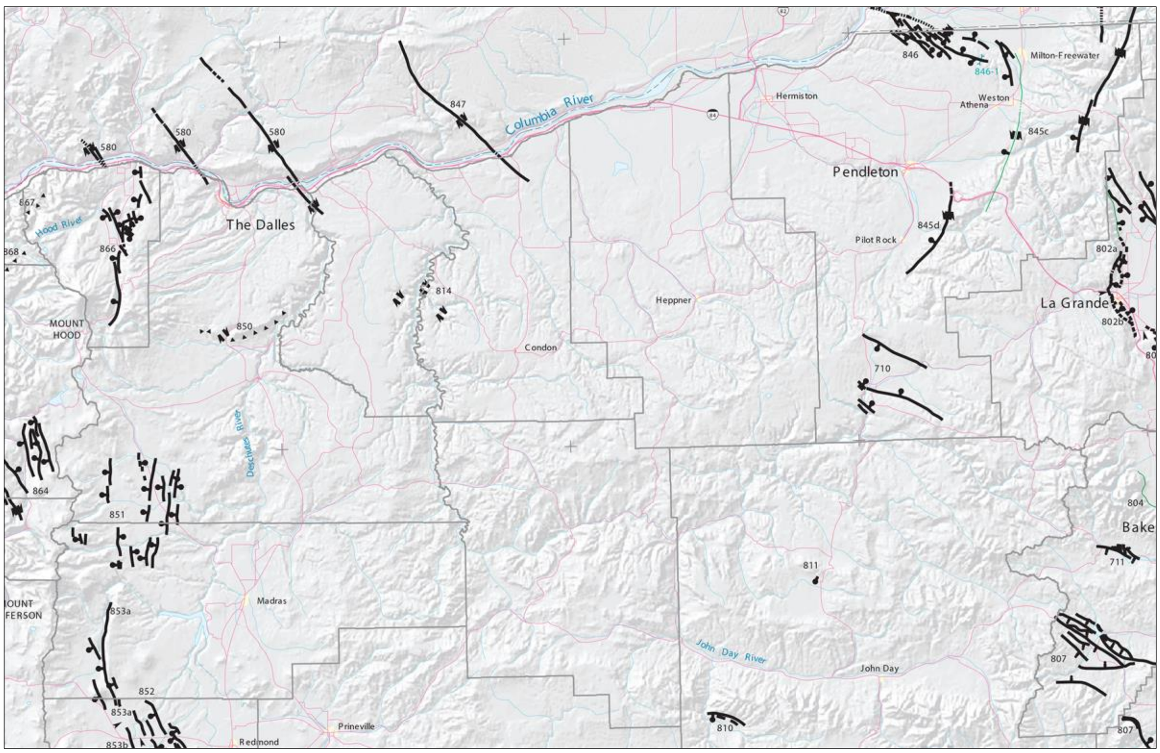
Poor visibility leading to motor vehicle crashes is the worst potential impact of these storms; often these crashes result in fatalities and major injuries. Other impacts include poor air quality, including dust infiltration of equipment and engines, loss of productive soil, and an increase in fine sediment loading of creeks and rivers.

Earthquakes

Characteristics

The geographic position of this region makes it susceptible to earthquakes from three sources: subduction zone, intraplate, and crustal events. The map below shows the location of the known crustal faults which could affect the region. Because only certain faults have been studied in detail and determined to be active, there may be many more crustal faults in the region capable of producing earthquakes which have not yet been identified. **Figure 2-168** shows the locations of faults in Region 5.

Figure 2-168. Quaternary Faults and Folds in Region 5

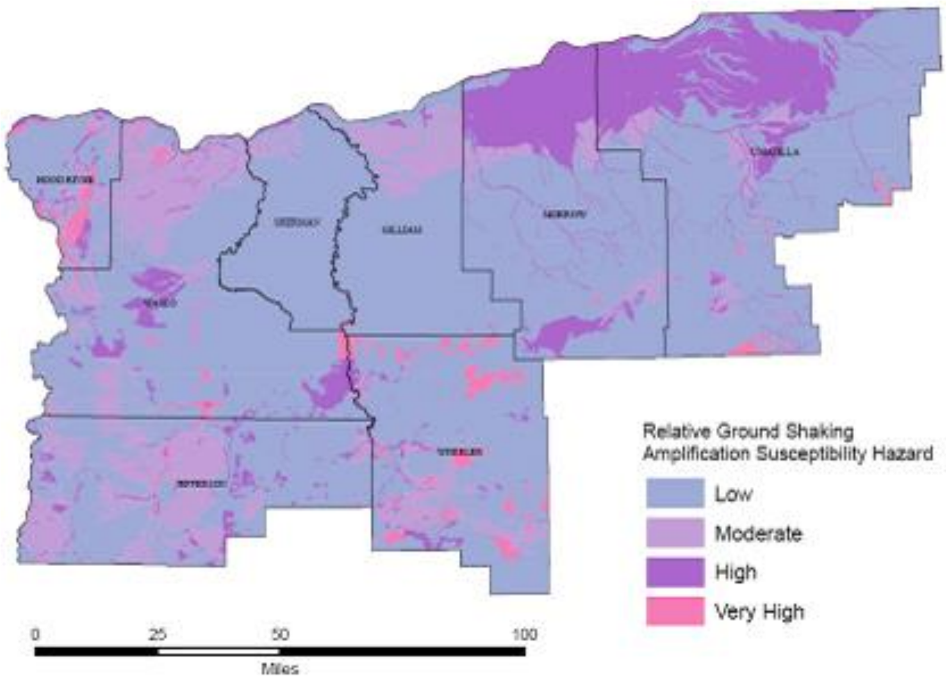


Source: Modified from Personius et al., 2003

When all of these earthquake sources are added together, the general earthquake hazard in the region can be displayed as a whole and is reflected in the USGS national seismic hazard maps. When compared to the rest of the United States, most of the region is within a relatively moderate seismicity area, except for Hood River and Wasco Counties which are mostly within relatively moderate to high zones.

Figure 2-169 displays the relative ground shaking amplification hazard throughout Region 5.

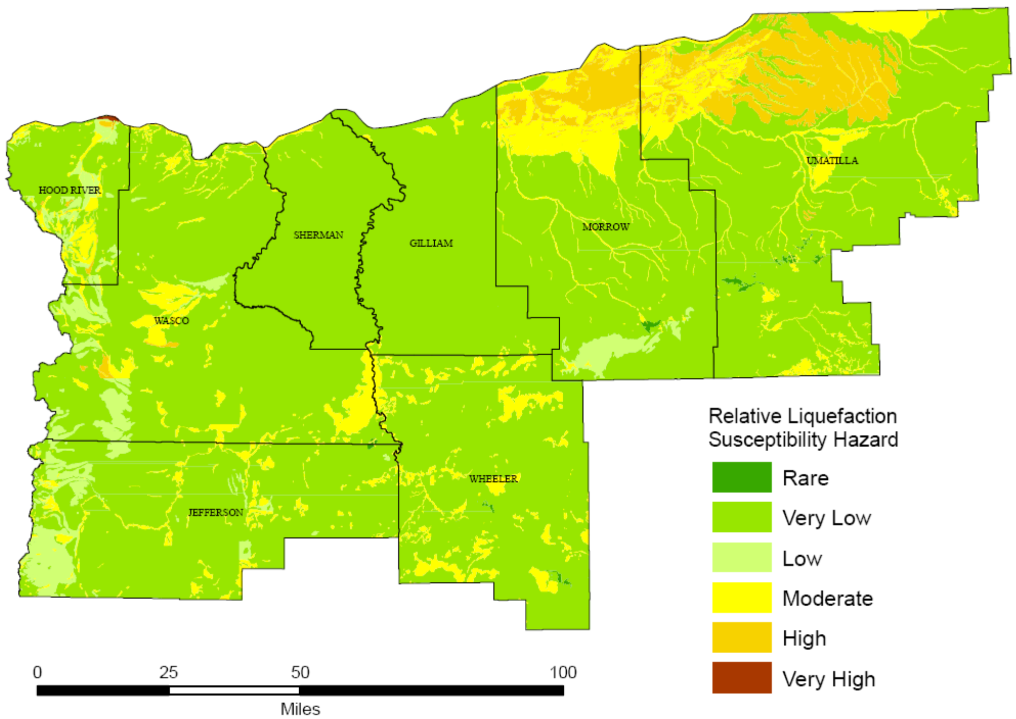
Figure 2-169. Relative Ground Shaking Amplification Hazard in Region 5



Source: Burns, 2007

During seismic shaking, deposits of loose saturated sands can be subjected to contraction resulting in an increase in pore water pressure. If the increase in pore water pressure is high enough, the deposit becomes "liquefied," losing its strength and its ability to support loads. Figure 2-170 displays the relative liquefaction hazard throughout Region 5.

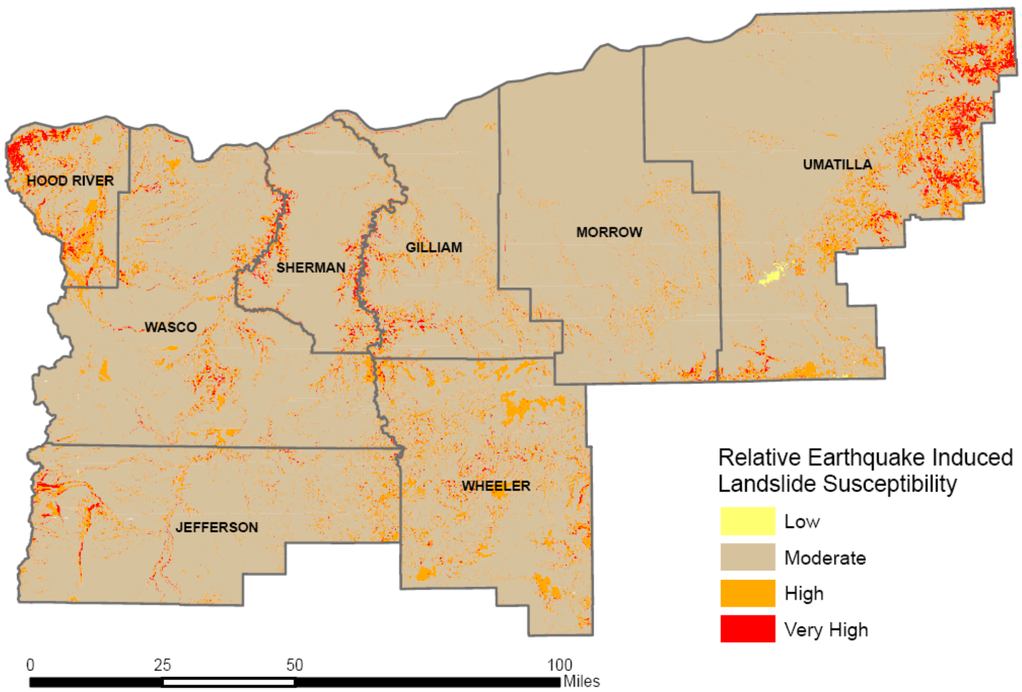
Figure 2-170. Relative Liquefaction Susceptibility Hazard in Region 5



Source: Burns, 2007

Strong ground shaking can also cause landslides and reactivate dormant landslides. Commonly, slopes that are marginally stable prior to an earthquake become unstable and fail. Some landslides result from liquefaction that causes lateral movement of soil, or lateral spread. Figure 2-171 displays the relative earthquake induced landslide hazard throughout Region 5.

Figure 2-171. Relative Earthquake-Induced Landslide Susceptibility Hazard in Region 5

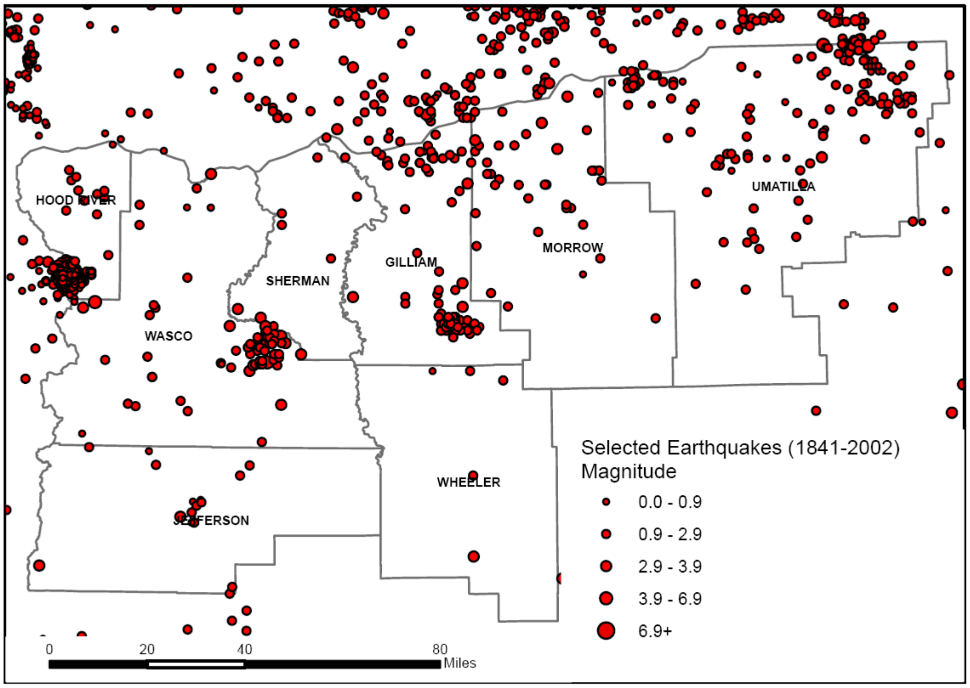


Source: Burns, 2007

Region 5 has experienced many earthquakes as shown in Figure 2-172 and Table 2-329. Three historic earthquakes of significance that were centered in the region are the 1893 Umatilla, 1936 Milton-Freewater (M6), 1951 Hermiston, and 1976 Maupin area (M4.8), all shallow crustal earthquakes. There are faults in the region that have been active in the last 20,000 years. The region has also been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered outside the area.

The map displays over 1,000 earthquakes that have been recorded in the region during the last century. Because the instrument network in the region was very sparse until the mid-2000s, it is likely that thousands of earthquakes have occurred in the region but were not recorded and thus do not appear on this map.

Figure 2-172. Selected Earthquakes in Region 5, 1841–2002



Source: Niewendorp and Neuhaus (2003)

Historic Earthquake Events

Table 2-329. Significant Earthquakes Affecting Region 5

Date	Location	Magnitude (M)	Comments
Approximate years: 1400 BCE, 1050 BCE, 600 BCE, 400, 750, 900	offshore, Cascadia subduction zone	probably 8-9	these are the midpoints of the age ranges for these six events
Jan. 26, 1700	offshore, Cascadia Subduction zone	about 9	generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Nov. 23, 1873	near Brookings, Oregon, at the Oregon-California border	6.8	may have been an intraplate event because of lack of aftershocks; felt as far away as Portland and San Francisco
Mar. 1893	Umatilla, Oregon	VI-VII (Modified Mercalli Intensity)	damage: unknown
July 15, 1936	Milton-Freewater, Oregon	6.4	two foreshocks and many aftershocks felt; damage: $100,000 (in 1936 dollars)
Apr. 13, 1949	Olympia, Washington	7.1	fatalities: eight; damage: $25 million (in 1949 dollars); cracked plaster, other minor damage in northwest Oregon
Jan. 1951	Hermiston, Oregon	V (Modified Mercalli Intensity)	damage: unknown
Nov. 5, 1962	Portland, Oregon and Vancouver, Washington	5.5	shaking up to 30 seconds; chimneys cracked, windows broke, furniture moved
May- June 1968	Adel	5.1	Increased flow at a hot spring
Apr. 12, 1976	near Maupin, Oregon	4.8	sounds described as distant thunder, sonic booms, and strong wind
Apr. 25, 1992	Cape Mendocino, California	7.0	subduction earthquake at the triple-junction of the Cascadia subduction zone and the San Andreas and Mendocino faults
Mar. 25, 1993	Scotts Mill	5.6	center: Mount Angel-Gates Creek fault; damage: $30 million, including Molalla High School and Mount Angel church
Sep. 20, 1993	Klamath Falls	5.9 and 6.0	fatalities: two; damage: $10 million, including county courthouse; rockfalls

*BCE: Before Common Era.

Sources: Wong et al. (1995); Pacific Northwest Seismic Network

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 5 will experience earthquakes is shown in **Table 2-330**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-330. Local Probability Assessment of Earthquakes in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Probability	M	M	L	L	H	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

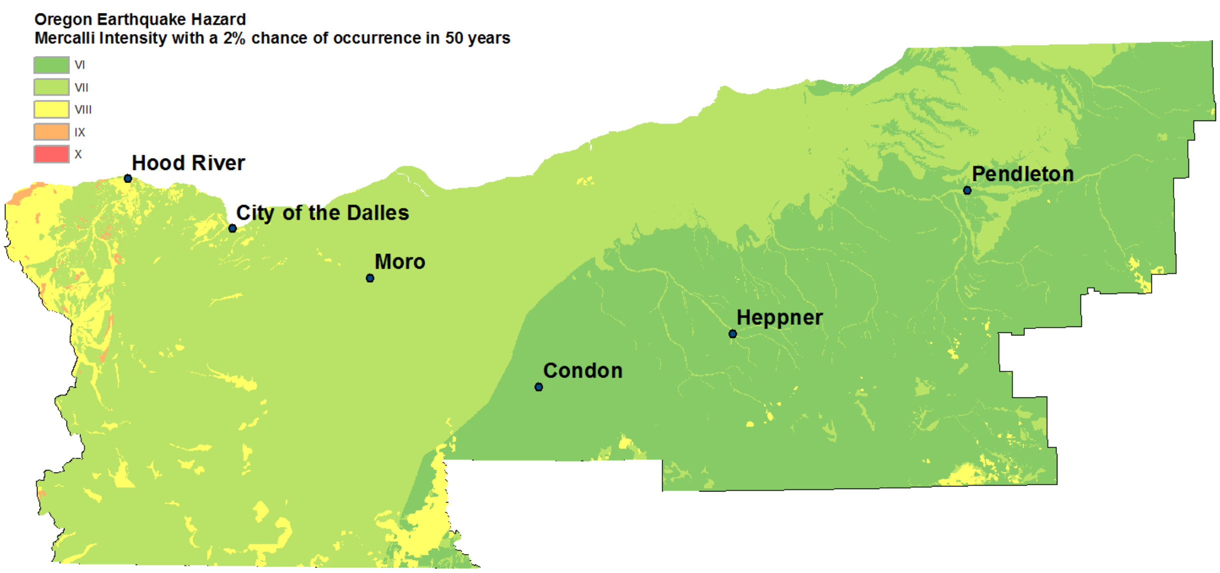
State Assessment

The probability of damaging earthquakes varies widely across the state. In Region 5, the hazard is dominated by local faults and background seismicity.

The probabilistic earthquake hazard for Region 5 in **Figure 2-173**. This map shows the expected level of earthquake damage that has a 2% chance of occurring in the next 50 years. The map is based on the 2008 USGS National Seismic Hazard Map and has been adjusted to account for the effects of soils following the methods of Madin and Burns (2013). In this case, the strength of shaking calculated as peak ground acceleration and peak ground velocity is expressed as Mercalli intensity, which describes the effects of shaking on people and structures. This map incorporates all that is known about the probabilities of earthquake on all Oregon faults, including the Cascadia Subduction Zone.

For Oregon west of the crest of the Cascades, the Cascadia subduction zone is responsible for most of the hazard. The paleoseismic record includes 18 magnitude 8.8–9.1 megathrust earthquakes in the last 10,000 years that affected the entire subduction zone. The return period for the largest earthquakes is 530 years, and the probability of the next such event occurring in the next 50 years ranges from 7 to 12%. An additional 10–20 smaller M_W 8.3–8.5 earthquakes affected only the southern half of Oregon and northern California. The average return period for these is about 240 years, and the probability of a small or large subduction earthquake occurring in the next 50 years is 37–43%.

Figure 2-173. Probabilistic Earthquake Hazard in Region 5



Color zones show the maximum level of earthquake shaking and damage (Mercalli Intensity Scale) expected with a 2% chance of occurrence in the next 50 years. A simplified explanation of the Mercalli levels is:

VI	Felt by all, weak buildings cracked;
VII	Chimneys break, weak buildings damaged, better buildings cracked;
VIII	Partial collapse of weak buildings, unsecured wood frame houses move;
IX	Collapse and severe damage to weak buildings, damage to wood-frame structures; and
X	Poorly built structures destroyed, heavy damage in well-built structures.

Source: Madin and Burns (2013)

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to earthquakes is shown in **Table 2-331**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-331. Local Vulnerability Assessment of Earthquakes in Region 5

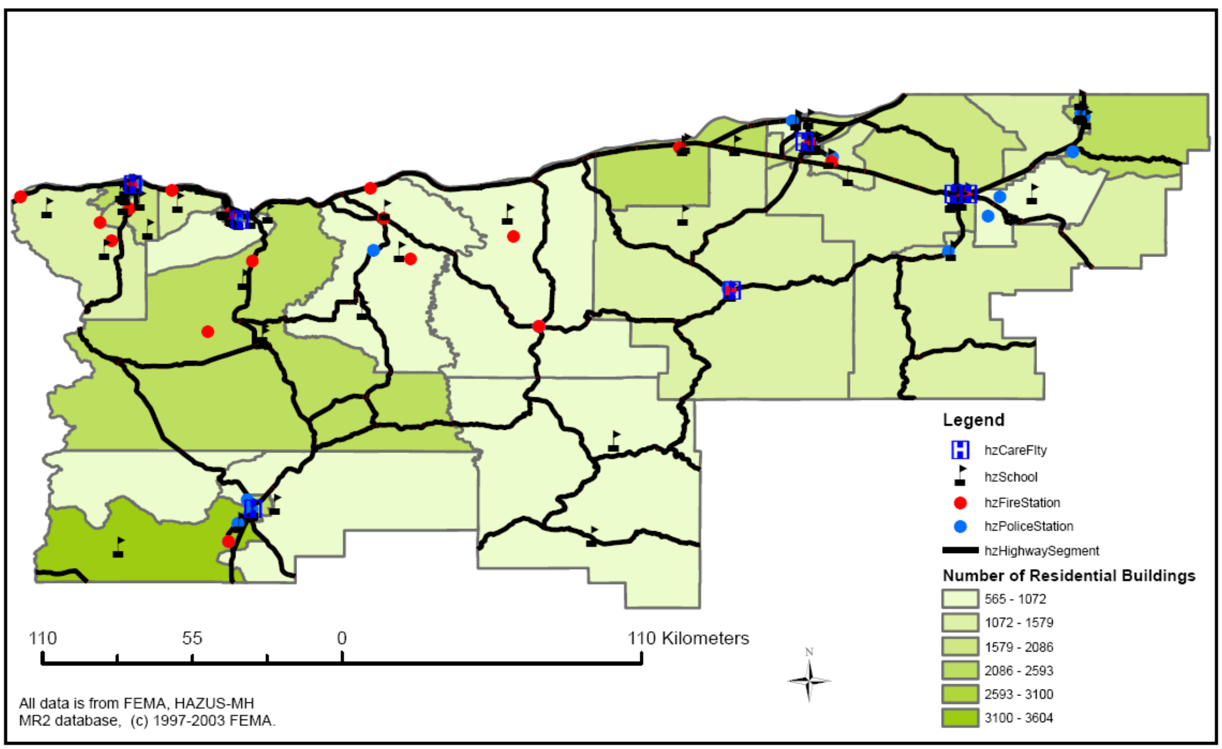
	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Vulnerability	M	M	H	L	M	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

According to the ranking of the counties' expected damages and losses, based on the 500 year model, none of the counties in Region 5 were ranked among the top 15. Nonetheless, the Mid-Columbia Region is considered moderately vulnerable to earthquake hazards from earthquake-induced landslides in the Cascades, ground shaking, and liquefaction.

Figure 2-174. Region 5 Generalized Earthquake Hazard Exposure



Data are from Hazus-MH MR2 database.
Source: Burns (2007)

Most of the people and infrastructure are along the I-84 corridor, which runs along the northern portion of the region. This multimodal transportation corridor is vital to Oregon's economy and includes a major interstate highway (I-84); two transcontinental rail lines, Union Pacific and Burlington Northern Santa Fe; the Columbia River inland water navigation; major electric power and gas lines; and communication conduits. Roughly $14 billion worth of goods are carried through the corridor each year (Wang and Chaker, 2004). **Figure 2-175** displays the general exposure of the region.

The geographic size of the region is roughly 13,700 square miles and contains 36 census tracts. There are over 54,000 households in the region and it has a total population of over 150,000 people (FEMA, 2006). There are an estimated 52,000 buildings in the region with a total building replacement value (excluding contents) of $8.5 billion. Approximately 99% of the buildings (and 84% of the building value) are associated with residential housing. The replacement values of the transportation system and utility lifeline systems are estimated to be approximately $16.5 billion and $4.8 billion, respectively.

Table 2-332 shows the number of school and emergency response buildings surveyed in each county and their respective rankings.

Table 2-332. School and Emergency Response Buildings Collapse Potential in Region 5

	Level of Collapse Potential			
County	**Low (< 1%)**	**Moderate (>1%)**	**High (>10%)**	**Very High (100%)**
Gilliam	4	2	5	4
Hood River	18	14	7	13
Morrow	11	10	7	5
Sherman	5	4	3	—
Umatilla	40	24	46	16
Wasco	23	7	10	—

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

As mentioned in the State Risk Assessment, DOGAMI developed two earthquake loss models for Oregon based on the two most likely sources of seismic events: (a) a M6.5 Arbitrary Crustal event and (b) a 2,500 year mean return period probabilistic earthquake scenario (2,500-year Model). Both models are based on Hazus-MH, a computer program currently used by the Federal Emergency Management Agency (FEMA) as a means of determining potential losses from earthquakes. The arbitrary crustal event is based on a potential M6.5 earthquake generated from an arbitrarily chosen fault using the Hazus software, and assuming a worst-case scenario. The 2,500-year crustal model does not look at a single earthquake (as in the CSZ model); it encompasses many faults, each with a 2% 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.

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. Results are found in **Table 2-333**, **Table 2-334**, and **Table 2-335.**

Table 2-333. Total Building, Transportation, and Utility Exposure and Potential Losses in Region 5 from a 2,500-Year-Return Interval Ground Motion

Region 5 Counties	Building Exposure	Transportation Exposure	Utility Exposure	Total Exposure	
Gilliam	$148,000,000	$1,777,000,000	$153,000,000	$2,078,000,000	
Hood River	$1,282,000,000	$1,413,000,000	$702,000,000	$3,397,000,000	
Jefferson	$1,009,000,000	$1,185,800,000	$405,910,000	$2,600,710,000	
Morrow	$517,000,000	$1,592,600,000	$740,040,000	$2,849,640,000	
Sherman	$124,000,000	$1,299,700,000	$117,520,000	$1,541,220,000	
Umatilla	$3,837,000,000	$4,956,900,000	$1,390,340,000	$10,184,240,000	
Wasco	$1,513,000,000	$3,305,400,000	$1,162,950,000	$5,981,350,000	
Region Total	$**8,430,000,000**	$**15,530,400,000**	$**4,671,760,000**	$**28,632,160,000**	
	Building Losses	**Transportation Losses**	**Utility Losses**	**Total Losses**	**Loss % of Total**
Gilliam	$6,300,000	$12,700,000	$6,040,000	$25,040,000	1.2%
Hood River	$153,510,000	$85,900,000	$102,990,000	$342,400,000	10.1%
Jefferson	$54,580,000	$15,600,000	$16,790,000	$86,970,000	3.3%
Morrow	$178,540,000	$49,300,000	$106,800,000	$334,640,000	11.7%
Sherman	$5,600,000	$45,300,000	$5,810,000	$56,710,000	3.7%
Umatilla	$736,640,000	$200,600,000	$135,480,000	$1,072,720,000	10.5%
Wasco	$191,010,000	$82,400,000	$116,890,000	$390,300,000	6.5%
Region Total	$**1,326,180,000**	$**491,800,000**	$**490,800,000**	$**2,308,780,000**	**8.0%**

Source: W. J. Burns, 2007, unpublished report: Hazards, Earthquake and Landslide Hazard Maps, and Future Earthquake Damage and Loss Estimates for Seven Counties in the Mid-Columbia River Gorge Region Including Hood River, Wasco, Sherman, Gilliam, Morrow, Umatilla, Jefferson, and Wheeler

Table 2-334. Estimated Losses in Region 5 Associated with an Arbitrary M6.5 Crustal Event

	Region 5 Counties					
	Gilliam	**Hood River**	**Morrow**	**Sherman**	**Umatilla**	**Wasco**
Injuries (5 pm time frame)	3	120	126	4	208	220
Deaths (5 pm time frame)	0	6	7	0	10	13
Displaced households	3	419	521	6	1,048	720
Economic Losses for buildings	$9.21 mil	$189.96 mil	$109.9 mil	$8.4 mil	$248.68 mil	$307.09 mil
Operational the day after the event:						
Fire stations	100%	60%	50%	0%	75%	50%
Police stations	100%	0%	100%	0%	79%	0%
Schools	100%	21%	43%	33%	88%	27%
Bridges	100%	100%	100%	88%	99%	98%
Economic losses to infrastructure:						
Highways	$0.1 mil	$37.2 mil	$43.5 mil	$33.1 mil	$77 mil	$35.5 mil
Airports	$3.2 mil	$7.3 mil	$1.7 mil	$2 mil	$16.5 mil	$13.3 mil
Communications	0	$0.08 mil	0	0	$0.05 mil	$0.08 mil
Debris generated (million tons)	0	0	0	0	0	0

Source: W. J. Burns, 2007, DOGAMI unpublished report: Geologic hazards, earthquake and landslide hazard maps, and future earthquake damage and loss estimates for seven counties in the Mid-Columbia River Gorge Region including Hood River, Wasco, Sherman, Gilliam, Morrow, Umatilla, Jefferson, and Wheeler

Table 2-335. Estimated Losses in Region 5 Associated with a 2,500-Year Probable M6.5 Driving Scenario

	Region 5 Counties					
	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Injuries (5 pm time frame)	2	111	164	2	623	136
Deaths (5 pm time frame)	0	6	8	0	32	8
Displaced households	0	303	768	1	2,957	373
Economic Losses for buildings	$6.3 mil	$153.51 mil	$178.54 mil	$5.68 mil	$736.64 mil	$191.01 mil
Operational the day after the event:						
Fire stations	100%	20%	0%	66%	25%	75%
Police stations	100%	100%	50%	100%	21%	67%
Schools	100%	14%	14%	100%	28%	33%
Bridges	100%	82%	100%	76%	93%	96%
Economic losses to infrastructure:						
Highways	$6.3 mil	$71.9 mil	$36.4 mil	$42.2 mil	$173.8 mil	$63.1 mil
Airports	$5.7 mil	$7.6 mil	$5.2 mil	$1.8 mil	$19.7 mil	$15.8 mil
Communications	$0	$0.05 mil	$0	$0	$ 0.24 mil	$0.05 mil
Debris generated (million tons)	0	0	0	0	0	0

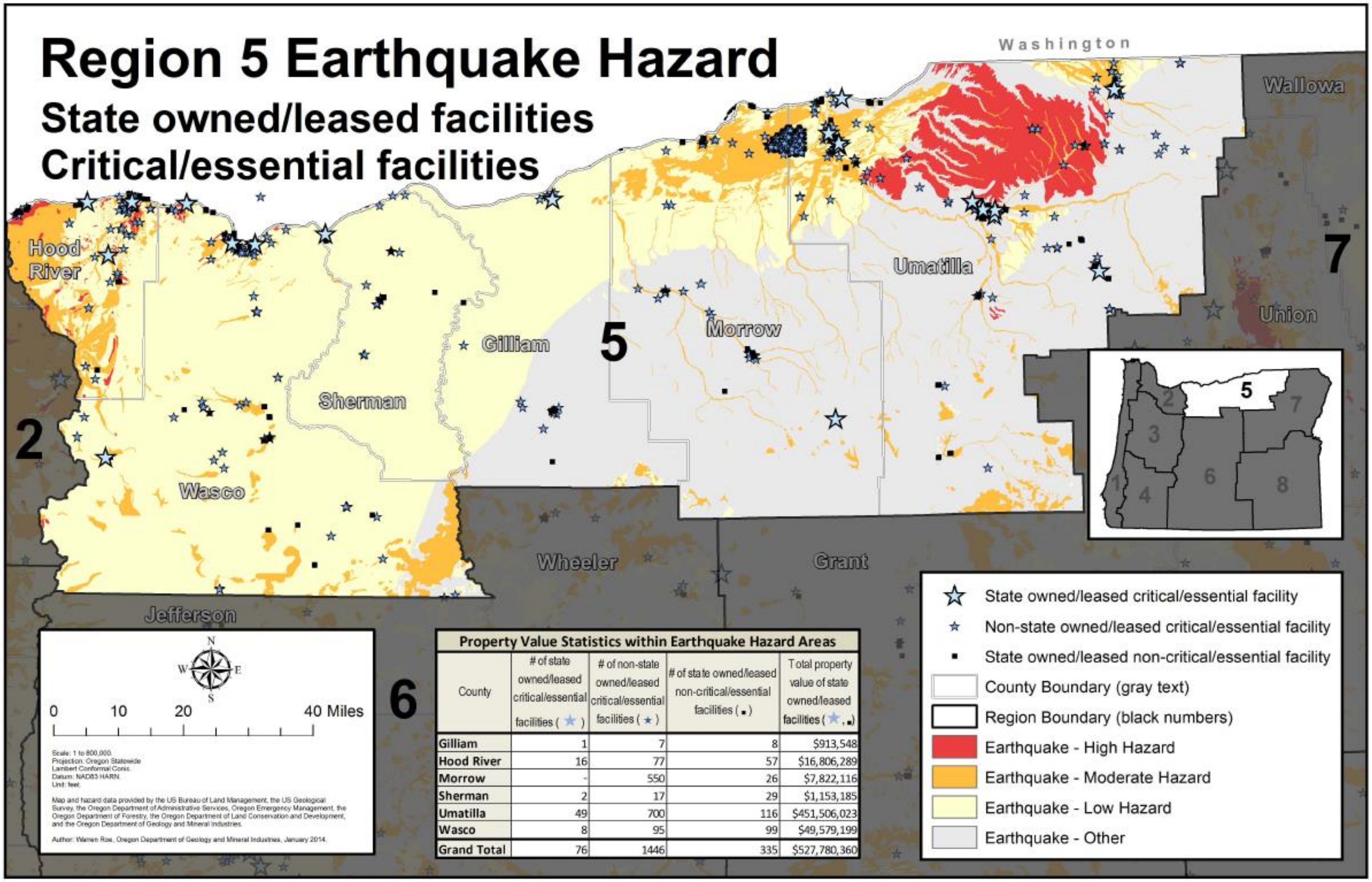
Source: W. J. Burns, 2007, DOGAMI unpublished report: Geologic hazards, earthquake and landslide hazard maps, and future earthquake damage and loss estimates for seven counties in the Mid-Columbia River Gorge Region including Hood River, Wasco, Sherman, Gilliam, Morrow, Umatilla, Jefferson, and Wheeler

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, Oregon Vulnerabilities section for more information.

Of 5,693 state facilities evaluated, 411 totaling roughly $528 million are located in an earthquake hazard zone in Region 5 (Figure 2-175). Among the 1,141 state-owned/leased critical/essential facilities, 76 are in an earthquake hazard zone in Region 5. Additionally, 1,446 non-state-owned/leased critical or essential facilities in Region 5 are located in an earthquake hazard zone.

Figure 2-175. State-Owned/Leased Facilities and Critical/Essential Facilities in an Earthquake Zone in Region 5



County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Gilliam	1	7	8	$913,548
Hood River	16	77	57	$16,806,289
Morrow	-	550	26	$7,822,116
Sherman	2	17	29	$1,153,185
Umatilla	49	700	116	$451,506,023
Wasco	8	95	99	$49,579,199
Grand Total	76	1446	335	$527,780,360

Source: DOGAMI

SEISMIC LIFELINES

"Seismic lifelines" are the state highways ODOT has identified as most able to serve response and rescue operations, reaching the most people and best supporting economic recovery. The process, methodology, and criteria used to identify them are described in **Section 2.2.2.6, Seismic Transportation Lifeline Vulnerabilities**, and the full report can be accessed at **Appendix 9.1.13**, *Statewide Loss Estimates: Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification* (OSLR). According to that report, seismic lifelines in Region 5 have the following vulnerabilities.

The following geographic zones identified in the OSLR are located within Region 5:

- Cascades Geographic Zone: OEM Mitigation Planning Region 5 is located in part within the OSLR Cascades Geographic Zone. Two crossings of the Cascades from western to central Oregon are partly within this zone and connect the highly seismically impacted western portion of the state to the less seismically impacted central portion of the state. The area contains one Tier 1 route: I-84. It also contains part of the Tier 2 route: OR-212 and US-26.
- Central Geographic Zone: Region 5 also encompasses the northerly part of the Central Geographic Zone, which contains Tier 1 routes I-84 from The Dalles to Biggs Junction and US-97. These roadways are subject to rockfall risks in several areas. There are no Tier 2 routes in this region, and one Tier 3 corridor: the north end of US-197.

REGIONAL IMPACT.

- Ground shaking: Ground shaking damage from a CSZ event is not expected to be significant in Region 5.
- Landslides and rockfall: Landslide and rockfall damage are not anticipated to be activated by a CSZ event in Region 5.
- Liquefaction: Structures in wetland, alluvial, and other saturated areas may be subject to liquefaction damage, particularly in areas associated with the Columbia River near the western end of Region 5.
- Other: Damage to shipping channels and shore facilities, and failure of Columbia River bridges west of Region 5 may have long-term impacts on freight shipments into and out of Region 5.

REGIONAL LOSS ESTIMATES. The highway-related losses include disconnection from supplies and replacement inventory, and the loss of tourists and other customers who must travel to do business with affected businesses.

MOST VULNERABLE JURISDICTIONS. Gilliam, Hood River, Morrow, Sherman, Umatilla and Wasco Counties have similar, relatively low vulnerability to ground shaking from a CSZ event. However, connections to markets and services will likely be disrupted due to the vulnerability of river transportation, ports, and surface routes to freight intermodal connections in the Portland Metro area.

Floods

Characteristics

Region 5 is subject to a variety of flood conditions. The most common type of flooding is associated with unseasonably warm weather during the winter months, which can quickly melt snow. This condition has produced devastating floods throughout the region. Flash floods, another type of flooding experienced in the region, are almost always a summer phenomenon associated with intense local thunderstorms. The flash flood of June 1903 in the City of Heppner (Morrow County) is a benchmark event. No flood in Oregon has been more lethal: 247 fatalities. Heppner's vulnerability to flash flood hazards has since been reduced through the construction of the Willow Creek Dam. The region's other flood events are linked to normal seasonal snowmelt and runoff from agricultural fields.

There are several rivers in the region that produce natural extreme flood conditions. Surprisingly, the Columbia is not one of them, nor is the lower Deschutes or the John Day. The Columbia is regulated by up-stream dams. A swollen Columbia River, however, can back up tributary streams to the point where they constitute a significant hazard. This has occurred on a number of occasions. The lower Deschutes and John Day are confined to fairly deep canyons with small floodplains. Consequently, they do not present the flood problems associated with smaller rivers, such as the Umatilla, the Walla Walla, and their tributaries.

Historic Flood Events

Table 2-336. Significant Historic Floods Affecting Region 5

Date	Location	Description	Type of Flood
June 1894	main stem Columbia River (Region 5 communities)	largest flood observed on the Columbia River (1,200,000 cfs); City of Umatilla inundated; widespread damage	snow melt
June 1903	Morrow County (Willow Creek)	very devastating flash flood; 40-ft wall of water in City of Heppner; 247 fatalities; 141 homes destroyed	flash flood
Jan. 1923	Mid-Columbia region	widespread flooding; unusually warm weather, intense rain	rain on snow
Jan. 1933	Mid-Columbia region	widespread flooding; heavy mountain snowpack followed by rain and mild temperatures	rain on snow
Dec. 1955	Mid-Columbia region	mild temperatures and rain; farms, highways flooded	rain on snow
Dec. 1964	entire state	record-breaking floods throughout state; heavy snow in mountains followed by intense rain; considerable flood damage	rain on snow
July 1965	Lane/Spears Canyons (Umatilla County)	thunderstorm; 8–10 ft wall of water from canyon; considerable damage; one fatality; several people injured	flash flood
Dec. 1980	Polallie Creek (Hood River County)	debris flow from vicinity of Mount Hood; debris dam formed a small lake that was later breeched; damage to highways and utilities	debris flow
Feb. 1985	Umatilla County	warm rain on snow at higher elevations; flooding throughout county	rain on snow
Feb. 1986	entire state	warm rain on snow; widespread flooding; considerable damage	rain on snow
May 1998	central and eastern Oregon	widespread flooding; rain melting mountain snow	rain on snow
Aug. 2003	Gilliam County	$7,000 in property damage	
Aug. 2003	Sherman County	Flash flood (Gerking Canyon) *excerpted from State Plan, 2006	
Apr. 2005	Morrow County	$2,000 in property damage	
Apr. 2005	Umatilla County	$170,000 in property damage	
Mar. 2006	Morrow County	flash flood from a collapsed irrigation dike embankment floods the south side of I-84 near Boardman, closing down the road	flash flood
Nov. 2006	Hood River County	Hood River near the City of Hood River caused extensive damage on OR-35 closing the highway for a month; moderate damage done to irrigation works; total $30 million in damage	riverine
May/ June 2011	Morrow County	intense rainfall in the Heppner and Lexington areas resulting in damage to roads, bridges, and the Morrow County Fairgrounds; total of $164,000 in damage	flash flood

Sources: Taylor and Hatton (1999); Hazards and Vulnerability Research Institute (2007); The Spatial Hazard Events and Losses Database for the United States, version 5.1 [online database]. Columbia, SC: University of South Carolina, available from http://www.sheldus.org; State Interagency Hazard Mitigation Team (2006). National Climatic Data Center, Storm Events, http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms

Table 2-337. Principal Flood Sources by County in Region 5

Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Columbia River Thirty Mile Creek	Columbia River Hood River Indian Creek	Columbia River Hinton Creek Little Blackhorse Canyon Creek Shobe Creek Willow Creek Rhea Creek	Columbia River	Columbia River Birch Creek McKay Creek Mill Creek Patawa Creek Stage Gulch Tutuilla Creek Umatilla River Walla Walla River Waterman Gulch Pine Creek Greasewood Creek	Columbia River Spanish Hollow Creek Fifteen Mile Creek Mosier Creek

Source: FEMA Flood Insurance Studies for Gilliam, Hood River, Morrow, Sherman, Umatilla, and Wasco Counties

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 5 will experience flooding is shown in **Table 2-338**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-338. Local Probability Assessment of Flood in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Probability	H	H	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The Federal Emergency Management Agency (FEMA) has mapped most flood-prone streams in Oregon. The maps depict the 1% flood (100-year) upon which the National Flood Insurance Program is based. All of the Region 5 counties have Flood Insurance Rate Maps (FIRM); however, some of the maps are old and could be outdated. The FIRM maps were issued at the following times:

- Gilliam, September 24, 1984;
- Hood River, September 24, 1984;
- Morrow, December 18, 2007;
- Sherman, September 24, 1984;
- Umatilla, September 2010; and
- Wasco, September 24, 1984.

Significant flooding occurs at least once every 5-7 years.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the region's vulnerability to flooding is shown in **Table 2-339**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-339. Local Vulnerability Assessment of Flood in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Vulnerability	M	M	H	M	M	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The Oregon Department of Land Conservation and Development (DLCD) created a countywide flood vulnerability index by compiling data from NOAA's Storm Events Database and from FEMA's National Flood Insurance Program. Data were calculated statewide for the period 1978 through 2013 for five input datasets: number of events, structure and crop damage estimates in dollars and NFIP claims number and dollar amounts. The mean and standard deviation were calculated for each input. Then each county was assigned a score ranging from 0 to 3 for each of these inputs according to **Table 2-340**.

Table 2-340. Scoring for Vulnerability Index

Score	Description
3	county data point is greater than 2.5 times standard deviation for the input data set
2	county data point is greater than 1.5 times standard deviation for the input data set
1	county data point is within standard deviation
0	no data reported

Source: DLCD

DLCD summed the scores for each of the five inputs to create a county-by-county vulnerability index. The maximum possible score is 15. A score over 6 indicates that at least one variable significantly exceeds average values.

Each of the counties in Region 5 had a flood vulnerability score of 5, except for Sherman County with a score of 4. This is below average for the state.

Region 5 is exposed to flood hazards. Most of the people and infrastructure are along the I-84 corridor, which runs along the northern portion of the region. This multimodal transportation corridor is vital to Oregon's economy and includes a major interstate highway (I-84); two transcontinental rail lines, Union Pacific and Burlington Northern Santa Fe; the Columbia River inland water navigation; major electric power and gas lines; and communication conduits. Roughly $14 billion worth of goods are carried through the corridor each year (Wang & Chaker, 2004).

The vulnerability from the hazard can be examined through the spatial relationship of the percent of a city's total area versus the percent of the city's area within the 100 year flood zone. Four of the top 10 cities in Oregon examined using this metric are located in Region 5: Helix, Ione, Adams, and Athena. This indicates that damaging floods are indeed possible in developed areas of the Region, but lower than average vulnerability is due to low populations in those cities. Nevertheless, floods can devastate these small cities.

FEMA has identified no Repetitive Loss properties in Region 5 (FEMA NFIP BureauNet, http://bsa.nfipstat.fema.gov/, accessed 12/1/2014).

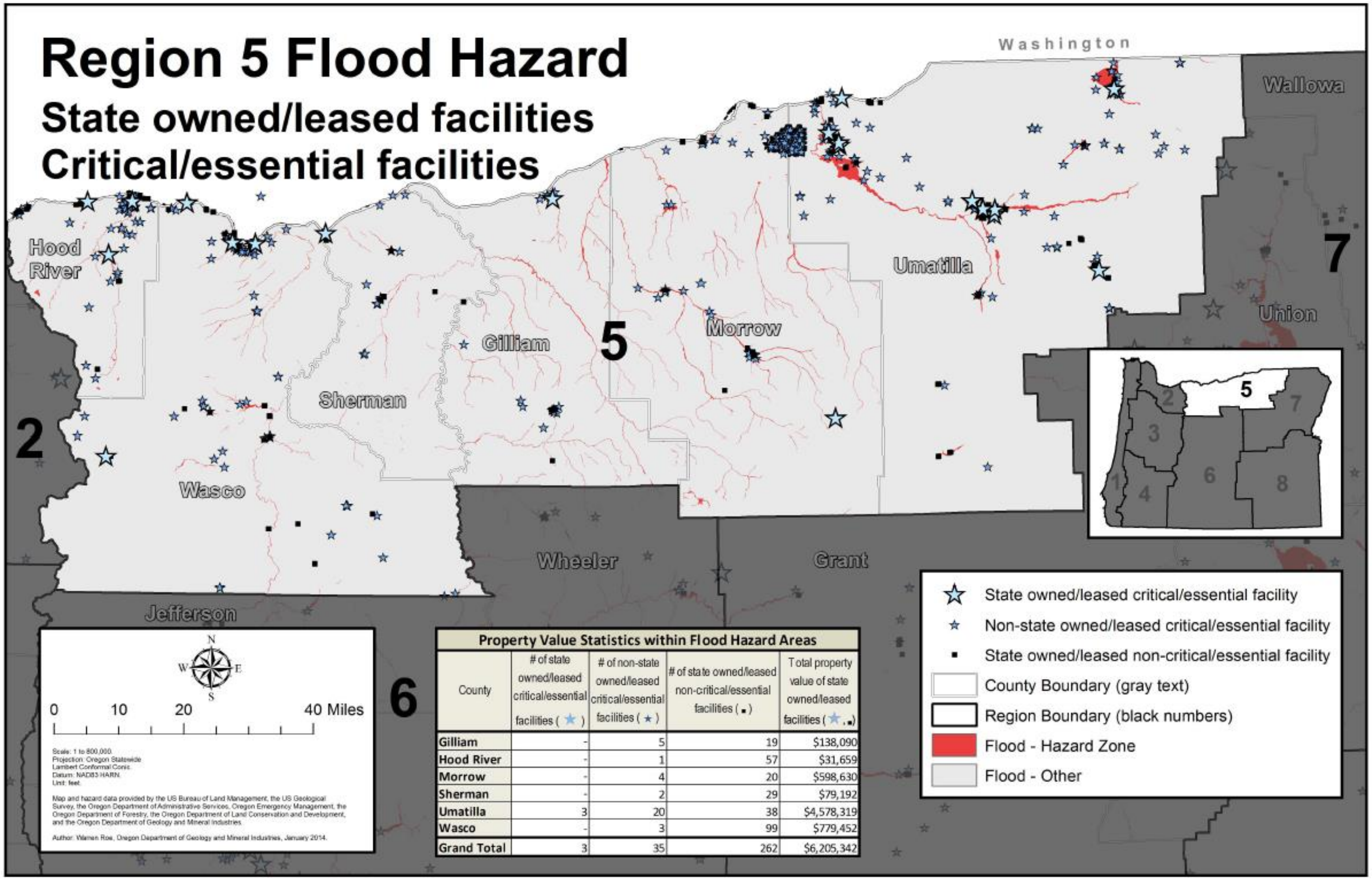
Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS), which results in reduced flood insurance costs. The cities of Stanfield and Heppner belong to CRS.

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of the 5,693 state facilities evaluated, 265 are currently located within a flood hazard zone in Region 5 and have an estimated total value of $6 million (**Figure 2-176**). Of these, three are identified as a critical or essential facility. An additional 35 non-state-owned/leased critical or essential facilities are located in a flood hazard zone in Region 5.

Figure 2-176. State-Owned/Leased Facilities and Critical/Essential Facilities in a Flood Hazard Zone in Region 5



Property Value Statistics within Flood Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★ , ▪)
Gilliam	-	5	19	$138,090
Hood River	-	1	57	$31,659
Morrow	-	4	20	$598,630
Sherman	-	2	29	$79,192
Umatilla	3	20	38	$4,578,319
Wasco	-	3	99	$779,452
Grand Total	3	35	262	$6,205,342

Source: DOGAMI

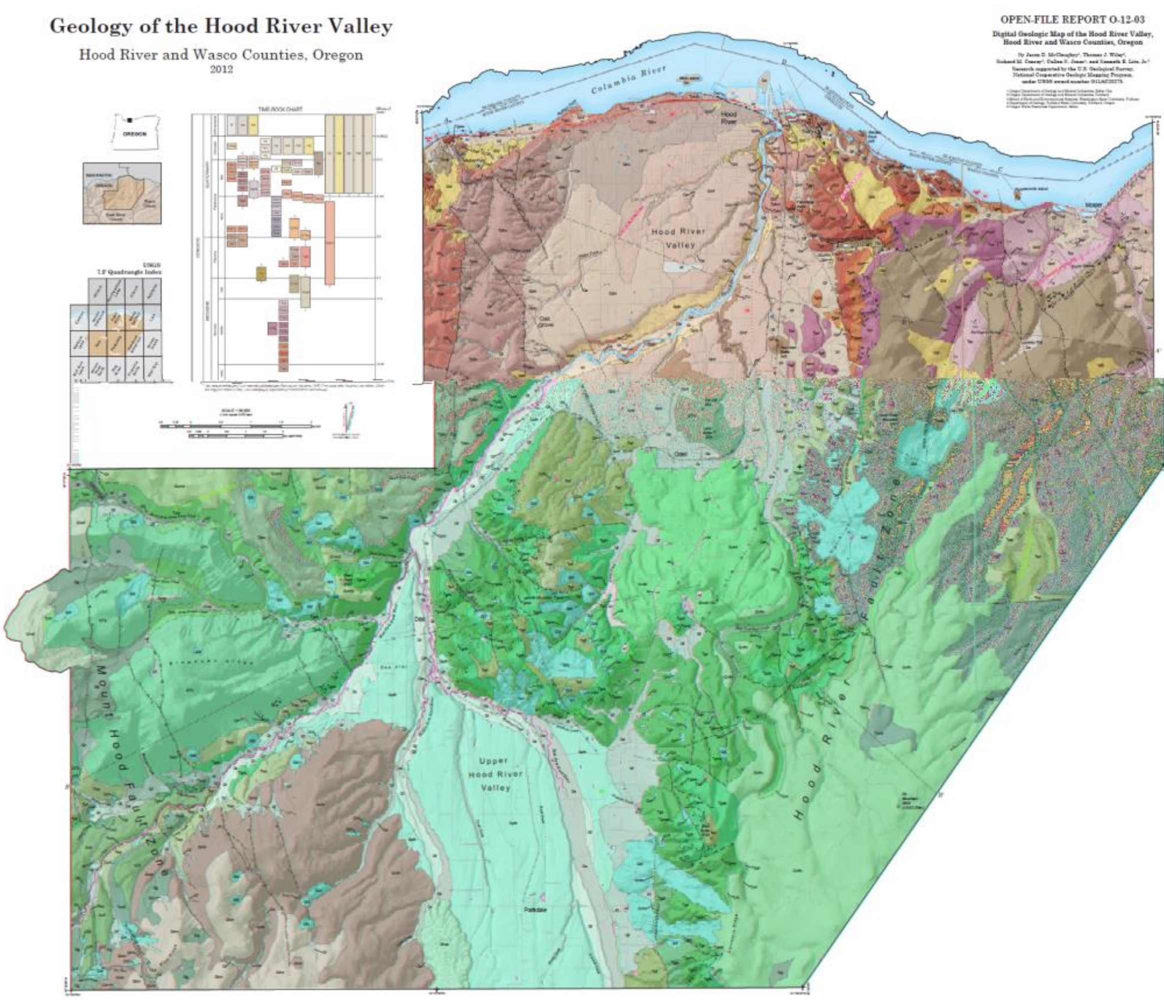
Landslides

Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. In general, the Cascade Mountains and the Columbia River Gorge have very high incidence of landslides. On occasion, major landslides sever major transportation routes such as U.S. or state highways and rail lines, causing temporary but significant economic damage.

For example, the new geology map of the Hood River area and the Mount Hood Multi-Hazard and Risk study both found hundreds of landslides in this area (McClaughry et al., 2012; Burns et al., 2012). In February 2014, a large rock slide in Hood River closed I-84 for almost a week.

Figure 2-177. Geology of the Hood River Valley



Source: Jason D. McClaughry, Thomas J. Wiley, Richard M. Conrey, Cullen B. Jones, and Kenneth E. Lite, Jr., 2012. DIGITAL GEOLOGIC MAP OF THE HOOD RIVER VALLEY, HOOD RIVER AND WASCO COUNTIES, OREGON. Oregon Department of Geology and Mineral Industries Open-File Report O-12-03.

Historic Landslide Events

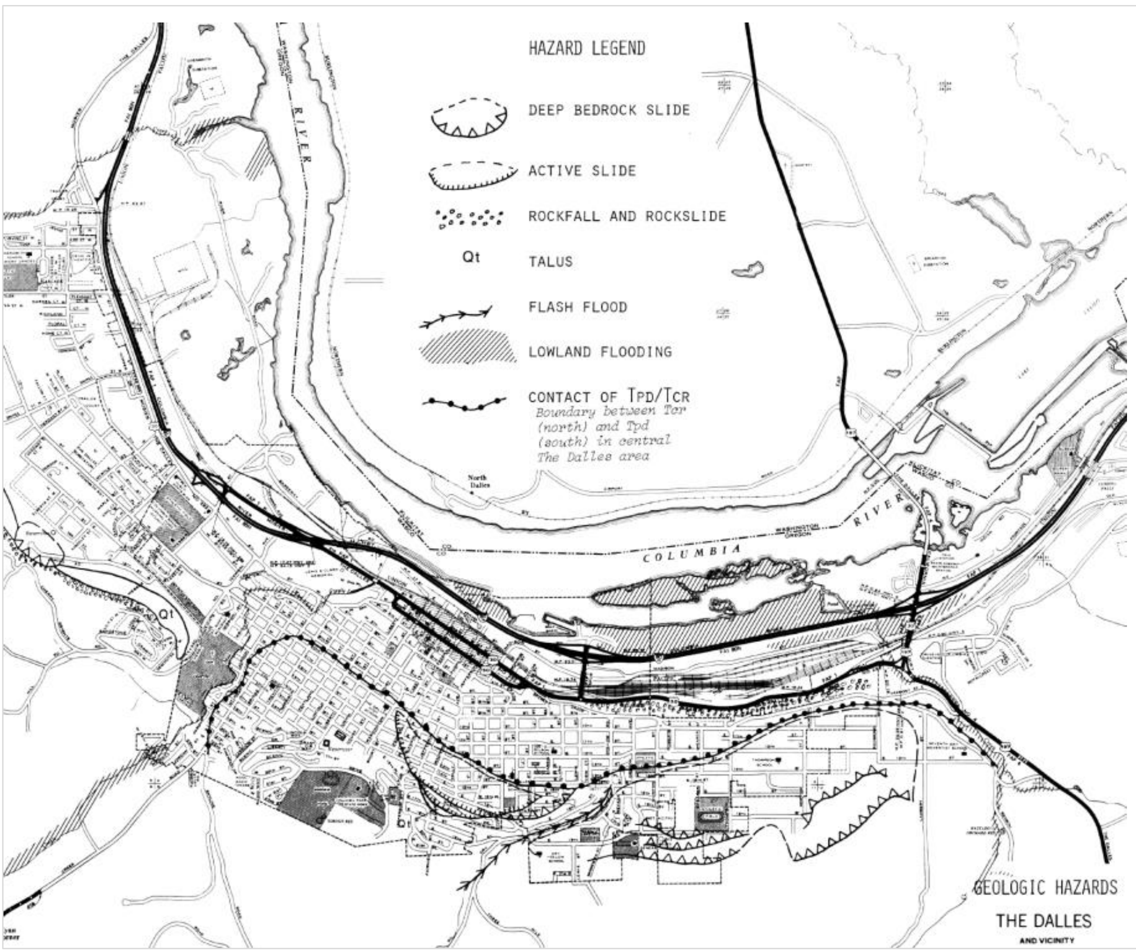
Table 2-341. Historic Landslides in Region 5

Date	Location	Description
2005	Sherman and Wasco Counties	property damage: $35,000 (includes Jefferson County)
2009	Hood River County	property damage: $78,571
2014	Hood River County	rock slide on I-84; interstate closed for days

Source: Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org/

Another existing landslide area affecting significant portions of the City of The Dalles was mapped in DOGAMI Bulletin 91 (**Figure 2-178**).

Figure 2-178. Landslides in the The Dalles, Oregon Area



Source: Beaulieu (1977)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 5 will experience landslides is shown in **Table 2-342**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-342. Local Probability Assessment of Landslides in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Probability	H	M	H	M	—	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Landslides are found in every county in Oregon. There is a 100% probability of landslides occurring in this region in the future. Although we do not know exactly where and when they will occur, they are more likely to happen in the general areas where landslides have occurred in the past. Also, they will likely occur during heavy rainfall events or a future earthquake.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to landslides is shown in **Table 2-343**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-343. Local Vulnerability Assessment of Landslides in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Vulnerability	M	M	M	M	—	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

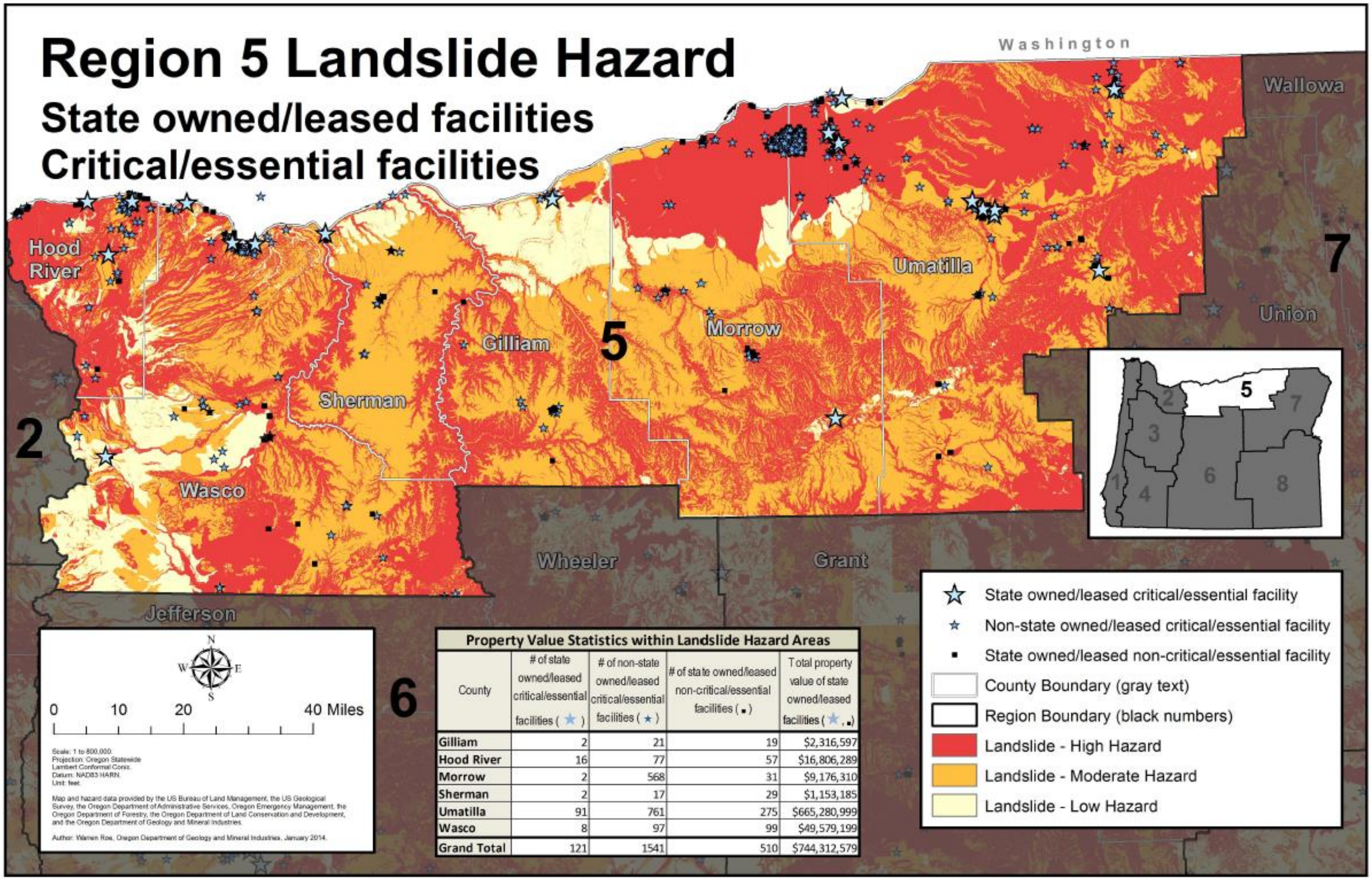
The Mid-Columbia Region is moderate to highly vulnerable to landslide hazards. Most of the people and infrastructure are along the I-84 corridor which runs along the northern portion of the region. This multimodal transportation corridor is vital to Oregon's economy and includes a major interstate highway (I-84); two transcontinental rail lines, Union Pacific and Burlington Northern Santa Fe; the Columbia River inland water navigation; major electric power and gas lines; and communication conduits. Roughly $14 billion worth of goods are carried through the corridor each year (Wang and Chaker, 2004). Many of the communities in this region are vulnerable to landslide hazard, for example the cities of Hood River and The Dalles have a moderate to high exposure to landslides.

STATE-OWNED/LEASED FACILITIES AND CRITICAL AND ESSENTIAL FACILITIES

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the **State Risk Assessment**, Oregon Vulnerabilities for more information.

Of the 5,693 state facilities evaluated, 631 are located within landslide hazard areas in Region 5, totaling roughly $744 million (**Figure 2-179**). This includes 121 critical or essential facilities. An additional 1,541 critical/essential facilities, not owned/leased by the state, are also located within a landslide hazard zone in Region 5.

Figure 2-179. State-Owned/Leased Facilities and Critical/Essential Facilities in a Landslide Hazard Zone in Region 5



Property Value Statistics within Landslide Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Gilliam	2	21	19	$2,316,597
Hood River	16	77	57	$16,806,289
Morrow	2	568	31	$9,176,310
Sherman	2	17	29	$1,153,185
Umatilla	91	761	275	$665,280,999
Wasco	8	97	99	$49,579,199
Grand Total	121	1541	510	$744,312,579

Source: DOGAMI

Volcanoes

Characteristics

The western boundary of the region coincides with the Cascade Range, which are mountains derived from volcanic activity. Within this range of mountains are several active and potentially active volcanoes. Mount Hood, Mount Jefferson, and Mount Adams are all potentially active volcanoes close to Region 5 that can impact these communities.

Volcanic activity can produce many types of hazardous events including landslides, ashfall, lahars, pyroclastic flows, and lava flows (Scott et al., 2001). Pyroclastic flows are fluid mixtures of hot rock fragments, ash, and gases that can move down the flanks of volcanoes at speeds of 50 to more than 150 kilometers per hour (30 to 90 miles per hour) (Scott et al., 2001). Lahars or volcanic debris flows are water-saturated mixtures of soil and rock fragments that can travel very long distances (over 100 km) as fast as 80 kilometers per hour (50 miles per hour) in steep channels close to a volcano(Scott et al., 1997). Lahars can be very localized (only meters across) or can affect areas hundreds of kilometers away (Walder et al., 1999).

Mount Hood’s eruptive history can be traced to late Pleistocene times (15,000–30,000 years ago) and will no doubt continue. But the central question remains: When? The most recent series of events (1760–1810) consisted of small lahars and debris avalanches; steam explosions and minor tephra falls occurred between 1859 and 1865. Mount Hood’s recent history also includes ashfalls, dome building, lahars, pyroclastic flows, and steam explosions.

Historic Volcanic Events

Table 2-344. Historic Volcanic Activity Affecting Region 5

Date	Location	Description
about 20,000 to 13,000 YBP	Polallie Eruptive episode, Mount Hood	lava dome, pyroclastic flows, lahars, tephra
about 7,700 YBP	Parkdale, north-central Oregon	eruption of Parkdale lava flow
about 1,500 YBP	Timberline eruptive period, Mount Hood	lava dome, pyroclastic flows, lahars, tephra
1760–1810	Crater Rock/Old Maid Flat on Mount Hood	pyroclastic flows in upper White River; lahars in Old Maid Flat; dome building at Crater Rock
1859–1865	Crater Rock on Mount Hood	steam explosions and tephra falls
1907 (?)	Crater Rock on Mount Hood	steam explosions

Note: YBP is years before present.

Source: U.S. Geological Survey, Cascades Volcano Observatory: http://volcanoes.usgs.gov/observatories/cvo/; Scott et al. (1997)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 5 will experience volcanic hazards is shown in **Table 2-345**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-345. Local Probability Assessment of Volcanic Activity in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Probability	L	L	—	L	—	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Mount St. Helens remains a probable source of ashfall. It has repeatedly produced voluminous amounts of this material and has erupted much more frequently in recent historical time than any other Cascade volcano. It blanketed Yakima and Spokane, Washington during the 1980 eruption and continues to be of concern. The location, size, and shape of the area affected by ashfall are determined by the vigor and duration of the eruption and the wind direction. Because wind direction and velocity vary with both time and altitude, it is impossible to predict the direction and speed of ash transport more than a few hours in advance.

Geoscientists have provided some estimates of future activity in the vicinity of Crater Rock, a well-known feature on Mount Hood. They estimate a 1 in 300 chance that some dome activity will take place in a 30-year period (1996–2026). For comparison, the 30-year probability of a house being damaged by fire in the United States is about 1 in 90.

The probability of 1 cm or more of ashfall from eruptions anywhere in the Cascade Range, include:

- Gilliam County: 1 in 1,000;
- Hood River County: Between 1 in 500 and 1 in 1,000;
- Morrow County: 1 in 1,000;
- Sherman County: 1 in 1,000;
- Umatilla County: Between 1 in 1,000 and 1 in 5,000; and
- Wasco County: Between 1 in 500 and 1 in 1,000.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to volcanic hazards is shown in **Table 2-346**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-346. Local Vulnerability Assessment of Volcanic Activity in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Vulnerability	M	L	—	L	—	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

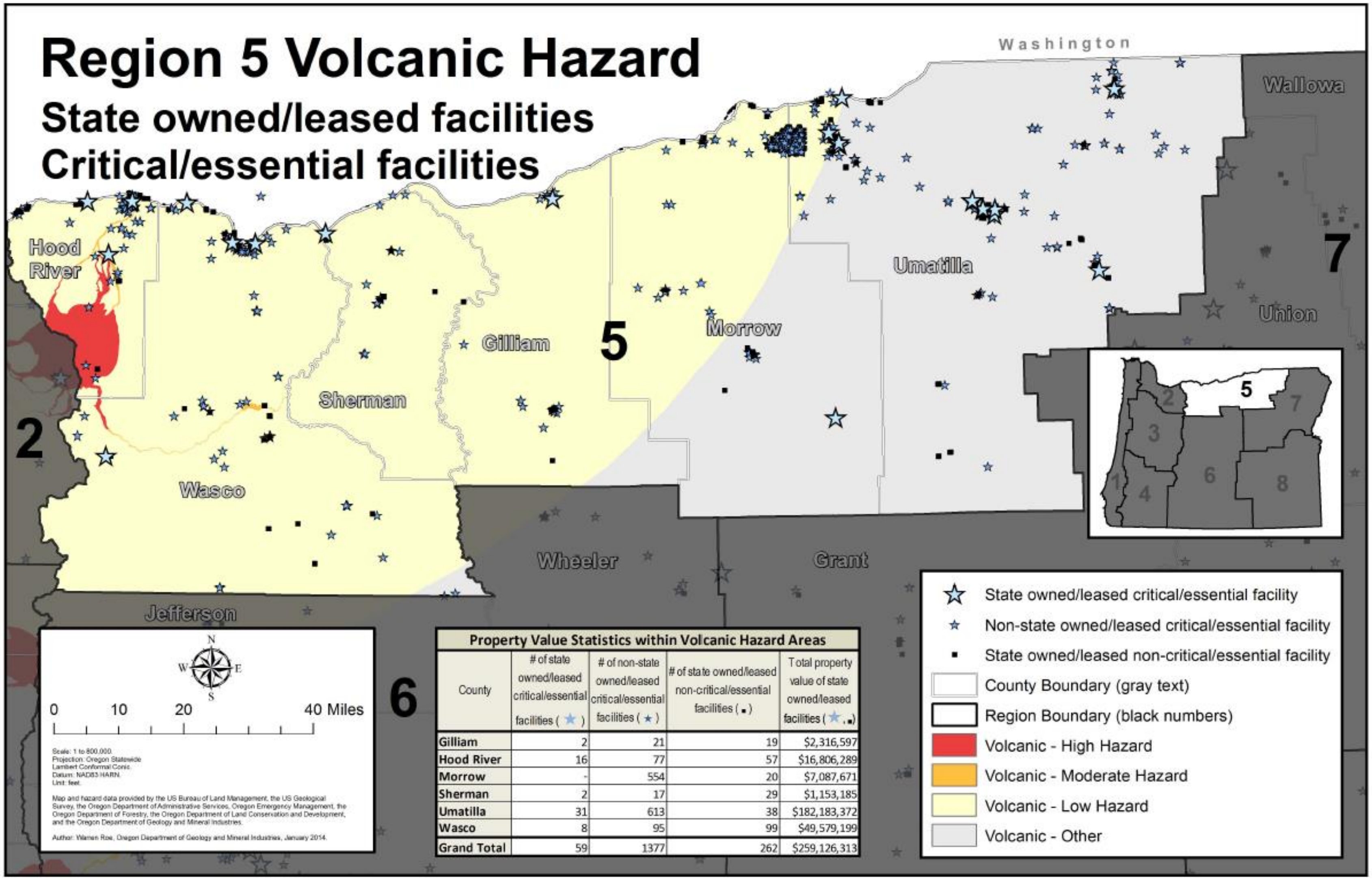
The U.S. Geological Survey has addressed volcanic hazards at Mount Hood (Scott et al., 1997). This report includes maps depicting the areas at greatest risk. The communities which are closer to Mount Hood, such as the Parkdale and the City of Hood River in Hood River County, are at risk from proximal as well as the distal hazards, such as lahars and ashfall. In Wasco County, communities situated along the White River may be at risk from pyroclastic flows and far-reaching lahars. Counties in Region 5, farther east of Mount Hood, are only at risk from the distal hazards such as ashfall.

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 321, with a total value $259 million, are located within a volcanic hazard area in Region 5. Furthermore, there are 1,377 non-state-owned/leased critical/essential facilities located within a volcanic hazard zone in Region 5 (**Figure 2-180**).

Figure 2-180. State-Owned/Leased Facilities and Critical/Essential Facilities in a Volcanic Hazard Zone in Region 5



Property Value Statistics within Volcanic Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Gilliam	2	21	19	$2,316,597
Hood River	16	77	57	$16,806,289
Morrow	-	554	20	$7,087,671
Sherman	2	17	29	$1,153,185
Umatilla	31	613	38	$182,183,372
Wasco	8	95	99	$49,579,199
Grand Total	59	1377	262	$259,126,313

Source: DOGAMI

Wildfires

Characteristics

In Region 5, Senate Bill 360 (Oregon Forestland-Urban Interface Protection Act) has been implemented in Hood River, Wasco and Umatilla Counties. Wildfires burn primarily in vegetative fuels outside the urban areas, and can generally be categorized as agricultural, forest, range, or wildland-urban interface fires.

Region 5 has unique geographic features, weather characteristics, a history of unmanaged fuels, and an expanding urban interface. Douglas fir, grand fir, and western hemlock (fire interval 150–400 years) dominate in the wetter forests of the western Columbia River Gorge, while ponderosa pine, Oregon white oak brush, and grass are more characteristic toward the east (15 year fire intervals). Historically, the region consisted of pine forests. More recently, due to decay in forest health and changes in forest practices, ponderosa pine has given way to brush and mixed conifer (Douglas fir, grand fir, and subalpine fir) at higher elevations. North and east facing slopes are typically forested while south and westerly aspects are generally open and grass covered.

This region is subject to weather patterns that can contribute significantly to extreme fire behavior. Annual precipitation levels vary from 8 to 10 inches along the Columbia River, to as high as 60 inches in the higher elevations of the Blue Mountains. Wind in the gorge is a constant variable. Wind at the east end of the gorge tends to be minimal; however, the west portion experiences 20–30 mph winds daily and, at times, winds exceed 40 mph. Significant drying occurs as sustained winds, coupled with high daytime temperatures and drier air from the desert, pushes toward the coast.

OEM Weather Statement

Extreme winds are experienced in all of Oregon's eight regions. The most persistent high winds occur along the Oregon Coast and the Columbia River Gorge. The Columbia Gorge is the most significant east-west gap in the mountains between California and Canada. It serves as a funnel for east and west winds, where direction depends solely on the pressure gradient. Once set in motion, the winds can attain speeds of 80 mph, halt truck traffic, and damage a variety of structures and facilities. The average wind speed at Hood River is 13 mph.

Land ownership and resultant management and suppression capabilities and protocols in this area also affect the potential for wildfires. In region 5, the most significant land ownership falls to federal agencies, and includes forested and wilderness areas. Federal lands in this area are characterized by dense stands, heavy underbrush, and ladder fuels, increasing the potential for wildfires. County, state, and private lands contribute to the remainder. These lands have a variety of management practices resulting in a mix of stand conditions and resultant fire potential.

Regardless of ownership, the majority of the forestlands in Region 5 are historically prone to wildfire. As the number of dwellings extends into these areas the potential for ignition and losses increases. Many of these communities in the wildland-urban interface fall just outside of any agency's primary protection coverage, which reduces their likelihood of surviving a wildfire.

Historic Wildfire Events

Table 2-347. Historic Wildfires in Region 5

Year	Name of Fire	Location	Acres Burned	Remarks
1977		Wasco		
1979	Pine Grove/Juniper Flat			
1983	Moro	Sherman		
1985	Maupin	Wasco		
1988		Wasco		
1991	Falls		1,100	fire along the Columbia Gorge
1994	Smith Canyon			
1998	Rowena	Wasco	2,208	
1998	Reith Barnhart/Coombs Canyon	Umatilla	45,000	
2000	Willow Creek	Morrow and Gilliam	27,000	
2000	Antelope	Wasco		
2001	Two Rivers	Umatilla	7,011	
2001	Bridge Creek	Umatilla	9,230	
2002	Sheldon Ridge	Wasco	12,681	
2003	Herman Creek	Wasco	300	3 structures were lost in this fire that affected Cascade Locks
2003		Umatilla County		$40,000 in property damage, $200,000 in crop damage
2003		Umatilla County		$15,000 in property damage, $500 in crop damage
2004		Gilliam, Morrow and Umatilla Counties		$6,000 in property damage
2005		Sherman and Wasco Counties		$1,000 in property damage *damage estimate includes Jefferson County
2005		Morrow and Umatilla Counties		$2,500 in property damage and $11,500 in crop damage
Mar. 2005		Gilliam, Morrow and Umatilla Counties		$113,900 in crop damage
July 2005		Umatilla and Morrow Counties		$5,000 in property damage, $23,000 in crop damage
May 2006		Gilliam, Morrow and Umatilla Counties		$10,000 in property damage
June 2006		Gilliam, Morrow and Umatilla Counties		$500,000 in property damage
2009	Microwave Fire	Wasco County		fire threatened Maupin, burned 2 residences
2011	High Cascade Complex	Wasco County	101,292	fire burned into Warm Springs
2013	Government Flats Complex	Wasco County	11,450	fire burned four homes in The Dalles; fire suppression costs more than $15 million

Source: Oregon Department of Forestry, 2013

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 5 will experience wildfire is shown in **Table 2-348**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-348. Local Probability Assessment of Wildfire in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Probability	H	H	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

In Region 5, weather patterns can produce summer lightning storms that start many fires. These multiple starts can put a strain on the wildland firefighting resources spread across the county. With the drying of fuels over time and the low relative humidity factored in, the probability for large fires can significantly increase during these lightning events. The number of days per season that forest fuels are capable of producing a significant fire event is also important to consider. Oregon Department of Forestry has determined that eastern Oregon is at the highest hazard rating for weather. This value was assigned through an analysis of daily wildfire danger rating indices in each regulated use area of the state.

The west side of the region includes the heavily wooded hills and mountains of the Cascades; the east side is lined with hills that are also wooded but drier, along with significantly more oak and grasses; the west end of the heavily wooded region is pinched between the Columbia River and the near vertical sides of the river gorge.

A healthy forest across this region is never free of insects, disease, or other disturbances and infestations can increase the likelihood of ignition and fire spread. The potential for extreme fire behavior is of concern for any valued property, whether it be a structure or scenic vista at the top of a bluff, hill, or canyon that has enough fuel to sustain a fire. The more fuels on a bluff, hill, or canyon, the more active the fire will become. As the percentage of slope increases more preheating of fuels preceding the fire front will occur. The fire front will proceed up the hill at a faster rate and the fire will burn more intensely. Coupled with high winds and low humidity, this region has the potential for a severe wildfire.

This region is susceptible to wildfire when favorable east wind conditions prevail. Fires have the potential to spread from Washington State across the river into Oregon via long-range spotting.

Sources of human-caused ignition include discarded cigarettes, motor cars and trucks, railroads, mowing, acts of nature, and fire emanating from adjoining land. Most fires adjacent to the freeway start in fine grasses and can rapidly progress into conifers that line the safety zone for almost the entire breadth of the region's west end.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to wildfire is shown in **Table 2-349**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-349. Local Vulnerability Assessment of Wildfire in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Vulnerability	M	M	M	M	M	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Based on data from the 2013 West Wide Wildfire Risk Assessment, in Region 5, Umatilla and Wasco Counties have a high percentage of wildland acres subject to Fire Risk, Wildland Development Areas, Fire Effects, or Fire Threat, making them especially vulnerable.

In addition, each year a significant number of people build homes within or on the edge of the forest (urban-wildland interface), thereby increasing vulnerability. These communities have been designated "Wildland-Urban Interface Communities" and listed in **Table 2-350**.

There is also critical infrastructure beyond the wildland-urban interface that is vulnerable to wildfire. Disruption to the municipal water supply and irrigation water supply from wildfires would negatively impact all of the residents and agricultural operators that depend on this resource by reducing water quality and availability. Roads, bridges, and evacuation routes could be compromised, limiting the ability of firefighters to reach the fire as well as inhibiting evacuation procedures. Utilities including Bonneville Power Administration power lines, Portland General Electric and Northwest Natural Gas electrical and gas distribution lines and communication infrastructure are also at risk.

The economic stability of the Region is dependent on a major interstate highway (I-84). This highway runs east-west, paralleling the Columbia River from MP 35 to MP 69. This four lane highway is considered part of the "National Defense Highway System" and as such some federal entities are sensitive to highway closures that impede or stop the flow of traffic. Most frequently, closures or restrictions are for motor vehicle accidents; however, closures can also be expected in the face of low or no visibility secondary to wildfire or inclement winter weather. Additional economic sectors that could be affected by wildfire are agriculture, forest products, tourism, manufacturing, recreation, and power generation. Community values and natural resources at risk of wildfire include agriculture and livestock, wildlife and salmonids, and historic buildings.

Table 2-350. Wildland-Urban Interface Communities in Region 5

Gillam	Hood River	Morrow	Sherman	Umatilla	Wasco
Arlington	Cascade Locks	Boardman	Moro	Adams	Antelope
Condon	Dee	Heppner	North Sherman	Athena	Dufur
Gilliam	Hood River	Ione	Rufus	East Umatilla	Juniper Flats
Lonerock	Odell	Irrigon	South Sherman	Echo	Maupin
North Gilliam	Parkdale	Lexington	Wasco	Helix	Mid-Columbia
South Gilliam	Pine Grove	Morrow		Hermiston	Mosier
	West Side			Lower McKay	Pine Grove
				McKay	Pine Hollow
				Milton-Freewater	Shaniko
				Pendleton	The Dalles
				Pilot Rock	Tygh Valley
				Riverside	Wamic
				Stanfield	Warm Springs
				Ukiah	Wasco
				Umatilla	
				Weston	

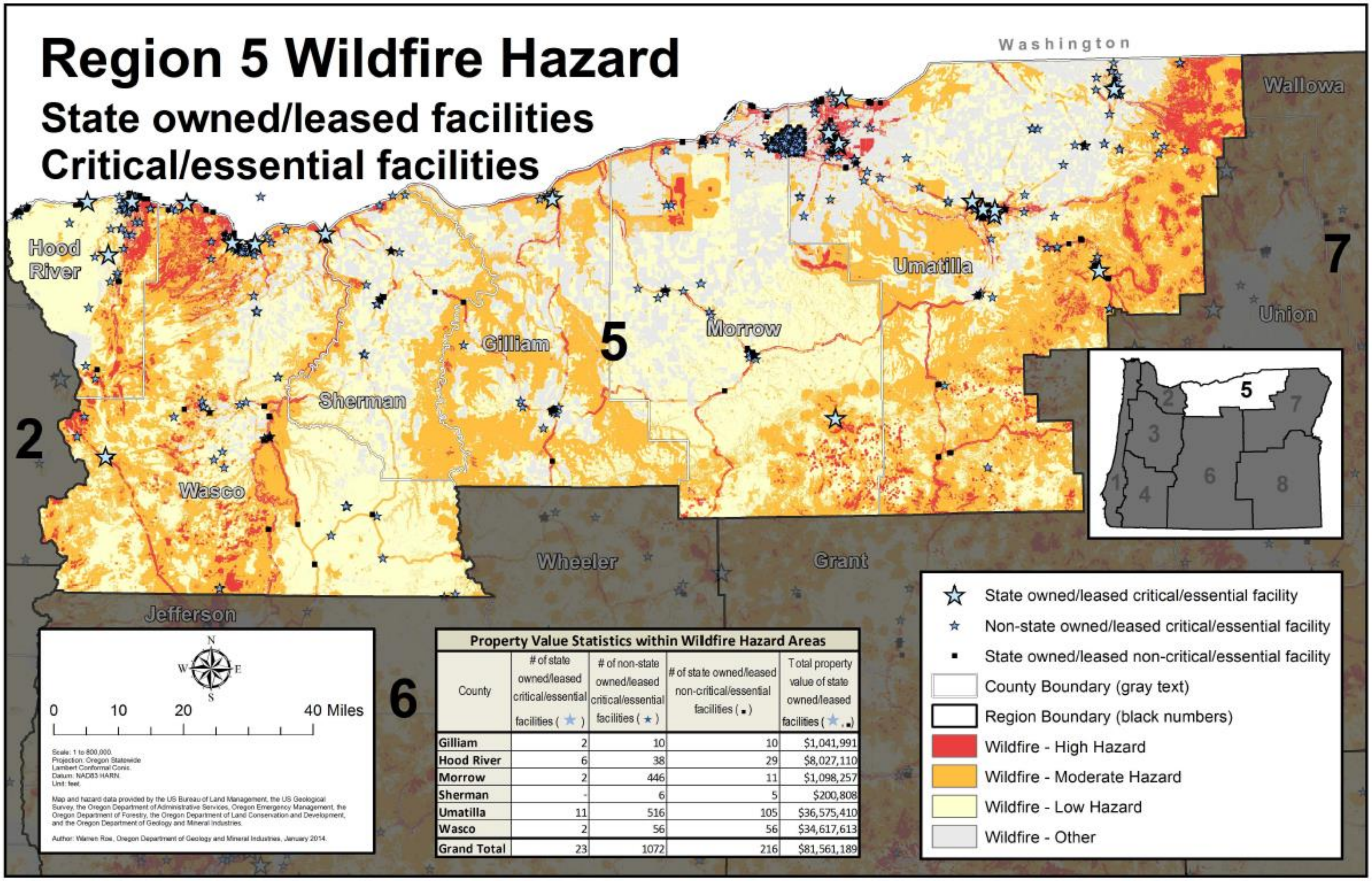
Oregon Dept. of Forestry Statewide Forest Assessment September, 2006

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 239 are within a wildfire hazard zone in Region 5 and total $81.5 million in value (**Figure 2-181**). Among State0owned/leased critical or essential facilities, 23 are located in a wildfire hazard zone in Region 5. An additional 1,072 non-state-owned/leased critical or essential facilities are also located in Region 5.

Figure 2-181. State-Owned/Leased Facilities and Critical/Essential Facilities in a Wildfire Hazard Zone in Region 5



Property Value Statistics within Wildfire Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Gilliam	2	10	10	$1,041,991
Hood River	6	38	29	$8,027,110
Morrow	2	446	11	$1,098,257
Sherman	-	6	5	$200,808
Umatilla	11	516	105	$36,575,410
Wasco	2	56	56	$34,617,613
Grand Total	23	1072	216	$81,561,189

Source: DOGAMI

Windstorms

Characteristics

Extreme winds are experienced in all of Oregon's eight regions. The most persistent high winds occur along the Oregon Coast and the Columbia River Gorge, so much so that these areas have special building code standards. All manufactured homes in Region 5 that are within 30 miles of the Columbia River must meet special anchoring standards. High winds in this area of Oregon are legendary. The Columbia Gorge is the most significant east-west gap in the mountains between California and Canada. It serves as a funnel for east and west winds, where direction depends solely on the pressure gradient. Once set in motion, the winds can attain speeds of 80 mph, halt truck traffic, and damage a variety of structures and facilities. The average wind speed at Hood River is 13 mph, not much less than the notoriously windy Texas and Kansas plains whose wind speeds average 15 mph (Taylor and Hatton, 1999).

Though their occurrence is somewhat less frequent, Region 5 has also experienced tornadoes. For the most part, these tornadoes have not resulted in major damages. **Table 2-352** lists historic tornadoes in the region.

Historic Winter Storm Events

Table 2-351. Historic Windstorms Affecting Region 5

Date	Affected Area	Characteristics
Apr. 1931	N. Central Oregon	unofficial wind speeds reported at 78 mph; damage to fruit orchards and timber
Dec. 1935	W. Columbia Gorge, Oregon	damage to automobiles; wind gusts at 120 mph
Nov. 10-11, 1951	statewide	widespread damage; transmission and utility lines; wind speed 40–60 mph; gusts 75–80 mph
Dec. 1951	statewide	wind speed 60 mph in Willamette Valley; 75 mph gusts; damage to buildings and utility lines
Dec. 1955	statewide	wind speeds 55–65 mph with 69 mph gusts; considerable damage to buildings and utility lines
Nov. 1958	statewide	wind speeds at 51 mph with 71 mph gusts; every major highway blocked by fallen trees
Oct. 1962	statewide	Columbus Day Storm; Oregon's most destructive storm to date; 116 mph winds in Willamette Valley.; estimated 84 houses destroyed, with 5,000 severely damaged; total damage estimated at $170 million
Mar. 1971	most of Oregon	greatest damage in Willamette Valley; homes and power lines destroyed by falling trees; destruction to timber in Lane County
Nov. 1981	statewide	severe wind storm
Dec. 1987	Umatilla County	damaging wind storm; two fatalities
Mar. 1991	Mid-Columbia / NE Oregon	severe wind storm
Dec. 1991	N. central Oregon	severe wind storm; blowing dust
Jan. 1993	northern Oregon	severe wind storm; damage to utilities
Dec. 1995	statewide	severe wind storm; widespread damage
Oct. 2003	Umatilla County	$1,000 in property damage
Jan. 2004	Morrow and Umatilla Counties	$2,500 in property damage

Date	Affected Area	Characteristics
Feb. 2004	Umatilla County	$3,000 in property damage *damage estimate includes Jefferson County
Apr. 2004	Hood River County	$25,000 in property damage
Apr. 2004	Wasco County	$1,000 in property damage
Oct. 2004	Gilliam, Morrow and Umatilla Counties	$333.33 in property damage
Dec. 2004	Gilliam, Morrow and Umatilla Counties	$166.66 in property damage
Dec. 2004	Sherman and Wasco Counties	$3,333.33 * damage estimate includes Jefferson County
Feb. 2005	Gilliam, Morrow and Umatilla Counties	$3,000 in property damage
Mar. 2005	Sherman and Wasco Counties	$2,500 in property damage *damage estimate includes Jefferson County
Nov. 2005	Umatilla County	$400 in property damage
Apr. 2006	Umatilla County	$10,000 in property damage in Hermiston
May 2006	Morrow County	$500,000 in property damage with a high wind gust measured at 117 mph; $1 million in crop damage
May 2006	Sherman County	$50,000 in property damage in Grass Valley; winds ranged from 70 to 80 mph
Nov. 2006	Morrow and Umatilla Counties	$35,000 in property damage from 80 mph winds; property damage also occurred in Union and Wallowa Counties, for a total storm damage of $70,000
Jan. 2007	Gilliam, Morrow, Sherman, Wasco and Umatilla Counties	$5,000 in property damage from 64 mph winds; damage estimate includes Jefferson County
June 2008	Umatilla County	powerful windstorm with wind speeds at 58 mph caused $10,000 in damage to buildings in Pendleton
June 2008	Morrow and Umatilla Counties	wind damage downed several trees and power lines, caused $250,000 in property damage and $100,000 crop damage in Morrow County, and $108,000 in property damage in Umatilla County
July 2010	Umatilla County	64 mph winds caused $40,000 in property damage in the Hermiston area
Nov. 2012	Wasco, Sherman, Umatilla, Gilliam, Morrow, Union and Wallowa Counties	74 mph winds $120,000 in damage *includes Jefferson County

Sources: Taylor and Hatton (1999); FEMA-1405-DR-OR, February 7, 2002, Hazard Mitigation Team Survey Report, Severe Windstorm in Western Oregon. and Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org and U.S. Department of Commerce. National Climatic Data Center. Available from http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms.

Table 2-352. Historic Tornadoes in Region 5

Date	Location	Result
June 1888	Morrow County (Lexington, Sand Hill, Pine City)	30 buildings, including two schools destroyed; six people killed (including two children); four people injured
Apr. 1925	Gilliam County	warehouse and automobiles destroyed in Condon; about $10,000 in damages
Apr. 1957	Gilliam and Morrow Counties	minor damage (rangeland)
Apr. 1970	Wasco County	observed; no damage
May 1991	Umatilla County	some damage to wheat fields
July 1995	Umatilla County	some damage to wheat fields
May 2006	Morrow County	$20,000 in property damage, F1 intensity
May 2009	Umatilla County	$50,000 in property damage, F1 intensity

Sources: Taylor and Hatton (1999); U.S. Department of Commerce. National Climatic Data Center. Available from http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 5 will experience windstorms is shown in **Table 2-353**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-353. Local Probability Assessment of Windstorm in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Probability	H	H	M	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

High winds occur yearly in the Columbia River Gorge. The 100-year event in this region consists of 1-minute average winds of 90 mph. A 50 year event has average winds of 80 mph. A 25-year event has average winds of 75 mph.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to windstorm is shown in **Table 2-354**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-354. Local Vulnerability Assessment of Windstorm in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Vulnerability	L	H	M	M	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Gilliam, Hood River, Morrow, and Sherman Counties are the most vulnerable to windstorms because of their proximity to the Columbia River.

Many buildings, utilities, and transportation systems within Region 5 are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It also is 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, which can affect emergency operations. In addition, uprooted 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. Uprooted trees growing next to a house have destroyed roofs when they fall as a result of windstorms. In some situations, strategic pruning may be the answer. Prudent counties will work with utility companies to identify problem areas and establish a tree maintenance and removal program.

Winter Storms

Characteristics

Severe winter weather in Region 5 can be characterized by extreme cold, snow, ice, and sleet. Winter storm events are an annual occurrence in Region 5; most communities are prepared for them. This is particularly true through the Columbia River Gorge where frigid air sometimes moves westward out of the Wallowa Mountains. During these periods, it is not unusual to receive snow or ice storms. Severe weather conditions do not last long in Region 5; consequently, winter-preparedness is a moderate priority. This is advantageous in at least one respect: in general, the region is prepared, and those visiting the region during the winter usually come prepared. However, there are occasions when preparation cannot meet the challenge.

Historic Winter Storm Events

Table 2-355. Historic Winter Storms Affecting Region 5

Date	Location	Remarks
Dec. 1861	entire state	storm produced 1–3 feet of snow throughout Oregon
Dec. 1884	Columbia Basin, Oregon	heavy snowfall; 29.5 inches in The Dalles in one day
Dec. 1885	Wasco County, Oregon	most snow recorded (6–10 feet); trains had difficulty reaching Portland
Dec. 1892	northern counties, Oregon	15–30 inches of snow throughout northern counties
Jan. 1916	entire state	two storms; very heavy snowfall, especially in mountainous areas
Jan. and Feb. 1937	entire state	deep snow drifts
Jan. 1950	entire state	record snowfalls; property damage throughout state
Mar. 1960	entire state	many automobile accidents; two fatalities
Jan. 1969	entire state	heavy snow throughout state
Jan. 1980	entire state	series of storms across state; injuries and power outages
Feb. 1985	entire state	2 feet of snow in northeast mountains; downed power lines; fatalities
Feb. 1986	central/eastern Oregon	Heavy snow in Deschutes Basin; traffic accidents; broken power lines
Mar. 1988	entire state	strong winds; heavy snow
Feb. 1990	entire state	heavy snow throughout state
Nov. 1993	Cascade Mountains, Oregon	heavy snow throughout region
Mar. 1994	Cascade Mountains, Oregon	heavy snow throughout region
Winter 1998-99	entire state	one of the snowiest winters in Oregon history (snowfall at Crater Lake: 586 inches)
Jan. 2005	Gilliam, Morrow, and Umatilla Counties	33 injuries
Nov. 2006	Hood River County	heavy freezing rain along I-84, closed the highway near Hood River
Dec. 2006	Hood River County	freezing rain and sleet caused ice conditions from Cascade Locks to Hood River; black ice on I-84
Jan. 2008	Hood River County	heavy freezing rain from Bonneville westward through Columbia Gorge causing accidents on I-84; one fatality

Sources: Taylor and Hatton (1999)

Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org

Probability and Vulnerability

As stated in the **State Risk Assessment**, section, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 5 will experience winter storms is shown in **Table 2-356**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-356. Local Probability Assessment of Winter Storms in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Probability	H	H	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Winter storms occur annually in Region 5. On the basis of historical data, severe winter storms could occur about every 4 years in this region. We can expect to have continued annual storm events in this region. However, there are no solid statistical data available upon which to base these judgments. There is no statewide program to study the past, present, and potential impacts of winter storms in the state of Oregon at this time.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to winter storms is shown in **Table 2-357**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-357. Local Vulnerability Assessment of Winter Storms in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Vulnerability	H	H	H	M	H	H

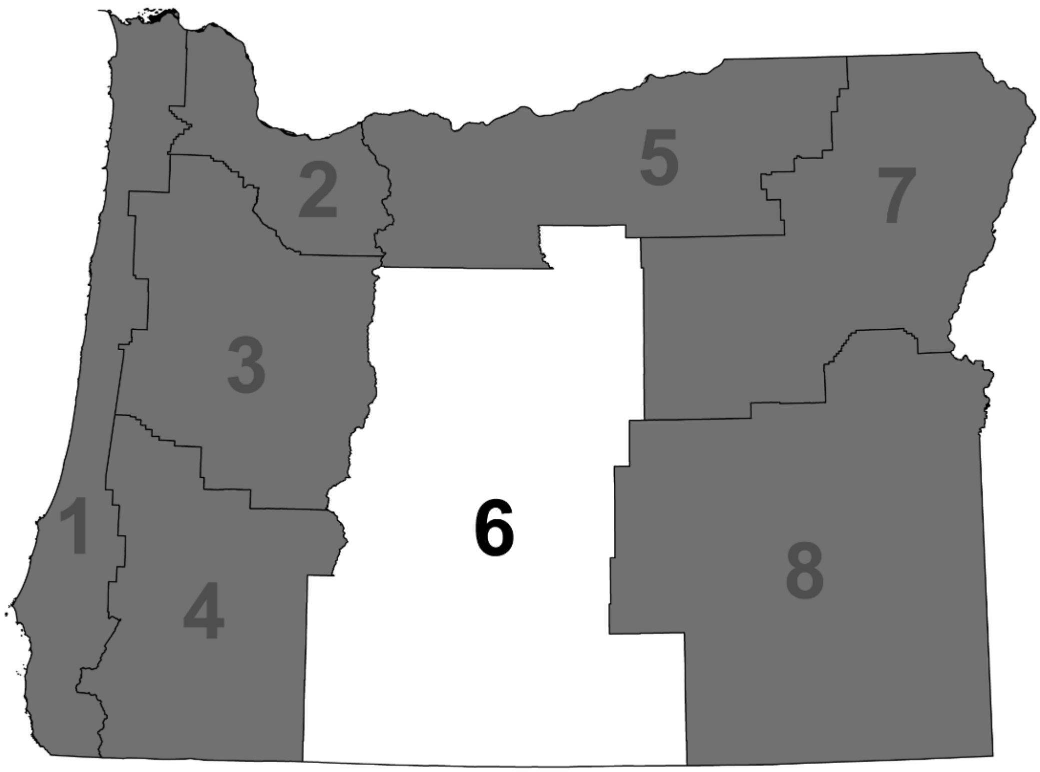
Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Within the State of Oregon, Region 5 communities are known for cold winter conditions. This region is the commodity flow route to Eastern Oregon. With long road closures the communities suffer from the loss of traffic and revenue. Drifting, blowing snow has brought highway traffic to a standstill. Also, windy and icy conditions have closed Oregon's principal east-west transportation route, I-84, for hours. In these situations, travelers must seek accommodations — sometimes in communities where lodging is very limited. For local residents, heating, food, and the care of livestock and farm animals are everyday concerns. Access to farms and ranches can be extremely difficult and present a serious challenge to local emergency managers.

2.3.6 Region 6: Central Oregon

Crook, Deschutes, Jefferson, Klamath, Lake, and Wheeler Counties



2.3.6.1 Summary

Profile

The region's demographic, economic, infrastructure, and development patterns suggest that some populations, structures and places may be more vulnerable to certain natural hazards than others. Mitigation efforts directed at these vulnerabilities may help boost the area's ability to bounce back after a natural disaster.

Regionally, social vulnerability is driven by high percentages of individuals with a disability and low median household incomes. At the county level, vulnerability is driven by a high share of senior citizens in Crook, Lake, and Wheeler Counties; increases in child poverty in Douglas and Deschutes Counties; vacant homes in Deschutes, Lake and Klamath Counties; and single-parent households in Klamath County.

Higher than average unemployment rates and low wages illustrate the region's slow recovery since the financial crisis that began in 2007. Average pay in Wheeler County is especially low, only 57% of the state average.

Road, bridge, rail and port infrastructure across the state are vulnerable to damage and disruption caused by icy conditions, flooding, or seismic events. The Redmond Regional Airport is of particular importance in this region because it has been identified as a primary airport for the state following a catastrophic Cascadia Subduction Zone (CSZ) earthquake.

Older centralized water infrastructure is vulnerable to pollution and flooding, which can have implications for human health and water quality.

Energy facilities and infrastructure in Central Oregon support the regional economy and are vulnerable to damage and service disruptions due to natural hazard events. Liquid natural gas pipelines run through Klamath, Deschutes, Crook, and Jefferson Counties. The region's diverse energy portfolio — including hydroelectric, natural gas, biomass, and solar voltaic systems — helps boosts its ability to withstand system disruptions.

Region 6 is mostly rural, with the majority of development occurring in communities along I-97. Mobile homes are inherently vulnerable to natural hazard events, and there are a significant number of mobile homes in Jefferson, Lake, and Wheeler Counties. Roughly half the homes in Klamath, Lake, and Wheeler Counties were built before 1970 and floodplain management and seismic building standards, making them especially vulnerable. With the exception of Crook and Deschutes Counties, the region's Flood Insurance Rate Maps (FIRMs) are not as up to date as those of other areas of the state.

Hazards and Vulnerability

Region 6 is affected by nine of the 11 natural hazards that affect Oregon communities. Coastal hazards and tsunamis do not directly impact this region.

Droughts: Droughts are common throughout Region 6. When droughts occur they can be problematic, impacting community water supplies, wildlife refuges, fisheries, and recreation. Klamath and Lake Counties are especially vulnerable. The U.S. Department of Agriculture designated both counties “natural disaster areas” due to damages or losses caused by drought – Klamath in 2010 and 2013, and Lake in 2007 and 2013.

Dust Storms: In Central Oregon, dust storms occur when strong winds carry fine silt, sand, and clay particles into the air. These storms can travel hundreds of miles at speeds of at least 25 miles per hour and can reach heights of over 10,000 feet. Dust storms are most common over the areas of dry land that are prevalent within this region. Dust storms affect the region annually during summer months and during periods of drought. In Region 6, Deschutes, Klamath, and Lake Counties have the most dust storms on record.

Earthquakes: Four types of earthquakes affect Region 6: (a) shallow crustal events, (b) deep intra-plate events within the subducting Juan de Fuca plate, (c) the offshore Cascadia Subduction Zone (CSZ) Fault, and (d) earthquakes associated with volcanic activity. Shallow crustal and intraplate earthquakes are the primary earthquake risks. In a CSZ event, most of the region’s impact will be secondary, due to disruptions to markets to the west. The region’s seismic lifelines have low vulnerability to a CSZ event, unless a Klamath Falls event is triggered. Region 6 is vulnerable to earthquake-induced landslides, liquefaction, and strong ground shaking. Klamath County ranks among the top 15 in the state with the highest expected earthquake related damages and losses. This region has 160 state-owned/leased facilities, valued at over $366 million, in an earthquake hazard zone. Of these, 100 are critical/essential facilities. An additional 721 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Floods: Flooding affects Central Oregon in a variety of ways, including (a) spring runoff from melting snow, (b) intense warm rain during the winter months, (c) ice-jam flooding (Deschutes County), (d) local flash flooding, (e) lake flooding associated with high winds (Klamath Lake), and (f) flooding associated with the breeching of natural debris dams (Deschutes County). East of the Cascades there have also been rain-on-snow floods associated with La Niña events. All of the region’s counties are considered moderately vulnerable to the flood hazard. There are 66 state-owned/leased facilities, valued at approximately $9 million, located in the region’s flood hazard zone. Of these, nine are considered critical/essential facilities. An additional 60 non-state-owned/leased critical/essential facilities are located in this hazard zone.

Landslides: Landslide events can occur throughout the region, though more tend to occur in areas with steeper slopes, weaker geology, and higher annual precipitation. Rain-induced landslides can occur during winter months. Earthquakes can trigger landslides. Most landslides in this region have taken place in the Klamath and Cascade Mountains, along the US-26 corridor near Prineville and Mitchell, and along US-97 just north of Klamath Falls. There are 785 state-owned/leased facilities in a landslide hazard zone in this region, valued at over $371 million. Of these, 103 are critical/essential facilities. An additional 744 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Volcanoes: Western areas of the region’s counties that coincide with the crest of the Cascade mountain range may be impacted by volcanic activity. Most volcanic activity is considered local, however, some activity (lahars and ashfall) can travel many miles. Due to proximity to potential volcanic activity, small mountain communities, dams, reservoirs, energy-generating facilities, and highways merit special attention. Communities closer to the main volcanoes — Bend, Sisters, La Pine, and Klamath Falls — are at the greatest risk for inundation by lava flows, pyroclastic flows, lahars, or ashfall. Communities on the eastern side of the region may be subject to ashfall from Cascade volcanoes. There are 32 state-owned/leased facilities located in a volcanic hazard zone within this region, a value of approximately $11.6 million. Of these, none are identified as critical/essential facilities. There are 22 non-state-owned/leased critical/essential facilities located in this hazard zone.

Wildfires: Central Oregon is especially vulnerable to wildfires because homes are widely dispersed among ladder fuels and overstocked pine, sage, grassy areas and invasive weeds. Fire risk is highest in late summer and fall when fuel conditions are dry. Based on data from the 2013 West Wide Wildfire Risk Assessment, in Region 6, Deschutes, Jefferson and Klamath and Wasco Counties have high percentages of wildland acres subject to Fire Risk, Wildland Development Areas, Fire Effects, or Fire Threat, making them especially vulnerable. Other areas of vulnerability are within wildland-urban interface communities. There are 504 state-owned/leased facilities located in a wildfire hazard zone with a value of approximately $188 million. Of these, 59 are identified as critical/essential facilities. An additional 350 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Windstorms: Windstorms are common in the inter-mountain areas of the region, and can reach speeds of 70-90 miles per hour. Most vulnerable to windstorms are insufficiently anchored mobile homes and buildings needing roof repair. Overturned trees pose problems as they can block roads and emergency routes and can damage buildings and utility lines.

Winter Storms: Annual winter storms bring colder weather and higher precipitation. Communities are typically prepared for light to moderate storms, but are less prepared for severe winter storms that occur less frequently. Winter storms have the potential to affect the entire region, particularly transportation corridors along US-97 and mountain passes to the west.

Climate Change

The most reliable information on climate change to date is at the state level. The state information indicates that hazards projected to be impacted by climate change in Region 6 include drought and wildfire. Climate models project warmer drier summers and a decline in mean summer precipitation for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, all eight regions are expected to be affected by an increased incidence of drought and wildfire. An increase in drought could result in the increased incidence of dust storms, though no current research is available on the direct effects of future climate conditions on the incidence of dust storms. Areas that have historically been both hotter and drier than the statewide average — such as Central Oregon counties — are at somewhat higher risk of increased drought and wildfire than the state overall. While winter storms and windstorms affect Region 6, there is little research on how climate change influences these hazards in the Pacific Northwest. For more information on climate drivers and the projected impacts of climate change in Oregon, see the section **Introduction to Climate Change**.

2.3.6.2 Profile

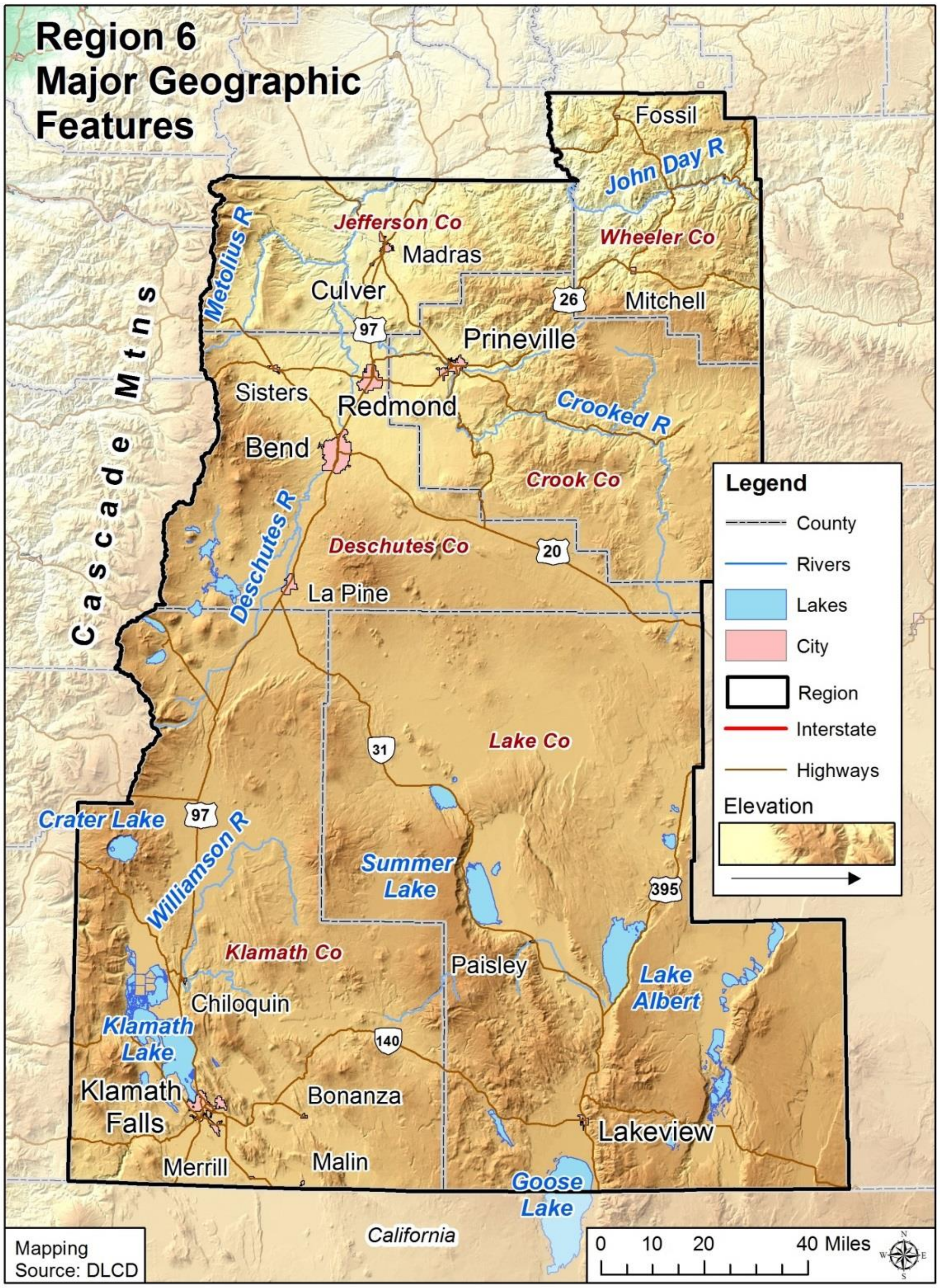
Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

Natural Environment

Geography

Central Oregon is approximately 24,144 square miles in size and includes Crook, Deschutes, Jefferson, Klamath, Lake, and Wheeler Counties. The Cascades crest to the west, Blue Mountains in the north and the California border to the south define the region. Region 6 has a diverse variety of ecological zones and is not shaped by any particular watershed, although the Deschutes, John Day, and Crooked Rivers are major watersheds to the north. Large lakes are common in the southern portions of Region 6.

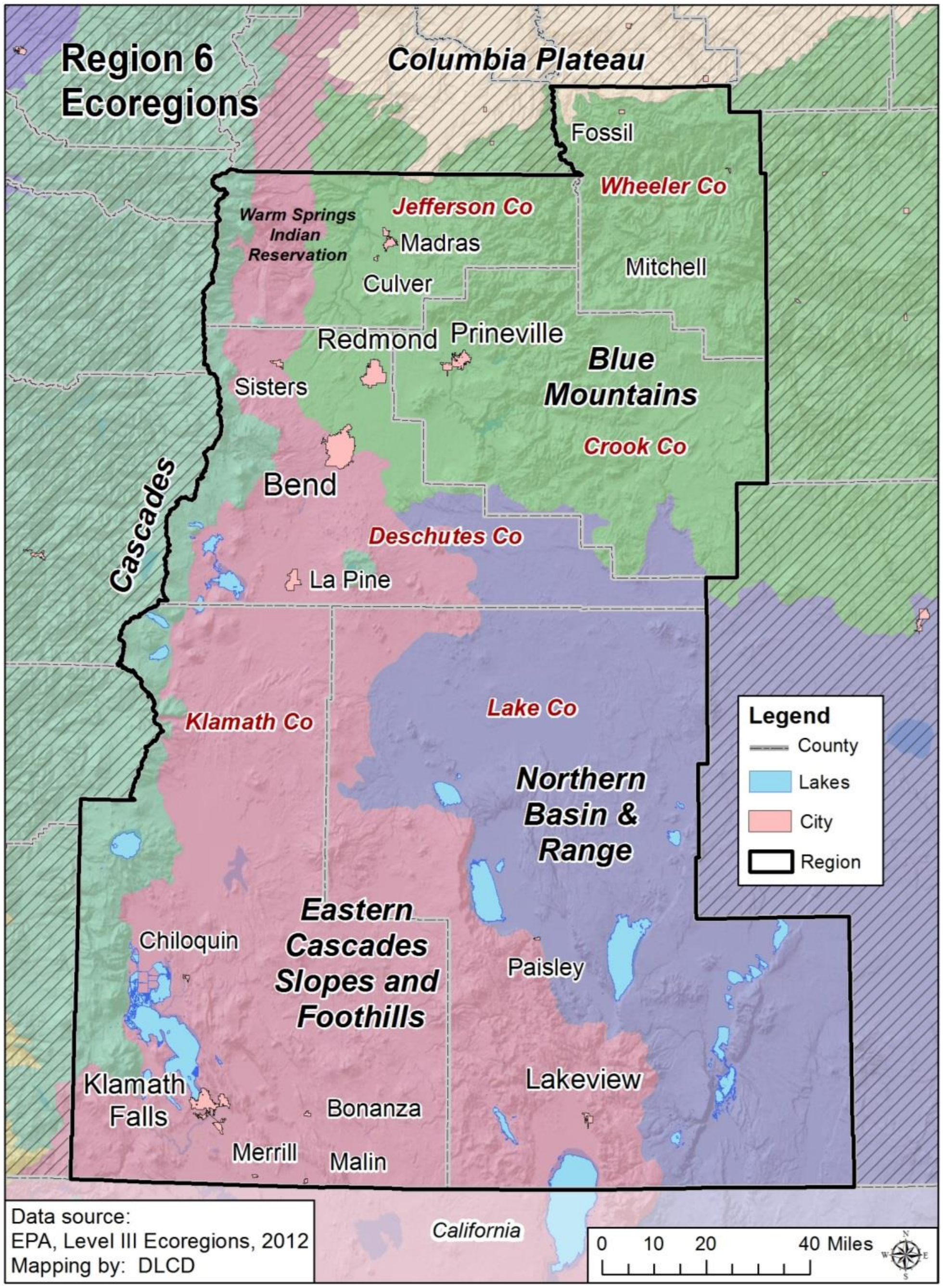
Figure 2-182. Region 6 Major Geographic Features



Source: Department of Land Conservation and Development

The U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Region 6 is composed of four ecoregions: the Blue Mountains, the Cascades, the Eastern Cascades Slope and Foothills, and the Northern Basin and Range (**Figure 2-183**).

Figure 2-183. Region 6 Ecoregions



Blue Mountains: This ecoregion is complex and diverse with many sub-ecoregions with unique conditions. While much of the Blue Mountains are flat with arid climates, the highly dissected John Day / Clarno Highlands contain the John Day and Crooked Rivers that provide more abundant water than other parts of the Blue Mountains ecoregion, which leads to higher levels of human settlement in proximity to the rivers. Grazing, logging, and fire suppression regimes have altered land cover throughout the region where juniper woodlands have given way to sagebrush grasslands and grand fir forests have given way to spruce fir forests. Other forests in the region predominantly have either a Douglas fir or ponderosa pine canopy. Ponderosa forests tend toward sparsely vegetated understories the ecoregion's Douglas fir forests tend toward dense shrub understories, making them more difficult to log. Some wet, high meadows also exist within Cold Basins of the Blue Mountains in Region 6 and unchannelized streams tend toward a meandering nature within wide floodplains, moving dynamically through the landscape. Riparian areas of the region have a diverse palette of understory shrubs with black cottonwoods, grand firs, and alders in the canopy layer (Thorson et al., 2003).

Cascades: This ecoregion is underlain by volcanic soils and naturally occurring mixed conifer forests have given way to predominantly Douglas fir forests that are managed for commercial logging. Logging activities have strained the ecological health of streams in the area (Thorson et al., 2003). Waterways in the steeper valleys support threatened cold-water salmonids including Chinook salmon, steelhead, and bull trout. Streams, lakes, reservoirs, rivers, and glacial lakes at higher elevations are key sources of water. Large volcanic peaks, glaciers, and year-round snowfields punctuate the alpine and subalpine areas of the ecoregion (Thorson et al., 2003).

Eastern Cascades Slope and Foothills: The Region 6 section of this ecoregion is an ecological mosaic. Wooded areas may be dominated by ponderosa pines or mixed fir canopies while rangelands are dominated by sagebrush, bitterbrush, and bunchgrasses. Most historically wet meadows have been drained to accommodate agricultural uses; however, marshland wildlife refuges have been established to preserve biodiversity, particularly for avian populations. Because of its location in the rain shadow of the Cascades, the ecoregion often experiences dramatic temperature extremes and native plants are adapted to dry climates and frequent wildfires. Much of this ecoregion is underlain by highly permeable volcanic pumice soils, which contribute to the effects of drought in the ecoregion. Logging, livestock grazing, agriculture and recreation are common land uses throughout (Thorson et al., 2003).

Northern Basin and Range: The Region 6 section of this ecoregion contains seasonally wet lake basins, high desert wetlands, high shrub- and grass-covered plains, scattered hills, mountains and buttes, playas, and dunes. Lake levels and salinity in the region can fluctuate seasonally and yearly, with several years passing before some lake beds are filled with water. The majority of this ecoregion is dominated by shrub- and grass-covered rangeland, lending itself primarily to wildlife habitat, recreation, and limited cropland farming and livestock grazing.

Climate

Climate refers to the temperatures, weather patterns, and precipitation in the region. This section covers historic climate information. For estimated future climate conditions and possible impacts refer to the **State Risk Assessment** for statewide projections.

Region 6 has diverse ecoregions with varying climatic conditions with the majority of the region's land divided almost equally between the four ecoregions. The region's predominantly arid climate supports limited agricultural activities, primarily livestock grazing. The region is subject drought, floods, landslides, and wildfires. When considering the climate, snowfall should also be taken into account. Flooding can be a direct result of rain-on-snow events. Likewise, the amount of snowpack in a region can also impact the ability of communities to cope with drought. Table 2-358 shows mean annual precipitation and temperatures for the three ecoregions in Region 6 (Thorson et al., 2003). Variations in temperature and precipitation vary widely by sub-ecoregion and microclimate. For more detailed and locally relevant climate data refer to the Oregon Climate Service.

Table 2-358. Average Precipitation and Temperature Ranges in Region 6 Ecoregions

Ecoregion	Mean Annual Precipitation Range (inches)	Mean Temperature Range (°F) January min/max	Mean Temperature Range (°F) July min/max
Cascades*	45–140	16/41	38/74
Eastern Cascades slopes and foothills*	10–55	12/40	38/85
Columbia Plateau*	9–25	21/41	52/86
Blue Mountains*	8–60	16/41	43/84
Northern Basin and Range*	6–26	17/42	42/86

*Data have been generalized from all the sub-ecoregions of the ecoregion in Region 6.

Source: Thorson et al. (2003)

Demography

Population

Population forecasts are an indicator of future development needs and trends. Community demographics may indicate where specific vulnerabilities may be present in the aftermath of a natural hazard (Cutter et al., 2003). If a population is forecast to increase substantially, a community's capacity to provide adequate housing stock, services, or resources for all populations post disaster may be stressed or compromised (Cutter et al., 2003).

Overall, from 2000 to 2013, 85% of the region's growth occurred in Deschutes County, an increase of more than 47,000 people. Wheeler was the only county to decline in population. By 2020, all counties in the region, except Deschutes and Jefferson, are projected to grow at a slower rate than the state overall. Population in Lake and Wheeler Counties is expected to decline.

Table 2-359. Population Estimate and Forecast for Region 6

	2000	2013	Percent Change (2000 to 2013)	2020 Projected	Percent Change (2013 to 2020)
Oregon	3,421,399	3,919,020	14.5%	4,252,100	8.5%
Region 6	226,302	281,435	24.4%	306,608	8.9%
Crook	19,182	20,690	7.9%	21,933	6.0%
Deschutes	115,367	162,525	40.9%	182,455	12.3%
Jefferson	19,009	22,040	15.9%	24,054	9.1%
Klamath	63,775	66,810	4.8%	68,853	3.1%
Lake	7,422	7,940	7.0%	7,936	-0.1%
Wheeler	1,547	1,430	-7.6%	1,378	-3.6%

Source: Population Research Center, Portland State University, 2013; U.S. Census Bureau, 2010 Decennial Census. Table DP-1; Office of Economic Analysis, Long-Term Oregon State's County Population Forecast, 2010-2050, 2013

Tourists

Tourists are not counted in population statistics and are therefore considered separately in this analysis. Tourism activities in Region 6 are largely centered on outdoor activities (hiking and backpacking, visiting national and state parks etc.), touring (traveling to experience scenic beauty, history and culture), and special events (such as fairs, festivals or sporting events) (Longwoods Travel USA, 2011f). Note that the Longwoods Travel Report includes Crook, Deschutes, Jefferson, and Wheeler Counties within the Central Region (which also includes parts of Gilliam, Sherman, and Wasco Counties). Klamath and Lake Counties are included within the Southern region (which also includes Douglas, Jackson, and Josephine Counties); see Region 4 for the results of this study area. Over 13% (3.6 million) of all overnight trips to Oregon included time within Region 6. Three fourths of all trips to the region occur between April and September, and the average travel party contains 3.7 persons. The average trip length is over 4.4 nights (Longwoods Travel USA, 2011f). Visitors to the region are just as likely to lodge in hotels/motels as in private homes and other accommodations.

Difficulty locating or accounting for travelers increases their vulnerability in the event of a natural disaster. Furthermore, tourists are often unfamiliar with evacuation routes, communication outlets, or even the type of hazard that may occur (MDC Consultants, n.d.). Targeting natural hazard mitigation outreach efforts to places where tourists lodge can help increase awareness and minimize the vulnerability of this population.

Table 2-360. Annual Visitor Estimates in Person Nights in Region 6

	2011		2012		2013	
	Number	Percent	Number	Percent	Number	Percent
Region 6	9,434	—	9,684	—	9,892	—
Crook	552	100%	602	100%	634	100%
Hotel/Motel	107	19.4%	144	23.9%	176	27.8%
Private Home	206	37.3%	212	35.2%	212	33.4%
Other	239	43.3%	246	40.9%	246	38.8%
Deschutes	5,649	100%	5,895	100%	6,058	100%
Hotel/Motel	1,821	32.2%	1,957	33.2%	2,067	34.1%
Private Home	2,040	36.1%	2,104	35.7%	2,148	35.5%
Other	1,788	31.7%	1,834	31.1%	1,843	30.4%
Jefferson	827	100%	845	100%	869	100%
Hotel/Motel	101	12.2%	114	13.5%	122	14.0%
Private Home	213	25.8%	215	25.4%	222	25.5%
Other	513	62.0%	516	61.1%	525	60.4%
Klamath	2,071	100%	2,020	100%	2,014	100%
Hotel/Motel	685	33.1%	646	32.0%	626	31.1%
Private Home	847	40.9%	831	41.1%	835	41.5%
Other	539	26.0%	543	26.9%	553	27.5%
Lake	262	100%	252	100%	248	100%
Hotel/Motel	65	25%	58	23%	53	21%
Private Home	78	30%	76	30%	76	31%
Other	119	45%	118	47%	119	48%
Wheeler	73	100%	70	100%	69	100%
Hotel/Motel	13	17.8%	10	14.3%	8	11.6%
Private Home	14	19.2%	14	20.0%	14	20.3%
Other	46	63.0%	46	65.7%	47	68.1%

Source: Oregon Travel Impacts: 1991–2013, April 2014. Dean Runyan Associates, http://www.deanrunyan.com/doc_library/ORImp.pdf

Persons with Disabilities

Disabilities appear in many forms. While some disabilities may be easily identified, others may be less perceptible. Disabled populations, while difficult to identify and measure, are disproportionately affected during disasters (Cutter et al., 2003). In Region 6, the proportion of people who identify as having a disability overall is only one percentage point higher than the proportion of people who do so throughout the state. However, the percentages in the individual counties of Region 6 range 3-8% higher, with the exception of Deschutes County where the percentage is lower. Roughly 42% of seniors in each of Jefferson, Lake and Wheeler Counties have a disability. Local natural hazard mitigation plans should specifically target outreach programs toward helping disabled residents better prepare for and recover from hazard events.

Table 2-361. People with a Disability by Age Groups in Region 6, 2012

	Total Population*	With a Disability		Under 18 Years with a Disability		65 Years and Over with a Disability	
	Estimate	Estimate	Percent	Estimate	Percent**	Estimate	Percent**
Oregon	3,796,881	511,297	13.5%	39,439	4.6%	200,374	37.8%
Region 6	274,535	39,778	14.5%	3,558	5.7%	15,570	34.9%
Crook	20,932	3,825	18.3%	214	4.8%	1,628	38.2%
Deschutes	158,076	19,066	12.1%	2,111	5.8%	7,369	31.0%
Jefferson	20,941	3,540	16.9%	351	6.4%	1,345	41.4%
Klamath	65,826	11,574	17.6%	788	5.3%	4,409	38.9%
Lake	7,479	1,501	20.1%	90	6.0%	650	41.7%
Wheeler	1,281	272	21.2%	4	2.1%	169	41.9%

Note: *Total population does not include institutionalized population

Note: **Percent of age group

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Homeless Population

Population estimates of the homeless in Oregon are performed each January. These are rough estimates and can fluctuate with many factors, including the economy or season. The overwhelming majority of homeless are either single adult males or families with children. Communities located along major transportation corridors, such as US-97, tend to have higher concentrations of homeless people (Thomas et al., 2008). This population has held steady in Region 6 from 2009 to 2011 at about 2,800 persons.

Extra attention is needed to care for and serve homeless communities. Some homeless people choose to remain hidden or anonymous, making it especially difficult to mitigate harm to them from natural hazard events. Accessible shelter and social services are key emergency considerations for the homeless community.

Table 2-362. Homeless Population Estimate for Region 6

	2009	2010	2011	3-Year Average
Oregon	17,122	19,208	22,116	19,482
Region 6	2,837	2,811	2,756	2,801
Crook	282	244	229	252
Deschutes	1,867	1,688	1,775	1,777
Jefferson	89	329	271	230
Klamath	599	539	428	522
Lake	0	11	52	21
Wheeler	0	0	1	0

Source: Oregon Point in Time Homeless Count, Oregon Housing and Community Services. http://www.oregon.gov/ohcs/pages/ra_point_in_time_homeless_count.aspx

Gender

The gender ratio in Region 6 is similar to that of the state, roughly 50:50 (U.S. Census Bureau; n.d.). 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 (Cutter et al., 2003).

Age

Region 6 has a slightly higher percentage of seniors than the state. Between 20% and 30% of the population in Crook, Lake and Wheeler Counties are seniors. Senior citizens may require special consideration due to sensitivity to heat and cold, reliance upon transportation to obtain medication, and comparative difficulty in making home modifications that reduce risk to hazards. In addition, the elderly may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to the elderly (Morrow, 1999).

The region's percentage of children is similar to that of the state, except in Wheeler County where its 8% less of its population are children. Special considerations should be given to young children, schools, and parents during the natural hazard mitigation process. Young children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities. Parents may lose time from work and money when their children's childcare facilities and schools are impacted by disasters (Cutter et al., 2003).

Table 2-363. Population by Vulnerable Age Groups, in Region 6, 2012

	Total Population	Under 18 Years Old		65 Years and Older	
	Estimate	**Estimate**	**Percent**	**Estimate**	**Percent**
Oregon	3,836,628	864,243	22.5%	540,527	14.1%
Region 6	277,255	62,920	22.7%	45,080	16.3%
Crook	21,102	4,583	21.7%	4,303	20.4%
Deschutes	158,884	36,349	22.9%	23,965	15.1%
Jefferson	21,746	5,467	25.1%	3,333	15.3%
Klamath	66,350	14,821	22.3%	11,480	17.3%
Lake	7,886	1,508	19.1%	1,593	20.2%
Wheeler	1,287	192	14.9%	406	31.5%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP05

Language

A greater percentage of the population in this region speak English "very well" compared to the state. Deschutes and Klamath Counties have the largest populations who do not speak English "very well." Outreach materials used to communicate with and plan for these communities should take into consideration their language needs.

Table 2-364. English Usage in Region 6, 2012

	Speak English "Very Well"		Speak English Less Than "Very Well"	
	Estimate	**Percent**	**Estimate**	**Percent**
Oregon	3,376,744	93.8%	224,905	6.2%
Region 6	252,787	96.9%	8,096	3.1%
Crook	19,623	98.0%	400	2.0%
Deschutes	145,397	97.3%	3,989	2.7%
Jefferson	18,845	93.4%	1,338	6.6%
Klamath	60,246	96.5%	2,208	3.5%
Lake	7,442	98.0%	152	2.0%
Wheeler	1,234	99.3%	9	0.7%

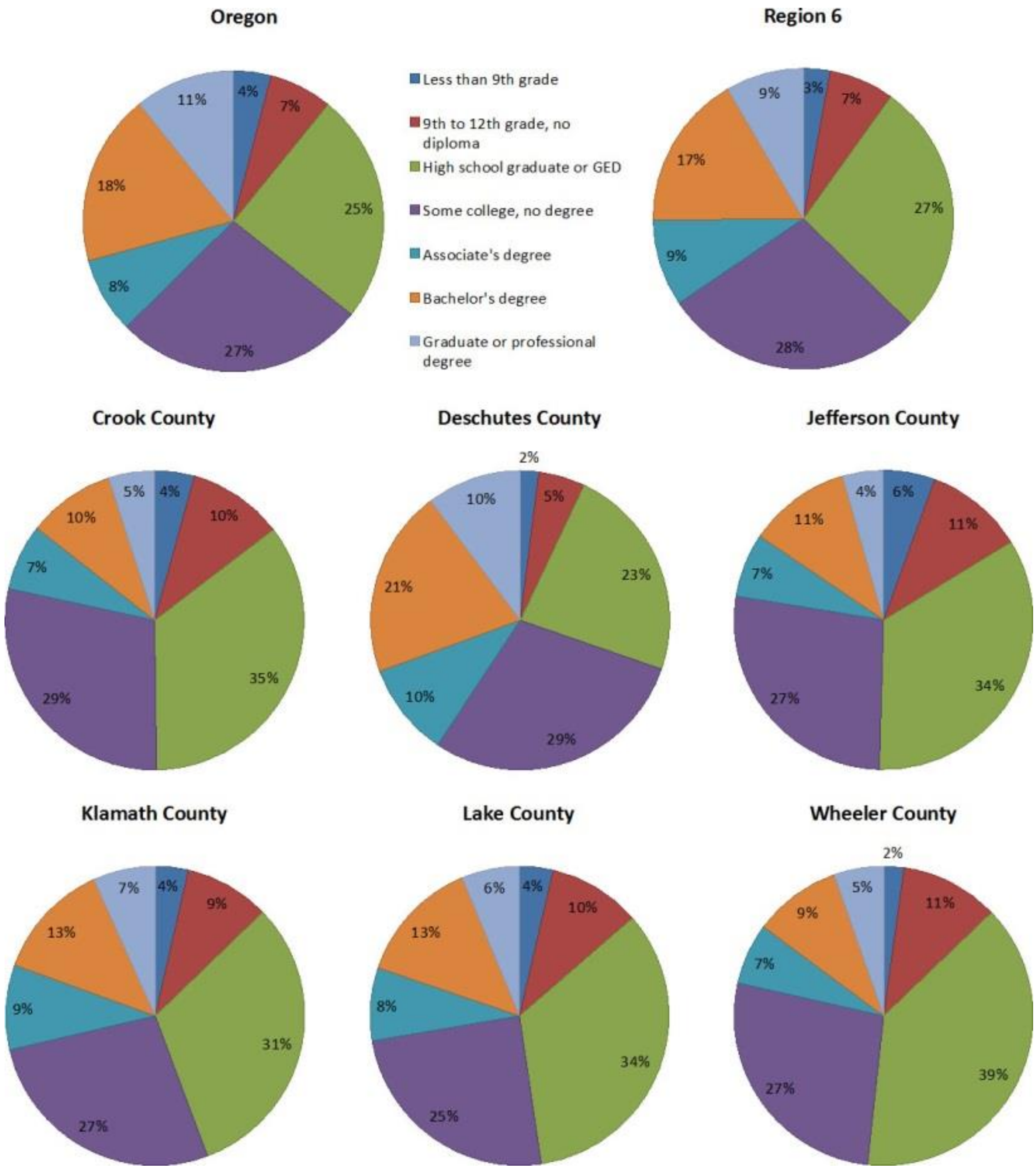
Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Education Level

Studies (Cutter et al., 2003) show that education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings. The region has a 2% higher percentage of high school graduates (including GEDs) and a 4% lower share of bachelor's degrees compared to state percentages. Deschutes County has the largest percentage of population with a bachelor's degree or higher (41%), while Wheeler County has the lowest percentage (21%).

Education can influence the ability to access resources, while lack of resources may constrain the ability to understand warning information (Cutter et al., 2003). Therefore, levels of education within the region should be considered when designing hazard outreach materials to local communities.

Figure 2-184. Educational Attainment in Region 6, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Income

The impact of a disaster in terms of loss and the ability to recover varies among population groups. According to Susan Cutter's research on vulnerability to environmental hazards, "the causes of social vulnerability are explained by the underlying social conditions that are often quite remote from the initiating hazard or disaster event." (Cutter, 2006, p. 76). Historically, 80% of the disaster burden falls on the public. Of this number, a disproportionate burden is placed upon those living in poverty. People living in poverty are more likely to be isolated in communities, are less likely to have the savings to rebuild after a disaster, and less likely to have access to transportation and medical care.

The financial crisis that began in 2007 affected median household incomes in this region in diverse ways. Crook and Deschutes Counties experienced the greatest losses in median household incomes. Only Jefferson County experienced average household income increases. In 2012, with the exception of Deschutes County, median household incomes were $6,700-$13,700 below statewide numbers. Deschutes County was about $1,400 above the state median income.

Table 2-365. Median Household Income in Region 6

	2009	2012	Percent Change
Oregon	$52,474	$50,036	-4.6%
Region 6	N/A	N/A	N/A
Crook	$49,215	$40,263	-18.2%
Deschutes	$57,697	$51,468	-10.8%
Jefferson	$43,081	$43,330	0.6%
Klamath	$43,920	$41,066	-6.5%
Lake	$40,132	$40,049	-0.2%
Wheeler	$34,609	$36,357	5.1%

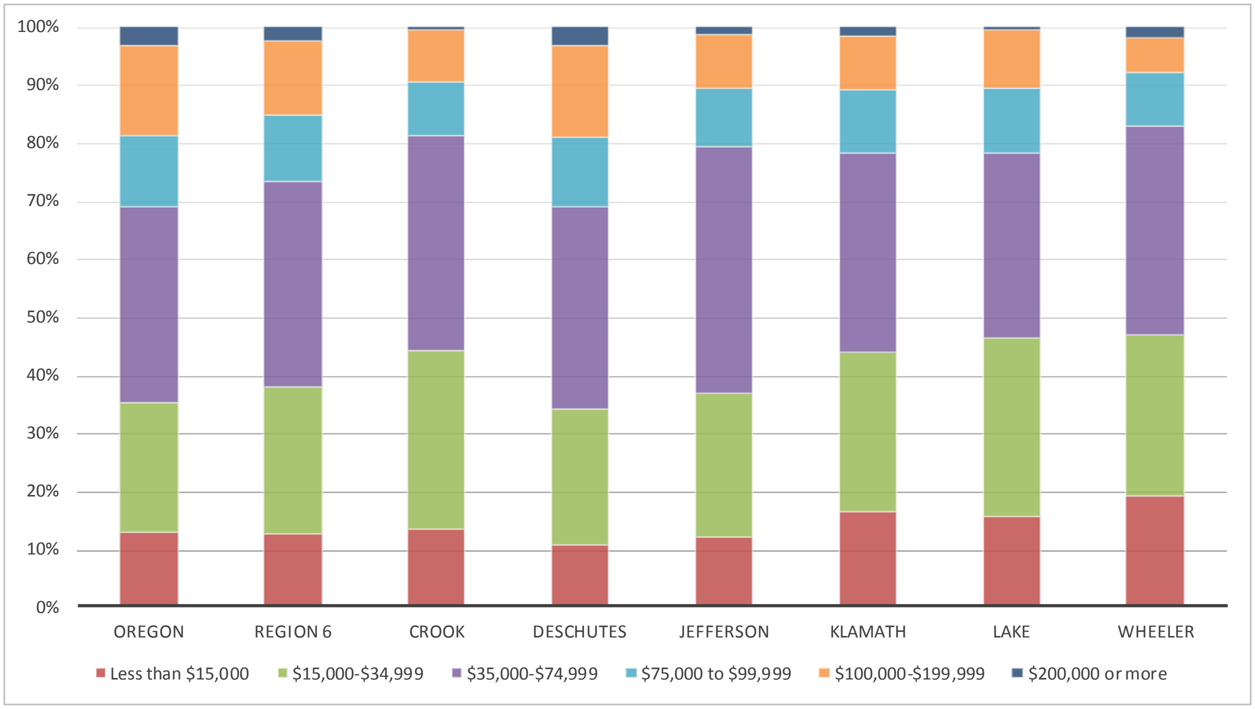
Note: 2009 dollars are adjusted for 2012 using Bureau of Labor Statistics' Consumer Price Index Inflation Calculator.

N/A = data not aggregated at the regional level.

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates. Table DP03.

Compared to statewide numbers, the region has a smaller percentage of households earning more than $75,000 per year. Just over one third of the region's households earn between $35,000 and $75,000 per year. Crook, Klamath, Lake, and Wheeler Counties have the highest percentage of households earning less than $35,000 per year.

Figure 2-185. Median Household Income Distribution in Region 6, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP03

The region has about the same percentage of individuals and children living in poverty as the state overall. By total population, poverty is declining only in Wheeler County. Jefferson and Klamath Counties have the highest total poverty rates, roughly 19%. Almost one third of all children in Jefferson County live in poverty. The largest increase in child poverty is in Deschutes County, with a dramatic increase of almost 61%.

Table 2-366. Poverty Rates in Region 6, 2012

	Total Population in Poverty			Children Under 18 in Poverty		
	Number	Percent	Percent Change*	Number	Percent	Percent Change*
Oregon	584,059	15.5%	17.7%	175,303	20.6%	17.6%
Region 6	41,857	15.3%	28.3%	13,224	21.5%	22.1%
Crook	3,631	17.4%	19.6%	1,171	26.1%	-6.8%
Deschutes	20,633	13.1%	53.9%	6,559	18.3%	60.5%
Jefferson	4,015	19.2%	21.1%	1,624	30.0%	10.1%
Klamath	12,143	18.7%	6.0%	3,493	24.6%	-1.6%
Lake	1,284	17.2%	7.4%	354	23.7%	-15.1%
Wheeler	151	12.0%	-26.0%	23	12.0%	-53.1%

Note: *Percent change since 2009.

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates, Table S1701

Low-income populations require special consideration when mitigating loss to a natural hazard. Often, those who earn less have little to no savings and other assets to withstand economic setbacks. When a natural disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the natural disaster. To reduce the compounded loss incurred by low-income populations post-disaster, mitigation actions need to be specially tailored to ensure safety nets are in place to provide further support to those with fewer personal resources (Cutter et al., 2003).

Housing Tenure

Wealth can increase the ability to recover following a natural disaster (Cutter et al., 2003), and homeownership, versus renting, is often linked to having more wealth. Renters often do not have personal financial resources or insurance to help recover post-disaster. On the other hand, renters tend to be more mobile and have fewer assets at risk. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable due to natural disaster events.

A smaller percentage of housing units are rented than average; the highest percentage of rental units are in Jefferson County. Lake County has the greatest percentage of vacant units, while Deschutes and Klamath Counties have the greatest total number of vacancies. In addition, the region has about 8% more seasonal or recreational homes than the state, and 70% of these homes are in Deschutes County (U.S. Census Bureau, 2008–2012 American Community Survey, Table DP04 and Table B25004).

Table 2-367. Housing Tenure in Region 6, 2012

	Total Occupied Units	Owner Occupied		Renter Occupied		Vacant^	
		Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	945,824	62.5%	566,894	37.5%	105,417	6.3%
Region 6	113,148	75,355	66.6%	37,793	33.4%	11,694	8.5%
Crook	8,745	6,313	72.2%	2,432	27.8%	838	8.2%
Deschutes	64,459	42,620	66.1%	21,839	33.9%	6,466	8.1%
Jefferson	8,005	5,161	64.5%	2,844	35.5%	702	7.2%
Klamath	27,747	18,395	66.3%	9,352	33.7%	3,112	9.5%
Lake	3,566	2,405	67.4%	1,161	32.6%	576	13.1%
Wheeler	626	461	73.6%	165	26.4%	66	7.5%

^ = Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04 and Table B25004.

Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households. Just over one fourth of all households within the region are family households with children. Similar to the state as a whole, this region has about twice as many single-parent households headed by females than by males. Jefferson County has the highest percentage of single-parent households.

Table 2-368. Family vs. Non-family Households in Region 6, 2012

	Total Households	Family Households		Nonfamily Households		Householder Living Alone	
	Estimate	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	964,274	63.7%	548,444	36.3%	421,620	27.9%
Region 6	113,148	76,376	67.5%	36,772	32.5%	28,515	25.2%
Crook	8,745	6,050	69.2%	2,695	30.8%	2,138	24.4%
Deschutes	64,459	43,686	67.8%	20,773	32.2%	15,759	24.4%
Jefferson	8,005	5,604	70.0%	2,401	30.0%	1,858	23.2%
Klamath	27,747	18,411	66.4%	9,336	33.6%	7,451	26.9%
Lake	3,566	2,228	62.5%	1,338	37.5%	1,088	30.5%
Wheeler	626	397	63.4%	229	36.6%	221	35.3%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Table 2-369 shows household structures for families with children in Region 6.

Table 2-369. Family Households with Children by Head of Household in Region 6, 2012

	Family Households with Children		Single Parent (Male)		Single Parent (Female)		Married Couple with Children	
	Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	415,538	27.5%	35,855	2.4%	93,575	6.2%	286,108	18.9%
Region 6	31,005	27.4%	3,373	3.0%	6,349	5.6%	21,283	18.8%
Crook	2,266	25.9%	205	2.3%	434	5.0%	1,627	18.6%
Deschutes	18,223	28.3%	1,805	2.8%	3,273	5.1%	13,145	20.4%
Jefferson	2,208	27.6%	370	4.6%	527	6.6%	1,311	16.4%
Klamath	7,395	26.7%	922	3.3%	1,959	7.1%	4,514	16.3%
Lake	825	23.1%	59	1.7%	137	3.8%	629	17.6%
Wheeler	88	14.1%	12	1.9%	19	3.0%	57	9.1%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04
Note: The table shows the percent of total households represented by each family household structure category.

Social and Demographic Trends

This analysis shows that Region 6 has a greater number of people than the state average who are predisposed to be particularly vulnerable during a hazard event, in the following categories:

- 85% of the region's growth is within Deschutes County.
- Higher percentages of the region's population has a disability than the state as a whole, except in Deschutes County.
- Crook, Lake, and Wheeler Counties have high percentages of seniors.
- All counties except Deschutes have lower than average median household incomes
- Child poverty is increasing in Deschutes and Jefferson Counties.
- Many housing units in Deschutes, Lake, and Klamath Counties are vacant.
- Klamath and Jefferson Counties have high percentages of single-parent households.

Economy

Employment

Employment status and salary level may impact the resilience of individuals and families in the face of disasters as well as their ability to mitigate losses created by natural hazards (Cutter et al., 2003). "The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster" (Cutter et al., 2003). Though the accelerated growth in Deschutes County has contributed to a broad recovery for the region since the financial crisis that began in 2007, still less than half of the county's 11,000 job losses have been recovered since the recession's peak in 2009 (Tauer, 2014). Deschutes County has the largest labor force and one of the lowest unemployment rates in the region. Wheeler County's labor force has remained relatively stable through the recession due to the county's sparse population and high self-employment rates (Fridley, 2014). Average salaries are lower than state average, ranging from 57% to 89% of that of the state. For example, the average salary in Crook County is $40,118, and in Wheeler County is $25,771.

Table 2-370. Unemployment Rates in Region 1, 2009-2013

	2009	2010	2011	2012	2013	Change (2009-2013)
Oregon	11.1%	10.8%	9.7%	8.8%	7.7%	-3.4%
Region 6	14.7%	14.2%	12.8%	11.8%	10.1%	-4.6%
Crook	17.9%	17.1%	15.3%	14.2%	12.3%	-5.7%
Deschutes	14.7%	14.3%	12.7%	11.4%	9.5%	-5.2%
Jefferson	14.8%	14.4%	13.4%	12.3%	10.7%	-4.1%
Klamath	13.9%	13.3%	12.4%	11.9%	10.7%	-3.2%
Lake	12.4%	13.6%	13.3%	12.8%	11.1%	-1.3%
Wheeler	9.0%	10.6%	9.8%	7.7%	7.1%	-2.0%

Source: Oregon Employment Department, 2014.

Table 2-371. Employment and Unemployment Rates in Region 6, 2013

	Civilian Labor Force	Employed Workers		Unemployed	
	Total	Total	Percent	Total	Percent
Oregon	1,924,604	1,775,890	92.3%	148,714	7.7%
Region 6	128,738	115,769	89.9%	12,969	10.1%
Crook	8,707	7,639	87.7%	1,068	12.3%
Deschutes	77,752	70,382	90.5%	7,370	9.5%
Jefferson	9,122	8,143	89.3%	979	10.7%
Klamath	28,905	25,798	89.3%	3,107	10.7%
Lake	3,573	3,176	88.9%	397	11.1%
Wheeler	679	631	92.9%	48	7.1%

Source: Oregon Employment Department, 2014.

Table 2-372. Employment and Payroll in Region 6, 2013

	Employees	Average Pay	Percent State Average
Oregon	1,679,364	$45,010	100%
Region 6	99,445	$36,865	81.9%
Crook	5,833	$40,118	89.1%
Deschutes	63,286	$37,749	83.9%
Jefferson	6,172	$34,196	76.0%
Klamath	21,513	$34,550	76.8%
Lake	2,334	$34,621	76.9%
Wheeler	307	$25,771	57.3%

Source: Oregon Employment Department, 2014

Employment Sectors and Key Industries

In 2013 the five major employment sectors in Region 6 were: (a) Trade, Transportation, and Utilities; (b) Government; (c) Education and Health Services; (d) Leisure and Hospitality; and (e) Professional and Business Services. Between 2012 and 2022, projected growth is expected to create a 18% increase in employment for Central Oregon, including Crook, Deschutes, Jefferson Counties, and a 14% increase in South Central Oregon, including Klamath and Lake Counties. For information on Wheeler County see the Region 5 Risk Assessment (Oregon Employment Department, n.d.b).

Table 2-373. Covered Employment by Sector in Region 6, 2013

Industry	Region 6	Crook County		Deschutes County		Jefferson County	
		Employment	Percent	Employment	Percent	Employment	Percent
Total All Ownerships	99,445	5,833	100%	63,286	100%	6,172	100%
Total Private Coverage	82.0%	4,618	79.2%	54,792	86.6%	3,780	61.2%
Natural Resources & Mining	2.6%	222	3.8%	534	0.8%	457	7.4%
Construction	4.5%	203	3.5%	3,511	5.5%	71	1.2%
Manufacturing	7.9%	731	12.5%	4,209	6.7%	907	14.7%
Trade, Transportation & Utilities	19.3%	1,630	27.9%	12,339	19.5%	793	12.8%
Information	1.7%	70	1.2%	1,407	2.2%	27	0.4%
Financial Activities	4.1%	117	2.0%	3,208	5.1%	111	1.8%
Professional & Business Services	9.7%	297	5.1%	6,879	10.9%	148	2.4%
Education & Health Services	14.8%	556	9.5%	10,330	16.3%	540	8.7%
Leisure & Hospitality	13.6%	553	9.5%	9,901	15.6%	544	8.8%
Other Services	3.7%	236	4.0%	2,457	3.9%	182	2.9%
Private Non-Classified	0.0%	(c)	0.0%	18	0.0%	(c)	0.0%
Total All Government	18.0%	1,216	20.8%	8,494	13.4%	2,392	38.8%
Federal Government	2.4%	304	5.2%	864	1.4%	132	2.1%
State Government	3.0%	203	3.5%	1,245	2.0%	311	5.0%
Local Government	12.5%	709	12.2%	6,385	10.1%	1,949	31.6%

Industry	Region 6	Klamath County		Lake County		Wheeler County	
		Employment	Percent	*Employment*	Percent	Employment	Percent
Total All Ownerships	99,445	21,513	100%	*2,334*	100%	307	100%
Total Private Coverage	82.0%	16,829	78.2%	*1,354*	58.0%	194	63.2%
Natural Resources & Mining	2.6%	999	4.6%	*326*	14.0%	48	15.6%
Construction	4.5%	667	3.1%	*50*	2.1%	(c)	0.0%
Manufacturing	7.9%	1,771	8.2%	*226*	9.7%	(c)	0.0%
Trade, Transportation & Utilities	19.3%	4,077	19.0%	*303*	13.0%	51	16.6%
Information	1.7%	179	0.8%	*18*	0.8%	(c)	0.0%
Financial Activities	4.1%	624	2.9%	*48*	2.1%	(c)	0.0%
Professional & Business Services	9.7%	2,220	10.3%	*61*	2.6%	(c)	0.0%
Education & Health Services	14.8%	3,172	14.7%	*94*	4.0%	55	17.9%
Leisure & Hospitality	13.6%	2,344	10.9%	*164*	7.0%	20	6.5%
Other Services	3.7%	776	3.6%	*60*	2.6%	9	2.9%
Private Non-Classified	0.0%	(c)	0.0%	*(c)*	0.0%	(c)	0.0%
Total All Government	18.0%	4,684	21.8%	*980*	42.0%	113	36.8%
Federal Government	2.4%	883	4.1%	*242*	10.4%	5	1.6%
State Government	3.0%	1,091	5.1%	*176*	7.5%	6	2.0%
Local Government	12.5%	2,710	12.6%	*562*	24.1%	102	33.2%

Source: Oregon Employment Department, 2013

Note: (c) = confidential, information not provided by Oregon Employment Department to prevent identifying specific businesses.

Each industry faces distinct vulnerabilities to natural hazards. Identifying key industries in the region enables communities to target mitigation activities toward those industries' specific sensitivities. Each of the primary private employment sectors has sensitivity to natural hazards, as follows.

Trade, Transportation, and Utilities: Retail Trade is the largest employment subsector within the Trade, Transportation, and Utilities sector. Retail Trade is vulnerable to disruptions in the disposable income of regional residents and to disruptions in the transportation system. Residents' discretionary spending diminishes after natural disasters as spending priorities tend to focus on essential items. Disruption of the transportation system could sever connectivity of people and retail hubs. Retail businesses are concentrated in the larger cities of the region.

Education and Health Services: The industries in these sectors play important roles in emergency response in the event of a disaster. Health care is a relatively stable revenue sector regionally with an increasing distribution of businesses primarily serving a local and aging population.

Leisure and Hospitality: This sector primarily serves regional residents with disposable income and tourists. The behavior of both of these social groups would be disrupted by a natural disaster. Regional residents may have less disposable income and tourists may choose not to visit a region with unstable infrastructure.

Professional and Business Services: This sector is composed of professional service providing industries including scientific and technical, management professionals and administrative and support services (e.g., engineering, law, headquarters, temp help, etc.). In general this sector has low vulnerability to natural disasters. Vulnerability is increased if suppliers are affected and/or physical infrastructure is damaged (buildings, roads, telecommunications, water systems, etc.). Mitigation efforts for this sector should include preparing business recovery plans.

Revenue by Sector

In 2007 Trade (Retail and Wholesale), Manufacturing, and Healthcare and Social Assistance were the highest revenue grossing industries in Region 6. (Revenue data from the 2012 Economic Census will not be released prior to the publication of this Plan.) Combined, these three industries generated over $8.7 billion (92% of total revenue) for the region. Trade (Retail and Wholesale) is the largest grossing sector in all counties.

Note: Due to the small size and few industries in the region the collected data is withheld in several categories, especially for manufacturing, to avoid disclosing data for individual companies. Information is aggregated to the county level.

Table 2-374. Revenue of Top Industries (in Thousands of Dollars) in Region 6, 2007

	Total Revenue (in Thousands)	Trade (Retail and Wholesale)	Manufacturing	Health Care and Social Assistance
Oregon	$277,017,733	44.4%	24.1%	7.3%
Region 6	$10,277,989	53.7%	18.4%	12.9%
Crook	$544,066	44.2%	38.6%	8.7%
Deschutes	$7,069,183	57.0%	12.7%	13.8%
Jefferson	$666,466	53.7%	36.4%	D
Klamath	$1,866,429	42.2%	28.9%	15.3%
Lake	$120,934	76.3%	—	15.2%
Wheeler	$10,911	94.9%	—	D

Source: U.S. Census, Economic Census. 2007, Table ECO700A1

Notes: D = Withheld to avoid disclosing data for individual companies; data are included in higher level totals, and "-" = data not provided.

Sectors that are anticipated to be major employers in the future warrant special attention, especially in the hazard mitigation planning process so workforces and employers can be more prepared to respond and adapt to needs that arise after a natural hazard event. According to the Oregon Employment Department, between 2012 and 2022, the largest job growth in Region 6 is expected to occur in the following sectors: (a) Education and Health Services; (b) Leisure and Hospitality; (c) Trade, Transportation, and Utilities (including retail trade); (d) Professional and Business Services; and (e) Manufacturing (Oregon Employment Department, 2014).

Identifying sectors with a large number of businesses and targeting mitigation strategies to support those sectors can help the region's resiliency. The Trade, Transportation, and Utilities sector includes the most businesses in Region 6, 18.6%. Professional and Business Services has the second most. Other Services, Construction, Education, and Health Services round out the top five sectors in the region (Oregon Employment Department, 2012). While many of these are small businesses, employing fewer than 20 employees, collectively they represent almost two thirds of the businesses in the region. Due to their small size and large collective share of the economy, these businesses are particularly sensitive to temporary decreases in demand, such as may occur following a natural hazard event.

Economic Trends and Issues

Current and anticipated financial conditions of a community are strong determinants of community resilience, since a strong and diverse economic base increases the ability of individuals, families, and communities to absorb impacts of a disaster and recover more quickly. The Economic analysis shows that Region 6 is particularly vulnerable during a hazard event due to the following characteristics:

- Less than half of the jobs lost at the peak of the financial crisis that began in 2007 have been recovered; and
- Wages in Region 6 are relatively low, particularly in Wheeler County.

Central Oregon has largely rebounded from the financial crisis that began in 2007. This is driven primarily by growth in Deschutes and Crook Counties. The educational and health, professional and business services, leisure and hospitality, and manufacturing sectors, driven by the state's fastest population growth rate and increasing tourism economy (both summer bicycling and winter skiing), drives the growth in employment within the region (Oregon Employment Department, n.d.c). Klamath, Lake, and Wheeler Counties have slower population growth rates and higher rates of unemployment and have not recovered as fully as the rest of the region. Supporting the growth of dominant industries and employment sectors as well as emerging sectors identified in this analysis can help the region become more resilient to economic downturns that often follow a hazard event (Stahl et al., 2000).

Infrastructure

Transportation

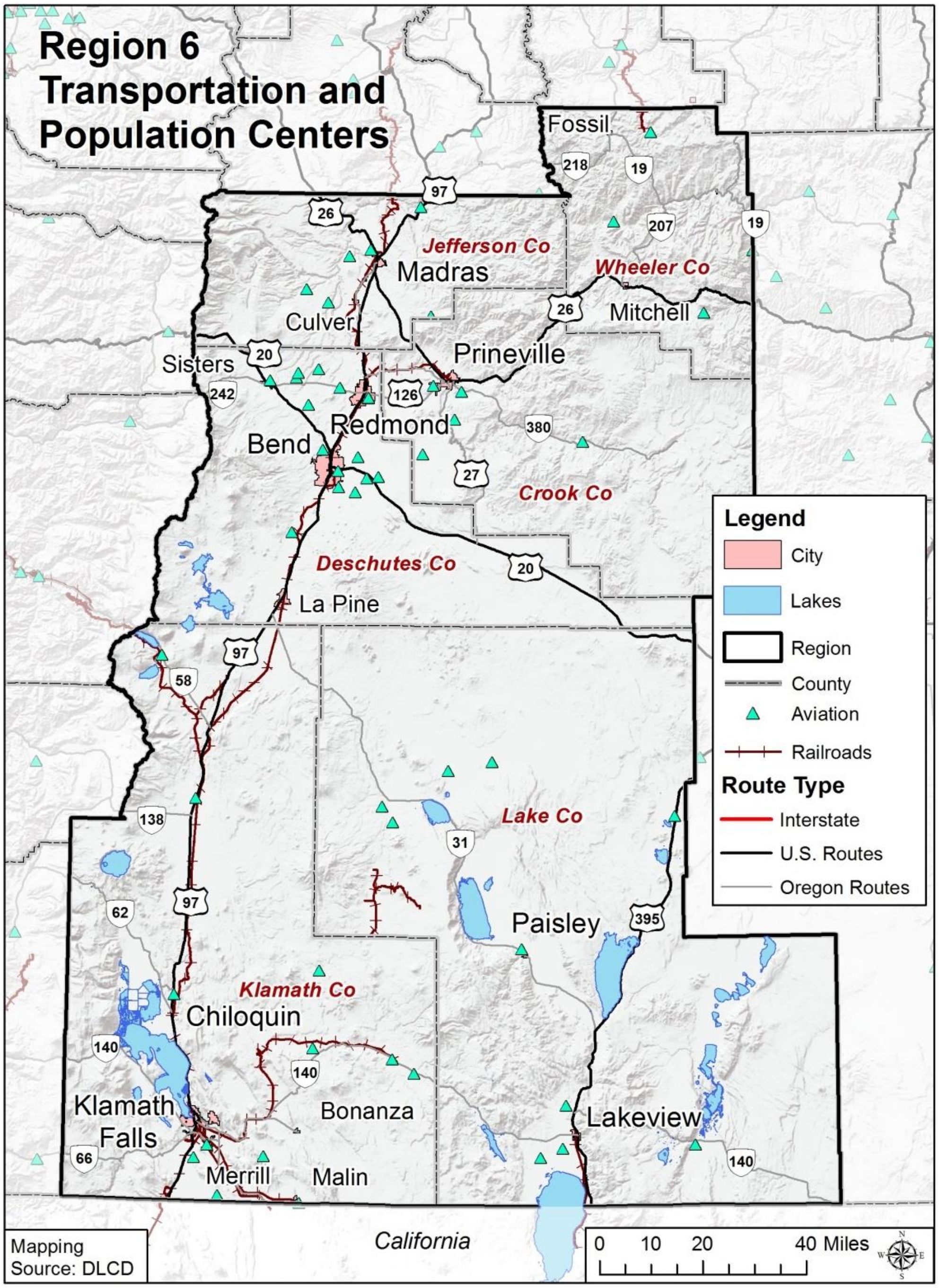
Roads

The largest population bases in Region 6 are located along the region's major highways. Growing population centers bring more workers, automobiles, and trucks onto roads. A high percentage of workers driving alone to work coupled with interstate and international freight movement create additional stresses on transportation systems. Some of these are added maintenance, congestion, oversized loads, and traffic accidents.

Natural hazards and emergency events can further disrupt automobile traffic, create gridlock, and shut down local transit systems, making evacuation and other emergency operations difficult. Hazards such as localized flooding can render roads unusable. Likewise, a severe winter storm has the potential to disrupt the daily driving routine of thousands of people.

According to the Oregon Department of Transportation's (ODOT's) Seismic Lifeline Report (**Appendix 9.1.13**), ground shaking from a CSZ event is not expected to cause damage in the region's major highways. However, either a local event or possibly one triggered by a CSZ event, can cause extensive damage. For information on ODOT's Seismic Lifeline Report findings for Region 6, see **Seismic Lifelines**.

Figure 2-186. Region 6 Transportation and Population Centers



Source: Oregon Department of Transportation, 2014

Bridges

Because of earthquake risk in Region 6, the seismic vulnerability of the region'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 region's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or that are part of regional and local systems that are maintained by the region's counties and cities. For information on ODOT's Seismic Lifeline Report findings for Region 6, see **Seismic Lifelines**.

Table 2-375 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 (ODOT, 2012, 2013). The table shows that the region has a lower percentage of bridges that are distressed and/or deficient (13%), than does the state (21%). About 15% of the region's ODOT bridges are distressed, compared to 22% for the state.

Table 2-375. Bridge Inventory for Region 6

	State Owned			County Owned			City Owned			Other Owned			Area Total			Historic
	Di	ST	%D*	De	ST	%D	De	ST	%D	De	ST	%D	D	T	%D	Covered
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
Crook	7	28	22%	5	24	21%	1	7	14%	0	0	-	13	63	21%	3
Deschutes	5	48	11%	8	47	17%	5	35	14%	1	4	25%	19	132	14%	2
Jefferson	1	13	7%	9	34	26%	0	4	0%	0	1	0%	10	53	19%	4
Klamath	8	55	16%	5	135	4%	2	11	18%	3	4	75%	18	201	9%	2
Lake	4	25	16%	1	38	3%	0	1	0%	0	0	—	5	64	8%	0
Wheeler	0	23	0%	1	6	17%	0	0	—	0	0	—	1	29	3%	1

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.

Source: ODOT (2012, 2013)

Railroads

Railroads that run through Region 6 support cargo and trade flows. The region's major (Class I) freight rail providers are the Union Pacific (UP) and the Burlington Northern-Santa Fe (BNSF) railroads. There is one major rail yard in the region (in Klamath Falls, Klamath County) operated by BNSF and UP (Cambridge Systematics, 2014). The Klamath Falls Yard, actually two adjacent yards, is used for switching, storing rail cars, and for locomotive repair (Cambridge Systematics, 2014).

Amtrak provides passenger rail service from the Willamette Valley south through Region 6 and southward to Los Angeles, California (with stops in Chemult and Klamath Falls) via the Coast Starlight line.

Rails are sensitive to icing from winter storms that can occur in Region 6. Disruptions in the rail system can result economic losses for the region. The potential for harm from rail accidents can also have serious implications for local communities, particularly if hazardous materials are involved.

Airports

The Redmond Regional Airport is the only commercial airport in the region (Redmond Airport website, http://www.flyrdm.com). The airport serves four passenger airlines (American Airlines, Alaska Air, Delta Air, United/United Express) providing direct service to Denver, Los Angeles, Portland, San Francisco, Salt Lake City, and Seattle (Redmond Airport website, http://www.flyrdm.com). This airport has been identified to become a primary airport following a Cascadia Subduction Zone (CSZ) seismic event.

In the event of a natural disaster, public and private airports are important staging areas for emergency response activities. Public airport closures will impact the region's tourism industries, as well as the ability for people to leave the region by air. Businesses relying on air freight may also be impacted by airport closures.

Table 2-376. Public and Private Airports in Region 6

	Number of Airports by FAA Designation				
	Public Airport	Private Airport	Public Helipad	Private Helipad	Total
Region 6	17	37	0	11	65
Crook	1	5	0	3	9
Deschutes	4	12	0	3	19
Jefferson	2	4	0	2	8
Klamath	5	7	0	2	14
Lake	5	5	0	1	11
Wheeler	0	4	0	0	4

Source: FAA Airport Master Record (Form 5010), 2014

Energy

Electricity

The region is served by several investor-owned, public, cooperative, and municipal utilities. The Bonneville Power Administration is the area's wholesale electricity distributor. Pacific Power and Light (Pacific Power) is the primary investor-owned utility company serving portions of Crook, Deschutes, Jefferson, Klamath, and Lake Counties. The region's electric cooperatives include: Central Electric Cooperative (Crook, Deschutes, Jefferson, Lake), Columbia Basin Cooperative (Wheeler), Columbia Power Cooperative (Wheeler), Harney Electric Cooperative (Crook, Deschutes, Harney, Lake), Midstate Electric Cooperative (Deschutes, Klamath, Lake), Surprise Valley Electric Cooperative (Klamath, Lake), and Wasco Electric Cooperative (Jefferson, Wheeler).

Table 2-377 lists electric power-generating facilities that are within Region 6. The region has a total of eight power-generating facilities: three are hydroelectric power facilities, two are natural gas power facilities, and three are categorized as "other" (biomass or solar voltaic). In total the power-generating facilities have the ability to produce up to 1,109 megawatts (MW) of electricity. The region also includes one natural gas power facility (Klamath County) that is approved but not constructed. It will have the capacity to generate up to 500 MW of electricity (Oregon Department of Energy, n.d.).

Table 2-377. Power Plants in Region 6

	Hydroelectric	Natural Gas	Wind	Coal	Other*	Total
Region 6	3	2	0	0	3	**8**
Crook	0	0	0	0	0	**0**
Deschutes	0	0	0	0	0	**0**
Jefferson	2	0	0	0	1	**3**
Klamath	1	2	0	0	0	**3**
Lake	0	0	0	0	2	**2**
Wheeler	0	0	0	0	0	**0**
Energy Production (MW)	**461**	**636**	**0**	**0**	**12**	**1,109**

* "Other" includes biomass, geothermal, landfill gas, solar, petroleum, and waste.

Source: Army Corps of Engineers; Biomass Power Association; Calpine Corporation; Eugene Water and Electric Board; Iberdola Renewables; Idaho Power Company; Klamath Energy LLC; Oregon Department of Energy; Owyhee Irrigation District; Form 10K Annual Report (2013), PacifiCorp; Form 10K Annual Report (2013), Portland General Electric; U.S. Geothermal, Inc.

Hydropower

Figure 2-187 shows the major dams operated by the Bonneville Power Administration (BPA), which provides hydro-generated electricity to the states consumer owned utilities. The major BPA dams in the region are located on the Deschutes River (Pelton and Round Butte).

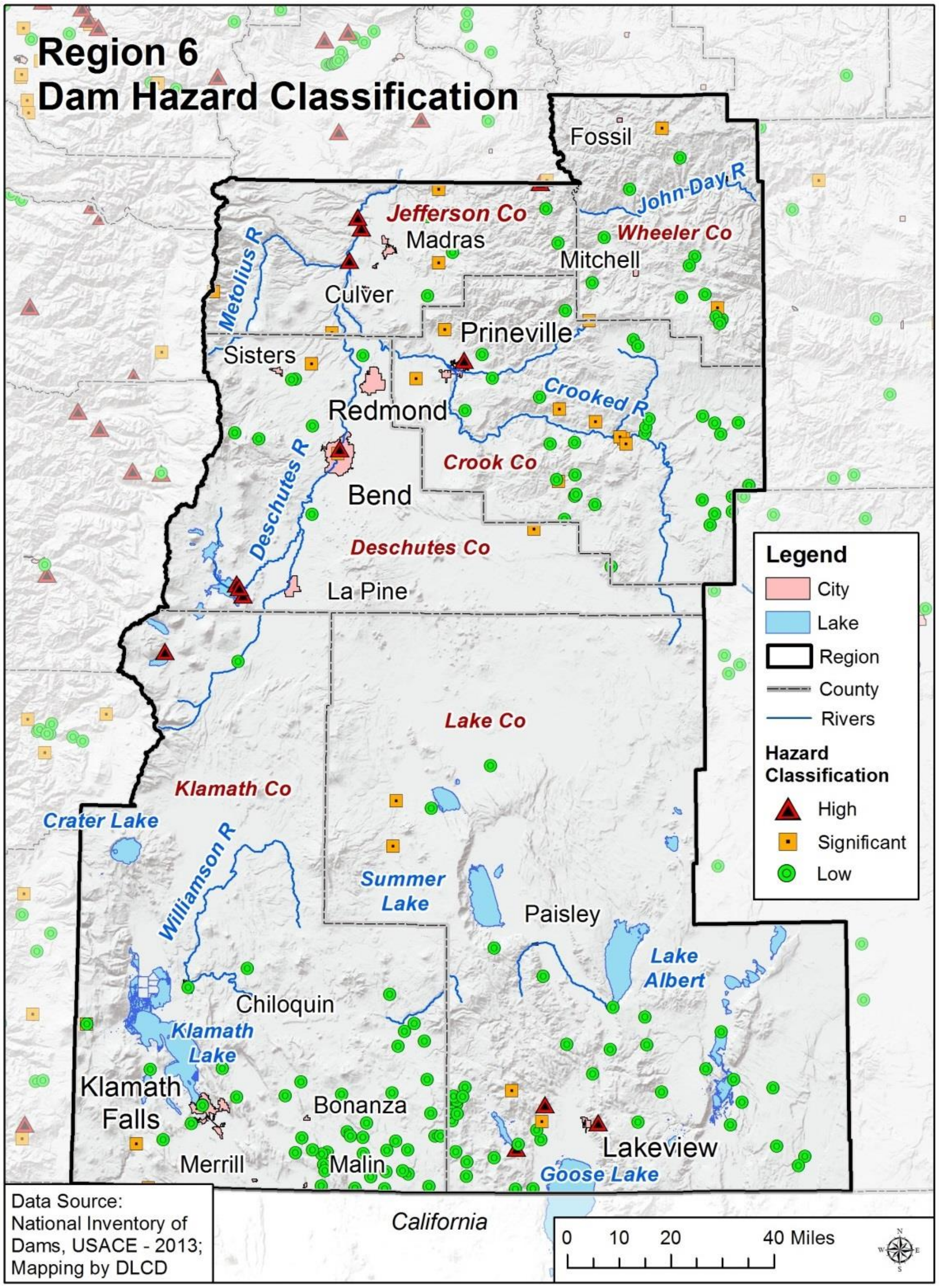
Minor dam failures can occur at any time. Most dam failures result in minor damage to structures and pose little or no risk to life safety. However, the potential for severe damage and fatalities does exist (major dam failures have occurred most recently near Hermiston, 2005, and Klamath Lake, 2006) (Association of Dam Safety Officials, n.d.). The Oregon Water Resources Department maintains an inventory of all large dams located in Oregon (using the National Inventory of Dams (NID) threat potential methodology). Table 2-378 lists the number of dams included in the inventory. The majority of dams in the region are located in Crook (53), Klamath (65), and Lake (79) Counties. There are 19 High Threat Potential dams and 23 Significant Threat Potential dams in the region.

Table 2-378. Threat Potential of Dams in Region 6

	Threat Potential			
	High	Significant	Low	Total Dams
Region 6	19	23	212	254
Crook	5	8	40	53
Deschutes	3	3	12	18
Jefferson	4	4	10	18
Klamath	4	3	58	65
Lake	3	5	71	79
Wheeler	0	0	21	21

Source: Oregon Water Resources Department, Dam Inventory Query, 2014

Figure 2-187. Region 6 Dam Hazard Classification

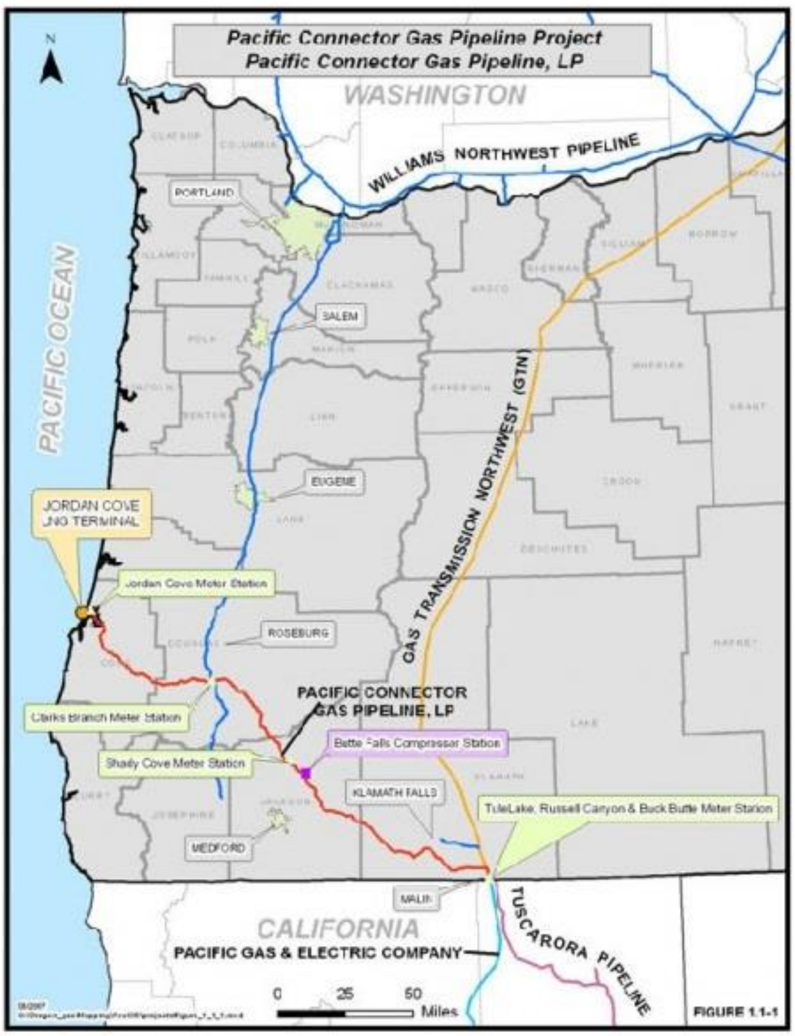


Source: National Inventory of dams, USACE, 2013

Natural Gas

Although natural gas does not provide the most energy to the region, it does contribute a significant amount of energy to the region's energy portfolio. Cascade Natural Gas Corporation is the major supplier of natural gas in Central Oregon. Liquefied natural gas (LNG) is transported via pipelines throughout the United States. **Figure 2-188** shows the Gas Transmission Northwest (GTN) line, which runs through Klamath, Deschutes, Crook, and Jefferson Counties (in green) and the proposed Pacific Connector that would connect to the GTN line in Klamath County (red) (Pipelines International, 2009). LNG pipelines, like other buried pipe infrastructure, are vulnerable to earthquakes and can cause danger to human life and safety, as well as environmental impacts in the case of a spill.

Figure 2-188. Liquefied Natural Gas Pipelines in Region 6



Source: Retrieved from http://gs-press.com.au/images/news_articles/cache/Pacific_Connector_Gas_Pipeline_Route-0x600.jpg

Utility Lifelines

Central Oregon is an important throughway for oil and gas pipelines and electrical transmission lines, connecting Oregon to California and Washington. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy. These lines may be vulnerable to severe but infrequent natural hazards such as earthquakes.

Region 6 primarily receives oil and gas from Alaska by way of the Puget Sound through pipelines and tankers. The region is at the southern end of this pipeline network. Oil and gas are supplied by Northern California via a separate network. The electric, oil, and gas lifelines that run through the County are both municipally and privately owned (Loy et al., 1976).

The network of electrical transmission lines running through Region 6 is operated primarily by Pacific Power and regional electrical cooperatives (and Bonneville Power Administration) and primarily facilitates local energy production and distribution (Loy et al., 1976b). Most of the natural gas Oregon uses originates in Alberta, Canada. Avista Utilities owns the main natural gas transmission pipeline in southern Oregon while Cascade Natural Gas supplies the greater part of Central Oregon (Loy et al., 1976).

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio). Region 6 is part of the Central Oregon Operational Area (Crook, Deschutes, Jefferson, Wheeler), the Lake-Harney Operational Area (Lake), and the Southern Oregon Operational Area (Klamath) under The Oregon State Emergency Alert System Plan (Oregon Office of Emergency Management, 2013.) There is a memorandum of understanding between these counties that facilitates the launching of emergency messages. Counties in these areas can launch emergency messages by contacting the Oregon Emergency Response System (OERS), which in turn creates emergency messages to communities statewide.

Beyond day-to-day operations, maintaining communications capabilities during disaster events and other emergency situations helps to keep citizens safe by keeping them informed of the situation's status, areas to avoid, and other procedural information. Additionally, responders depend on telecommunications infrastructure to be routed to sites where they are needed.

Television

Television serves as a major provider for local, regional, and national news and weather information and can play a vital role in emergency communications. The Oregon State Emergency Alert System Plan does not identify a local primary station for emergency messages. Messages are provided via the three state primary networks: Oregon Public Broadcasting (Portland), KOBI TV (Medford), and KWAX-FM (Eugene).

Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband service providers serve Region 6. Broadband technology including mobile wireless is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless, and mobile wireless. Internet service is readily available throughout most parts the region with a smaller number of providers and service types available in the more remote parts of the region (NTIA, n.d.). Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

Wireless providers sometimes offer free emergency mobile phones to those impacted by disasters, which can aid in communication when landlines and broadband service are unavailable.

Radio

Radio is readily available to those who live within Region 6 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Radio transmitters for the Central Oregon Operational Area are:

- KOAB-FM, 91.3 MHZ, Bend; and
- KWRX-FM, 88.5 MHZ, Redmond (KWAX-FM Network).

The radio transmitter for the Lake-Harney Operational Area is:

- KOAP-FM, 88.7 MHZ, Lakeview.

The radio transmitter for the Southern Oregon Operational Area is:

- KOTI-TV, Ch. 13, Klamath Falls.

Ham Radio

Amateur radio, or ham radio, is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). ARES Districts 2 (Crook, Deschutes, Jefferson), 3 (Wheeler), and 4 (Klamath, Lake) provide service to Region 6. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (Oregon Office of Emergency Management, n.d.). The official ham emergency station calls for Region 6 include (American Relay Radio League Oregon Chapter, n.d., www.arrloregon.org):

- Crook County: W7KFO;
- Deschutes County: KE7TMU;
- Jefferson County: K1GER;
- Klamath County: WA7YPR;
- Lake County: KE7QP; and
- Wheeler County: W7ILD.

Water

Water infrastructure includes drinking water, stormwater, and wastewater systems. All of these systems possess some level of vulnerability to natural hazards that can have repercussions on human health, ecosystems, and industry.

Drinking Water

In Region 6 municipal drinking water supply is obtained from both surface and ground sources. In Crook, Deschutes, Jefferson, and Klamath Counties rural areas draw water from surface water sources. In the upper basin of Klamath County rural drinking water is drawn from springs, while the lower basin draws water from Klamath Lake for drinking water and irrigation. In rural areas of Lake County drinking water is primarily drawn from wells. Rural drinking water and irrigation water is primarily drawn from surface water sources and may be delivered by localized irrigation districts or may be drawn directly by landowners with water rights. The region’s cities primarily draw drinking water from groundwater wells with the exception of the City of Bend, which draws water from Bridge Creek, a spring-fed waterway. A small portion of the City of Lakeview’s drinking water is drawn from springs.

Region 6 is impacted by several threats to water quality and quantity. Low levels of snowpack and rain can lead to water shortages in a region that is often subject to annual shortages. Water rights in the region are fully appropriated in the summer season, which may impact opportunities for new development of urban and farm lands in the region. Above-ground storage in reservoirs is a tool used throughout the region to help prepare for potential water shortages. Aging wells in the region may also contribute to shortages because of decreased efficiency in water delivery. However, the age and maintenance level of wells is mostly a concern because older equipment may not filter minerals and bacteria as effectively as well maintained infrastructure.

Water quality in Crook, Deschutes, and Jefferson Counties is generally high, partially due to the volcanic nature of the area’s soil and bedrock, which lacks high levels of sedimentation. However, concerns regarding water quality do exist. Sedimentation could be caused by river bank erosion due to freeze-thaw cycles in the winter and weed growth lowering channel capacity. A decrease in channel capacity may in turn contribute to turbidity and sedimentation. Throughout the region, complaints about hydrogen sulfide causing unpleasant odors to the water occasionally occur; however, the unpleasant odor is not indicative of any health concerns. In Lake County, minerals including arsenic and boron are of concern and monitored regularly. In the area surrounding the City of Lakeview tailings and runoff from abandoned mines are a concern for the area’s water quality. In Klamath County, the shallow, slow-moving nature of waterways causes high water temperatures, which threatens water quality. Throughout the region, bacterial coliform levels are monitored to ensure that waterborne diseases do not threaten the quality of drinking water.

Surface sources for drinking water are vulnerable to pollutants caused by non-point sources and natural hazards. Non-point source pollution is a major threat to surface water quality, and may include stormwater runoff from roadways, agricultural operations, timber harvest, erosion and sedimentation. Landslides, flood events, and earthquakes and resulting liquefaction can cause increased erosion and sedimentation in waterways

Underground water supplies and aging or outdated infrastructure — such as reservoirs, treatment facilities, and pump stations — can be severed during a seismic event. Rigid materials such as cast iron may snap under the pressure of liquefaction. More flexible materials such as polyvinyl chloride (PVC) and ductile iron may pull apart at joints under the same stresses. These types of infrastructure damages could result in a loss of water pressure in municipal water supply systems, limiting access to potable water. This can lead to unsanitary conditions that may threaten human health. Lack of water can also impact industry, such as the manufacturing sector. Moreover, if transportation infrastructure is impacted by a disaster event, repairs to water infrastructure will be delayed.

Stormwater and Wastewater

In urbanized areas severe precipitation events may cause flooding that leads to stormwater runoff. A non-point source of water pollution, stormwater runoff can adversely impact drinking water quality. It can also lead to environmental issues such as increasing surface water temperatures that can adversely affect habitat health. Furthermore, large volumes of fast-moving stormwater that enter surface waterways can cause erosion issues.

Stormwater can also impact water infrastructure. Leaves and other debris can be carried into storm drains and pipes, which can clog stormwater systems. In areas where stormwater systems are combined with wastewater systems (combined sewers), flooding events can lead to combined sewer overflows (CSOs). CSOs present a heightened health threat as sewage can flood urban areas and waterways. Underground stormwater and wastewater pipes are also vulnerable to damage by seismic events.

In Region 6, county and municipal building codes and stormwater management plans (city and county) emphasize use of centralized storm sewer systems to manage stormwater. Low impact development (LID) mitigation strategies can alleviate or lighten the burden on a jurisdiction's storm sewer system by allowing water to percolate through soil onsite or detaining water so water enters the storm sewer system at lower volumes, at lower speed, and at lower temperatures. The largest municipalities in the region (Fossil, Madras, Prineville, Redmond, Bend, La Pine, Klamath Falls, and Lakeview) do not require use LID strategies in their building codes. Promoting and requiring decentralized LID stormwater management strategies could help reduce the burden of new development on storm sewer systems, and increase a community's resilience to many types of hazard events.

Infrastructure Trends/Issues

Physical infrastructure is critical for everyday operations and is essential following a disaster. Lack or poor condition of infrastructure can negatively affect a community's ability to cope with, respond to, and recover from a hazard event. Diversity, redundancy, and consistent maintenance of infrastructure systems help create system resiliency (Meadows, 2008).

Damage or service interruption to roads, bridges, rail systems, and ports can have devastating effects the region's economy. Icy winter conditions may disrupt the flow of cargo and trade by rail as well as Amtrak's passenger service. The Redmond Regional Airport will become a primary airport for the state following a catastrophic Cascadia Subduction Zone (CSZ) earthquake event.

The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards. The region has a diverse energy portfolio that boosts its ability to withstand system disruptions due to natural hazard events. This includes eight power-generating facilities: three hydroelectric, two natural gas, and three biomass or solar voltaic facilities. The region has two large dams and hydroelectric projects on the Deschutes River. LNG is transported through the region via the Gas Transmission Northwest (GTN) pipeline that runs through Klamath, Deschutes, Crook, and Jefferson Counties. A natural gas power plant has been proposed for Klamath County. In addition, there is an emerging solar photovoltaic energy infrastructure in Central Oregon.

Decentralization and redundancy in the region's telecommunication systems can help boost the area's ability to communicate before, during, and after a disaster event. It is important to note that broadband and mobile telephone services may not cover rural areas of the region that are distant from US-97. This may present a communication challenge in the wake of a hazard event. Encouraging residents to keep AM/FM radios available for emergency situations could help increase the capacity for communicating important messages throughout the region.

Water systems in the region are particularly vulnerable to hazard events because they tend to be older, centralized, and lacking system redundancies. Furthermore, because most drinking water is sourced from surface water or wells, the region is at risk of high levels of pollutants entering waterways through stormwater runoff and combined sewer overflows (CSOs) during high-water events. The implementation of decentralized LID stormwater systems can increase the region's capacity to better manage high precipitation events.

Built Environment

Development Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's program is 19 land use goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards (Department of Land Conservation and Development, website: http://www.oregon.gov/http://www.oregon.gov/).

Settlement Patterns

The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people or an "urban cluster" of at least 2,500 people (but less than 50,000). Wheeler County does not meet either definition; therefore all of its population is considered rural even though the county has incorporated cities.

The region's percent urban growth between 2000 and 2010 is double that of the state. Deschutes County has the highest population in urban and rural areas and has experienced roughly 57% urban growth. Overall, the region's urban areas are growing about 4 times faster than rural areas. Rural populations have grown significantly, between 10 and 18%, in all counties except Deschutes and Wheeler. Wheeler is the only county that does not have an urban population, even though it contains incorporated cities, and it is also the only county in the region that is losing rural population.

Urban housing is growing at twice the rate of rural housing in the region. Deschutes County gained the most urban housing units (approximately 21,150), growing by 69%. Notably, rural housing has increased by about 30% in Crook and Klamath Counties.

The region's population is clustered around the US-97 corridor and the cities of Bend, Klamath Falls, Madras, and Redmond.

Table 2-379. Urban and Rural Populations in Region 6

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	2,694,144	3,104,382	15.2%	727,255	726,692	-0.1%
Region 6	134,438	177,374	31.9%	91,864	98,773	7.5%
Crook	10,290	10,905	6.0%	8,892	10,073	13.3%
Deschutes	72,554	114,130	57.3%	42,813	43,603	1.8%
Jefferson	7,252	8,010	10.5%	11,757	13,710	16.6%
Klamath	41,153	41,434	0.7%	22,622	24,946	10.3%
Lake	3,189	2,895	-9.2%	4,233	5,000	18.1%
Wheeler	0	0	0%	1,547	1,441	-6.9%

Source: U.S. Census Bureau. 2000 Decennial Census, Table P002 and 2010 Decennial Census, Table P2

Table 2-380. 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	0%	842	895	6.3%

Source: U.S. Census Bureau. 2000 Decennial Census, Table H002 and 2010 Decennial Census, Table H2

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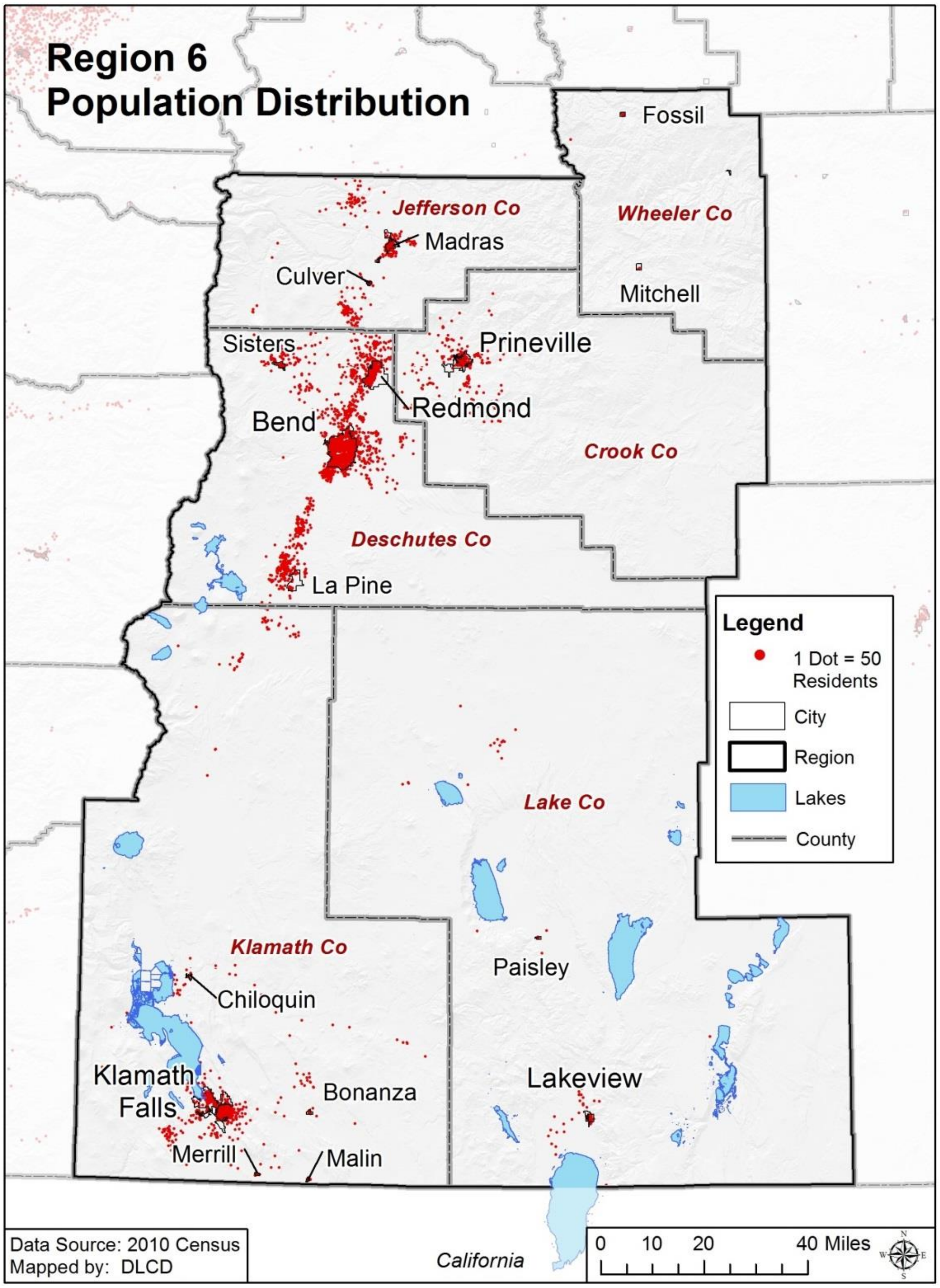
Figure 2-189. Region 6 Population Distribution



Source: U.S. Census, 2012

Land Use and Development Patterns

Land ownership and geography tend to drive the land use patterns in Region 6. Federal ownership (61%) is made up primarily of the U.S. Forest Service in the western portion ranging up the Cascade crest, and BLM has holdings generally ranging from southeast of Redmond and increasing until dominating the area of Lake County. The majority of land ownership is private holdings (36%) from the north Jefferson County and Madras area through the Prineville/Redmond/Sisters/Bend areas. The Warm Springs Indian Reservation dominates the northeast portion.

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% 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% less in the 2005–2009 period when compared to the 1974–1984 period. Similar trends, although less pronounced, are seen in Klamath County (Lettman, 2011).

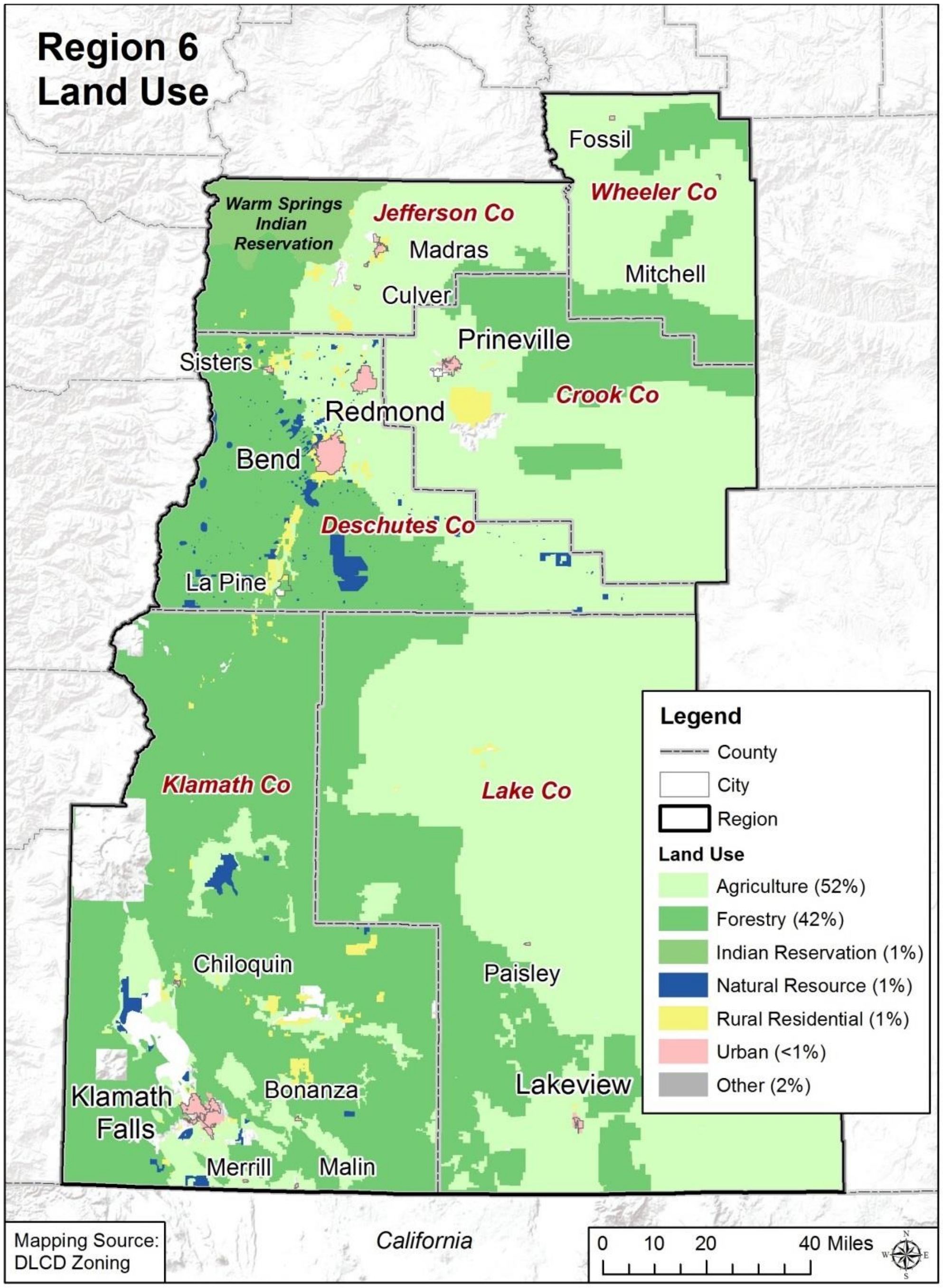
Responding to rapid growth and changing demographics, in 2011 Deschutes County completed a multi-year effort to establish “Plan 2030.” This new plan incorporates updated goals and policies, community plans, and new projects like the South County Plan, destination resort remapping, a 2030 Transportation System Plan, and a South County Local Wetland Inventory.

Increasing federal efforts to protect sage grouse habitat affect large portions of Deschutes, Crook, and Lake County’s resource lands devoted to farm, ranch, or forest uses. Land use threats to habitat have been identified as conversion to agriculture, energy development, mining, infrastructure, and urbanization. Counties have been addressing some of these issues through their land use planning programs.

While periodic flooding is a challenge in the northern portion of the Region, the wildland-urban interface areas are a constant concern for community planners and emergency managers. The Oregon Forestland-Urban Interface Fire Protection Act — often referred to as Senate Bill 360 — enlists the aid of property owners toward the goal of turning fire-vulnerable urban and suburban properties into less volatile zones where firefighters may more safely and effectively defend homes from wildfires. All Region 6 counties implemented this in 2013.

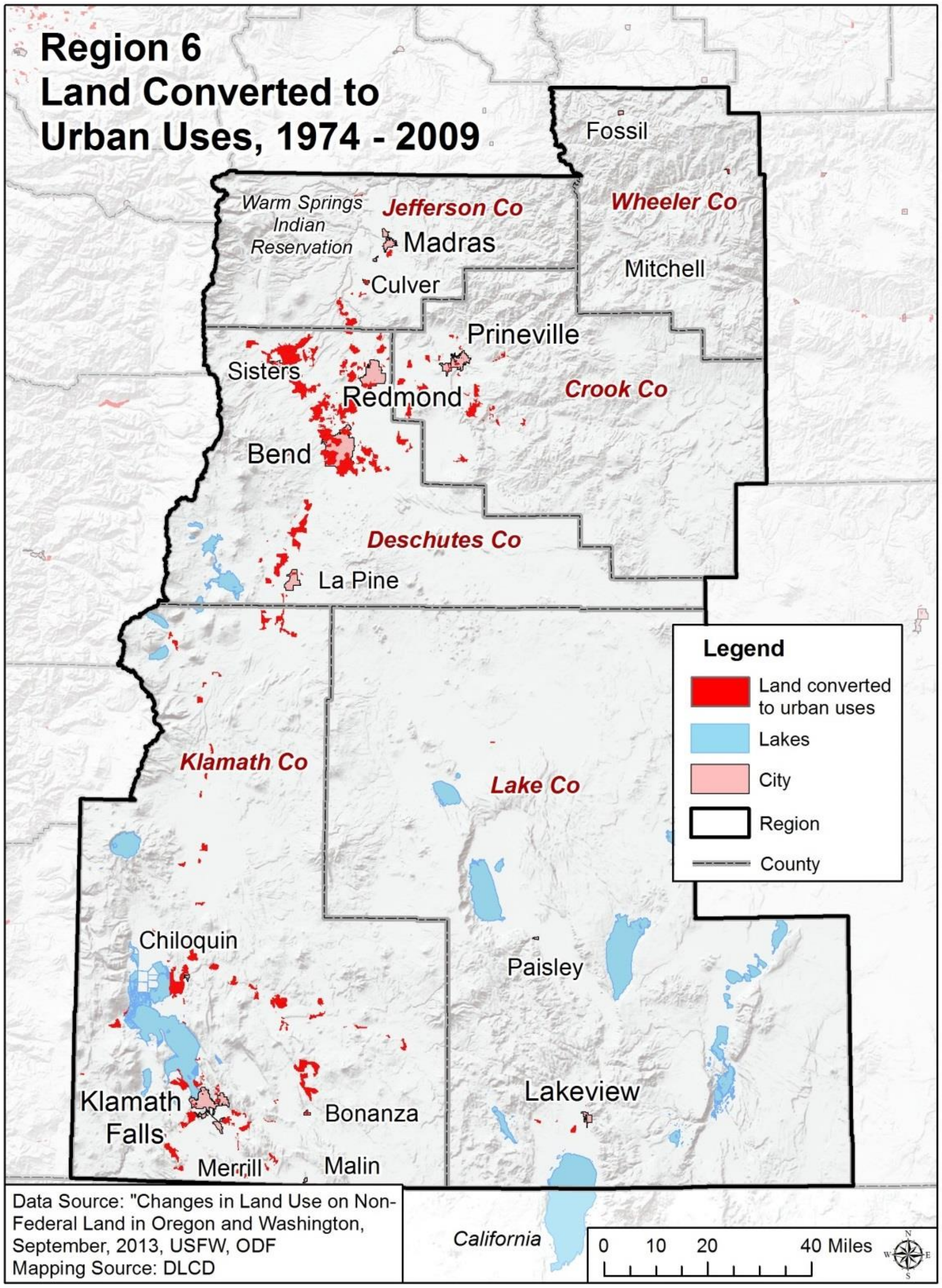
The City of Madras in 2014 began working on integrating portions of its Comprehensive Plan with its Local Natural Hazards Mitigation Plan; this may prove to be a model for others.

Figure 2-190. Region 6 Land Use



Source: Department of Land Conservation and Development, 2014

Figure 2-191. Region 6 Land Converted to Urban Uses, 1974-2009



Source: Land Use Change on Non-Federal Land in Oregon and Washington, September, 2013, USFS, ODF

Housing

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. Almost two thirds of the region's housing stock is single-family homes. Mobile homes account for 13% of Region 6's housing, and roughly 70% of all mobile homes are located in Deschutes and Klamath Counties. In natural hazard events such as earthquakes and floods, mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of OES, 1997).

Table 2-381. Housing Profile for Region 6, 2012

	Total Housing Units	Single Family		Multi-Family		Mobile Homes	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	1,140,319	68.1%	460,852	27.5%	139,768	8.4%
Region 6	138,082	102,288	74.1%	17,474	12.7%	18,017	13.0%
Crook	10,204	7,763	76.1%	663	6.5%	1,669	16.4%
Deschutes	80,039	61,145	76.4%	11,557	14.4%	7,308	9.1%
Jefferson	9,807	6,409	65.4%	1,009	10.3%	2,337	23.8%
Klamath	32,737	23,393	71.5%	4,033	12.3%	5,250	16.0%
Lake	4,413	2,914	66.0%	204	4.6%	1,243	28.2%
Wheeler	882	664	75.3%	8	0.9%	210	23.8%

Note: The percentages listed above do not reflect the number of structures that are built within special flood hazard areas or that are at risk of seismic damage.

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25024

Aside from location and type of housing, the year structures were built (Table 2-382) has implications. Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for the Cascadia earthquake fault (Judson, 2012). Therefore, homes built before 1994 are more vulnerable to seismic events.

Also in the 1970s, FEMA began assisting communities with floodplain mapping as part of administering 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. Regionally, about one quarter of the housing stock was built prior to 1970 — including roughly half of the residences in Lake and Wheeler Counties — before the implementation of floodplain management ordinances. Regionally, just under 54% of the housing stock was built before 1990 and the codification of seismic building standards.

Table 2-382. Age of Housing Stock in Region 6, 2012

	Total Housing Units	Pre 1970		1970 to 1989		1990 or later	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	609,062	36.4%	518,569	31.0%	545,962	32.6%
Region 6	138,082	32,008	23.2%	42,128	30.5%	63,946	46.3%
Crook	10,204	2,840	27.8%	2,624	25.7%	4,740	46.5%
Deschutes	80,039	10,166	12.7%	24,414	30.5%	45,459	56.8%
Jefferson	9,807	2,325	23.7%	2,952	30.1%	4,530	46.2%
Klamath	32,737	14,015	42.8%	10,623	32.4%	8,099	24.7%
Lake	4,413	2,183	49.5%	1,286	29.1%	944	21.4%
Wheeler	882	479	54.3%	229	26.0%	174	19.7%

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25034

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. Table 2-383 shows the initial and current FIRM effective dates for Region 6 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, Flood section.

Table 2-383. Community Flood Map History in Region 6

	Initial FIRM	Current FIRM
Crook County	July 17, 1989	Feb. 12, 2012
Prineville	July 17, 1989	Feb. 12, 2012
Deschutes County	Aug. 16, 1988	Sep. 28, 2007
Bend	Sep. 4, 1987	Sep. 28, 2007
La Pine	Sep. 28, 2007	Sep. 28, 2007
Sisters	Sep. 29, 1986	Sep. 28, 2007
Jefferson County	July 17, 1989	July 17, 1989
Culver	Sep. 4, 1987	Sep. 4, 1987
Madras	July 17, 1989	July 17, 1989
Klamath	Dec. 18, 1984	Dec. 18, 1984
Bonanza	June 1, 1983	June 1, 1983 (M)
Chiloquin	Aug. 15, 1984	Aug. 15, 1984
Klamath Falls	June 5, 1985	June 5, 1985
Lake	Dec. 5, 1989	Dec. 5, 1989
Lakeview	Nov. 16, 1982	Sep. 5, 1990
Paisley	Sep. 15, 1989	Sep. 15, 1989
Wheeler County	July 17, 1989	July 17, 1989
Fossil	May 4, 1989	May 4, 1989
Mitchell	Apr. 17, 1989	Apr. 17, 1989

(M) = no elevation determined; all Zone A, C and X.

Source: Federal Emergency Management Agency, Community Status Book Report

State-Owned/Leased and Critical/Essential Facilities

In 2014 the Department of Geology and Mineral Industries updated the 2012 Oregon NHMP inventory and analysis of state-owned/leased facilities and critical/essential facilities. Results from this report relative to Region 6 can be found in **Table 2-384**. The region contains 5.1% of the total value of state-owned/leased critical/essential facilities.

Table 2-384. Value of State-Owned/Leased Critical and Essential Facilities in Region 6

	Total Property Value (State Facilities)	Percent State Total
Oregon	$7,339,087,023	100%
Region 6	$371,339,811	5.1%
Crook	$17,310,982	0.2%
Deschutes	$105,581,675	1.4%
Jefferson	$164,051,549	2.2%
Klamath	$41,694,108	0.6%
Lake	$38,521,237	0.5%
Wheeler	$4,180,262	0.1%

Source: DOGAMI

Built Environment Trends and Issues

The trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. Region 6 is largely a rural county with urban development focused along US-97, around the population centers of Bend, Klamath Falls, Prineville, and Redmond. Deschutes County has the fastest growing urban population in the region while Wheeler County is entirely rural and is declining in population. The region’s housing stock is largely single-family homes, though Jefferson, Lake, and Wheeler Counties have approximately triple the state’s percentage of mobile homes. Roughly half the homes in Klamath, Lake, and Wheeler were built before 1970. With the exception of Crook and Deschutes Counties, none of the region’s FIRMs have been modernized or updated, leaving this region’s flood maps less up to date than those of other regions.

2.3.6.3 Hazards and Vulnerability

Droughts

Characteristics

Every county in Central Oregon has experienced drought conditions at some point during the past 10 years, with Klamath County receiving the most Governor-declared declarations. A summary of Governor-declared droughts since 1995 is given in **Table 2-385**. The U.S. Department of Agriculture can also designate a county as a "natural disaster area" due to damages or losses caused by a drought. In 2007, Lake County was declared a natural disaster area and Klamath County received the same designation in 2010. In August 2013, Klamath and Lake Counties were declared natural disaster areas.

Historic Drought Events

Table 2-385. Historic Droughts in Region 6

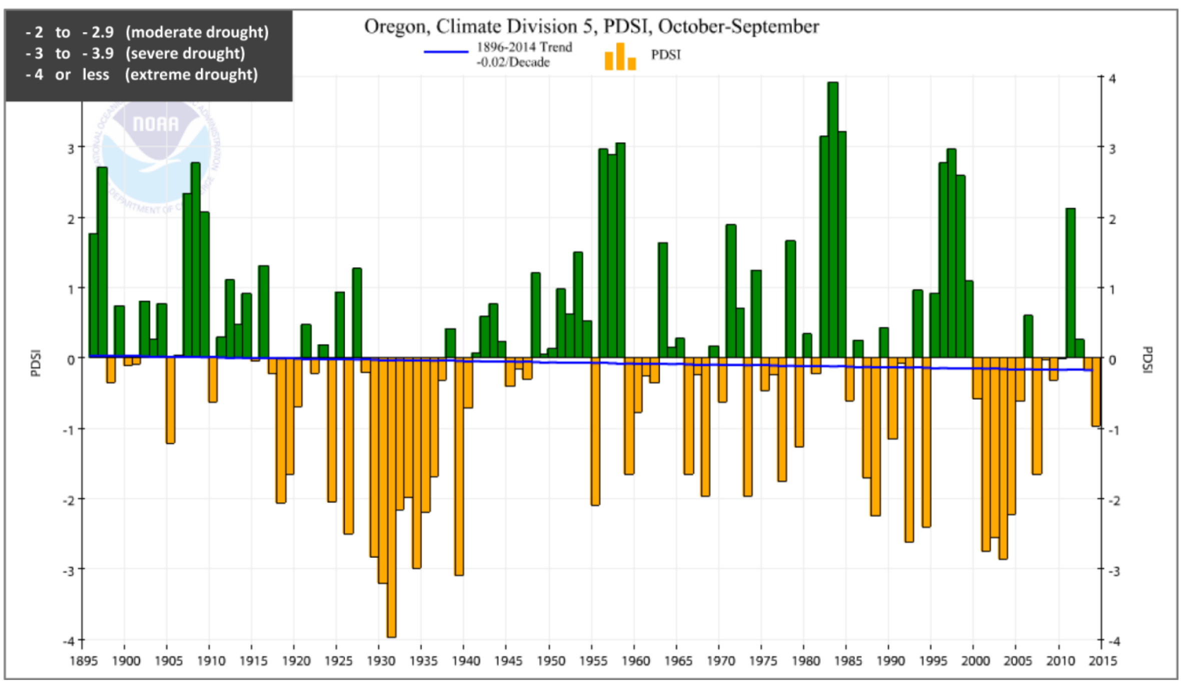
Date	Location	Description
1929–1931	Region 1–3, 5–7 (1929-1930); Region 6 and 7 (1930-1931) (extreme drought)	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country; moderate to severe drought affected much of the state
1939	statewide	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country
1977	N. & S. central and eastern Oregon	the water year was significantly drier than normal, but temperatures were near normal
1994	Regions 4–8	in 1994, Governor's drought declaration covered 11 counties located within Regions 4–8
2001	southern, eastern OR	Jefferson, Wheeler, Crook, Deschutes, Klamath, and Lake Counties under a Governor-declared drought; in 2001, 18 counties were declared statewide
2002	southern, eastern Oregon	counties declared in 2001 remained in effect; Governor added five additional counties in 2002, bringing the total to 23 counties
2003	southern, eastern Oregon	Jefferson, Deschutes, and Lake Counties' drought declarations expired June 23, 2003; Governor issued new drought declarations for Wheeler and Crook Counties and extended Klamath drought order through December 2003
2004	eastern Oregon	Klamath County under a Governor drought declaration; three other counties declared in neighboring regions
2005	Regions 5–7	Governor declared drought in Wheeler, Crook, Deschutes, Klamath, and Lake Counties; all Region 5 counties declared as well as two counties in Region 7
2007	Regions 6–8	Governor declared drought in Lake County, along with five other counties in Regions 6 and 7
2010	Region 6	Governor declared drought for Klamath County and "contiguous counties"
2012	Region 6	Governor declared drought for Lost River Basin only, located within Klamath and Lake Counties
2013	Regions 5-8	Governor declared drought for Klamath County along with four other counties
2014	Regions 4, 6–8	Governor declared drought in 10 counties including Crook, Wheeler, Klamath, Lake

Sources: Taylor and Hatton (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.

Historical drought information can also be obtained from the National Climatic Data Center, which provides historical climate data showing wet and dry conditions, using the Palmer Drought Severity Index (PDSI), that dates back to 1895. The Palmer Index is not the best indicator of water availability for Oregon as it does not account for snow or ice (delayed runoff), but it has the advantage of providing the most complete, long-term record. **Figure 2-192** shows years where drought or dry conditions affected the high plateau region of Oregon, which comprises much of Klamath County and smaller portions of Lake and Deschutes Counties (Climate Division 5).

Based on this index, 1931 was the driest year in this record with an index value of -3.98. The late 1920s were moderately dry, followed with many severe droughts in the 1930s. 1992 and 1994 were moderate years, followed by many moderate, nearly severe drought years in the early 2000s.

Figure 2-192. Palmer Drought Severity Index for Region 6



Source: National Climatic Data Center, http://www.ncdc.noaa.gov/cag/

The PDSI for Climate Division 7 (south central Oregon), which includes Deschutes, Jefferson, Crook, Wheeler, portions of Lake County, and the southern portion of Klamath County, along with Harney County (a “Region 7” county for hazard planning) had similar dry years, but in terms of severity, these years were higher in PDSI values. Water Year 1934, for example, had a PDSI value of −5.58, compared to the high plateau region value of −2.99. Also the south central region had more occurrences of "severe droughts" than the high plateau region. Water Year 1977 was the fourth driest year for the south central Oregon (PDSI value −3.89), whereas in the high plateau region, 1977 had a PDSI value of −1.76 (normal or mid-range condition).

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the probability that Region 6 will experience drought is shown in **Table 2-386**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-386. Local Probability Assessment of Drought in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Probability	M	H	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

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

Oregon has yet to undertake a statewide comprehensive risk analysis for drought to determine probability or vulnerability for a given community. Considering that several drought declarations have occurred during the last 10 years, is it reasonable to assume that there is a high probability that Region 6 will experience drought in the near future.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to drought is shown in **Table 2-387**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-387. Local Vulnerability Assessment of Drought in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Vulnerability	H	L	H	M	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Oregon has not undertaken a comprehensive statewide analysis to identify which communities are most vulnerable to drought. However, based on a review of drought declarations issued by the Governor, Klamath County could be considered one of the communities most vulnerable to drought and its related impacts. Since 1992, Klamath County has been under a drought declaration during 11 of the past 22 years, more than any other county in the state.

In 2013, the Klamath Falls area experienced the second driest January through March period on record with precipitation measuring below average throughout the Klamath Basin. According to the U.S. Bureau of Reclamation, Klamath Basin Project irrigators have not received a full supply of water in nine out of the last thirteen irrigation seasons During dry or drought years, national wildlife refuges in the Klamath Basin received smaller water deliveries as well. These refuges are important nesting and feeding grounds for birds migrating along the Pacific Flyway. Reduced river flows, especially during the summer months, can negatively impact fisheries, recreation, and other uses as well.

Lake County could also be considered one of the communities most vulnerable to drought and its related impacts, based on Governor-declared drought declarations. Declarations have been issued in 1992, 2001 (which continued through June 2003), 2005, 2007, 2012, and most recently in February 2014.

Dust Storms

Characteristics

The characteristics of dust storms in Region 6 are well described in the State Risk Assessment, **Drought** section. There is little about the dust storms in this region that differs from the general description, except to note that agricultural practices generally don't play as big a role as they do in Region 5. That written, Central Oregon farmers, ranchers, homeowners, resort properties, and wildlife sometimes find themselves vying for limited water. This competition for scarce water can affect the locations and amounts of dust lifted into the atmosphere, and blown on the wind.

Examples of dust storms in this region are listed in **Table 2-388**. One of the most recent significant storms occurred in April 2001. High winds blowing dust from a recently plowed field severely limited visibility.

Historic Dust Storms

Table 2-388. Historic Dust Storms Affecting Region 6

Date	Location	Description
Apr. 1931[1]	central Oregon	a heavy bank of clouds filled with dust reportedly worked their way over mountain passes into the Santiam Canyon
Mar. 1935	central Oregon	"A dust storm which reduced visibility to a few hundred yards spread over several Central Oregon counties… slowing traffic on the Dallas (sic) – California highway and spreading a fine coating of dry dust over all adjacent wheat lands." [2]
Apr. 2001	near Klamath Falls	US-97 about 5 miles north of Klamath Falls was closed for approximately 6 hours following three separate crashes; 11 cars were involved, sending nine people to the hospital; the accidents were due to severely limited visibility caused by high winds blowing dust from a recently plowed field across the highway. [3]
June 2004[4]	Lake County	blowing dust from a dry lake bed filled the sky in and near Summer Lake
Mar. 2005	Deschutes and Jefferson Counties	visibilities of a half mile or less due to blowing dust were reported from this event; "Motorists on Highway 97 north of Madras reported visibilities down to near zero at times" [5]
Nov. 2009[6]	Lake County	an alkaline dust storm blew into Lakeview

Sources:

(1) Oregon Statesman, "Dust, Wind, and Fire Cause Great Damage," April 23, 1931, and "Dust Storm Precedent on Record 88 Years Ago," April 26, 1931; information on this event, as well as the 1906 event, may also be found in the Pacific Northwest Quarterly, "The Pacific Northwest Dust Storm of 1931," Paul C. Pitzer, April 1988, pp. 50-55, as informed by the following sources used by Mr. Pitzer:

Albany Democrat-Herald, April 22, 1931
Astoria Evening Budget, April 24, 1931
Coos Bay Times, April 22, 23, 1931
Corvallis Gazette-Times, April 22, 24, 1931
Pendleton East Oregonian, April 22, 1931
Portland Oregonian, April 22, 25, 26 and May 1, 1931
Portland Oregonian, Lancaster Pollard, August 21, 1955 and November 25, 1962
Roseburg News-Review, April 22, 23, 1931
Salem Oregon Journal, April 22, 23, 24, 1931
San Francisco Chronicle, April 25, 1931
The Dalles Optimist, April 24, 1931
Wenatchee Daily World, April 22, 1931
Beef Cattle Industry in Oregon: 1890-1938, Dexter K. Strong, 1940
Wind Erosion and Dust Storms in Oregon, Arthur King, 1938

(2) New York Times, March 25, 1935, p. 17; "the Dallas" clearly should be "The Dalles." It may be that someone in New York believed that they were correcting a typographical error.

(3) One of the sources for this is the Herald and News, April 17, 2001, though there are other sources.

(4) The Oregonian (and Associated Press), June 21, 2004

(5) https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5439654

(6) https://en.wikipedia.org/wiki/Goose_Lake_%28Oregon%E2%80%93California%29

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the probability that Region 6 will experience dust storms is depicted **Table 2-389**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-389. Local Probability Assessment of Dust Storms in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Probability	L	—	—	—	—	—

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Five significant storms in 75 years indicates the history and probability of dust storms in Region 6 are both high.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to dust storms is shown in **Table 2-390**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-390. Local Vulnerability Assessment of Dust Storms in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Vulnerability	L	—	—	—	—	—

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

It is difficult to specifically identify the communities most vulnerable to dust storms in Region 6, but Deschutes, Klamath, and Lake Counties are the places with an identified history. Poor visibility leading to motor vehicle crashes is the worst potential impact of these storms; often these crashes result in fatalities and major injuries. Other impacts include poor air quality, including dust infiltration of equipment and engines, loss of productive soil, and an increase in fine sediment loading of creeks and rivers.

Earthquakes

Characteristics

The geographic position of this region makes it susceptible to earthquakes from four sources: (a) the off-shore Cascadia Fault Zone, (b) deep intra-plate events within the subducting Juan de Fuca plate, (c) shallow crustal events within the North America Plate, and (d) earthquakes associated with volcanic activity.

Central Oregon includes portions of five physiographic provinces (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 earthquakes that have been centered in the region, all in Klamath County: 1920 Crater Lake, and the 1993 Klamath County earthquakes (M5.9 and 6). There are also numerous identified faults in the region (mostly Klamath County) that have been active in the last 20,000 years. The region has also been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered outside the area. Earthquakes produced through volcanic activity could possibly reach magnitudes of 5.5. The 1980 Mount St. Helens eruption was preceded by a magnitude 5.1 earthquake. Despite the fact that the Cascade volcanoes are some distance away from the major population centers in Region 6, earthquake shaking and secondary earthquake-related hazards such as lahars could cause major damage to these centers.

Most of the region is within a relative moderate seismicity area, except for portions of Klamath County, which is within a relative high zone as shown in **Figure 2-193**.

There have been several significant earthquakes that have been centered in the region, all in Lake County: 1906 north of Lakeview, 1923 Lakeview area, 1958 Adel (M4.5), and 1968 Adel swarm (M4.7–5.1). There are also numerous identified faults in the region (mostly in Lake County) that have been active in the last 20,000 years. The region has also been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered outside the area. All considered, there is good reason to believe that the most devastating future earthquakes would probably originate along shallow crustal faults in the region.

Historic Earthquake Events

Table 2-391. Significant Earthquakes Affecting Region 6

Date	Location	Magnitude (M)	Remarks
Approximate Years: 1400 BCE*, 1050 BCE, 600 BCE, 400, 750, 900	Offshore, Cascadia Subduction Zone	probably 8-9	these are the mid-points of the age ranges for these six events
Jan. 1700	Offshore, Cascadia Subduction Zone	about 9.0	generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Apr. 1906	North of Lakeview, Oregon	V	three felt aftershocks
Apr. 1920	Crater Lake, Oregon	V	one of three shocks
Jan. 1923	Lakeview, Oregon	VI	
1968	Adel, Oregon	5.1	swarm lasted May through July, decreasing in intensity; increased flow at a hot spring
Sep, 1993	Klamath Falls, Oregon	5.9 and 6.0	series of earthquakes, largest: M6.0; damage: considerable (in and around Klamath Falls); fatalities: two (one rock fall on highway and one heart attack)
Apr. 28, 1999	Christmas Valley, Oregon	3.8	damage: unknown
Apr. 1999	Christmas Valley, Oregon	1.9–3.0	at least six earthquakes occurred in the area
June 30, 2004	SE of Lakeview, Oregon	4.4	damage: unknown
June 2004	SE of Lakeview, Oregon	1.9–3.9	at least 20 earthquakes occurred in the area

*BCE: Before Common Era.

Sources: Wong and Bolt (1995); Pacific Northwest Seismic Network

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 6 will experience earthquakes is shown in **Table 2-392**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-392. Local Probability Assessment of Earthquakes in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Probability	L	M	L	M	M	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

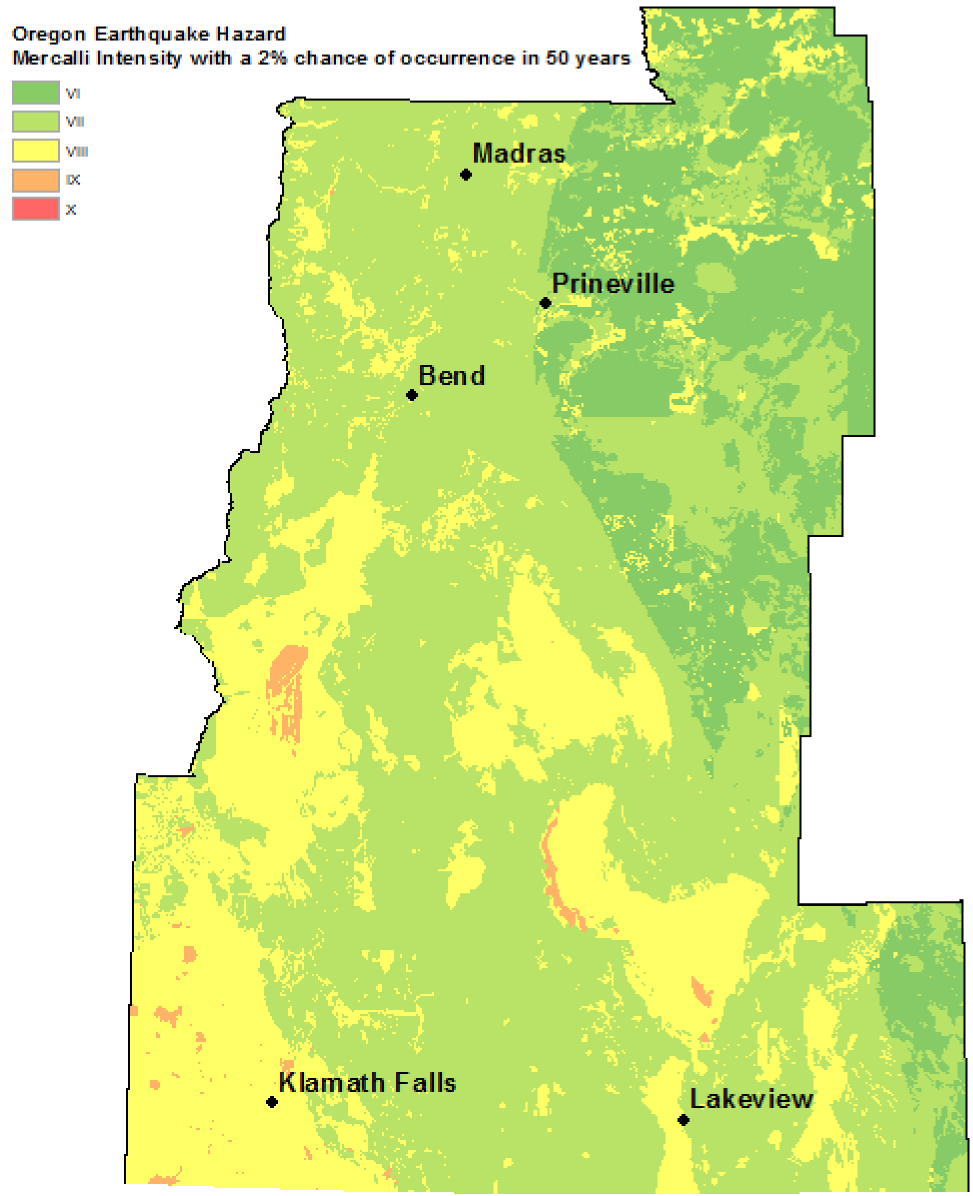
State Assessment

The probability of damaging earthquakes varies widely across the state. In Region 6, the hazard is dominated by local faults and background seismicity.

The probabilistic earthquake hazard for Region 6 is depicted in **Figure 2-193**. This map shows the expected level of earthquake damage that has a 2% chance of occurring in the next 50 years. The map is based on the 2008 USGS National Seismic Hazard Map and has been adjusted to account for the effects of soils following the methods of Madin and Burns (2013). In this case, the strength of shaking calculated as peak ground acceleration and peak ground velocity is expressed as Mercalli intensity, which describes the effects of shaking on people and structures. This map incorporates all that is known about the probabilities of earthquake on all Oregon faults, including the Cascadia Subduction Zone.

The Cascadia subduction zone is responsible for most of the hazard shown in **Figure 2-193**. The paleoseismic record includes 18 magnitude 8.8–9.1 megathrust earthquakes in the last 10,000 years that affected the entire subduction zone. The return period for the largest earthquakes is 530 years, and the probability of the next such event occurring in the next 50 years ranges from 7 to 12%. An additional 10–20 smaller, magnitude 8.3–8.5, earthquakes affected only the southern half of Oregon and northern California. The average return period for these is about 240 years, and the probability of a small or large subduction earthquake occurring in the next 50 years is 37–43%.

Figure 2-193. Probabilistic Earthquake Hazard in Region 6



Color zones show the maximum level of earthquake shaking and damage (Mercalli Intensity Scale) expected with a 2% chance of occurrence in the next 50 years. A simplified explanation of the Mercalli levels is:

VI	Felt by all, weak buildings cracked;
VII	Chimneys break, weak buildings damaged, better buildings cracked;
VIII	Partial collapse of weak buildings, unsecured wood frame houses move;
IX	Collapse and severe damage to weak buildings, damage to wood-frame structures; and
X	Poorly built structures destroyed, heavy damage in well-built structures.

Source: Madin and Burns (2013)

Vulnerability

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to earthquakes is shown in **Table 2-393**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-393. Local Vulnerability Assessment of Earthquakes in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Vulnerability	L	M	L	M	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State 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: (a) the Cascadia Subduction Zone (CSZ), and (b) combined crustal events (500-year model). 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. The 500-year crustal model does not look at a single earthquake (as in the CSZ model). Rather, 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 buildings 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.

Region 6 is vulnerable to earthquake-induced landslides, liquefaction, and strong ground shaking. Based on the 500 year model, Klamath County is one of the top 15 counties expected to have highest loss and most damage statewide. Results are found in **Table 2-394** and **Table 2-395**.

Table 2-394. Building Collapse Potential in Region 6

	Level of Collapse Potential			
County	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Crook	7	7	3	13
Deschutes	55	35	41	9
Jefferson	11	1	12	11
Klamath	15	10	37	18
Lake	13	1	4	10
Wheeler	5	1	6	3

Source: Lewis (2007)

Table 2-395. Projected Dollar Losses in Region 6, Based on an M8.5 Subduction Event and a 500-Year Model

County	Economic Base in Thousands (1999)	Greatest Absolute Loss In Thousands (1999) from a M8.5 CSZ Event	Greatest Absolute Loss In Thousands (1999) from a 500-Year Event
Crook	$733,000	less than $1,000	$6,000
Deschutes	$4,673,000	$5,000	$71,000
Jefferson	$707,000	less than $1,000	$14,000
Klamath	$3,134,000	$41,000	$939,000

Note: New Hazus data were developed for Jefferson County using Hazus-MH. The data are available through W. J. Burns, unpublished report (2007): Geologic Hazards, Earthquake and Landslide Hazard Maps, and Future Earthquake Damage and Loss Estimates for Seven Counties in the Mid-Columbia River Gorge Region Including Hood River, Wasco, Sherman, Gilliam, Morrow, Umatilla, Jefferson, and Wheeler.

Source: Wang and Clark (1999)

Table 2-396. Estimated Losses in Region 6 Associated with an M8.5 Subduction Event

	Crook	Deschutes	Jefferson	Klamath
Injuries	0	1	0	14
Deaths	0	0	0	0
Displaced households	0	0	0	37
Economic losses for buildings	$156,000	$5 mil	$764,000	$41 mil
Operational the day after the event:				
Fire stations	96%	100%	100%	99%
Police stations	96%	99%	100%	99%
Schools	97%	99%	99%	97%
Bridges	100%	100%	100%	98%
Economic losses to infrastructure:				
Highways	$6,000	$17,000	$9,000	$339,000
Airports	0	$40,000	0	$642,000
Communications	$8,000	$2,000	0	$141,000
Debris generated (thousands of tons)	0	3	1	28

Source: Wang and Clark (1999)

Table 2-397. Estimated Losses in Region 6 Associated with a 500-Year Model

	Crook	Deschutes	Jefferson	Klamath
Injuries	1	17	7	630
Deaths	0	0	0	12
Displaced households	0	5	12	1,409
Economic losses for buildings[2]	5.5 mil	$71 mil	$14 mil	$939 mil
Operational the “day after” the event[3]:				
Fire stations	N/A	N/A	N/A	N/A
Police stations	N/A	N/A	N/A	N/A
Schools	N/A	N/A	N/A	N/A
Bridges	N/a	N/A	N/A	N/A
Economic losses to infrastructure:				
Highways	$879,000	$572,000	$698,000	$28 mil
Airports	$316,000	$2 mil	$395,000	$15 mil
Communications	$18 mil	$1 mil	$104,000	$14 mil
Debris generated (thousands of tons)	0	47	10	610

Note: Every part of Oregon is subject to earthquakes. The 500-year model is an attempt to quantify the risk across the state. The estimate does not represent a single earthquake. Instead, the 500-year model includes many faults. More and higher magnitude earthquakes than used in this model may occur (DOGAMI, 1999).

[2]“…there are numerous unreinforced masonry structures (URMs) in Oregon, the currently available default building data does not include any URMs. Thus, the reported damage and loss estimates may seriously under-represent the actual threat” (Wang, 1998, p. 5)

[3]Because the 500-year model includes several earthquakes, the number of facilities operational the “day after” cannot be calculated

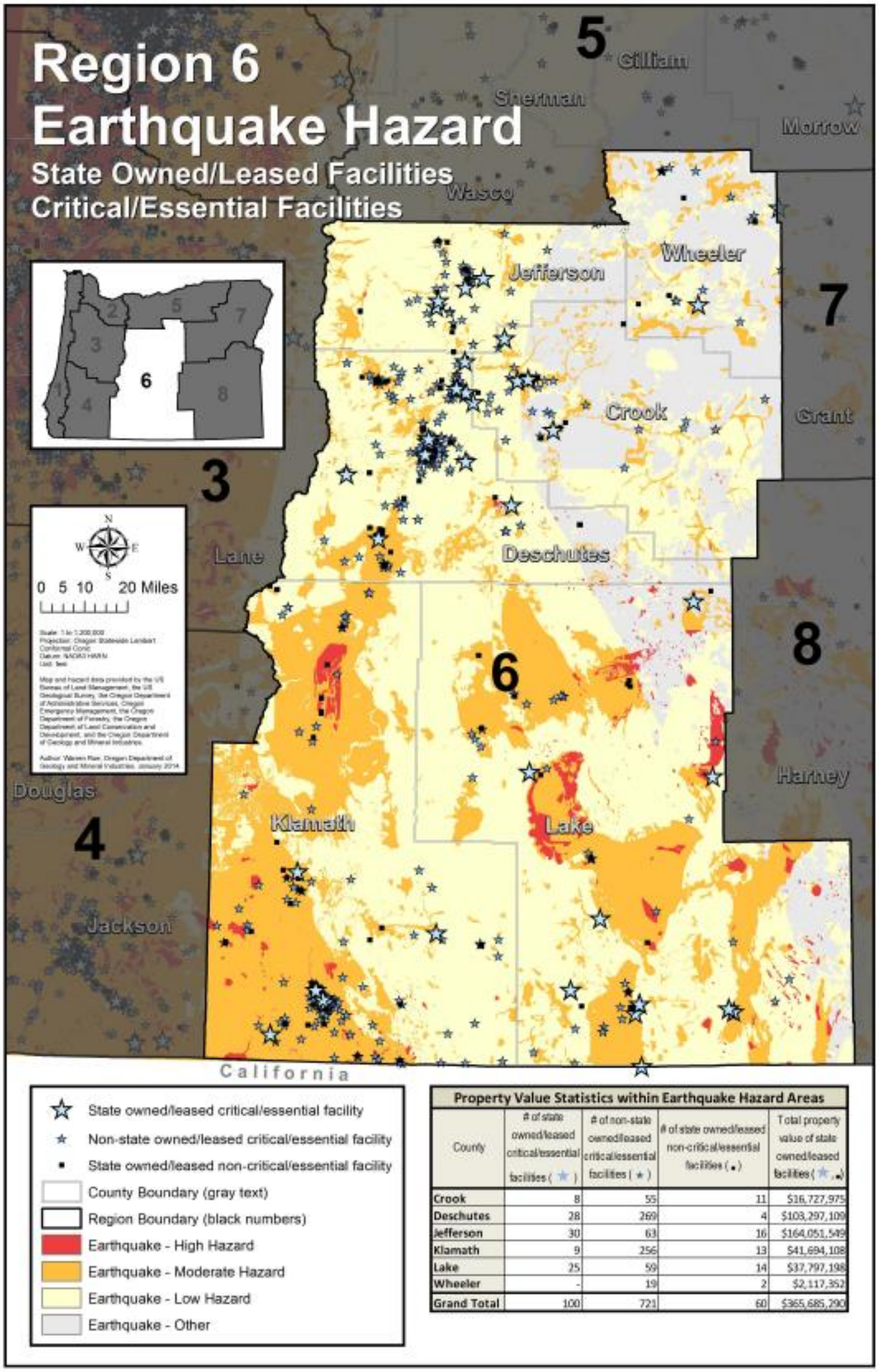
Source: Wang and Clark (1999)

STATE-OWNED/LEASED FACILITIES AND CRITICAL AND ESSENTIAL FACILITIES

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of 5,693 state facilities evaluated, 160 totaling roughly $366 million worth of property are located in an earthquake hazard zone in Region 6 (**Figure 2-194**). Among the 1,141 critical/essential state facilities, 100 are in an earthquake hazard zone in Region 6. Additionally, 721 non-state critical/essential facilities in Region 6 are located in an earthquake hazard zone.

Figure 2-194. State-Owned/Leased Facilities and Critical/Essential Facilities in an Earthquake Zone in Region 6



Property Value Statistics within Earthquake Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Crook	8	55	11	$16,727,975
Deschutes	28	269	4	$103,297,109
Jefferson	30	63	16	$164,051,549
Klamath	9	256	13	$41,694,108
Lake	25	59	14	$37,797,198
Wheeler	-	19	2	$2,117,352
Grand Total	100	721	60	$365,685,290

Source: DOGAMI

SEISMIC LIFELINES

"Seismic lifelines" are the state highways ODOT has identified as most able to serve response and rescue operations, reaching the most people and best supporting economic recovery. The process, methodology, and criteria used to identify them are described in **Section 2.2.2.6, Seismic Transportation Lifeline Vulnerabilities**, and the full report can be accessed at **Appendix 9.1.13**, *Statewide Loss Estimates: Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification* (OSLR). According to that report, seismic lifelines in Region 6 have the following vulnerabilities.

Regional delineations for this Plan and for the OSLR are slightly different. Regions in the OSLR that correspond to Region 6 include sections of the OSLR Cascades and Central Geographic Zones, as follows:

- *Cascades Geographic Zone:* The Cascades Geographic Zone consists of five crossings of the Cascades from western to central Oregon. These routes connect the highly seismically impacted western portion of the state to the less seismically impacted central portion of the state. In addition, the southernmost route can serve as a connection from Medford to the Klamath Falls area should a seismic event occur in the Klamath Falls area.

  OR-58 is the only Tier 1 transportation lifeline in the Cascades Geographic Zone. The Tier 2 system in the Cascades Geographic Zone consists of OR-22 from Salem to Santiam Junction, US-20 from Santiam Junction to Bend, and OR-140 from Medford to Klamath Falls. There are no corridors designated as Tier 3 in this region.

- *Central Geographic Zone:* Region 6 contains only the southerly portion of the Central Geographic zone. The only Tier 1 system in this area is US-97.

REGIONAL IMPACT.

- Ground Shaking: In Region 6, ground shaking from a CSZ event is not expected to cause damage. However, a Klamath Falls event, either a local event or possibly one triggered by a CSZ event, can cause extensive damage. Unreinforced structures, roadbeds and bridges will be damaged to varying extents. Unreinforced bridges on lifeline corridors may be damaged and require clearing or temporary repairs to remain in service.
- Landslides and Rockfall: The east-west routes in this region are cut into or along landslide prone features. A major seismic event may increase landslide and rockfall activities and may reactivate ancient slides.
- Liquefaction: Structures in wetland, alluvial and other saturated areas will be subject to liquefaction damage; the total area of such impacts will vary with the extent of saturated soils at the time of the event. The Klamath Basin is the one area in this region with extensive wetland and otherwise saturated soil areas.

REGIONAL LOSS ESTIMATES. Economic losses caused by a CSZ event were not calculated for the specific zones of study or for specific highway facilities. The economic loss assessment statewide considered only the losses directly due to highway closures, so, for example, it does not include productivity losses due to business site damage. The highway-related losses include disconnection from supplies and replacement inventory, and the loss of tourists and other customers who must travel to do business with affected businesses. Losses in this region are expected to be low locally. Economic disruption from major losses in the larger markets of the state will affect the economy in this region.

Most Vulnerable Jurisdictions. Crook, Deschutes, Jefferson, Wheeler, Lake and Klamath have similar, relatively low vulnerability to ground shaking from a CSZ event and resulting landslides and rockfall. Relative to the western regions of the state, fewer roadways in this region are sited in landslide prone areas, but those that are may be easily damaged.

Klamath County is the Region 6 county most vulnerable to a local surface fault earthquake, with ground shaking for over 50 miles noted for relatively small earthquakes. A Klamath Falls earthquake could cause damage in Lake and Jackson Counties, as well.

Floods

Characteristics

Central Oregon is subject to a variety of flood conditions, including: (a) spring runoff from melting snow, (b) intense warm rain during the winter months, (c) ice-jam flooding, (d) local flash flooding, (e) lake flooding associated with high winds (e.g., Klamath Lake), and (f) flooding associated with the breeching of natural debris dams. Although not as notable as flash floods, the most common flood condition in Central Oregon is associated with warm winter rain on snow.

Rain-on-snow floods, so common in western Oregon, also occur east of the Cascades. The weather pattern that produces these floods occurs during the winter months and has come to be associated with La Niña events, 3- to 7-year cycles 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). Some of Oregon's most devastating floods are associated with these events (Taylor, 1999).

Although flooding occurs throughout central Oregon, local geology and the relatively low population of the six-county area lessen its effects. Volcanic rocks, some of which have a large capacity for water storage, underlie much of the region. Consequently, the discharge rates for some streams (e.g., Deschutes River) are very low considering the size of their basins (June 8, 1998, Deschutes County Flood Insurance Study). In addition, there are some large reservoirs in the upper watersheds that can contain considerable quantities of runoff. Potential flood losses also are mitigated through land use standards; all Region 6 communities participate in the National Flood Insurance Program.

The Flood Insurance Studies (FIS) for each of the Region 6 counties provide some insights associated with ice jam flooding (Deschutes County), lake level differentials produced by local wind conditions (Klamath County), and possible flooding caused by the failure of natural debris dams (Deschutes County). Although these phenomena have not and would not produce devastation like historical flash floods in Jefferson County, they certainly warrant the consideration of local emergency managers.

Historic Flood Events

Table 2-398. Significant Historic Floods Affecting Region 6

Date	Location	Description	Type of Flood
June 1884	Wheeler County (Painted Hills)	mother and three children perished	flash flood
June 1900	Wheeler County (Mitchell)	large area of county devastated	flash flood
Dec, 1964	entire state	severe flooding in central Oregon	rain on snow
Aug. 1976	Jefferson County (Ashwood)	severe flooding; damaged buildings	flash flood
Feb, 1986	entire state	severe flooding	rain on snow
Aug. 1991	Crook County (Aspen Valley)	severe flooding; one fatality	flash flood
Mar. 1993	Wheeler County	severe flooding	rain on snow
May 1998	Crook County (Prineville)	Federal disaster declaration (FEMA-DR-1221-Oregon); Ochoco Dam threatened	rain on snow
Dec. 2005	Crook, Deschutes Counties	$1,000,000 in property damage	
Dec. 2005	Klamath and Lake Counties	$500,000 in property damage	
June 2006	Klamath County	a dike on Upper Klamath Lake failed, inundating agricultural fields, the Running Y Golf Resort, and OR-140	flash flood

Source: Taylor and Hatton (1999)

Source: Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org

Source: U.S. Department of Commerce. National Climatic Data Center. Available from http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms

Table 2-399. Principal Riverine Flood Sources by County Affecting Region 6

Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Crooked River Ochoco River	Deschutes River Little Deschutes River Whychus Creek Paulina Creek Spring River	Willow Creek unnamed stream north of Culver Muddy Creek	Sprague River Williamson River Klamath River Williamson River Link River Four Mile Creek Varney Creek Upper Klamath Lake	Chewaucan River N. Goose Lake Basin	Bridge Creek Keyes Creek

Sources: FEMA, Crook County Flood Insurance Study (FIS) 07/17/89; FEMA, Deschutes County FIS, 06/08/98; FEMA, Jefferson County FIS, 07/17/89; FEMA, Klamath County FIS, 06/18/84; FEMA

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 6 will experience flooding is shown in **Table 2-400**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-400. Local Probability Assessment of Floods in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Probability	H	H	H	M	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The Federal Emergency Management Agency (FEMA) has mapped the 10, 50, 100, and 500-year floodplains corresponding to a 10%, 2%, 1%, and 0.2% chance of a certain magnitude flood in any given year in Region 6 counties. 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.

All of the Region 6 counties have Flood Insurance Rate Maps (FIRM); however, some of the maps are old and could be outdated. The FIRMs were issued at the following times:

- Crook, February 2012;
- Deschutes, September 2007;
- Jefferson, July 17, 1989;
- Klamath, December 18, 1984;
- Lake, December 5, 1989; and
- Wheeler, July 17, 1989.

Significant flooding occurs at least once every 5–7 years.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the region's vulnerability to flooding is shown in **Table 2-401**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-401. Local Vulnerability Assessment of Floods in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Vulnerability	H	L	M	M	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The Oregon Department of Land Conservation and Development (DLCD) created a countywide flood vulnerability index by compiling data from NOAA's Storm Events Database and from FEMA's National Flood Insurance Program. Data were calculated statewide for the period 1978 through 2013 for five input datasets: number of events, structure and crop damage estimates in dollars and NFIP claims number and dollar amounts. The mean and standard deviation were calculated for each input. Then, each county was assigned a score ranging from 0 to 3 for each of these inputs according to **Table 2-402**.

Table 2-402. Scoring for Vulnerability Index

Score	Description
3	county data point is greater than 2.5 times standard deviation for the input data set
2	county data point is greater than 1.5 times standard deviation for the input data set
1	county data point is within standard deviation
0	no data reported

Source: DLCD

DLCD summed the scores for each of the five inputs to create a county-by-county vulnerability index. The maximum possible score is 15. A score over 6 indicates that at least one variable significantly exceeds average values.

Each county in this region received a flood vulnerability score of 5, except for Klamath County which received a score of 6.

FEMA has identified no Repetitive Loss properties in Region 6 (FEMA NFIP BureauNet, http://bsa.nfipstat.fema.gov/, accessed 12/1/2014).

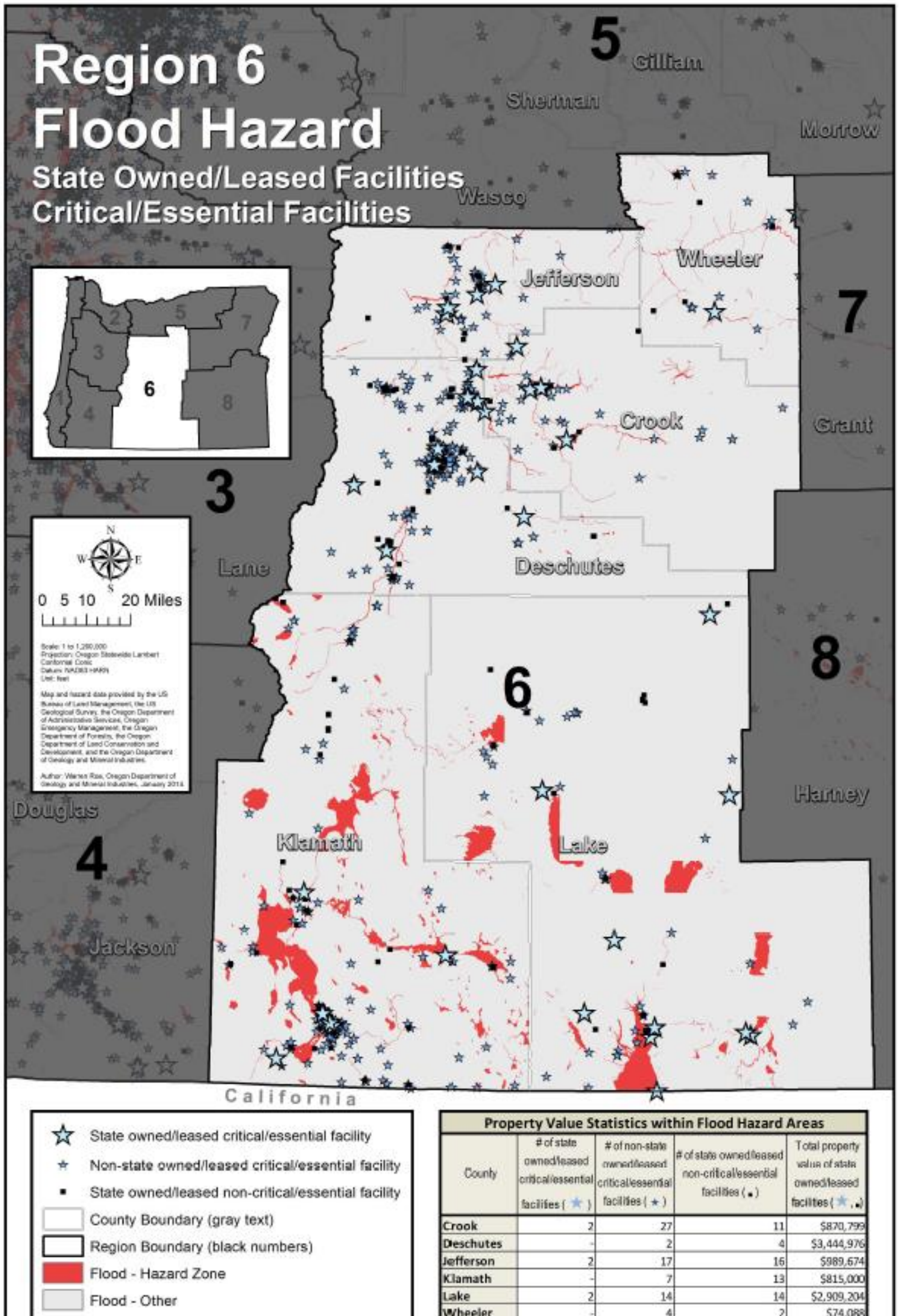
Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS) Program, which results in reduced flood insurance costs. No Region 6 communities participate in the CRS Program.

STATE-OWNED/LEASED FACILITIES AND CRITICAL AND ESSENTIAL FACILITIES

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of the 5,693 state facilities evaluated, 66 are currently located within a flood hazard zone in Region 6 and have an estimated total value over $9 million (**Figure 2-195**). Of these, six are identified as a critical or essential facility. An additional 60 non-state-owned/leased critical/essential facilities are located in a flood hazard zone in Region 6.

Figure 2-195. State-Owned/Leased Facilities and Critical/Essential Facilities in a Flood Hazard Zone in Region 6



Property Value Statistics within Flood Hazard Areas

County	# of state owned/leased critical/essential facilities	# of non-state owned/leased critical/essential facilities	# of state owned/leased non-critical/essential facilities	Total property value of state owned/leased facilites
Crook	2	27	11	$870,799
Deschutes	-	2	4	$3,444,976
Jefferson	2	17	16	$989,674
Klamath	-	7	13	$815,000
Lake	2	14	14	$2,909,204
Wheeler	-	4	2	$74,088
Grand Total	6	71	60	$9,103,740

Source: DOGAMI

Landslides

Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. In general, the Cascade Mountain Range and the Klamath Mountains have a high incidence of landslides. On occasion, major landslides sever major transportation routes such as U.S. or state highways and rail lines, causing temporary but significant economic damage.

Most landslides in Region 6 occur within the US-26 corridor (Prineville-Mitchell). US-97 just north of Klamath Falls has a history of rock falls. One person was killed by a rockslide in this area during the 1993 Klamath Falls earthquake.

Historic Landslide Events

Table 2-403. Significant Landslides in Region 6

Date	Location	Description
Dec. 2005	Jefferson County	damage: $11,666.67 * (includes Sherman and Wasco Counties)

Source: Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 6 will experience landslides is shown in **Table 2-404**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-404. Local Probability Assessment of Landslides in Region 5

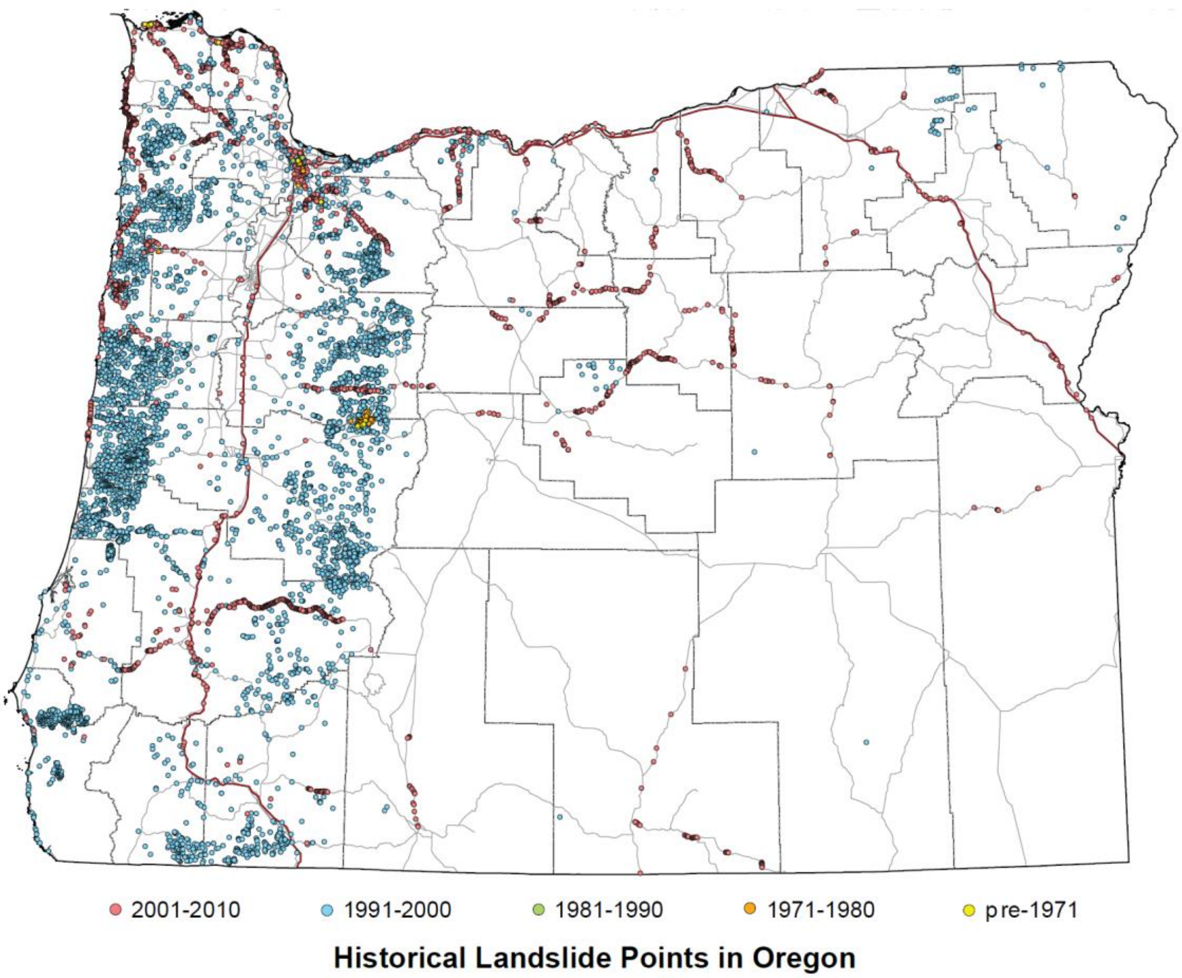
	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Probability	M	—	M	—	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Landslides are found in every county in Oregon. There is a 100% probability of landslides occurring in this region in the future. Although we do not know exactly where and when they will occur, they are more likely to happen in the general areas where landslides have occurred in the past. Also, they will likely occur during heavy rainfall events or during a future earthquake.

Figure 2-196. Historic Landslides in Oregon



Source: Burns et al. (2011a)

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to landslides is depicted **Table 2-405**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-405. Local Vulnerability Assessment of Landslides in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Vulnerability	L	—	L	—	L	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

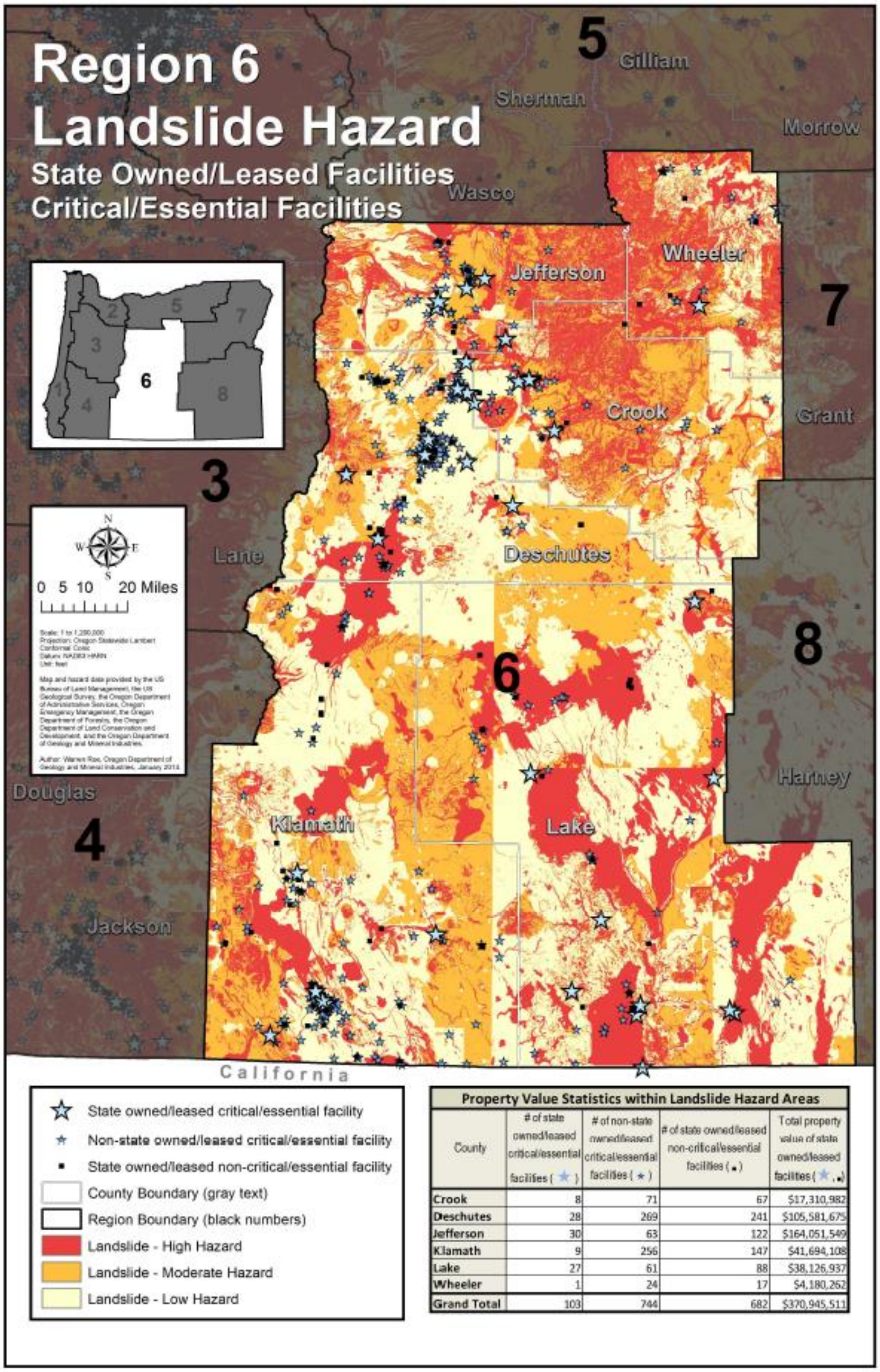
Many of the historic landslides occur along the highways in this region and the areas along the Cascade Mountains (Burns et al., 2012).

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 785 are located within landslide hazard areas in Region 6, totaling roughly $371 million (**Figure 2-197**). This includes 103 critical or essential facilities. An additional 744 critical/essential facilities not owned/leased by the State are located within a landslide hazard zone in Region 6.

Figure 2-197. State-Owned/Leased Facilities and Critical/Essential Facilities in a Landslide Hazard Zone in Region 6



Property Value Statistics within Landslide Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (■)	Total property value of state owned/leased facilities (★, ■)
Crook	8	71	67	$17,310,982
Deschutes	28	269	241	$105,581,675
Jefferson	30	63	122	$164,051,549
Klamath	9	256	147	$41,694,108
Lake	27	61	88	$38,126,937
Wheeler	1	24	17	$4,180,262
Grand Total	103	744	682	$370,945,511

Source: DOGAMI

Volcanoes

Characteristics

The western boundaries of Jefferson, Deschutes, and Klamath Counties coincide with the Cascade Mountains. Volcanic activity in the Cascades will continue, but questions regarding how, to what extent, and when, remain. Most volcano-associated hazards are local (e.g., explosions, debris, lava, and pyroclastic flows). However, lahars can travel considerable distances through stream valleys and wind-borne ash can blanket areas many miles from the source.

There is virtually no risk from lahars, debris, or pyroclastic flows in Wheeler and Crook Counties, although normal prevailing winds could carry ash into those areas. Jefferson, Deschutes, and Klamath Counties are at risk, however, and should consider the impact of volcano-related activity on small mountain communities, natural debris dams (e.g., South Sister, Broken Top), dams creating reservoirs, tourist destinations (e.g., Crater Lake), highways and railroads. These counties also should consider probable impacts on the local economy (e.g., wood products and recreation) should a volcano-related hazard occur.

The history of volcanic activity in the Cascade Range is contained in its geologic record, and the ages of the volcanoes vary considerably. Some lava flows on Washington's Mount Rainier are thought to be older than 840,000 years; Mount St. Helens erupted in May 1980, and continues to be active. In short, all of the Cascade volcanoes are characterized by long periods of quiescence with intermittent activity, making predictions, recurrence intervals, or probability very difficult to attain.

Several Region 6 communities are within a few miles of prominent volcanoes. Mt. Jefferson, the Three Sisters, Broken Top, and Mt. Bachelor dominate the skyline between Redmond and Bend (Deschutes County). A less imposing, but nonetheless important volcano, Newberry Crater, is within 15 miles of La Pine (Deschutes County) and less than 25 miles from the City of Bend. The string of volcanoes continues south with Mount Thielsen, Mount Scott (Crater Lake), and Mount McLaughlin dominating the horizon. The composition, eruptive behavior, and history of these volcanoes are not the same, which probably has a bearing on any future activity.

Historic Volcanic Events

Table 2-406. Historic Volcanic Events in Region 6

Date	Location	Description
about 18,000 to 7,700 YBP	Mount Bachelor, central Cascades	cinder cones, lava flows
about 13,000 YBP	Lava Mountain, south-central Oregon	Lava Mountain field, lava flows
about 13,000 YBP	Devils Garden, south-central Oregon	Devils Garden field, lava flows
about 13,000 YBP	Four Craters, south-central Oregon	Four Craters field, lava flows
about 7,700 YBP	Crater Lake Caldera	formation of Crater Lake caldera, pyroclastic flows, widespread ashfall
< 7,700 YBP; 5,300 to 5,600 YBP	Davis Lake, southern Cascades	lava flows and scoria cones in Davis Lake field
about 10,000 to <7,700 YBP	Cones south of Mount Jefferson; Forked Butte and South Cinder Peak	lava flows
about 2,000 YBP	South Sister Volcano	rhyolite lava flow
about 1,300 YBP	Newberry Volcano, central Oregon	eruption of Big Obsidian flow
about 1,300 YBP	Blue Lake Crater, central Cascades	spatter cones and tephra

Note: YBP is years before present.

Sources: Sherrod et al. (1997); Bacon et al. (1997); Walder et al. (1999); Scott et al. (2001); and U.S. Geological Survey, Cascades Volcano Observatory: http://volcanoes.usgs.gov/observatories/cvo/

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 6 will experience volcanic hazards is shown in **Table 2-407**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-407. Local Probability Assessment of Volcanic Activity in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Probability	L	L	L	L	L	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The probability of volcanic activity can be very difficult to predict, unless there are obvious precursors. The precursors might include increased seismic activity, temperature, and chemical changes in groundwater, etc. Probability is especially difficult when the volcano has been inactive for many thousands of years and lacks a clear geologic record of past events. Also, the knowledge of volcanoes is too limited to know how long a dormant period at any volcano can last (Walder et al., 1999) and this probably is the case for most Cascade volcanoes. Eruption probabilities generated by the U.S. Geological Survey for the Oregon Cascades are largely based on the position of volcanic rocks in the geologic record. There is a considerable opportunity for error. **Table 2-408** describes the probability of volcano-related hazards in Region 6.

Table 2-408. Probability of Volcano-Related Hazards in Region 6

Volcano-Related Hazards	Jefferson	Deschutes	Klamath	Crook	Remarks
Volcanic ash (annual probability of 1 cm or more accumulation from eruptions throughout the Cascade Range)	1 in 5,000	1 in 5,000	1 in 5,000	1 in 5,000	Sherrod et al. (1997)
Lahar	Source: Mt. Jefferson	Source: Newberry Crater and Three Sisters	Source: Crater Lake	no risk	if the Detroit Lake dam is breached, lahars could reach Mill City, Lyons, and Stayton in Marion County Sources: Walder et al. (1999); Lane County: Scott et al. (2001)
Lahar	Source: Mt. Jefferson	Source: Newberry Crater and Three Sisters	Source: Crater Lake	no risk	if the Detroit Lake dam is breached, lahars could reach Mill City, Lyons, and Stayton in Marion County. Walder et al. (1999); Lane County: Scott et al. (2001)
Lava flow	Source: Mt. Jefferson	Source: Newberry Crater and Three Sisters	Source: Crater Lake	no risk	Mount Jefferson: Walder et al. (1999); Three Sisters: Scott et al. (2001)
Debris flow / avalanche	Source: Mt. Jefferson	Source: Three Sisters	Source: Crater Lake	no risk	Mt. Jefferson: Walder et al. (1999); Three Sisters: Scott et al. (2001)
Pyroclastic flow	Source: Mt. Jefferson	Source: Newberry Crater and Three Sisters	Source: Crater Lake and Newberry Crater	no risk	Mt. Jefferson: Walder et al. (1999); Three Sisters: Scott et al. (2001)

Source: Sherrod et al. (1997); Walder et al. (1999); Scott et al. (2001)

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to volcanic hazards is shown in **Table 2-409**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-409. Local Vulnerability Assessment of Volcanic Activity in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Vulnerability	H	H	H	L	H	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

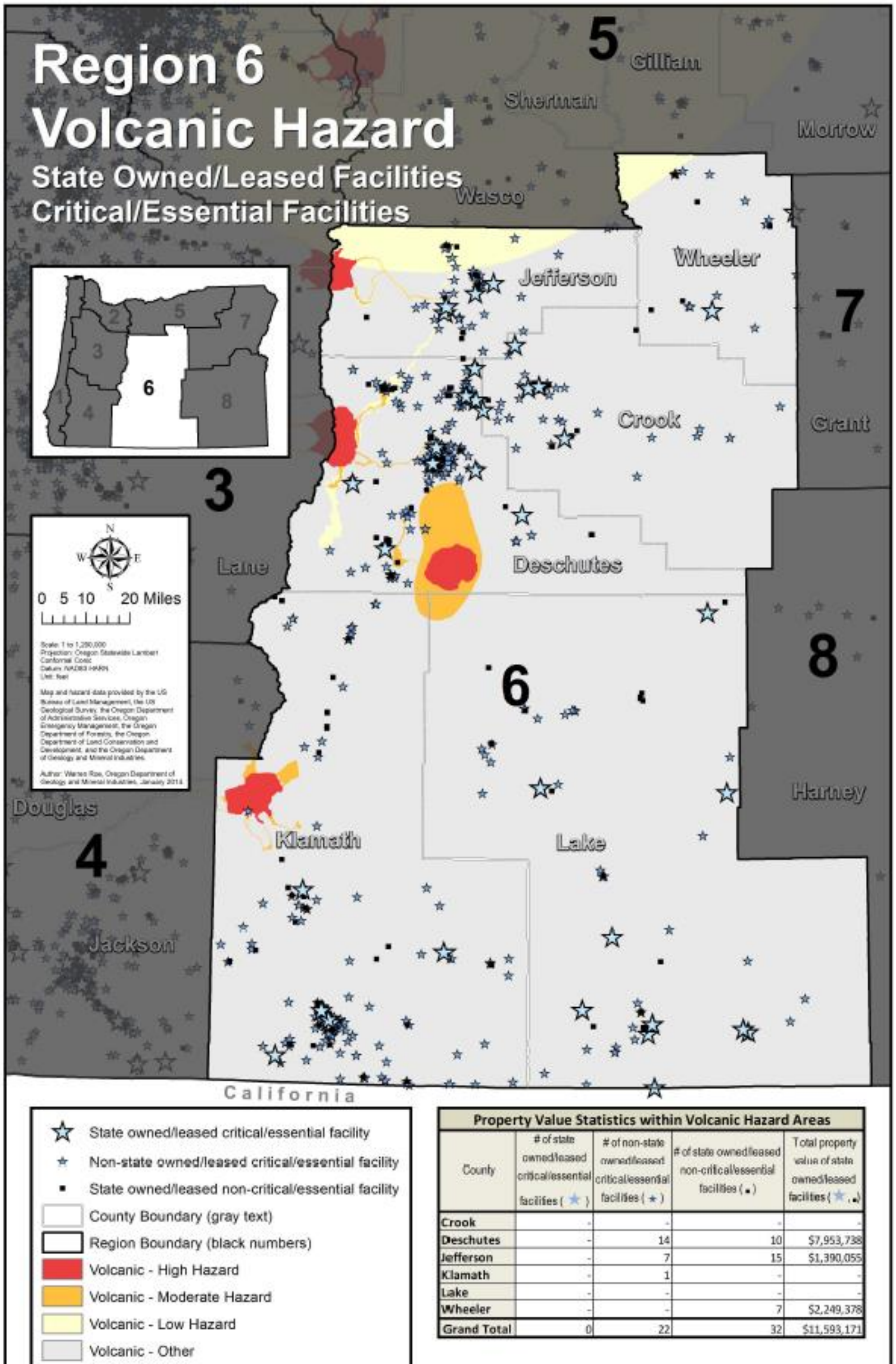
The U.S. Geological Survey has addressed volcanic hazards at Mount Jefferson (Walder et al., 1999), the Three Sisters (Scott et al., 2001), Newberry Volcano (Sherrod et al., 1997), and Crater Lake (Bacon et al., 1997). These reports include maps depicting the areas at greatest risk. Communities which are closer to the main volcanoes such as Bend, Sisters, La Pine, and Klamath Falls are at the greatest risk for inundation by lava flows, pyroclastic flows, lahars, or ashfall. Counties on the eastern side of Region 6 may be subject to ashfall from Cascade volcanoes.

STATE-OWNED/LEASED FACILITIES AND CRITICAL AND ESSENTIAL FACILITIES

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 32 are within a volcanic hazard zone in Region 6 and total about $11.6 million in property value (**Figure 2-198**). None of these state facilities are critical or essential facilities. 22 non-state critical/essential facilities are located in volcanic hazard zones in Region 6.

Figure 2-198. State-Owned/Leased Facilities and Critical/Essential Facilities in a Volcanic Hazard Zone in Region 6



Property Value Statistics within Volcanic Hazard Areas				
County	# of state owned/leased critical/essential facilities	# of non-state owned/leased critical/essential facilities	# of state owned/leased non-critical/essential facilities	Total property value of state owned/leased facilities
Crook	-	-	-	-
Deschutes	-	14	10	$7,953,738
Jefferson	-	7	15	$1,390,055
Klamath	-	1	-	-
Lake	-	-	-	-
Wheeler	-	-	7	$2,249,378
Grand Total	0	22	32	$11,593,171

Source: DOGAMI

Wildfires

Characteristics

Oregon Senate Bill 360 Forestland-Urban Interface Protection Act has been implemented in all counties in Region 6. The growth of the wildland-urban interface occurs in areas dominated by juniper, sage, and grass. As populations increase, so do the number of wildland fires. Homes are widely dispersed in these pine-fringe areas, putting them at a greater risk of a high-intensity wildfire.

The hazard of wildland fire is high in Region 6 due to ladder fuels and overstocked ponderosa pine stands, juniper invasion into sagebrush and grasslands, and the pervasiveness of invasive weeds such as cheat grass and Medusahead grass. Fire risk is extreme during the late summer and fall months when grasses and weeds are dry. These flashy fuels are easily ignited, burn rapidly, and resist suppression. Many structures are at risk because owners do not follow Firewise guidelines for protection.

Historic Wildfire Events

Table 2-410. Significant Wildfires in Region 6

Year	Name of Fire	Location	Acres Burned	Remarks
1981	Redmond			State Conflagration Act Fire
1984	Crooked River Ranch			State Conflagration Act Fire
1985	Crooked River Ranch			State Conflagration Act Fire
1990	Delicious	Deschutes	1704	
1990	Awbrey Hall	Deschutes	3,400	this fire was an act of arson that affected the western fringe of Bend
1992	Hanes Butte	Deschutes	348	
1992	Sage Flat	Deschutes	995	
1992	Round Lake	Klamath	490	
1992	Lone Pine	Klamath	30,320	
1994	LaClair	Jefferson		
1995	Day Road	Deschutes		
1996	Little Cabin	Jefferson	2,438	
1996	Smith Rock	Deschutes	500	one structure destroyed
1996	Simnasho	Jefferson		
1996	Skeleton	Deschutes	17,700	19 structures destroyed, impacting the eastern fringe of Bend
1996	Ashwood/ Donnybrook	Central Oregon	118,000	this fire burned in areas of the state not protected from fire
1996	Wheeler Point	Wheeler	21,980	
1999	McCoin Road	Deschutes	99	Prineville
2002	Eyerly	Jefferson	23,573	37 structures destroyed
2002	Winter	Lake County	35,779	
2002	Cache Mountain	Deschutes	4,200	2 structures destroyed
2003	Booth	Crook	90,800 (acreage also includes BandB fire)	13 structures destroyed
2003	Davis	Deschutes	16,000	
2005		Jefferson		$333.33 in property damage *Damage estimate includes Sherman and Wasco Counties for a total of $1000 in damages
2007		Klamath		$100,000 in property damage
2007	GW	Deschutes	7,357	
2008	Summit Springs Complex	Deschutes	1,973	

Source: Oregon Department of Forestry, 2013

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 6 will experience wildfire is shown in **Table 2-411**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-411. Local Probability Assessment of Wildfire in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Probability	H	H	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The lightning potential in Region 6 is very high. For example, in Lake County only about 5% of the fires were human ignited, while 95% were lightning caused. There is very little that can be done in terms of ignition prevention from lightning.

Due to many years of fire suppression, logging, and other human activities, the forests and rangelands of Region 6 have changed significantly. Areas that historically experienced frequent, low-severity wildfires now burn with much greater intensity due to the build-up of understory brush and trees. This region's fires are larger and more severe, killing the trees and vegetation at all levels. The combination of steep slope, canyons, open rangeland, and fuel type have a history and potential for fast moving and fast spreading wildfires. The area is highly vulnerable to a wind-driven fires, whose embers could ignite grasses and weeds, and cause spot fires in more populated areas. Typical summer conditions could prove to be problematic due to a fire moving uphill from a structure fire on a lower slope, or from a wildland fire pushing upslope through the trees on a windy day, endangering multiple homes simultaneously in a very short period of time. Residents would have very short notice of an approaching fire.

Fire protection districts are created and staffed to deal with the fire emergency needs of the property within the district. Wildland fires that threaten multiple homes simultaneously can quickly overwhelm the available fire-fighting resources. The areas protected by these fire districts are typically large, with few stations, which causes longer response time for additional fire forces. This could prove to be a negative factor for early fire control. When a wildland fire is threatening structures, additional resources are ordered, but may be several hours away. A wildland fire can easily travel into and through a wildland-urban interface (WUI) community before additional responding resources can arrive. There simply are not enough fire engines to protect all threatened homes. Ultimately, the homes that are less vulnerable to ignition are most likely to survive. A home that is extremely vulnerable may not be able to be protected regardless of protection resources on the scene. Under dry, windy conditions, an advanced house fire could extend within the area, or a rapidly approaching wildland fire could have the potential to overwhelm local firefighters before additional outside resources could arrive.

In more populated areas like Klamath County, historic wildfire occurrence shows that most of the large and damaging wildfires that threatened communities or other improvements were caused by humans.

Recreation is a main attraction for people currently living in and moving to Central Oregon. There are popular recreation destinations for hunting, fishing, camping and water sports, such as Lake Billy Chinook, the Middle Deschutes River, Lake of the Woods, Crescent, Odele, Crater Lake, and Haystack Reservoir. This area swells with visitors on any given weekend in the summer during fire season. Most fires are concentrated near recreation areas and reservoirs. Concerns in this region not only include potential evacuation in the event of an emergency, but also the potential for recreationists to inadvertently start wildfires through improper campfire use, smoking, or use of all-terrain vehicles.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to wildfire is shown in **Table 2-412**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-412. Local Vulnerability Assessment of Wildfire in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Vulnerability	M	M	M	L	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Based on data from the 2013 West Wide Wildfire Risk Assessment, in Region 6, Deschutes, Jefferson and Klamath Counties have high percentages of wildland acres subject to Fire Risk, Wildland Development Areas, Fire Effects, or Fire Threat, making them especially vulnerable.

In addition, each year a significant number of people build homes within or on the edge of the forest (urban-wildland interface area), thereby increasing vulnerability. These communities have been designated "Wildland-Urban Interface Communities" and are shown in **Table 2-413**.

The checkerboard pattern of land ownership means that many residences are dispersed on small, scattered private parcels of land. Narrow roads, dead end roads, and long steep driveways are prevalent. Access and egress could be cumbersome with evacuees and fire forces operating in the area at the same time. Evacuation and fire suppression could be problematic due to bottle necking.

Many people choose to live in Central Oregon for its cultural interest and historic values, creating an imperative to protect key homestead, Native American, and other historic sites.

The northwest corner of Region 6 belongs to the Confederated Tribes of the Warm Springs Reservation. The Warm Springs community is an historic community with heavy home densities and infrastructure, and is protected by a structural fire department. Homes are all distributed within Trust and restricted title lands of the Confederated Tribes of Warm Springs.

Economic values at risk include businesses, private forests, farmland, ranchland, grazing land, hunting, and other recreational land. Wildfires have the potential to change the vegetative landscape, which would have a significant effect on the natural resource industries that are the economic staple of this region. Critical infrastructure (communication sites, electrical transmission lines and substations, gas lines, water sources, highways, bridges, and railroad lines) are also vulnerable to wildfires and could be out of service for extended periods of time. . Many of the communities that depend on this infrastructure are very remote and could be very adversely impacted while it is out of service.

There are extensive areas of private land within the county that receive no wildland or structural fire protection. Rural areas have general issues including the absence of formal fire protection and extended response times, dense vegetation capable of causing flame lengths greater than four feet, insufficient water supply, insufficient ingress/egress, and combustible structures.

Table 2-413. Wildland-Urban Interface Communities by County in Region 6

Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Jasper Point Resort	Bend	Ashwood	Beaty	Adel	Fossil
Paulina	Black Butte	Camp Sherman	Beaver Marsh	Christmas Valley	Mitchell
Post	Brothers	Crooked River Ranch	Bly	Drew's Gap	Richmond
Prineville	Elk Lake	Culver	Bly Mountain	Lakeview Basin	Spray
	Hampton	Gateway	Bonanza	New Pine Creek	Twickenham
	La Pine	Madras	Chemult	Paisley	Winlock
	Redmond	Metolius	Chiloquin	Plush	
	Sisters-Cloverdale	Warm Springs	Crater Lake	Silver Lake	
	Sunriver		Crescent	South Drews	
	Terrebonne		Crescent Lake	Summer Lake	
	Tumalo		Dairy	Valley Falls / Chandler	
			Diamond Lake Junction		
			Gilchrist		
			Harriman		
			Keno		
			Klamath Falls		
			Little River		
			Malin		
			Merrill		
			Odell Lake		
			Rocky Point		
			Rosedale		
			Running Y		
			Sand Creek		
			Klamath		
			Sprague River Valley		
			Sycan Estates		

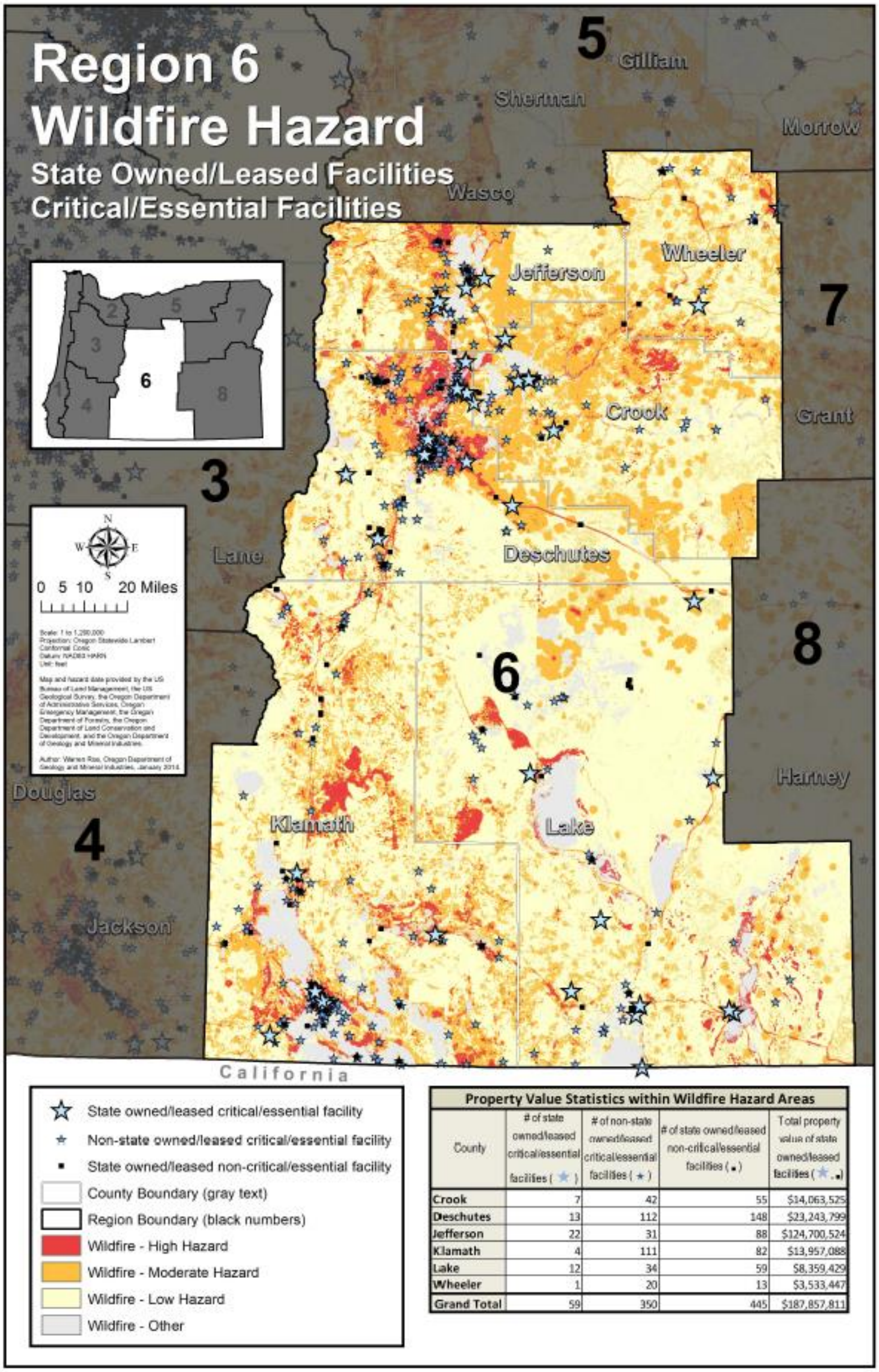
Source: Oregon Dept. of Forestry Statewide Forest Assessment September, 2006

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 504 are within a wildfire hazard zone in Region 6 and total roughly $188 million in value (**Figure 2-199**). Among those, 59 are state critical/essential facilities. An additional 350 non-state critical/essential facilities are also located in Region 6.

Figure 2-199. State-Owned/Leased Facilities and Critical/Essential Facilities in a Wildfire Hazard Zone in Region 6



Property Value Statistics within Wildfire Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★ ▪)
Crook	7	42	55	$14,063,525
Deschutes	13	112	148	$23,243,799
Jefferson	22	31	88	$124,700,524
Klamath	4	111	82	$13,957,088
Lake	12	34	59	$8,359,429
Wheeler	1	20	13	$3,533,447
Grand Total	59	350	445	$187,857,811

Source: DOGAMI

Windstorms

Characteristics

High winds in inter-mountain areas in Central Oregon are not uncommon. For example, stiff winds from the Ochoco Mountains often occur in the City of Prineville (Crook County). These areas experience thunderstorms, which are sometimes accompanied by strong outflow and surface winds. Fallen trees and structural damage from windstorms are not uncommon in these areas. The prominent Cascade Range can act as a buffer to strong storms that mostly affect western Oregon. However, the interior counties in this region may experience strong down sloping winds off the lee side of the mountains.

Historic Windstorm Events

Table 2-414. Historic Windstorms in Region 6

Date	Affected Area	Characteristics
Apr. 1931	N. central Oregon	unofficial wind speeds reported at 78 mph; damage to fruit orchards and timber
Nov. 10-11, 1951	statewide	widespread damage; transmission and utility lines; wind speed 40-60 mph; gusts 75–80 mph
Dec. 1951	statewide	wind speed 60 mph in Willamette Valley; 75-mph gusts; damage to buildings and utility lines
Dec. 1955	statewide	wind speeds 55–65 mph with 69-mph gusts; considerable damage to buildings and utility lines
Nov. 1958	statewide	wind speeds at 51 mph with 71-mph gusts; every major highway blocked by fallen trees
Oct. 1962	statewide	Columbus Day Storm; Oregon's most destructive storm to date; 116 mph winds in Willamette Valley; estimated 84 houses destroyed, with 5,000 severely damaged; total damage estimated at $170 million
Mar. 1971	most of Oregon	greatest damage in Willamette Valley; homes and power lines destroyed by falling trees; destruction to timber in Lane County
Nov. 1981	statewide	severe wind storm
Dec. 1991	N. central Oregon	severe wind storm; blowing dust; damage reported in Bend (Deschutes County)
Dec. 1995	statewide	severe wind storm
Apr. 2003	Deschutes County	$10,000 in property damage
Aug. 2003	Wheeler County	$1,000
Nov. 2003	Deschutes County	$2,000 in property damage
Jan. 2004	Jefferson County	$3,000 in property damage
June 2004	Crook and Jefferson Counties	$1,000 in property damage
Aug. 2004	Crook Count	$100 in property damage
Dec. 2004	Jefferson County	$3,333.33 in property damage *damage estimate includes Sherman and Wasco Counties
Mar. 2005	Jefferson County	$2,000 in property damage *damage estimate includes Sherman and Wasco Counties
Mar. 2005	Crook, Deschutes Counties	$9,000 in property damage
Aug.2005	Klamath County	hail storm caused $1,000 in damage
Oct. 2005	Crook and Deschutes Counties	$50,000 in property damage

Date	Affected Area	Characteristics
Nov. 2005	Crook and Deschutes Counties	$40,000 in property damage
June 2006	Jefferson, Deschutes and Crook Counties	strong winds and hail caused $10,000 in damages to grass and alfalfa crops in Jefferson County, $7 million in insurance claims for damage to automobiles and homes in Deschutes County, $20 million in insurance claims for damage to automobiles and homes in Crook County
July 2006	Deschutes County	lightning from a severe storm hit an electrical transmission line, knocking out power to 31,500 people
Aug. 2006	Klamath County	severe windstorm with winds up to 66 mph downed several trees and power lines between Klamath Falls and Chiloquin
July 2007	Klamath County	extensive wind, rain, and hail damage to Malin and Yonna Valleys, and several power lines downed due to falling trees
Oct. 2007	Crook and Deschutes Counties	$1000 in total damage from high wind storm
Oct. 2007	Crook and Deschutes Counties	$50,000 in total damage from high wind storm
Aug. 2009	Jefferson County	high winds broke boat docks off the shore at Pelton Park Reservoir; $50,000 in total damages

Sources: Taylor and Hatton (1999); FEMA-1405-DR-OR, February 7, 2002, Hazard Mitigation Team Survey Report, Severe Windstorm in Western Oregon; Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org ; U.S. Department of Commerce. National Climatic Data Center. Available from http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms

Table 2-415. Tornadoes Recorded in Region 6

County	Date	Location	Damage
Lake	Dec. 1973	County	no reported damage
Lake	Aug. 2005	Christmas Valley, OR	no reported damage

Source: Taylor and Hatton (1999)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 6 will experience windstorms is shown in **Table 2-416**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-416. Local Probability Assessment of Windstorms in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Probability	H	H	—	—	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

In this region, a 100-year event is considered to have one-minute average winds of 90 mph. A 50-year event has average winds of 80 mph. A 25-year event has average winds 70 mph.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to windstorm is shown in **Table 2-417**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-417. Local Vulnerability Assessment of Windstorms in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Vulnerability	M	L	—	—	M	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Many buildings, utilities, and transportation systems within Region 6 are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It also is 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, uprooted or shattered trees can down power 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. Many roofs have been destroyed by uprooted trees felled by high winds. In some situations, strategic pruning may be the answer. Prudent counties will work with utility companies to identify problem areas and establish a tree maintenance and removal program.

Winter Storms

Characteristics

Severe winter weather in Region 6 can be characterized by extreme cold, snow, ice, and sleet. While there are annual winter storm events in Region 6 with an average of 24 inches of snow annually, most communities are prepared for them. Severe winter storms are considered to be unusual. Light to moderate snowfall is prepared for and expected on an annual basis in this central region. Heavier snowfall is expected and planned for in the areas on the west side of the region into the Cascades as elevation increases.

Historic Winter Storm Events

Table 2-418. Significant Winter Storms in Region 6

Date	Location	Remarks
Dec. 1861	entire state	storm produced 1–3 feet of snow
Dec. 1892	northern counties, Oregon	15–30 inches of snow fell throughout the northern counties
Jan. 1916	entire state	two storms; heavy snowfall, especially in mountain areas
Jan. and Feb. 1937	entire state	deep snow drifts
Jan. 1950	entire state	record snowfalls; property damage throughout state
Mar. 1960	entire state	many automobile accidents; two fatalities
Jan. 1969	entire state	heavy snow throughout state
Jan. 1980	entire state	series of string storms across state; many injuries and power outages
Feb. 1985	entire state	2 feet of snow in northeast mountains; downed power lines; fatalities
Feb. 1986	central/eastern Oregon	heavy snow in Deschutes Basin; traffic accidents; broken power lines
Mar. 1988	entire state	strong winds; heavy snow
Feb. 1990	entire state	heavy snow throughout state
Nov. 1993	Cascade Mountains, Oregon	heavy snow throughout region
Mar. 1994	Cascade Mountains, Oregon	heavy snow throughout region
Winter 1998-99	entire state	one of the snowiest winters in Oregon history (snowfall at Crater Lake: 586 inches)
Dec. 2003–Jan. 2004	entire state	the most significant winter storm in several years brought snowfall to most of Oregon in late December 2003; according to the state climatologist, a combination of cold air near the surface and overrunning moist air from a Pacific weather system was responsible for the storm

Source: Taylor and Hatton (1999); and unknown sources.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section [2.2.2.4, Local and State Vulnerability Assessment Comparison]**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 6 will experience winter storms is shown in **Table 2-419**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-419. Local Probability Assessment of Winter Storms in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Probability	M	H	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Winter storms occur annually in Region 6. On the basis of historical data, severe winter storms could occur about every 4 years in this region. We can expect to have continued annual storm events in this region. However, there are no solid statistical data available upon which to base these judgments. There is no statewide program to study the past, present, and potential impacts of winter storms in the state of Oregon at this time.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to winter storms is shown in **Table 2-420**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-420. Local Vulnerability Assessment of Winter Storms in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Vulnerability	M	H	H	M	H	H

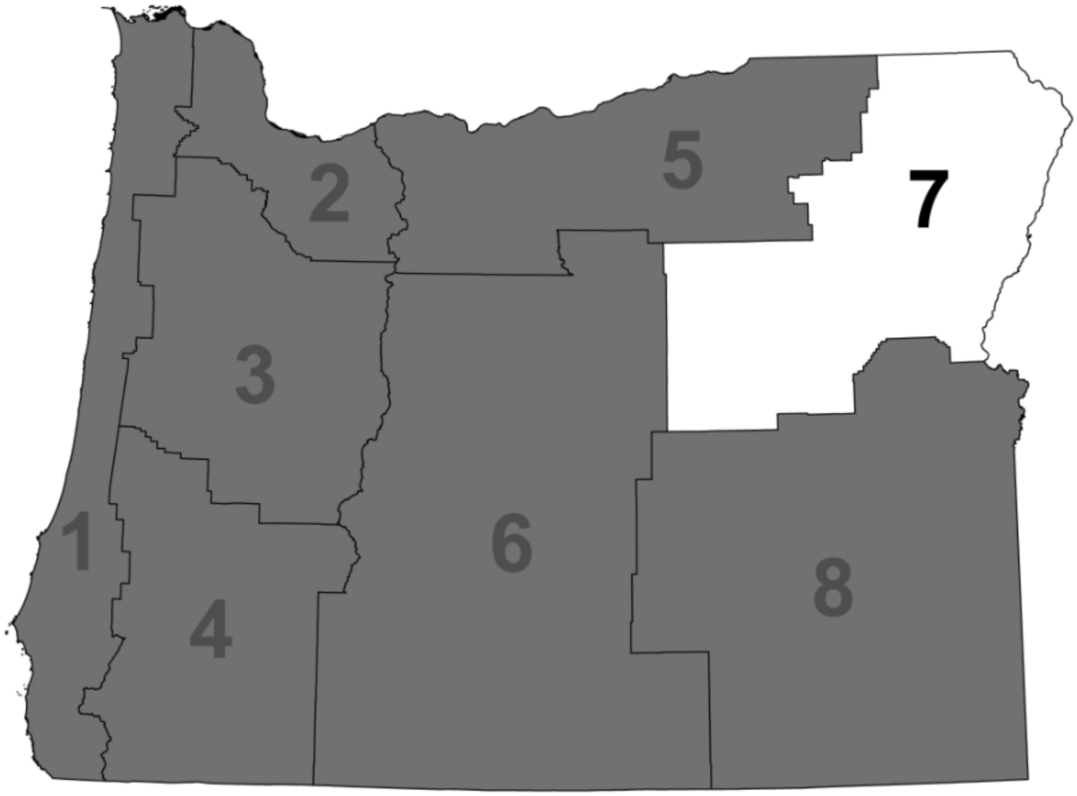
Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Region 6 communities are known for cold, snowy winters. This is advantageous in at least one respect: in general, the region is prepared, and those visiting the region during the winter usually come prepared. However, there are occasions when preparation cannot meet the challenge. Drifting, blowing snow has often brought highway traffic to a standstill. Also, windy, icy conditions have often closed mountain passes and canyons to certain classes of truck traffic. In these situations, travelers must seek accommodations, sometimes in communities where lodging is very limited. For local residents, heating, food, and the care of livestock and other farm animals are everyday concerns. Access to farms and ranches can be extremely difficult and present a serious challenge to local emergency managers.

2.3.7 Region 7: Northeast Oregon

Baker, Grant, Wallowa, and Union Counties



2.3.7.1 Summary

Profile

The region's demographic, economic, infrastructure, and development patterns indicate that some populations, structures and places may be more vulnerable to certain natural hazards than others. Mitigation efforts directed at these vulnerabilities may help boost the area's ability to bounce back after a natural disaster.

Social vulnerability in Region 7 is driven by a declining population; high numbers of senior citizens, many of whom have disabilities; low rates of college degrees; child poverty; and low median household incomes. Additional vulnerabilities at the county level include high numbers of children in Baker and Wallowa Counties and vacant homes in Grant and Wallowa Counties.

Though Region 7 has been recovering jobs lost during the financial crisis that began in 2007, the area lags behind the state overall with fewer jobs and lower wages. Unemployment remains greater than statewide. Regionally, wages remain low, averaging only 75% of the state median wage.

Roads and railways are susceptible to winter storms and flooding. Damage or service interruption to the region's transportation systems can have devastating effects on the region's economy. In addition, many of the bridges in the area are distressed or deficient.

Older centralized water infrastructure is vulnerable to pollution and flooding, which can have implications for human health and water quality. Drinking water is sourced from surface water or wells and is susceptible to pollution from stormwater runoff and combined sewer overflows (CSO) during high-water events. Only Baker City employs low impact development (LID) standards in its building regulations.

Northeast Oregon's energy facilities and conveyance system infrastructure support the regional economy and are susceptible to damage and disruptions due to natural hazards. The region has five power-generating facilities (hydroelectric, wind, and biomass). Liquid natural gas pipelines run through Union and Baker Counties. However, diversity of the region's energy sources boosts its ability to provide power should service be disrupted.

The region's limited growth is occurring within Union County and some other areas along I-84. A high share of mobile homes and homes built before floodplain management and seismic building standards coupled with the lack of modernized Flood Insurance Rate Maps (FIRMs) increase the vulnerability of development in Region 7.

Hazards and Vulnerability

Region 7 is affected by nine of the 11 natural hazards that affect Oregon communities. Coastal hazards and tsunami do not directly impact this region.

Droughts: Droughts are common in all Northeast Oregon counties, particularly within Lake and Klamath Counties. Drought conditions can result in limited water supplies, losses in agriculture, increased fire risk, and adverse impacts to tourism and therefore to the local economy. Baker County has been under an emergency drought declaration eight times and is considered one of the communities most vulnerable to drought conditions.

Dust Storms: Dust storms occur when strong winds carry fine silt, sand, and clay particles into the air. These storms can travel hundreds of miles at speeds of at least 25 miles per hour and can reach heights of over 10,000 feet. Dust storms are most common over areas of the dry land that are prevalent in this region. Dust Storms in Region 7 can lead to poor air quality and poor visibility which can lead to traffic accidents. Baker and Union Counties are the counties most vulnerable to dust storms in this region.

Earthquakes: Two types of earthquakes affect Region 7: (a) shallow crustal events and (b) earthquakes associated with volcanic activity. Northeast Oregon is considered moderately vulnerable to earthquake hazards due to earthquake-induced landslides, liquefaction, and ground shaking. The region's seismic lifelines have low vulnerability to a Cascadia Subduction Zone (CSZ) event as most of the region's impact will be secondary, due to disruptions to markets to the west. This region has 344 state-owned/leased facilities, valued at over $130 million, within an earthquake hazard zone. Of these, 47 are critical/essential facilities. An additional 168 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Floods: In this region, the most damaging floods have been rain-on-snow events in the mountains during the winter. Other forms of flooding here have been associated with ice jams, normal spring runoff, and summer thunderstorms. Flooding has also been associated with heavily vegetated stream banks, low stream gradients, breeched dikes, low bridge clearances, over-topped irrigation ditches, and natural stream constrictions. All of the region's counties are considered moderately vulnerable to the flood hazard. There are 89 state-owned/leased facilities, valued at approximately $41 million, located in this region's flood hazard zone. Of these, 14 are considered critical/essential facilities. An additional 28 non-state-owned/leased critical/essential facilities are located in this hazard zone.

Landslides: Landslides can occur throughout the region, though to a lesser extent than in parts of western Oregon. In general, areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. Rain-induced landslides can occur during winter months. Earthquakes can also trigger landslides. The Blue and Wallowa Mountains have a moderate to high incidence of landslides. Landslides can also sever transportation routes along highways and rail lines, which can impact the region's economy. There are 419 state-owned/leased facilities, valued at over $139.5 million, in this region's landslide hazard zone. Of these, 58 are critical/essential facilities. An additional 237 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Volcanoes: Though volcanic activity does not occur within this region, ashfall can travel many miles and may affect the region. Communities potentially vulnerable to ashfall are Baker City, La Grande, and John Day. There are no state-owned/leased facilities located in a volcanic hazard zone. Similarly, there are no non-state-owned/leased critical/essential facilities located in this hazard zone.

Wildfires: Though population and development has declined in this region overall, development has increased in this region's non-federal forests and may impact fire protection capability. Summertime lightning-caused fires are prevalent in the mountainous and timbered regions of eastern Oregon. Wildfire in this region can adversely impact timber and rangeland, recreation and tourism, wildlife habitat and diversity including endangered species, and water quality and supply. Vulnerability is further heightened where fire stations are located far distances from many communities, resulting in longer response times. Based on data from the 2013 West Wide Wildfire Risk Assessment, in Region 7, Grant and Union Counties have high percentages of wildland acres subject to Fire Risk, Fire Effects, and Fire Threat, making them especially vulnerable. Other areas of vulnerability are within wildland-urban interface communities. There are 229 state-owned/leased facilities located in a wildfire hazard zone in Region 7, with a value of approximately $84 million. Of these, 32 are identified as critical/essential facilities. An additional 141 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Windstorms: Inter-mountain valley regions of Northeast Oregon are known for high winds. Windstorms generally affect the region's buildings, utilities, tree-lined roads, transmission lines, residential parcels, and transportation systems along open areas such as grasslands and farmland.

Winter Storms: Winter storms bring colder weather and higher precipitation to this region annually. These storms average 24 inches of snow per year. Moderate to heavy snowfall is prepared for and expected. Heavier snowfall is expected and planned for in higher elevation of the Wallowa Mountains.

Climate Change

The most reliable information on climate change to date is at the state level. The state information indicates that hazards projected to be impacted by climate change in Region 7 include drought and wildfire-climate models project warmer drier summers and a decline in mean summer precipitation for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, all eight regions are expected to be affected by an increased incidence of drought and wildfire. An increase in drought could result in the increase incidence of dust storms, though no current research is available on the direct effects of future climate conditions on the incidence of dust storms. Areas that have historically been both hotter and drier than the statewide average — such as Eastern Oregon counties — are at somewhat higher risk of increased drought and wildfire than the state overall. While winter storms and windstorms affect Region 7, there is little research on how climate change influences these hazards in the Pacific Northwest. For more information on climate drivers and the projected impacts of climate change in Oregon, see the section **Introduction to Climate Change**.

2.3.7.2 Profile

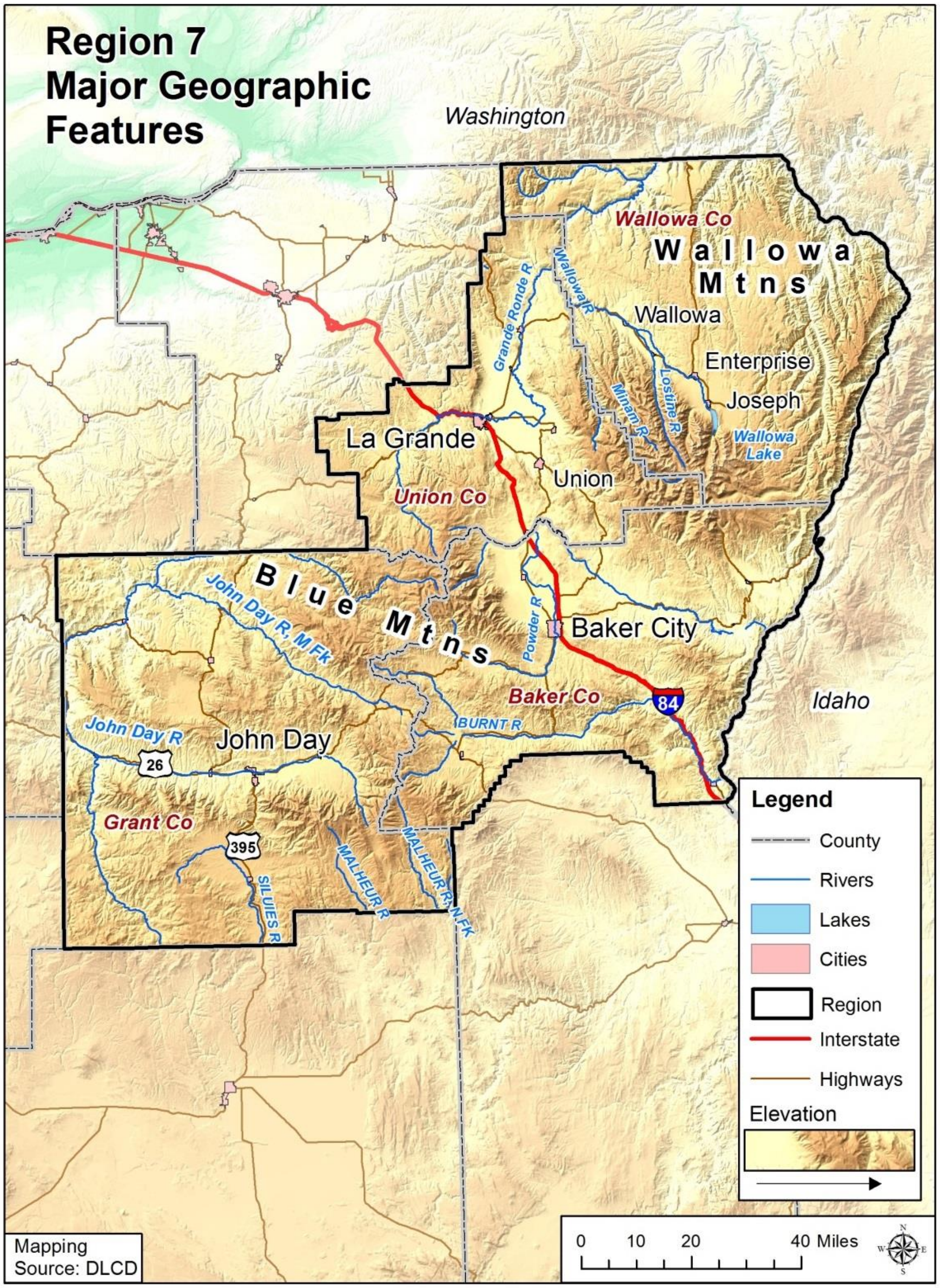
Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

Natural Environment

Geography

Northeastern Oregon is approximately 12,765 square miles in size, and includes Baker, Grant, Union, and Wallowa Counties. The region is bordered by the Snake River to the east and the Columbia River to the north. Columbia River Basalt lava flows formed the high plateaus of the region, and the Blue and Wallowa Mountains are included in the region. Major rivers in the region include the John Day, Grande Ronde, and the Snake.

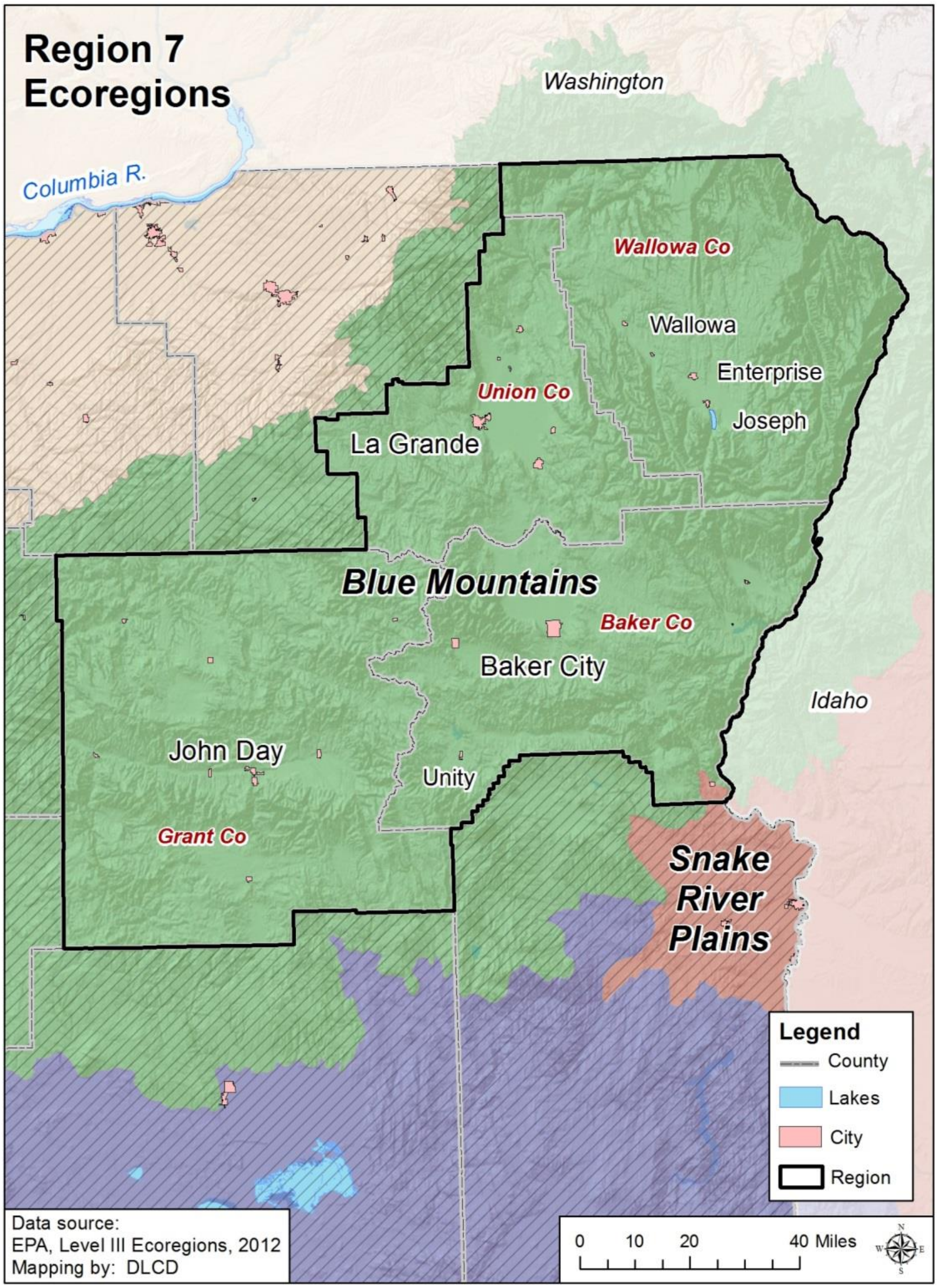
Figure 2-200. Region 7 Major Geographic Features



Source: Department of Land Conservation and Development, 2014

The U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Region 7 is composed of two ecoregions: the Blue Mountains and very small area of the Snake River Plain ecoregion (Figure 2-201).

Figure 2-201. Region 7 Ecoregions



Blue Mountains: This ecoregion is complex and diverse, with many sub-ecoregions having unique conditions. In general, the Blue Mountains areas of Region 7 have dry continental climate with marine intrusions because of proximity to the Columbia Gorge. While much of the Blue Mountains are flat with arid climates, the highly dissected John Day / Clarno Highlands contain the John Day and Crooked Rivers that provide more abundant water than other parts of the Blue Mountains ecoregion, which leads to higher levels of human settlement in proximity to the rivers. Much of the Blue Mountains are underlain with volcanic rock although land in the Wallowa and Elkhorn Mountain ranges is composed of granitic intrusives, deep sea sediments, and metamorphic rocks. Grazing, logging, and fire suppression regimes have altered land cover throughout the region where juniper woodlands have given way to sagebrush grasslands and grand fir forests have given way to spruce fir forests. Other forests in the region predominantly have either a Douglas fir or ponderosa pine canopy. Ponderosa forests tend toward sparsely vegetated understories the ecoregion’s Douglas fir forests tend toward dense shrub understories, making them more difficult to log. Some wet, high meadows also exist within Cold Basins of the Blue Mountains in Region 7 and unchannelized streams tend toward a meandering nature within wide floodplains, moving dynamically through the landscape. Riparian areas of the region have a diverse palette of understory shrubs with black cottonwoods, grand firs, and alders in the canopy layer.

Snake River Plain: The Region 7 portion of the Snake River Plain ecoregion is classified as the “Unwooded Alkaline Foothills,” which is underlain by alkaline lacustrine deposits. The landscape includes rolling foothills, hills, benches, alluvial fans, and badlands. Wyoming sagebrush and associated grasses are the dominant vegetation with salt-tolerant shrubs found on alkaline outcrops. The land is high value rangeland and wildlife habitat.

Climate

Climate refers to the temperatures, weather patterns, and precipitation in the region. This section covers historic climate information. For estimated future climate conditions and possible impacts refer to the **State Risk Assessment** for statewide.

Region 7’s predominantly arid climate supports limited agricultural activities, primarily livestock grazing. The region is subject drought, floods, landslides, and wildfires. When considering the climate, snowfall should also be taken into account. Flooding can be a direct result of rain-on-snow events. Likewise, the amount of snowpack in a region can also impact the ability of communities to cope with drought. **Table 2-421** shows mean annual precipitation and temperatures for the two ecoregions in Region 7. Temperature and precipitation vary widely by sub-ecoregion and microclimates. For more detailed and locally relevant climate data refer to the Oregon Climate Service.

Table 2-421. Average Precipitation and Temperature Ranges in Region 7 Ecoregions

Ecoregion	Mean Annual Precipitation Range (inches)	Mean Temperature Range (°F) January min/max	Mean Temperature Range (°F) July min/max
Blue Mountains*	9–80	15/39	40/85
Snake River Plain	9–12	19/35	57/96

*Data have been generalized from all the sub-ecoregions of the ecoregion in Region 7.

Source: Thorson et al. (2003)

Demography

Population

Population forecasts are an indicator of future development needs and trends. Community demographics may indicate where specific vulnerabilities may be present in the aftermath of a natural hazard (Cutter et al., 2003). If a population is forecast to increase substantially, a community's capacity to provide adequate housing stock, services, or resources for all populations after a disaster may be stressed or compromised (Cutter et al., 2003).

Overall, for 2000-2013, Region 7 lost population. Union is the only county that grew in population during this 13-year period, offsetting the other counties' losses, and is the only county projected to grow by 2020. Growth in Baker and Wallowa Counties is expected to be relatively flat, while Grant County is expected to continue to decline in population.

Table 2-422. Population Estimate and Forecast for Region 7

	2000	2013	Percent Change (2000 to 2013)	2020 Projected	Percent Change (2013 to 2020)
Oregon	3,421,399	3,919,020	14.5%	4,252,100	8.5%
Region 7	56,432	57,085	1.2%	58,910	3.2%
Baker	16,741	16,280	-2.8%	16,315	0.2%
Grant	7,935	7,435	-6.3%	7,321	-1.5%
Union	24,530	26,325	7.3%	28,216	7.2%
Wallowa	7,226	7,045	-2.5%	7,058	0.2%

Source: Population Research Center, Portland State University, 2013; U.S. Census Bureau, 2000 Decennial Census. Table DP-1; Office of Economic Analysis, Long-Term Oregon State's County Population Forecast, 2010-2050, 2013

Tourists

Tourists are not counted in population statistics and are therefore considered separately in this analysis. Tourism activities in Region 7 (Longwoods Travel USA, 2011d) are largely centered on outdoor activities (hiking/backpacking, visiting national/state parks etc.), touring (traveling to experience scenic beauty, history, and culture), and special events (such as fairs, festivals, or sporting events) (Longwoods Travel USA, 2011d). Approximately 8% (2.2 million) of all overnight visitor trips to Oregon included time within Region 7. Three fourths of all trips to the region occur between April and September and the average travel party contains 3.8 persons. The average trip length is 4.3 nights (Longwoods Travel USA, 2011d). Visitors to the region are just as likely to be lodged in hotels/motels, private homes or other accommodations. The Longwoods Travel Report includes all of the Region 7 counties, Harney and Malheur Counties (Region 8), and Morrow, Umatilla, and parts of Gilliam Counties within the Eastern Region.

Difficulty locating or accounting for travelers increases their vulnerability in the event of a natural disaster. Furthermore, tourists are often unfamiliar with evacuation routes, communication outlets, or even the type of hazard that may occur (MDC Consultants, n.d.). Targeting natural hazard mitigation outreach efforts to places where tourists lodge can help increase awareness and minimize the vulnerability of this population.

Table 2-423. Annual Visitor Estimates in Person Nights in Region 7

	2011		2012		2013	
	Number	Percent	Number	Percent	Number	Percent
Region 7	6,153	—	6,104	—	6,095	—
Baker	4,797	100%	4,736	100%	4,756	100%
Hotel/Motel	1,571	32.7%	1,509	31.9%	1,493	31.4%
Private Home	1,914	39.9%	1,893	40.0%	1,914	40.2%
Other	1,312	27.4%	1,334	28.2%	1,349	28.4%
Grant	208	100%	206	100%	212	100%
Hotel/Motel	31	14.9%	30	14.6%	33	15.6%
Private Home	72	34.6%	72	35.0%	74	34.9%
Other	105	50.5%	104	50.5%	105	49.5%
Union	526	100%	538	100%	526	100%
Hotel/Motel	127	24.1%	130	24.2%	123	23.4%
Private Home	254	48.3%	259	48.1%	252	47.9%
Other	145	27.6%	149	27.7%	151	28.7%
Wallowa	622	100%	624	100%	601	100%
Hotel/Motel	136	21.9%	136	21.8%	124	20.6%
Private Home	69	11.1%	68	10.9%	67	11.1%
Other	417	67.0%	420	67.3%	410	68.2%

Source: Oregon Travel Impacts: 1991–2013, April 2014. Dean Runyan Associates, http://www.deanrunyan.com/doc_library/ORImp.pdf

Persons with Disabilities

Disabilities appear in many forms. While some disabilities may be easily identified, others may be less perceptible. Disabled populations, while difficult to identify and measure, are disproportionately affected during disasters (Cutter et al., 2003). About 5% more people in Region 7 identify as having a disability than do people throughout the state. Over 40% of seniors (65 or older) report having a disability. Local natural hazard mitigation plans should specifically target outreach programs toward helping disabled residents better prepare for and recover from hazard events.

Table 2-424. People with a Disability by Age Groups in Region 7, 2012

	Total Population*	With a Disability		Under 18 Years with a Disability		65 Years and Over with a Disability	
	Estimate	Estimate	Percent	Estimate	Percent**	Estimate	Percent**
Oregon	3,796,881	511,297	13.5%	39,439	4.6%	200,374	37.8%
Region 7	55,230	10,124	18.3%	512	4.4%	4,764	43.3%
Baker	15,702	3,000	19.1%	179	5.5%	1,477	41.7%
Grant	7,285	1,538	21.1%	32	2.3%	833	48.8%
Union	25,363	4,211	16.6%	219	3.8%	1,851	44.4%
Wallowa	6,880	1,375	20.0%	82	6.3%	603	38.1%

*Total population does not include institutionalized population

**Percent of age group

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Homeless Population

Population estimates of the homeless in Oregon are performed each January. These are rough estimates and can fluctuate with many factors, including the economy or season. The overwhelming majority of homeless are either single adult males or families with children. Communities located along major transportation corridors, such as I-84, tend to have higher concentrations of homeless populations (Thomas et al., 2008). Between 2009 and 2011 this population has held steady in Region 7.

Extra attention is needed to care for and serve homeless communities. Some homeless people choose to remain hidden or anonymous, making it especially difficult to mitigate harm to them from natural hazard events. Accessible shelter and social services are key emergency considerations for the homeless community.

Table 2-425. Homeless Population Estimate for Region 7

	2009	2010	2011	3-Year Average
Oregon	17,122	19,208	22,116	19,482
Region 7	45	43	27	38
Baker	22	4	6	11
Grant	0	0	N/A	0
Union	23	37	21	27
Wallowa	0	2	0	1

Source: Oregon Point in Time Homeless Count, Oregon Housing and Community Services. http://www.oregon.gov/ohcs/pages/ra_point_in_time_homeless_count.aspx

Gender

The gender ratio in Region 7 is similar to that of the state, roughly 50:50 (U.S. Census Bureau; n.d.). 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 (Cutter et al., 2003).

Age

All counties in Region 7 have a higher percentage of seniors than does the state overall. Senior citizens may require special consideration due to sensitivity to heat and cold, reliance upon transportation to obtain medication, and comparative difficulty in making home modifications that reduce risk to hazards. In addition, the elderly may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to the elderly (Morrow, 1999).

The percentage of children is slightly lower than the statewide percentage in all counties except Union. Special considerations should be given to young children, schools, and parents during the natural hazard mitigation process. Young children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities. Parents may lose time from work and money when their children's childcare facilities and schools are impacted by disasters (Cutter et al., 2003).

Table 2-426. Population by Vulnerable Age Groups, in Region 7, 2012

	Total Population	Under 18 Years Old		65 Years and Older	
	Estimate	Estimate	Percent	Estimate	Percent
Oregon	3,836,628	864,243	22.5%	540,527	14.1%
Region 7	56,066	11,721	20.9%	11,273	20.1%
Baker	16,092	3,242	20.1%	3,590	22.3%
Grant	7,366	1,419	19.3%	1,746	23.7%
Union	25,670	5,755	22.4%	4,319	16.8%
Wallowa	6,938	1,305	18.8%	1,618	23.3%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP05

Language

A very small share of the population does not speak English “very well.” Outreach materials used to communicate with and plan for this community should take into consideration their language needs.

Table 2-427. English Usage in Region 7, 2012

	Speak English "Very Well"		Speak English Less Than "Very Well"	
	Estimate	Percent	Estimate	Percent
Oregon	3,376,744	93.8%	224,905	6.2%
Region 7	52,233	98.5%	778	1.5%
Baker	15,142	99.0%	150	1.0%
Grant	6,988	99.4%	42	0.6%
Union	23,529	97.7%	552	2.3%
Wallowa	6,574	99.5%	34	0.5%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Education Level

Studies (Cutter et al., 2003) show that education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings. Compared to statewide numbers, 8% less of Region 7’s population has a bachelor’s degree or higher.

Education can influence the ability to access resources, while lack of resources may constrain the ability to understand warning information (Cutter et al., 2003). Therefore, levels of education within the region should be considered when designing hazard outreach materials to local communities.

Figure 2-202. Educational Attainment in Region 7, 2012

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Income

The impact of a disaster in terms of loss and the ability to recover varies among population groups. "The causes of social vulnerability are explained by the underlying social conditions that are often quite remote from the initiating hazard or disaster event" (Cutter, 2006, p. 76). Historically, 80% of the disaster burden falls on the public. Of this number, a disproportionate burden is placed upon those living in poverty. People living in poverty are more likely to become isolated, are less likely to have the savings to rebuild after a disaster, and are less likely to have access to transportation and medical care.

All counties in the region have lower median household incomes than the state average, ranging from $8,200–$15,700 below state numbers. Decreases in median household incomes were especially notable in Grant and Wallowa Counties between 2009 and 2012.

Table 2-428. Median Household Income in Region 7

	2009	2012	Percent Change
Oregon	$52,474	50,036	-4.6%
Region 7	N/A	N/A	N/A
Baker	$41,096	40,348	-1.8%
Grant	$37,759	34,337	-9.1%
Union	$43,387	41,784	-3.7%
Wallowa	$44,286	40,204	-9.2%

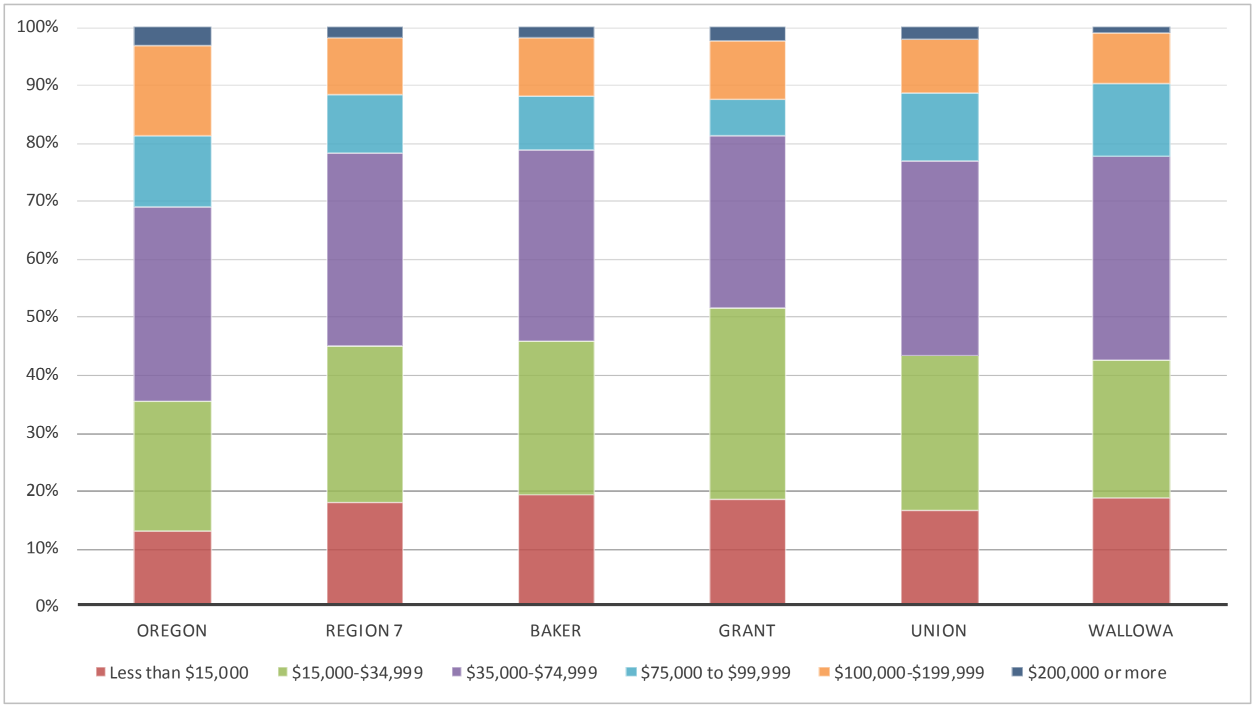
Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates. Table DP03.

Note: 2009 dollars are adjusted for 2012 using Bureau of Labor Statistics' Consumer Price Index Inflation Calculator.

N/A = data not aggregated at the regional level.

Compared to statewide numbers, the region has a greater share (10% more) of its households earning less than $35,000 per year. More than half of all households in Grant County earn less than $35,000 per year. In addition, roughly 9% fewer households earn more than $75,000.

Figure 2-203. Median Household Income Distribution in Region 7, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP03

The region has about the same percentage of individuals living in poverty as the state overall, but child poverty is 9% higher. Notably, poverty overall grew by almost 40% in Wallowa County. All counties except Union have experienced a growth in child poverty. Though Baker is the only county with a declining poverty rate, one third of all children in the county live in poverty.

Table 2-429. Poverty Rates in Region 7, 2012

	Total Population in Poverty			Children Under 18 in Poverty		
	Number	Percent	Percent Change*	Number	Percent	Percent Change*
Oregon	584,059	15.5%	17.7%	175,303	20.6%	17.6%
Region 7	9,517	17.3%	11.6%	2,785	29.3%	22.9%
Baker	3,059	19.6%	-0.7%	1,048	33.3%	45.6%
Grant	1,144	15.7%	15.0%	277	19.6%	27.6%
Union	4,318	17.2%	15.5%	1,238	21.6%	6.9%
Wallowa	996	14.5%	39.5%	222	17.1%	29.8%

*Percent change since 2009

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates, Table S1701

Low-income populations require special consideration when mitigating loss to a natural hazard. Often, those who earn less have little to no savings and other assets to withstand economic setbacks. When a natural disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the natural disaster. To reduce the compounded loss incurred by low-income populations post-disaster, mitigation actions need to be specially tailored to ensure safety nets are in place to provide further support to those with fewer personal resources (Cutter et al., 2003).

Housing Tenure

Wealth can increase the ability to recover following a natural disaster (Cutter et al., 2003), and homeownership, versus renting, is often linked to having more wealth. Renters often do not have personal financial resources or insurance to help recover post-disaster. On the other hand, renters tend to be more mobile and have fewer assets at risk. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable due to natural disaster events.

Slightly lower than statewide numbers, roughly 33% of housing units in this region are rentals. Union County has the highest share of rental units. The region has about a 3% higher vacancy rate than the state. Grant and Wallowa Counties have the highest vacancy rates, and Baker and Union Counties have the highest number of vacant units. In addition, the region has about 5% more seasonal or recreational homes than the state average (U.S. Census Bureau, 2008–2012 American Community Survey, Table DP04 and Table B25004).

Table 2-430. Housing Tenure in Region 7, 2012

	Total Occupied Units	Owner-Occupied		Renter-Occupied		Vacant*	
		Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	945,824	62.5%	566,894	37.5%	105,417	6.3%
Region 7	23,729	16,001	67.4%	7,728	32.6%	2,629	9.2%
Baker	7,074	4,827	68.2%	2,247	31.8%	854	9.7%
Grant	3,376	2,368	70.1%	1,008	29.9%	485	11.2%
Union	10,299	6,666	64.7%	3,633	35.3%	858	7.5%
Wallowa	2,980	2,140	71.8%	840	28.2%	432	10.5%

*Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04 and Table B25004.

Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households. Region 7 is predominantly composed of family households. Just under one quarter of all households have families with children. About 3 times as many single-parent households are headed by females than by males. These numbers are similar to statewide averages.

Table 2-431. Family vs. Non-family Households in Region 7, 2012

	Total Households	Family Households		Nonfamily Households		Householder Living Alone	
	Estimate	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	964,274	63.7%	548,444	36.3%	421,620	27.9%
Region 7	23,729	15,670	66.0%	8,059	34.0%	6,638	28.0%
Baker	7,074	4,781	67.6%	2,293	32.4%	1,941	27.4%
Grant	3,376	2,213	65.6%	1,163	34.4%	1,015	30.1%
Union	10,299	6,852	66.5%	3,447	33.5%	2,635	25.6%
Wallowa	2,980	1,824	61.2%	1,156	38.8%	1,047	35.1%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Table 2-432. Family Households with Children by Head of Household in Region 7, 2012

	Family Households with Children		Single Parent (Male)		Single Parent (Female)		Married Couple with Children	
	Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	415,538	27.5%	35,855	2.4%	93,575	6.2%	286,108	18.9%
Region 7	5,812	24.5%	514	2.2%	1,425	6.0%	3,873	16.3%
Baker	1,714	24.2%	127	1.8%	419	5.9%	1,168	16.5%
Grant	756	22.4%	84	2.5%	164	4.9%	508	15.0%
Union	2,805	27.2%	279	2.7%	651	6.3%	1,875	18.2%
Wallowa	537	18.0%	24	0.8%	191	6.4%	322	10.8%

Note: The table shows the percent of total households represented by each family household structure category.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Social and Demographic Trends and Issues

This analysis shows that Region 7 has a greater number of people than the state average who are predisposed to be particularly vulnerable during a hazard event:

- Population has been declining and is expected to continue to decline or stay flat, except in Union County.
- Children constitute about one fifth of the region's population.
- Seniors constitute about one fifth of the region's population, and approximately 40% of seniors are disabled.
- Fewer people have college degrees than the state as a whole.
- Median household incomes are low and have significantly declined in Grant and Wallow Counties.
- Child poverty stands at about 30% regionwide.
- The region has a high percentage of home vacancies.

Economy

Employment

Employment status and salary level may impact the resilience of individuals and families in the face of disasters as well as their ability to mitigate losses created by natural hazards (Cutter et al., 2003). "The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster" (Cutter et al., 2003). The region is still recovering from the financial crisis that began in 2007. Unemployment rates have been declining steadily since 2009 but remain 1.4% higher than the state. Union County has the largest labor force and the lowest unemployment rate. Conversely, Grant County has the smallest labor force and the highest unemployment rate. Nonfarm job counts are up in Union and Wallowa Counties, but struggling to mount a sustained recovery in Baker and Grant Counties (Tauer, 2014). Overall, average salaries are 73% that of the state. Wallowa County has the lowest average salary, $30,002, or 66.7% of the state average.

Table 2-433. Unemployment Rates in Region 7, 2009–2013

	2009	2010	2011	2012	2013	Change (2009–2013)
Oregon	11.1%	10.8%	9.7%	8.8%	7.7%	-3.4%
Region 7	11.4%	11.0%	10.8%	10.2%	9.1%	-2.3%
Baker	10.2%	10.1%	10.6%	10.1%	9.2%	-1.0%
Grant	13.4%	13.5%	13.5%	13.5%	11.8%	-1.7%
Union	11.4%	10.5%	10.1%	9.3%	8.2%	-3.3%
Wallowa	11.8%	12.0%	11.3%	10.3%	9.9%	-1.9%

Source: Oregon Employment Department, 2014.

Table 2-434. Employment and Unemployment Rates in Region 7, 2013

	Civilian Labor Force	Employed Workers		Unemployed	
	Total	Total	Percent	Total	Percent
Oregon	1,924,604	1,775,890	92.3%	148,714	7.7%
Region 7	25,895	23,526	90.9%	2,369	9.1%
Baker	7,073	6,423	90.8%	650	9.2%
Grant	3,337	2,944	88.2%	393	11.8%
Union	11,950	10,974	91.8%	976	8.2%
Wallowa	3,535	3,185	90.1%	350	9.9%

Source: Oregon Employment Department, 2014.

Table 2-435. Employment and Payroll in Region 7, 2013

	Employees	Average Pay	Percent State Average
Oregon	1,679,364	$45,010	100%
Region 7	19,149	$32,868	73.0%
Baker	5,014	$32,063	71.2%
Grant	2,324	$33,503	74.4%
Union	9,488	$33,840	75.2%
Wallowa	2,323	$30,002	66.7%

Source: Oregon Employment Department, 2014

Employment Sectors and Key Industries

In 2013 the five major employment sectors in Region 7 were: (a) Government; (b) Trade, Transportation, and Utilities; (c) Education and Health Services; (d) Manufacturing; and (e) Leisure and Hospitality (9.5%). Table 2-436 shows the distribution of total employment across all sectors. Region 7 is expected to have a 9-10% increase in employment from 2012-2022.

Table 2-436. Covered Employment by Sector in Region 7, 2013

Industry	Region 7	Baker		Grant	
		Employment	Percent	Employment	Percent
Total All Ownerships	19,149	5,014	100%	2,324	100%
Total Private Coverage	74.4%	3,884	77.5%	1,362	58.6%
Natural Resources & Mining	5.0%	176	3.5%	228	9.8%
Construction	4.0%	196	3.9%	57	2.5%
Manufacturing	10.3%	475	9.5%	141	6.1%
Trade, Transportation & Utilities	18.5%	970	19.3%	305	13.1%
Information	1.2%	72	1.4%	38	1.6%
Financial Activities	3.3%	138	2.8%	66	2.8%
Professional & Business Services	5.0%	301	6.0%	119	5.1%
Education & Health Services	13.9%	742	14.8%	169	7.3%
Leisure & Hospitality	9.5%	581	11.6%	174	7.5%
Other Services	3.7%	234	4.7%	63	2.7%
Private Non-Classified	—	—	—	(c)	—

Total All Government	25.6%	1,130	22.5%	962	41.4%
Federal Government	4.2%	218	4.3%	265	11.4%
State Government	7.6%	250	5.0%	138	5.9%
Local Government	13.8%	662	13.2%	559	24.1%

		Union		Wallowa	
Industry	**Region 7**	**Employment**	**Percent**	**Employment**	**Percent**
Total All Ownerships	19,149	9,488	100%	2,323	100%
Total Private Coverage	74.4%	7,321	77.2%	1,688	72.7%
Natural Resources & Mining	5.0%	377	4.0%	168	7.2%
Construction	4.0%	380	4.0%	127	5.5%
Manufacturing	10.3%	1,207	12.7%	142	6.1%
Trade, Transportation & Utilities	18.5%	1,865	19.7%	402	17.3%
Information	1.2%	115	1.2%	12	0.5%
Financial Activities	3.3%	301	3.2%	136	5.9%
Professional & Business Services	5.0%	450	4.7%	95	4.1%
Education & Health Services	13.9%	1,479	15.6%	275	11.8%
Leisure & Hospitality	9.5%	837	8.8%	220	9.5%
Other Services	3.7%	312	3.3%	109	4.7%
Private Non-Classified	—	(c)	—	(c)	—
Total All Government	25.6%	2,167	22.8%	635	27.3%
Federal Government	4.2%	223	2.4%	95	4.1%
State Government	7.6%	967	10.2%	97	4.2%
Local Government	13.8%	977	10.3%	443	19.1%

Source: Oregon Employment Department, 2013

Note: (c) = confidential, information not provided by Oregon Employment Department to prevent identifying specific businesses.

Each industry faces distinct vulnerabilities to natural hazards. Identifying key industries in the region enables communities to target mitigation activities toward those industries' specific sensitivities. Each of the primary private employment sectors has sensitivity to natural hazards, as follows.

Trade, Transportation, and Utilities: Retail Trade is the largest employment subsector within the Trade, Transportation, and Utilities sector. Retail Trade is vulnerable to disruptions in the disposable income of regional residents and to disruptions in the transportation system. Residents' discretionary spending diminishes after natural disasters as spending priorities tend to focus on essential items. Disruption of the transportation system could sever connectivity of people and retail hubs. Retail businesses are concentrated in the larger cities of the region.

Education and Health Services: The industries in these sectors play important roles in emergency response in the event of a disaster. Health care is a relatively stable revenue sector regionally with an increasing distribution of businesses primarily serving a local and aging population.

Manufacturing: This sector is highly dependent upon transportation networks in order to access supplies and send finished products to outside markets. For these reasons the manufacturing sector may be susceptible to disruptions in transportation infrastructure. However, manufacturers are not dependent on local markets for sales, which may contribute to the economic resilience of this sector.

Leisure and Hospitality: This sector primarily serves regional residents with disposable income and tourists. The behavior of both of these social groups would be disrupted by a natural disaster. Regional residents may have less disposable income and tourists may choose not to visit a region with unstable infrastructure.

Revenue by Sector

In 2007 Trade (Retail and Wholesale), Manufacturing, and Healthcare and Social Assistance were the highest revenue grossing industries in Region 7. (Revenue data from the 2012 Economic Census will not be released prior to the publication of this Plan.) Combined, these three industries generated over $1.3 billion (88% of total revenue) for the region. Trade (Retail and Wholesale) is the largest grossing sector in all counties, except Union County.

Note: Due to the small size and few industries in the region, the collected data is withheld in several categories to avoid disclosing data for individual companies. Data is aggregated to the county level).

Table 2-437. Revenue of Top Industries (in Thousands of Dollars) in Region 7, 2007

	Total Revenue (in Thousands)	Trade (Retail and Wholesale)	Manufacturing	Health Care and Social Assistance
Oregon	$277,017,733	44.4%	24.1%	7.3%
Region 7	$1,436,457	46.2%	33.1%	8.4%
Baker	$362,682	48.1%	38.0%	D
Grant	$82,545	87.9%	—	D
Union	$856,609	39.0%	39.4%	11.2%
Wallowa	$134,621	61.5%	—	18.0%

Notes: D = Withheld to avoid disclosing data for individual companies; data are included in higher level totals, and "-" = data not provided.

Source: U.S. Census, Economic Census. 2007, Table ECO700A1

Sectors that are anticipated to be major employers in the future warrant special attention, especially in the hazard mitigation planning process so the workforce and employers can be more prepared to respond and adapt to needs that arise after a natural hazard event. Between 2012 and 2022, the largest job growth in Region 7 is expected to occur in the following sectors: (a) Education and Health Services; (b) Natural Resources and Mining; (c) Trade, Transportation, and Utilities (including retail trade); (d) Government; and (e) Leisure and Hospitality (Oregon Employment Department, Employment Projections by Industry and Occupation 2012–2022, Northeast and Southeast Oregon Reports, 2012).

Identifying sectors with a large number of businesses, and targeting mitigation strategies to support those sectors, can help the region's resiliency. The Trade, Transportation, and Utilities sector includes the most businesses in Region 7 with 18.0% of all businesses. Government (particularly local government) has the second most number of businesses. Construction, Other Services, and Education and Health Services round out the top five sectors (Oregon Employment

Department, 2012). While many of these are small businesses, employing fewer than 20 employees, collectively they represent almost two thirds of the businesses in the region. Due to their small size and large collective share of the economy, these businesses are particularly sensitive to temporary decreases in demand, such as may occur following a natural hazard event.

Economic Trends and Issues

Current and anticipated financial conditions of a community are strong determinants of community resilience, since a strong and diverse economic base increases the ability of individuals, families, and communities to absorb impacts of a disaster and recover more quickly. The economic analysis shows that Region 7 is particularly vulnerable during a hazard event due to the following characteristics:

- Higher unemployment, especially in Grant County; and
- Lower regional wages.

Northeastern Oregon is still recovering from the financial crisis that began in 2007. Much of the growth in employment within the region is spurred by the health care industrial sector and the region's aging population. Supporting the growth of dominant industries and employment sectors, as well as emerging sectors identified in this analysis, can help the region become more resilient to economic downturns that often follow a hazard event (Stahl et al., 2000).

Infrastructure

Transportation

Roads

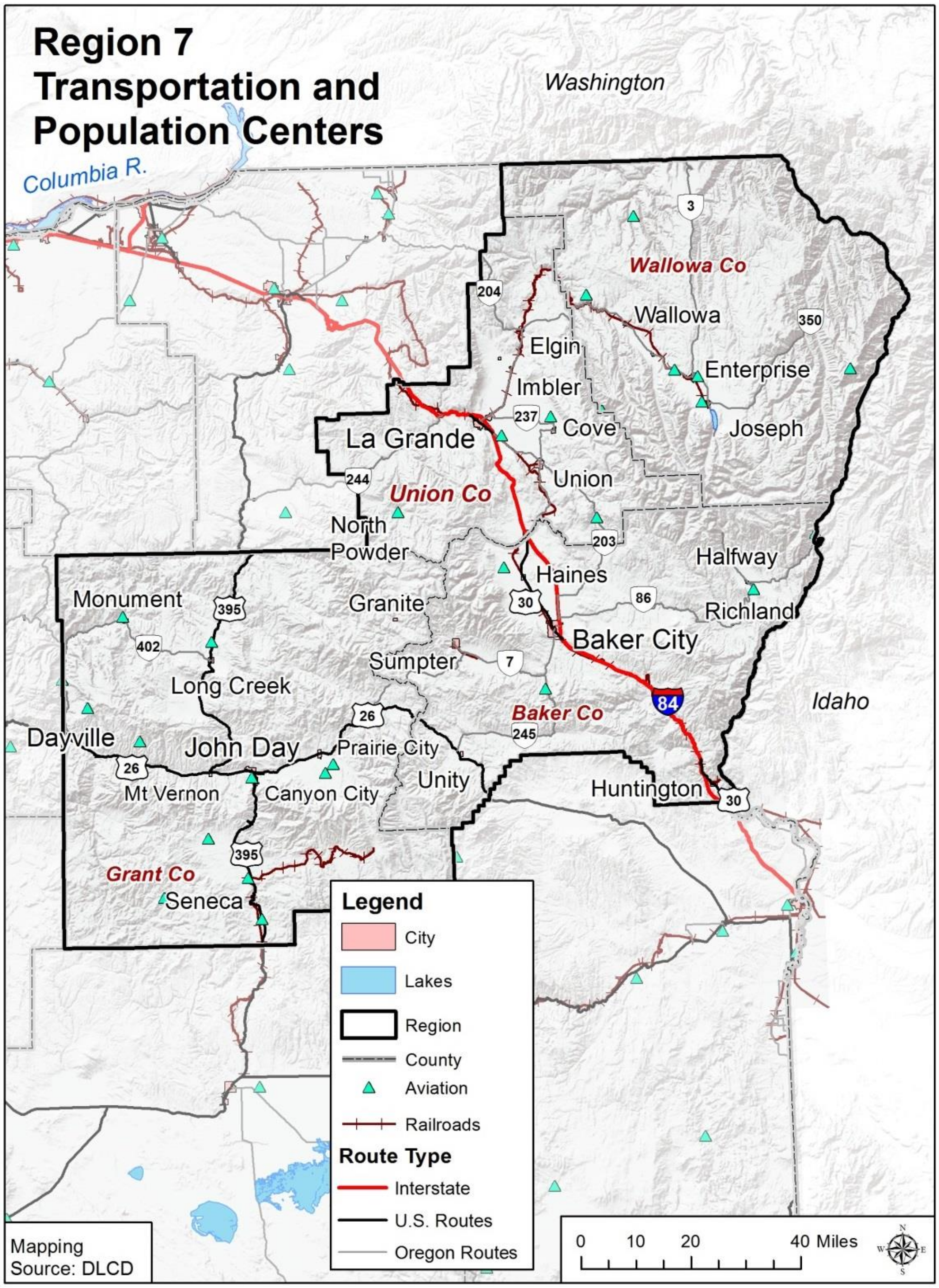
The largest population bases in Region 7 are located along the region's major freeways. I-84 runs north-south and is the main passage for automobiles and trucks traveling east of the Cascade Range between Portland and Idaho. US-26, US-244, OR-245, and US-395 provide access west into Grant County. OR-82 provides access into Wallowa County. An additional north-south access is provided from Wallowa County to Washington via OR-3.

Region 7's growing population centers bring more workers, automobiles and trucks onto roads. A high percentage of workers driving alone to work coupled with interstate and international freight movement create additional stresses on transportation systems. Some of these include added maintenance, congestion, oversized loads, and traffic accidents.

Natural hazards and emergency events can further disrupt automobile traffic, create gridlock, and shut down local transit systems, making evacuations and other emergency operations difficult. Hazards such as localized flooding can render roads unusable. Likewise, a severe winter storm has the potential to disrupt the daily driving routine of thousands of people.

According to the Oregon Department of Transportation's (ODOT's) Seismic Lifeline Report (**Appendix 9.1.13**), the projected impacts of a CSZ event are considered negligible in this part of the state. However, damage to I-84 to the west and damage to the Columbia River's freight functions could impact the region's economy. For information on ODOT's Seismic Lifeline Report findings for Region 7, see **Seismic Lifelines**.

Figure 2-204. Region 7 Transportation and Population Centers



Source: Oregon Department of Transportation, 2014

Bridges

Because of earthquake risk in Region 7, the seismic vulnerability of the region'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 region's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or are part of regional and local systems that are maintained by the region's counties and cities. For information on ODOT's Seismic Lifeline Report findings for Region 7, see **Seismic Lifelines**.

Table 2-438 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 (ODOT, 2012, 2013). In this region, 14% of bridges are distressed and/or deficient.

Table 2-438. Bridge Inventory for Region 7

	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 7	36	212	17%	33	237	14%	3	33	9%	0	4	0%	72	499	14%	15
Baker	11	81	14%	10	79	13%	0	8	0%	0	0	-	21	165	13%	3
Grant	4	45	8%	10	38	26%	2	9	22%	0	1	0%	16	96	17%	1
Union	15	69	19%	5	61	8%	1	6	17%	0	1	0%	21	146	14%	6
Wallowa	6	17	29%	8	59	14%	0	10	0%	0	2	0%	14	92	15%	5

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.

Source: ODOT (2012, 2013)

Railroads

Railroads that run through Region 7 support cargo and 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 Class I rail line follows the I-84 corridor and another non-class I rail line provides access to the city of Enterprise (Wallowa County). There are no active rail lines in Grant County. There is one rail yard in the region (in La Grande, Union County) operated by UP (Cambridge Systematics, 2014).

There is no passenger rail available in Region 7.

Oregon's rail system is critical to the state's economy, energy, and food systems. Rail systems export lumber and wood products, pulp and paper, and other goods produced in Oregon and transport products from other states to and through Oregon (Cambridge Systematics, 2014).

Rails are sensitive to icing from winter storms that can occur in Region 7. Disruptions in the rail system can result economic losses for the region. The potential for harm from rail accidents can also have serious implications for local communities, particularly if hazardous materials are involved.

Airports

There are no commercial airports in the region. There are several general aviation public airports including the Baker City and La Grande airports.

In the event of a natural disaster, public and private airports are important staging areas for emergency response activities. Public airport closures will impact the region's tourism industries, as well as the ability for people to leave the region by air. Businesses relying on air freight may also be impacted by airport closures.

Table 2-439. Public and Private Airports in Region 7

	Number of Airports by FAA Designation				
	Public Airport	**Private Airport**	**Public Helipad**	**Private Helipad**	**Total**
Region 7	7	23	0	5	35
Baker	1	5	0	5	11
Grant	2	9	0	0	11
Union	1	3	0	0	4
Wallowa	3	6	0	0	9

Source: FAA Airport Master Record (Form 5010), 2014

Energy

Electricity

The region is served by several investor-owned, public, cooperative and municipal utilities. The Bonneville Power Administration is the area's wholesale electricity distributor. Pacific Power and Light (Pacific Power) is the primary investor-owned utility company serving Wallowa County. Idaho Power Company serves portions of Baker County. The region's electric cooperatives include: Oregon Trail Electric Cooperative (Baker, Grant, and Union), Central Electric Cooperative (Grant), Columbia Power Cooperative (Grant), and the Umatilla Electric Cooperative (Union). The Oregon Trail Electric Cooperative serves the major population centers in the region.

Table 2-440 lists electric power-generating facilities in Region 7. The region has a total of five power-generating facilities: three are hydroelectric power facilities, one is a wind power facility, and one is categorized as “other” (biomass). In total, the power-generating facilities have the ability to produce up to 1,277 megawatts (MW) of electricity.

Table 2-440. Power Plants in Region 7

	Hydro-electric	Natural Gas	Wind	Coal	Other*	Total
Region 7	3	0	1	0	1	5
Baker	2	0	0	0	0	2
Grant	0	0	0	0	1	1
Union	0	0	1	0	0	1
Wallowa	1	0	0	0	0	1
Energy Production (MW)	1,166	0	101	0	10	1,277

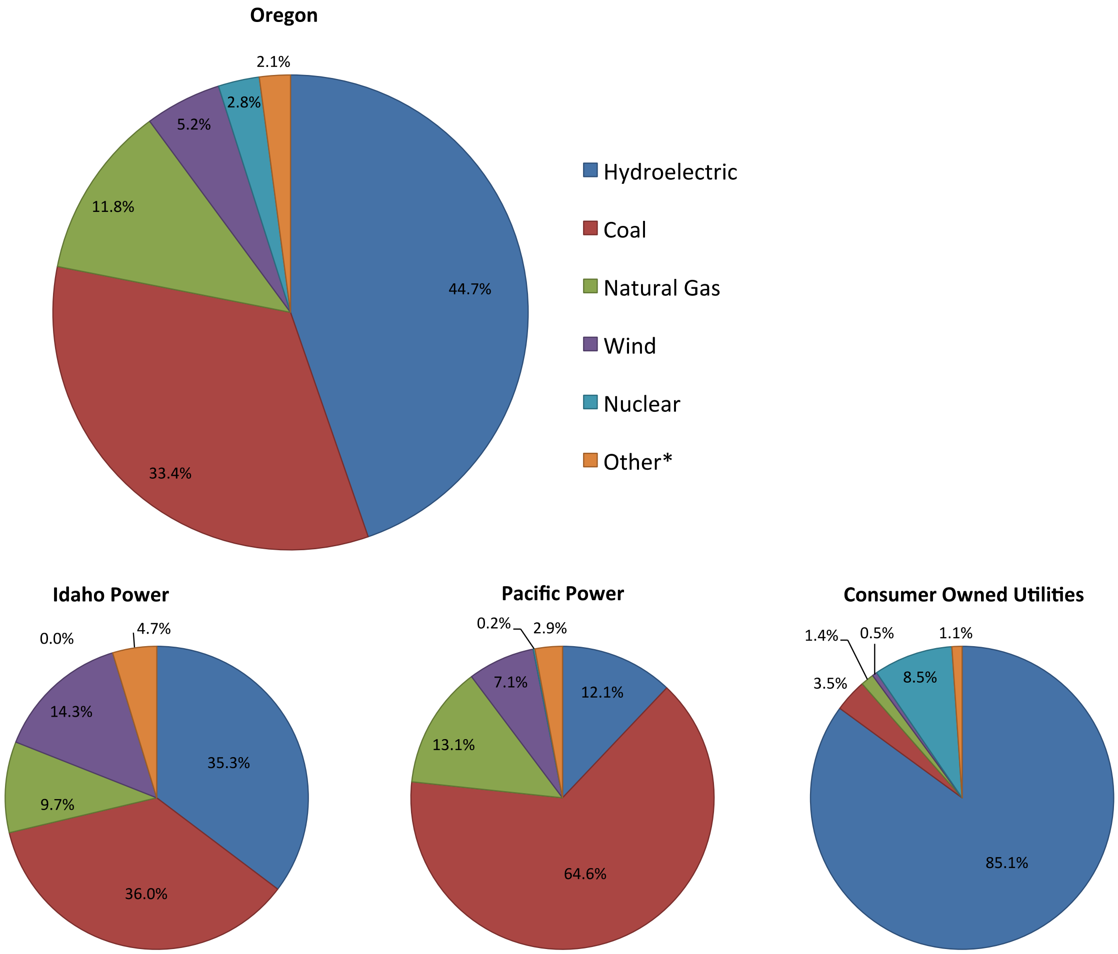
*“Other” includes biomass, geothermal, landfill gas, solar, petroleum, and waste.

Source: Army Corps of Engineers; Biomass Power Association; Calpine Corporation; Eugene Water and Electric Board; Iberdola Renewables; Idaho Power Company; Klamath Energy LLC; Oregon Department of Energy; Owyhee Irrigation District; Form 10K Annual Report (2013), PacifiCorp; Form 10K Annual Report (2013), Portland General Electric; U.S. Geothermal, Inc.

Oregon has a diverse energy portfolio (Figure 2-205) (Oregon Department of Energy, n.d.b). Consumer Owned Utilities provide for approximately 30% of the state’s electricity consumption (largely through Bonneville Power Administration’s electric generation facilities) while Pacific Power provides about 28% of the state’s electricity need.

Pacific Power generates supply from a variety of sources including sites in Oregon and other western states. Transmission lines from the Rocky Mountain Region provide additional energy sources. Natural hazard events can create additional stresses to energy infrastructure that may lead to system damage or disruption in service. The redundancies and diversity in Pacific Power’s energy generation portfolio and pipeline systems adds to the region’s resilience in the face of power system damage or service disruption.

Figure 2-205. Oregon Energy Portfolio



Note: 3.9% of Oregon's electricity needs are met through Electric Service Suppliers that are not required to provide descriptions of their power sources to the State of Oregon.

*Other includes biomass, geothermal, landfill gas, solar, petroleum, and waste.

Source: Oregon Department of Energy, 2014.

Hydropower

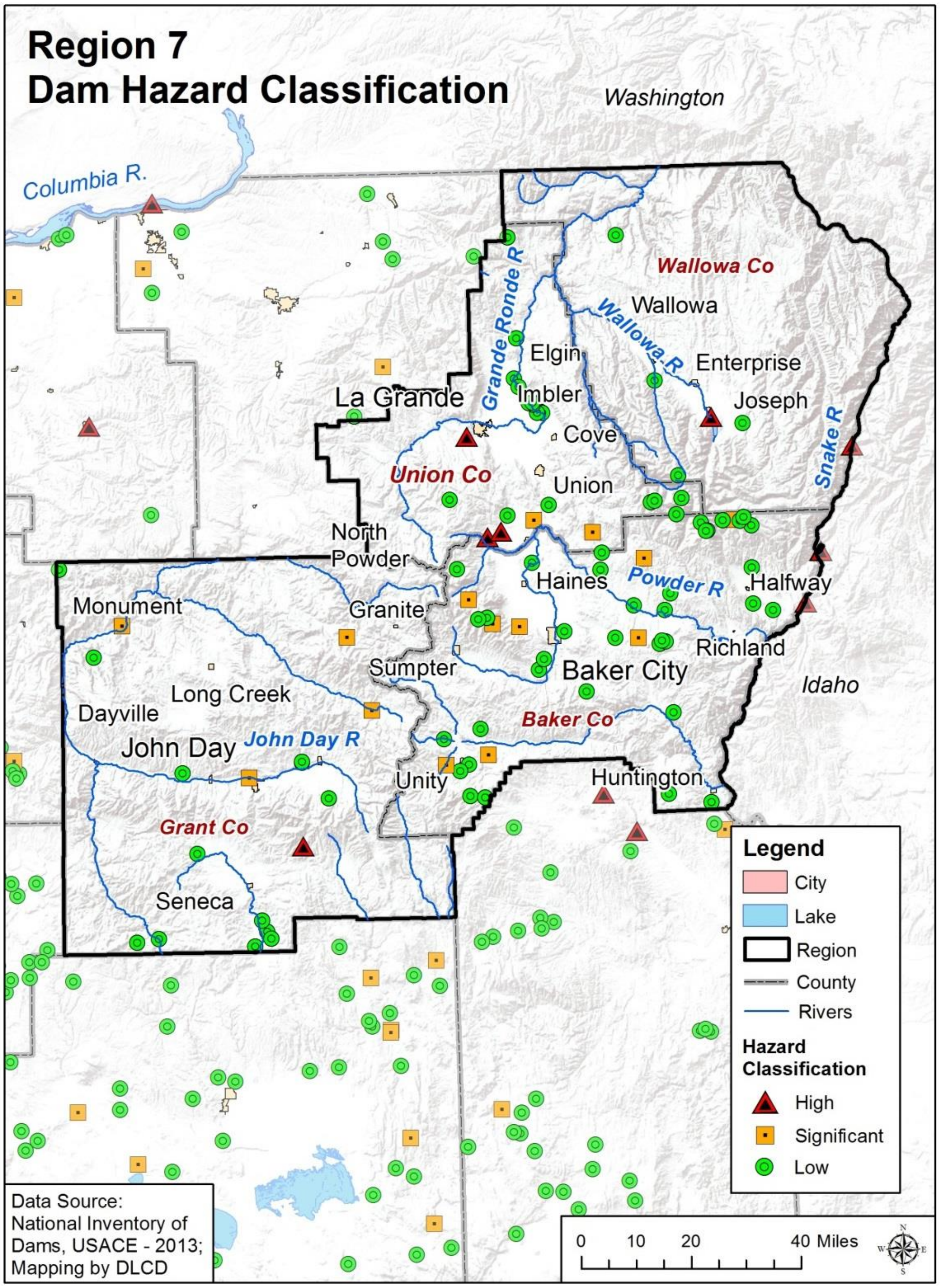
Major dams in the region are located on the Snake River (Brownlee, Oxbow, and Hells Canyon). Dam failures can occur at any time. Most result in minor damage to structures and pose little or no risk to life safety. However, the potential for severe damage and fatalities does. The Oregon Water Resources Department maintains an inventory of all large dams located in Oregon (using the National Inventory of Dams (NID) threat potential methodology). Most dams in the region are located in Baker County (70). There are 11 High Threat Potential dams and 10 Significant Threat Potential dams in the region.

Table 2-441. Threat Potential of Dams in Region 7

	Threat Potential			Total Dams
	High	Significant	Low	
Region 7	11	10	117	138
Baker	5	8	57	70
Grant	1	0	27	28
Union	3	2	26	31
Wallowa	2	0	7	9

Source: Oregon Water Resources Department, Dam Inventory Query, 2014

Figure 2-206. Region 7 Dam Hazard Classification

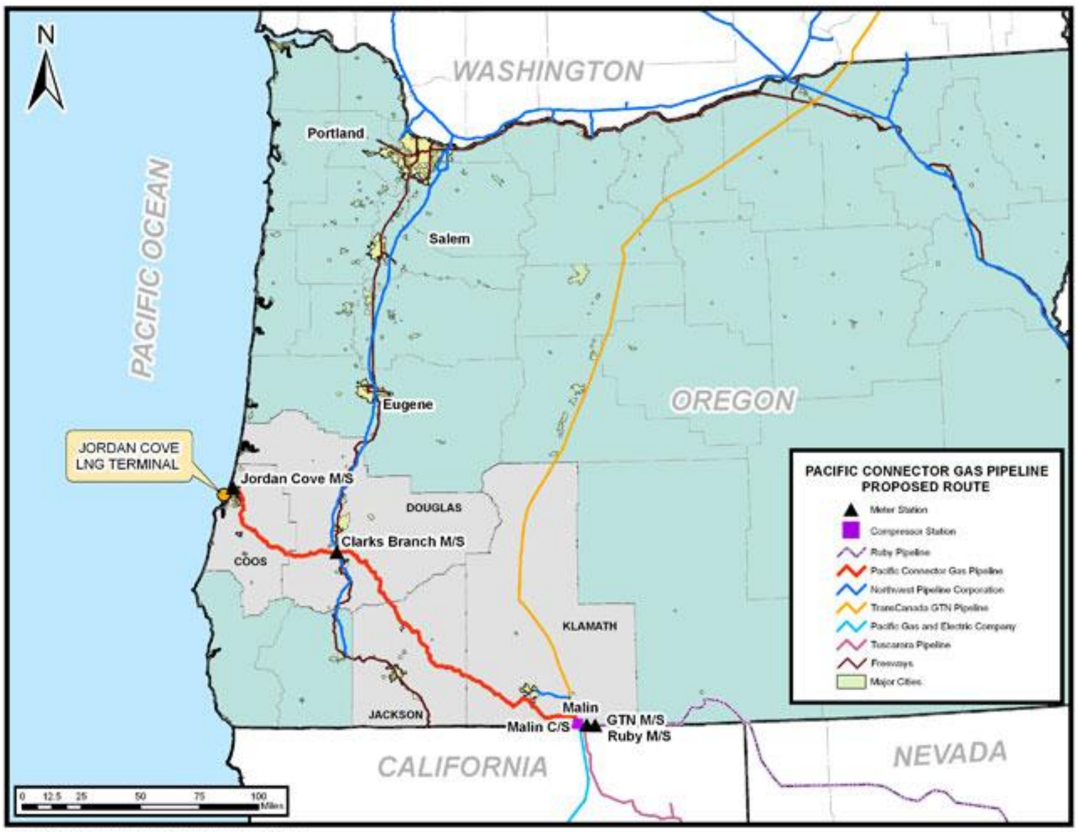


Source: National Inventory of Dams, USACE, 2013

Natural Gas

Although natural gas does not provide the most energy to the region, it does contribute a significant amount of energy to the region's energy portfolio. Liquefied natural gas (LNG) is transported via pipelines throughout the United States. **Figure 2-207** shows the Northwest Pipeline, which runs through Union and Baker Counties (in blue) (*Northwest Pipeline* Retrieved from http://www.northwest.williams.com/NWP_Portal/extLoc.action?Loc=FilesNorthwestother&File=pipelineInfo.html). LNG pipelines, like other buried pipe infrastructure, are vulnerable to earthquakes and can cause danger to human life and safety, as well as environmental impacts in the case of a spill.

Figure 2-207. Liquefied Natural Gas Pipelines in Region 7



Source: Williams Corporation

Utility Lifelines

Northeast Oregon is an important throughway for oil and gas pipelines and electrical transmission lines, connecting Oregon to Idaho and Washington. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy. These lines may be vulnerable to severe, but infrequent natural hazards, such as earthquakes.

Region 7 primarily receives oil and gas from Alaska by way of the Puget Sound through pipelines and tankers. The electric, oil, and gas lifelines that run through the County are both municipally and privately owned (Loy et al., 1976).

The network of electrical transmission lines running through Region 7 is operated primarily by Pacific Power and regional electrical cooperatives (and supplied by the Idaho Power Company and Bonneville Power Administration) and primarily facilitates local energy production and distribution (Loy et al., 1976). Most of the natural gas Oregon uses originates in Alberta, Canada. The Williams Company owns the main natural gas transmission pipeline in northeastern Oregon.

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio). Region 7 is part of the Eastern Oregon Operational Area under The Oregon State Emergency Alert System Plan (Oregon Office of Emergency Management (2013). There is a memorandum of understanding between these counties that facilitates the launching of emergency messages. Counties in these areas can launch emergency messages by contacting the Oregon Emergency Response System (OERS), which in turn creates emergency messages to communities statewide.

Beyond day-to-day operations, maintaining communications capabilities during disaster events and other emergency situations helps to keep citizens safe by keeping them informed of the situation's status, areas to avoid, and other procedural information. Additionally, responders depend on telecommunications infrastructure to be routed to sites where they are needed.

Television

Television serves as a major provider for local, regional, and national news and weather information and can play a vital role in emergency communications. The Oregon State Emergency Alert System Plan does not identify a local primary station for emergency messages. However, messages are provided via the three state primary networks: Oregon Public Broadcasting (Portland), KOBI-TV (Medford), and KWAX-FM (Eugene).

Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband service providers serve Region 7. Broadband technology including mobile wireless is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless, and mobile wireless. Internet service is readily available throughout most parts the region with a smaller number of providers and service types available in the more remote parts of the region (NTIA, n.d.). Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

Wireless providers sometimes offer free emergency mobile phones to those impacted by disasters, which can aid in communication when landlines and broadband service are unavailable.

Radio

Radio is readily available to those who live within Region 7 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Due to the remote nature and sparse population Region 7 lacks a station that would serve the Eastern Oregon Operational Area. ,Radio transmitters for the Eastern Oregon Operational Area are:

Local Primary Stations:

- KCMB-FM, 104.7 MHZ (Baker City, Baker, Morrow, Umatilla, and Union Counties);
- KJDY-FM, 94.5 MHZ (John Day, Grant County); and
- WVR-FM, 92.1 MHZ (Enterprise, Wallowa County).

State Primary Stations:

- KOBK-FM, 104.7 MHZ, Baker City (OPB Radio Network, also monitors KBOI-AM 690, Boise, PEP station)
- KOJD-FM, 89.7 MHZ, John Day (OPB Radio Network);
- KTVR-FM, 90.3 MHZ, La Grande (OPB Radio Network); and
- KETP-FM, 88.7 MHZ, Enterprise (OPB Radio Network).

Ham Radio

Amateur radio, or ham radio, is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). ARES Districts 3 (Union, Wallowa) and 6 (Baker, Grant) provide service to Region 7. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (Oregon Office of Emergency Management, n.d.). Union County is the only county in the region with an active ham emergency station. Calls for Region 7 include (American Relay Radio League Oregon Chapter, n.d., www.arrloregon.org):

- Baker County: Vacant;
- Grant County: Vacant;
- Union County: KE7QYU; and
- Wallowa County: Vacant.

Water

Water infrastructure includes drinking water, stormwater, and wastewater systems. All of these systems possess some level of vulnerability to natural hazards that can have repercussions on human health, ecosystems, and industry.

Drinking Water

In Region 7 municipal drinking water supply is obtained from both surface and ground sources. In Wallowa and Grant Counties, the majority of municipal drinking water is from wells drawing from the aquifer with cities having water rights for surface water sources as backup sources in late summer. In Grant County, cities draw drinking water equally from a combination of surface and ground sources. Baker City draws its water from mountain springs and is unique in the state because it uses only ultraviolet water treatment without any filtration. Other cities in Baker County depend primarily on groundwater wells for municipal drinking water. Rural residents also obtain water primarily from both surface sources and groundwater wells.

Region 7 is impacted by several threats to water quality and quantity. Low levels of snowpack can lead to severe surface water shortages in a region that is already subject to annual shortages. Low water levels in surface sources can cause stagnation, low flows, and increased mineralization downstream, which negatively impacts water quality. Effluent runoff from feedlots is a lower priority concern for the region's water quality; however, other agricultural products such as pesticides and herbicides leeching into ground and surface water sources is a concern for water quality. High water temperatures are a concern in the region because of impacts to wildlife as well as increases in bacteria levels associated with high surface water temperatures. Riparian improvement projects are being implemented in Grant County to combat the issue of high surface water temperatures. Other concerns for water quality include industrial contamination, diesel spills, chromium, arsenic, iron and sulfur levels.

Surface sources for drinking water are vulnerable to pollutants caused by non-point sources and natural hazards. Non-point source pollution is a major threat to surface water quality, and may include stormwater runoff from roadways, agricultural operations, timber harvest, erosion and sedimentation. Landslides, flood events, and earthquakes and resulting liquefaction can cause increased erosion and sedimentation in waterways

Underground water supplies and aging or outdated infrastructure — such as reservoirs, treatment facilities, and pump stations — can be severed during a seismic event. Rigid materials such as cast iron may snap under the pressure of liquefaction. More flexible materials such as polyvinyl chloride (PVC) and ductile iron may pull apart at joints under the same stresses. These types of infrastructure damages could result in a loss of water pressure in municipal water supply systems, limiting access to potable water. This can lead to unsanitary conditions that may threaten human health. Lack of water can also impact industry, such as the manufacturing sector. Moreover, if transportation infrastructure is impacted by a disaster event, repairs to water infrastructure will be delayed.

Stormwater and Wastewater

In urbanized areas severe precipitation events may cause flooding that leads to stormwater runoff. A non-point source of water pollution, stormwater runoff can adversely impact drinking water quality. It can also lead to environmental issues such as increasing surface water temperatures that can adversely affect habitat health. Furthermore, large volumes of fast-moving stormwater that enter surface waterways can cause erosion issues.

Stormwater can also impact water infrastructure. Leaves and other debris can be carried into storm drains and pipes, which can clog stormwater systems. In areas where stormwater systems are combined with wastewater systems (combined sewers), flooding events can lead to combined sewer overflows (CSOs). CSOs present a heightened health threat as sewage can flood urban areas and waterways. Underground stormwater and wastewater pipes are also vulnerable to damage by seismic events.

In Region 7, most municipal building codes and stormwater management plans (city and county) emphasize use of centralized storm sewer systems to manage stormwater. Low impact development (LID) mitigation strategies can alleviate or lighten the burden to a jurisdiction's storm sewer system by allowing water to percolate through soil onsite or detaining water so water enters the storm sewer system at lower volumes, at lower speed, and at lower temperatures. In Region 7, only Baker City refers to LID techniques in its municipal code, requiring new surface parking areas are required to use LID strategies for stormwater runoff. Requiring decentralized LID stormwater management strategies in the other Region 7 counties could help reduce the burden of new development on storm sewer systems and increase the region's resilience to many types of hazard events.

Infrastructure Trends and Issues

Physical infrastructure is critical for everyday operations and is essential following a disaster. Lack or poor condition of infrastructure can negatively affect a community's ability to cope with, respond to, and recover from a hazard event. Diversity, redundancy, and consistent maintenance of infrastructure systems help create system resiliency (Meadows, 2008).

Damage or service interruption to roads, bridges, rail systems, and ports can have devastating effects the region's economy. Hazards such as flooding and winter weather can close the highways that connect communities in Region 7 to the rest of the state. Fourteen percent of all bridges in Northeast Oregon are distressed or deficient. Railroads that run through Region 7 support cargo and trade flows, and are vulnerable to icy conditions.

The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards. There are five power-generating facilities located in this region: three hydroelectric, one wind, and one biomass facility. The area is the location of three large dams and hydroelectric projects on the Snake River. LNG is transported through the region via the Northwest Pipeline that runs through Union and Baker Counties.

Decentralization and redundancy in the region's telecommunication systems can help boost the area's ability to communicate before, during, and after a disaster event. It is important to note that broadband and mobile telephone services may not cover rural areas of the region that are distant from I-84. This may present a communication challenge in the wake of a hazard event. Encouraging residents to keep AM/FM radios available for emergency situations could help increase the capacity for communicating important messages throughout the region.

Water systems in the region are particularly vulnerable to hazard events because they tend to be older, centralized, and lacking system redundancies. Because most drinking water is sourced from surface water or wells, the region is at risk of high levels of pollutants entering waterways via stormwater runoff or combined sewer overflows (CSO) during high-water events. Older, centralized infrastructure in storm and wastewater infrastructure creates vulnerability in the system during flood events. Baker City is the only community Region 7 that requires low impact development (LID) stormwater management practices in its building code, and it is only required for new surface parking.

Built Environment

Development Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's program is 19 land use goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards (DLCD website: http://www.oregon.gov/).

Settlement Patterns

The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people, or an "urban cluster" of at least 2,500 people (but less than 50,000). Grant and Wallowa Counties do not meet either definition. Therefore even though both counties contain incorporated cities, the counties are considered 100% rural.

Statewide, Oregon counties added residents from 2000 to 2010, but several northeast counties lost population over the decade. Baker, Grant, and Wallowa Counties all decreased in population over the 10-year period, a combined population decrease of over 1,300 people. Union County increased by 5% and was the only county to experience growth in both urban and rural areas; however, its rate of urban growth was less than half of the state as a whole. At the city level, La Grande grew the most (+755). The region's population is clustered around the I-84 corridor and the cities of Baker City, La Grande, John Day, and Enterprise.

Table 2-442. Urban and Rural Populations in Region 7

	Urban			Rural		
	2000	**2010**	**Percent Change**	**2000**	**2010**	**Percent Change**
Oregon	2,694,144	3,104,382	15.2%	727,255	726,692	-0.1%
Region 7	23,883	24,427	2.3%	32,549	31,908	-2.0%
Baker	9,605	9,518	-0.9%	7,136	6,616	-7.3%
Grant	0	0	—	7,935	7,445	-6.2%
Union	14,278	14,909	4.4%	10,252	10,839	5.7%
Wallowa	0	0	0%	7,226	7,008	-3.0%

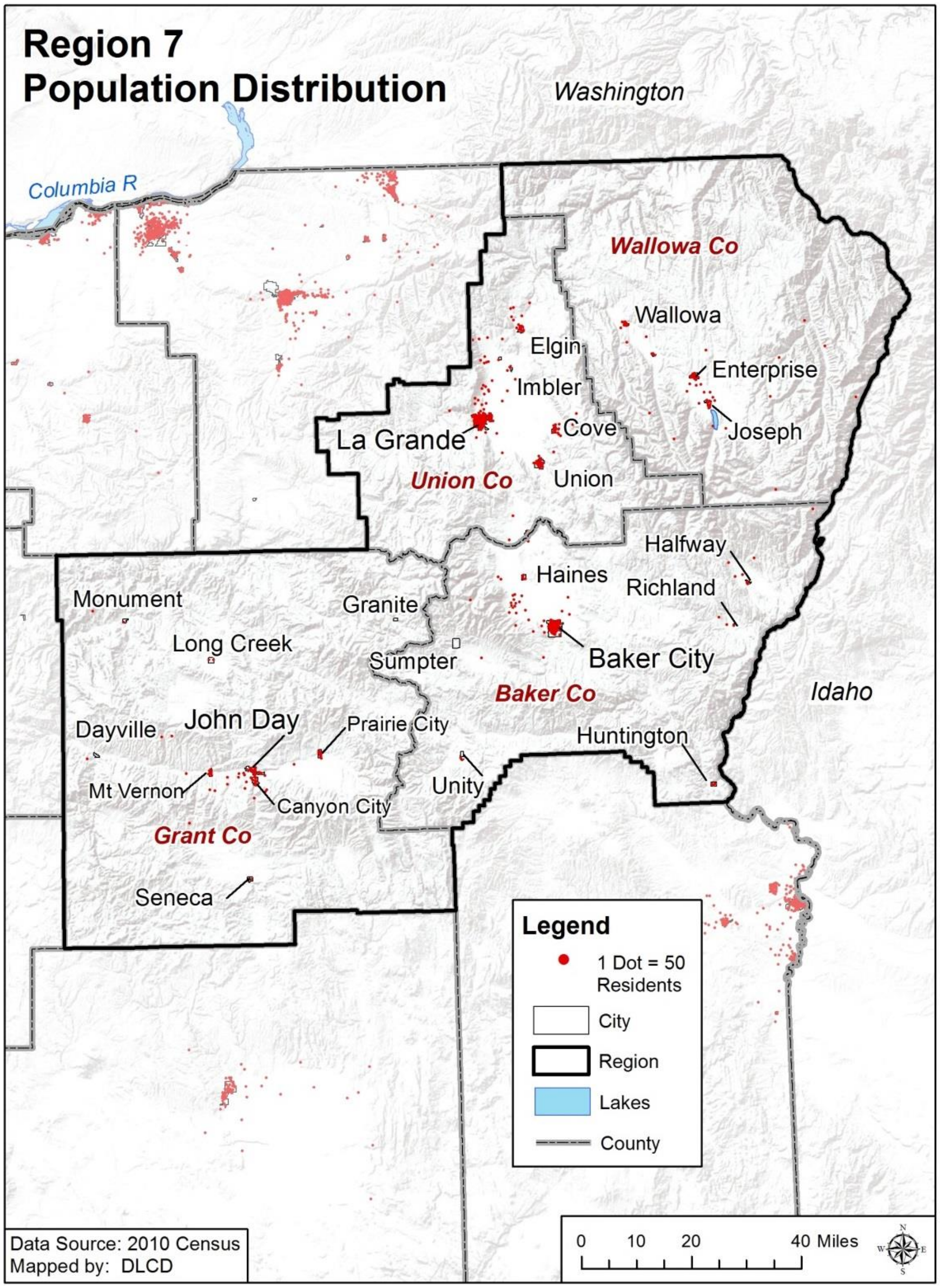
Source: U.S. Census Bureau. 2000 Decennial Census, Table P002 and 2010 Decennial Census, Table P2

Table 2-443. Urban and Rural Housing Units in Region 7

	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 7	10,552	11,039	4.6%	16,357	17,728	8.4%
Baker	4,342	4,498	3.6%	4,060	4,328	6.6%
Grant	0	0	—	4,004	4,344	8.5%
Union	6,210	6,541	5.3%	4,393	4,948	12.6%
Wallowa	0	0	0%	3,900	4,108	5.3%

Source: U.S. Census Bureau. 2000 Decennial Census, Table H002 and 2010 Decennial Census, Table H2

Figure 2-208. Region 7 Population Distribution



Source: U.S. Census, 2012

Land Use and Development Patterns

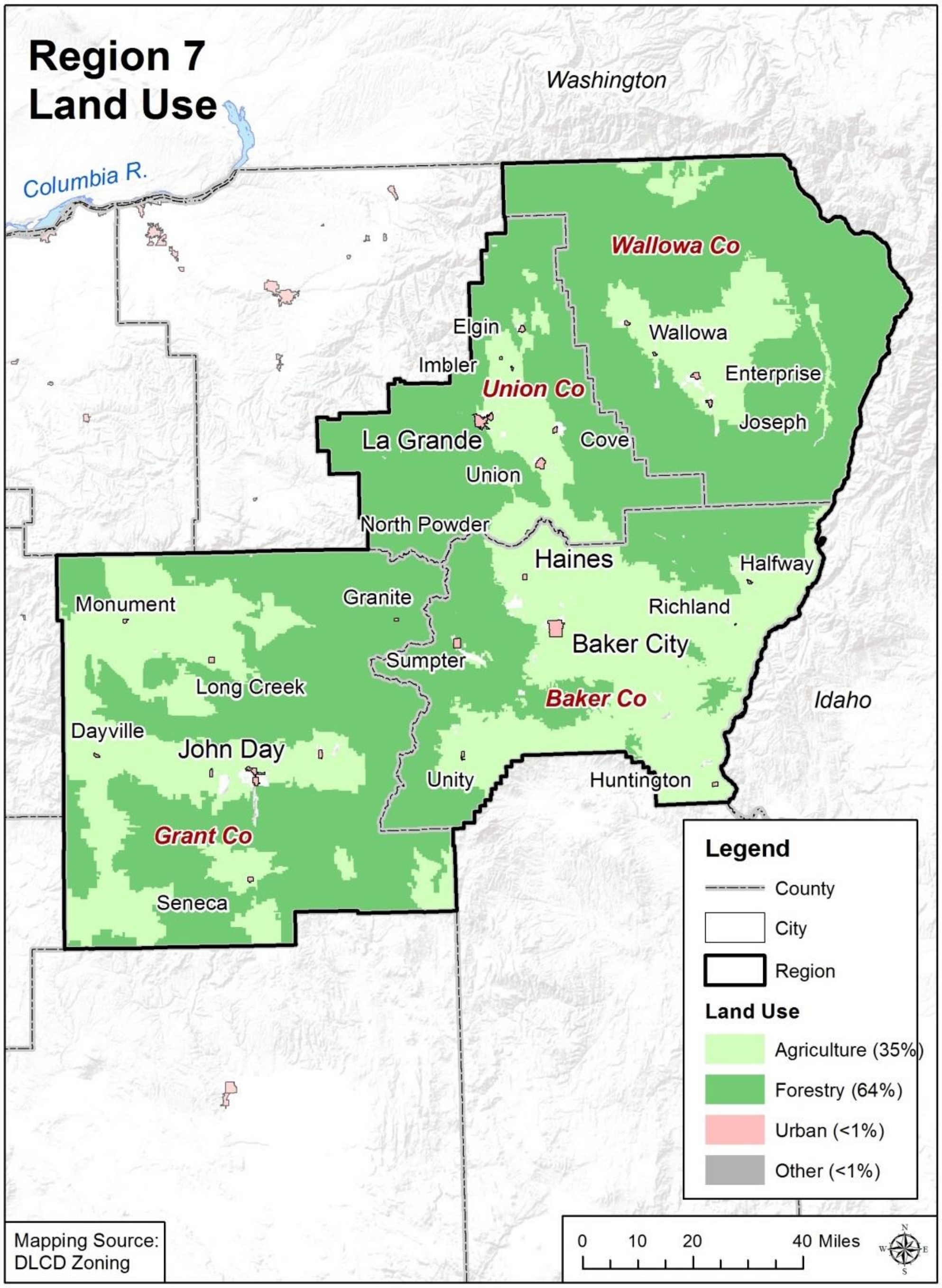
Private land generally has developed more slowly in Eastern Oregon than in Western Oregon between 1974 and 2009. State and local programs have been successful in limiting rural residential and urban development and maintaining large parcel sizes. Demand for large-scale development in this part of the state has historically been very low. Land ownership is almost completely split between federal (60%) and private (39+%) with less than 1% shared by state and local government.

To the extent it has occurred, development has generally been located along existing transportation corridors. Nearly half of the people in Region 7 reside in the cities of Baker City, John Day, La Grande, and Enterprise, and most unincorporated development in this region is located along the I-84 corridor.

As with other regions in the state this area has seen an upswing in building permits since the spring of 2012, although modest (U.S. Census Bureau, 2010). Any regional rate of growth is expected to be small. The Office of Economic Analysis projects that Region 7's population will increase by less than 1% over a 30-year period.

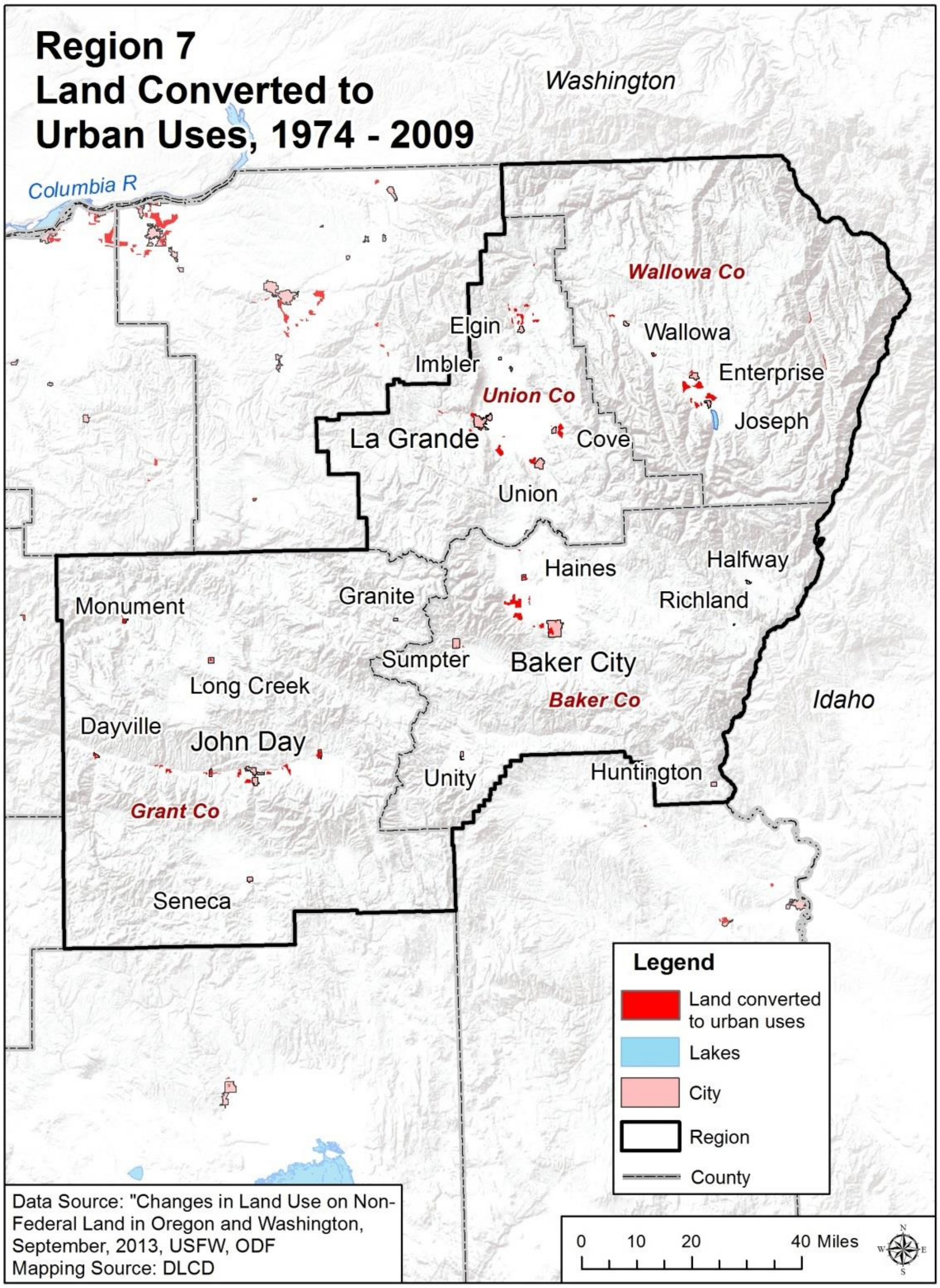
All the cities within the four counties of the region have acknowledged comprehensive land use plans that are periodically reviewed and updated. In 2013, the City of La Grande's Urban Growth Boundary (UGB) was extended, adding over 250 acres of vacant industrial land to the available land inventory.

Figure 2-209. Region 7 Land Use



Source: Department of Land Conservation and Development, 2014

Figure 2-210. Region 7 Land Converted to Urban Uses, 1974–2009



Source: Land Use Change on Non-Federal Land in Oregon and Washington, September, 2013, USFS, ODF

Housing

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. Almost 71% of the region's housing stock is single-family homes. The region's share of multi-family units is less than half that of the state, and almost two thirds of those units are in Union County. The region has twice the percentage of mobile homes as the state, comprising one quarter of all homes in Grant County. In natural hazard events such as earthquakes and floods, mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of Emergency Services, 1997).

Table 2-444. Housing Profile for Region 7, 2012

	Total Housing Units	Single Family		Multi-Family		Mobile Homes	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	1,140,319	68.1%	460,852	27.5%	139,768	8.4%
Region 7	28,698	20,361	70.9%	3,668	12.8%	4,637	16.2%
Baker	8,826	6,509	73.7%	1,023	11.6%	1,274	14.4%
Grant	4,327	3,079	71.2%	200	4.6%	1,048	24.2%
Union	11,444	7,618	66.6%	2,104	18.4%	1,710	14.9%
Wallowa	4,101	3,155	76.9%	341	8.3%	605	14.8%

Note: The percentages listed above do not reflect the number of structures that are built within special flood hazard areas, or that are at risk of seismic damage.

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25024

Aside from location and type of housing, the year structures were built (Table 2-445) has implications. Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for the Cascadia earthquake fault (State of Oregon Building Codes Division, 2012). Therefore, homes built before 1994 are more vulnerable to seismic events.

Also in the 1970s, FEMA began assisting communities with floodplain mapping as a part of administering 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. Regionally about one half of the housing stock was built prior to 1970, before the implementation of floodplain management ordinances. About 80% of the housing stock was built before 1990 and the codification of seismic building standards.

Table 2-445. Age of Housing Stock in Region 7, 2012

	Total Housing Units	Pre 1970		1970 to 1989		1990 or later	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	609,062	36.4%	518,569	31.0%	545,962	32.6%
Region 7	28,698	14,574	50.8%	8,691	30.3%	5,433	18.9%
Baker	8,826	4,987	56.5%	2,150	24.4%	1,689	19.1%
Grant	4,327	2,249	52.0%	1,443	33.3%	635	14.7%
Union	11,444	5,326	46.5%	3,913	34.2%	2,205	19.3%
Wallowa	4,101	2,012	49.1%	1,185	28.9%	904	22.0%

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25034

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. Table 2-446 shows the initial and current FIRM effective dates for Region 7 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, Flood section.

Table 2-446. Community Flood Map History in Region 7

	Initial FIRM	Current FIRM
Baker County	Feb. 28, 1978	June 3, 1988
Baker City	Apr.17, 1984	June 3, 1988
Haines	June 3, 1988	June 3, 1988
Halfway	Sep. 24, 1984	June 3, 1988
Huntington	Sep 24, 1984	June 3, 1988
Sumpter	Sep 24, 1984	June 3, 1988
Grant County	Feb. 15, 1979	May 18, 1982
Canyon City	Sep 18, 1987	Sep 18, 1987
Dayville	Sep 24, 1984	Sep 24, 1984 (M)
John Day	Sep 15, 1977	Feb. 23, 1982
Long Creek	Sep 24, 1984	Sep 24, 1984 (M)
Monument	Sep 24, 1984	Sep 24, 1984 (M)
Mt. Vernon	Sep 18, 1987	Sep 18, 1987
Prairie City	Feb. 17, 1988	Feb. 17, 1988
Seneca	Sep 24, 1984	Sep 24, 1984 (M)
Spray	Aug. 16, 1988	Aug. 16, 1988 (M)
Union County	May 15, 1980	Apr. 3, 1996
Elgin	Nov. 15, 1978	Nov. 15, 1978
Island City	Nov. 15, 1978	Sep 30, 1987
La Grande	Sep 30, 1980	Apr.3, 1996
North Powder	Sep 29, 1978	Sep 29, 1987
Summerville	Jan. 15, 1980	Jan. 15, 1980 (M)
Union City	Dec.15, 1978	Dec. 15, 1978
Wallowa County	June 28, 1977	Feb. 17, 1988
Enterprise	Jan. 23, 1976	Feb. 17, 1988
Joseph	Dec. 5, 1975	Feb. 17, 1988
Lostine	Nov. 8, 1975	Feb. 17, 1988
Wallowa City	April 23, 1976	Feb. 17, 1988

(M) = no elevation determined; all Zone A, C, and X.

Source: Federal Emergency Management Agency, Community Status Book Report

State-Owned/Leased and Critical/Essential Facilities

In 2014 the Department of Geology and Mineral Industries updated the 2012 Oregon NHMP inventory and analysis of state-owned/leased facilities and critical/essential facilities. Results from this report relative to Region 7 can be found in **Table 2-447**. The region contains 1.9% of the total value of state-owned/leased critical/essential facilities.

Table 2-447. Value of State-Owned/Leased Critical/Essential Facilities in Region 7

	Total Property Value (State Facilities)	Percent State Total
Oregon	$7,339,087,023	100%
Region 7	$139,508,917	1.9%
Baker	$35,831,967	0.5%
Grant	$17,494,768	0.2%
Union	$71,475,427	1.0%
Wallowa	$14,706,756	0.2%

Source: DOGAMI

Built Environment Trends and Issues

The trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. Region 7 is largely a rural county with urban development focused along I-84 and around the population centers of Baker City, Enterprise, John Day, and La Grande. Union County has the only growing urban and rural populations in the region. All counties in the region have higher percentages of mobile homes compared to statewide numbers. Notably, about one quarter of all housing units in Grant County are mobile structures. Almost half the homes were built before 1970 and floodplain management standards, and 80% were built before 1990 and current seismic building standards. None of the region’s FIRMs have been modernized or updated. The region’s share of state-owned facilities are mostly within Union County.

2.3.7.3 Hazards and Vulnerability

Droughts

Characteristics

Drought is a common occurrence in the northeastern portion of the state. Every county in Region 7 has been impacted by drought on several occasions during the last 20 years. Together, winter snowpack and spring rains provide water for meeting a variety of needs. Extended drought conditions in this region can result in significant losses for the agriculture and tourism industries as well as increased fire danger.

Historic Drought Events

Table 2-448. Historic Droughts in Region 7

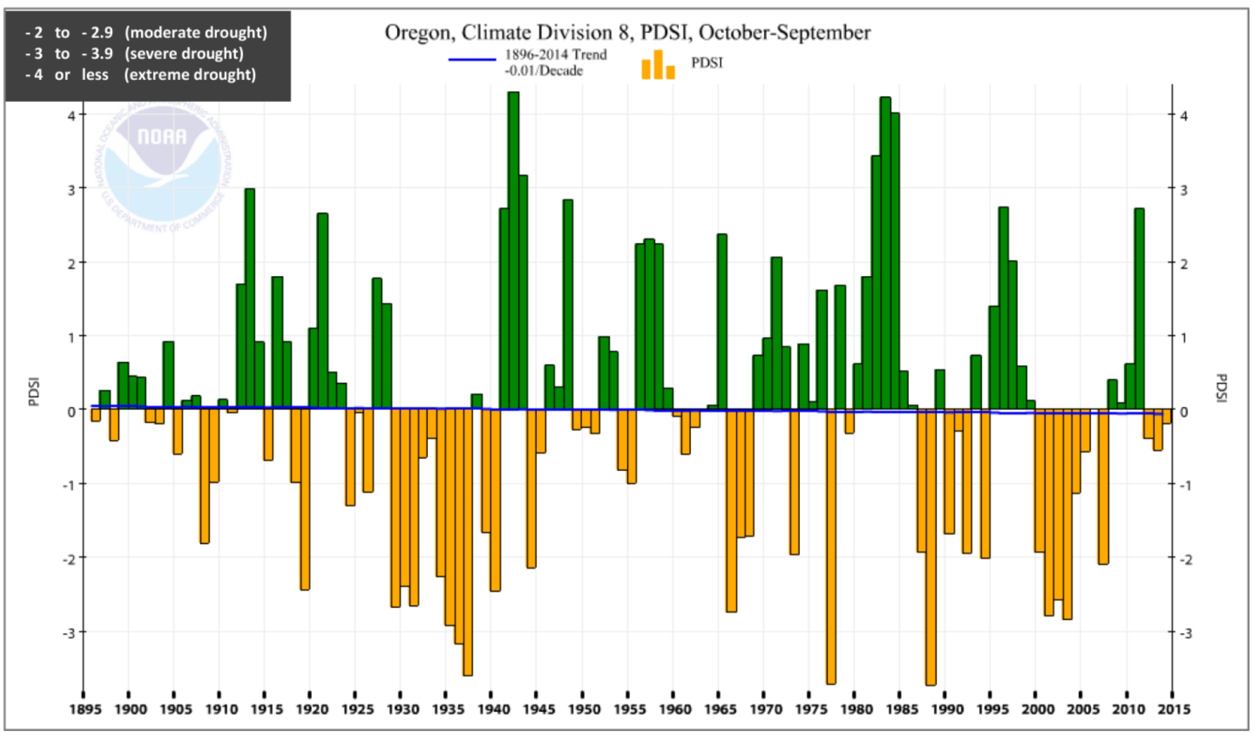
Year	Location	Description
1938-1939	statewide	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country
1977	N & S central Oregon; eastern Oregon	a severe drought for northeast Oregon
1994	Regions 4–8	in 1994, Governor's drought declaration covered 11 counties located within regions 4, 5, 6, 7, and 8
2002	southern and eastern Oregon	2001 drought declarations remain in effect for all counties, including Region 7's Baker, Union, and Wallowa Counties; Governor adds Grant County in 2002, along with five additional counties, bringing statewide total to 23 counties under a drought emergency.
2003	southern and eastern Oregon	Grant County 2002 declaration remains in effect through June 2003; Governor issues new declarations for Baker, Union, and Wallowa Counties, which are in effect through December 2003
2004	Region 5–8	Baker County receives Governor-declared drought emergency on June 2004, along with three other counties in neighboring regions
2005	Regions 5–7; 13 counties affected	Baker and Wallowa County receive a Governor drought declaration; all Region 5 counties affected, and most of Region 6 affected
2007	Regions 6–8	Grant, Baker, and Union Counties receive a Governor drought declaration; three other counties affected in neighboring regions
2013	Regions 5-8	Baker County receives a drought declaration, as well as four other counties in neighboring regions
2014	Regions 4, 6–8	Grant and Baker County receive drought declarations, including eight other counties in other regions

Sources: Taylor and Hatton (September 1999). The Oregon Weather Book: State of Extremes, and the Oregon Secretary of State's Archives Division. 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.

Historic drought information can be obtained from the National Climatic Data Center, which provides historical climate data showing wet and dry conditions, using the Palmer Drought Severity Index (PDSI) that dates back to 1895. The Palmer Index is not the best indicator of water availability for Oregon as it does not account for snow or ice (delayed runoff), but it has the advantage of providing the most complete, long-term record. [Figure 2-211](#) shows years where drought or dry conditions affected the north eastern area of Oregon (Climate Division 8).

Based on this index, 1936, 1937, 1977, and 1988 were severe drought years, while more than a dozen years in this record were moderate drought years.

Figure 2-211. Palmer Drought Severity Index for Region 7



Source: National Climatic Data Center, http://www.ncdc.noaa.gov/cag/

Probability and Vulnerability

As stated in the State Risk Assessment, **Section [2.2.2.4, Local and State Vulnerability Assessment Comparison](#)**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the probability that Region 7 will experience drought is shown in **Table 2-449**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-449. Local Probability Assessment of Drought in Region 7

	Baker	Grant	Wallowa	Union
Probability	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

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

Oregon has yet to undertake a comprehensive risk analysis for drought on a statewide basis, to determine probability or vulnerability for a given community. Considering historical statewide droughts and the number of drought declarations made in recent years, it is reasonable to assume that it is very likely that Region 7 will experience drought in the near future.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to drought is shown in **Table 2-450**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-450. Local Vulnerability Assessment of Drought in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	H	H	H	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Oregon has not undertaken a comprehensive statewide analysis to identify which communities are most vulnerable to drought. However, based on a review of drought declarations issued by the Governor, Baker County could be considered one of the communities most vulnerable to drought and its related impacts. Since 1992, Baker County has been under an emergency drought declaration on eight different occasions: 1992, 2001 (remained in effect during 2002), 2003, 2004, 2005, 2007, and 2013. This is only second to Klamath County in Region 6.

Dust Storms

Characteristics

The characteristics of dust storms in Region 7 are well described in the State Risk Assessment, **Dust Storms** section. There is little about the dust storms in this region that differs from the general description, except to note that agricultural practices likely play less of a role here than in Region 5. There are six examples of significant dust storms in this region that impacted Baker and Union Counties (**Table 2-451**).

Historic Drought Events

Table 2-451. Historic Dust Storms in Region 7

Date	Location	Description
Aug. 1905	Wallowa County	a dust storm described as “without a doubt the worst ever known in the history of the county” was said to be “the natural result of the long dry spell… there having been no rain since June” (Wallowa County Chieftain [Enterprise, Oregon], August 31, 1905)
May 1997	Union County	“blowing dust caused a three-car accident on Highway 82 between Island City and Imbler” (https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5597949)
Mar. 2004	Union County	“Sustained wind speeds between 20 and 30 mph kicked up blowing dust in the Grande Ronde Valley. Hunter Road and Booth Lane were closed due to low visibility caused by the dust storm.” (https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5388550)
Jan. 2008	Baker and Union Counties	ODOT closed the freeway’s westbound lanes between Baker City and La Grande about noon because of blowing snow, dust, and debris that created near-zero visibility in the Ladd Canyon area east of La Grande, leading to motor vehicle crashes
Dec. 2012	Union County	“The winds kicked up a dust storm in the Grande Ronde Valley near La Grande that was moderated slightly by patches of snow.” (Plus Media Solutions, December 21, 2012)
Sept. 2013	Baker County	dust storm occurred in and near Baker City

Source: Daily Mail, September 16, 2013; YouTube, Fredrik Anderson, September 12, 2013

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk

Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the probability that Region 7 will experience dust storms is shown in **Table 2-452**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-452. Local Probability Assessment of Dust Storms in Region 7

	Baker	Grant	Wallowa	Union
Probability	M	—	—	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The fact that three of the six storms noted occurred within the most recent 10 years of record suggests that the probability of these events may be increasing in Region 7. This hypothesis would benefit from more research.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to dust storms is shown in **Table 2-453**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-453. Local Vulnerability Assessment of Dust Storms in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	M	—	—	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Of all four counties in the region, Baker County is most vulnerable to dust storms. Union County is also vulnerable.

Poor visibility leading to motor vehicle crashes is the worst potential impact of these storms; often these crashes result in fatalities and major injuries. Other impacts include poor air quality, including dust infiltration of equipment and engines, loss of productive soil, and an increase in fine sediment loading of creeks and rivers.

Earthquakes

Characteristics

The geographic position of this region makes it susceptible to earthquakes from two sources: (a) shallow crustal events within the North America Plate, and (b) volcanic-earthquakes.

Region 7 contains high mountains and broad valleys. Although there is abundant evidence of faulting, seismic activity is low when compared with other areas of the state. Baker County probably has the most recorded seismic activity in the region. Not surprisingly, it appears to occur in the vicinity of Hells Canyon, an area with a complex geologic history. Several significant earthquakes have occurred in the region: the 1913 Hells Canyon; the 1927 and 1942 Pine Valley – Mountain; the 1965 John Day (M4.4); and the 1965 and 1966 Halfway (M4.3 and 4.2) (Table 2-454).

There are also a few identified faults in Union County that have been active in the last 20,000 years. The region has also been shaken historically by crustal earthquakes and prehistorically by subduction zone earthquakes centered outside the area (Table 2-454). All considered, there is good reason to believe that the most devastating future earthquakes in Region 7 would probably originate along shallow crustal faults.

Historic Earthquake Events

Table 2-454. Significant Earthquakes Affecting Region 7

Date	Location	Magnitude	Remarks
Approximate Years: 1400 BCE*, 1050 BCE, 600 BCE, 400, 750, 900	offshore, Cascadia Subduction Zone	probably 8-9	these are the mid-points of the age ranges for these six events
Jan. 1700	offshore, Cascadia Subduction Zone	about 9.0	generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Oct. 1913	Hells Canyon, Oregon	VI	damage unknown
Apr. 1927	Pine Valley-Cuddy Mountain, Oregon	V	damage unknown
June 1942	Pine Valley-Cuddy Mountain, Oregon	V	damage minor
Aug. 1965	John Day, Oregon	4.4	damage unknown
Nov. 1965	Halfway, Oregon	4.3	damage unknown
Dec. 1966	Halfway, Oregon	4.2	damage unknown

*BCE: Before Common Era.

Sources: University of Washington. List of Magnitude 4.0 or Larger Earthquakes in Washington and Oregon 1872-2002; and Wong and Bott, November 1995, A Look Back at Oregon’s Earthquake History, 1841-1994, *Oregon Geology*.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region7 will experience earthquakes is depicted **Table 2-455**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-455. Local Probability Assessment of Earthquakes in Region 7

	Baker	Grant	Wallowa	Union
Probability	M	L	L	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

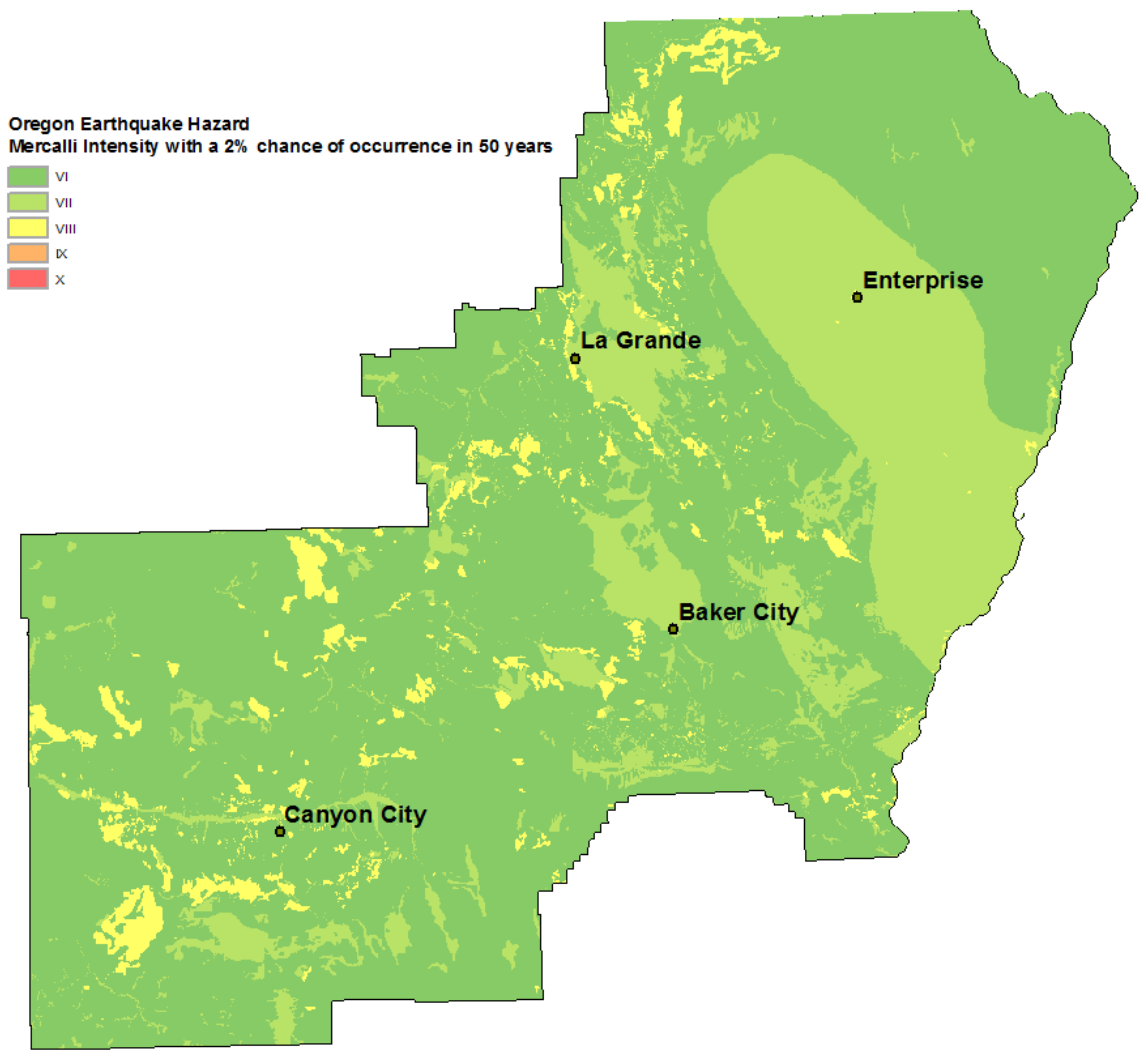
State Assessment

The probability of damaging earthquakes varies widely across the state. In Region 7, the hazard is dominated by local faults and background seismicity.

The probabilistic earthquake hazard for Region 7 is depicted in **Figure 2-212**. This map shows the expected level of earthquake damage that has a 2% chance of occurring in the next 50 years. This map is based on the 2008 USGS National Seismic Hazard Map and has been adjusted to account for the effects of soils following the methods of Madin and Burns (2013). In this case, the strength of shaking calculated as peak ground acceleration and peak ground velocity is expressed as Mercalli intensity, which describes the effects of shaking on people and structures. This map incorporates all that is known about the probabilities of earthquake on all Oregon faults, including the Cascadia Subduction Zone.

The Cascadia subduction zone is responsible for most of the hazard shown in **Figure 2-212**. The paleoseismic record includes 18 magnitude 8.8–9.1 megathrust earthquakes in the last 10,000 years that affected the entire subduction zone. The return period for the largest earthquakes is 530 years, and the probability of the next such event occurring in the next 50 years ranges from 7 to 12%. An additional 10–20 smaller, magnitude 8.3–8.5, earthquakes affected only the southern half of Oregon and northern California. The average return period for these is about 240 years, and the probability of a small or large subduction earthquake occurring in the next 50 years is 37–43%.

Figure 2-212. Probabilistic Earthquake Hazard in Region 7



Color zones show the maximum level of earthquake shaking and damage (Mercalli Intensity Scale) expected with a 2% chance of occurrence in the next 50 years. A simplified explanation of the Mercalli levels is:

VI	Felt by all, weak buildings cracked;
VII	Chimneys break, weak buildings damaged, better buildings cracked;
VIII	Partial collapse of weak buildings, unsecured wood frame houses move;
IX	Collapse and severe damage to weak buildings, damage to wood-frame structures; and
X	Poorly built structures destroyed, heavy damage in well-built structures.

Source: Madin and Burns (2013)

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to earthquakes is shown in **Table 2-456**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-456. Local Vulnerability Assessment of Earthquakes in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	M	M	L	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Region 7 is considered moderately vulnerable to earthquake hazards due to earthquake-induced landslides, liquefaction, and ground shaking.

In 2007, DOGAMI (Lewis, 2007) 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 a total of 3,349 buildings, giving each 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 (Lewis, 2007). 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 prioritize buildings for further study. Results are found in **Table 2-457**, **Table 2-458**, and **Table 2-459**.

Table 2-457 shows the number of school and emergency response buildings surveyed in each county with their respective rankings.

Table 2-457. Buildings with Their Collapse Potential in Region 7

County	Level of Collapse Potential			
	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Baker	4	15	6	8
Grant	12	2	15	17
Union	10	6	14	24
Wallowa	10	2	10	3

Source: Lewis (2007)

Table 2-458. Projected Dollar Losses in Region 7, Based on an M8.5 Subduction Event and a 500-Year Model

	Economic Bae in Thousands (1999)	Greatest Absolute Loss in Thousands (1999) from a (M) 8.5 CSZ Event	Greatest Absolute Loss in Thousands (1999) from a 500-Year Event
Baker County	$943,000	Less than $1,000	$13,000
Grant County	$415,000	Less than $1,000	$3,000
Union County	$1,237,000	Less than $1,000	$9,000
Wallowa County	$444,000	Less than $1,000	$8,000

Source: Wang and Clark (1999)

Table 2-459. Estimated Losses in Region 7 Associated with a 500-Year Model

	Baker	Grant	Union	Wallowa	Remarks
Injuries	3	0	1	1	
Deaths	0	0	0	0	
Displaced households	10	0	1	1	
Operational the day after the quake[1]:					
Fire stations	N/A	N/A	N/A	N/A	
Police stations	N/A	N/A	N/A	N/A	
Bridges	N/A	N/A	N/A	N/A	
Economic losses to:					
Highways	$5 mil	$3 mil	$1 mil	0	
Airports	$2 mil	$2 mil	$618,000	$3 mil	
Communications	$1,000	$469,900	$$479,000	$116,000	
Debris generated (thousands of tons)	8	1	5	4	

The Hazus run that produced the data in this table did not account for unreinforced masonry buildings.

[1]The 500-year model includes several earthquakes; the number of facilities operational the day after the earthquake cannot be calculated.

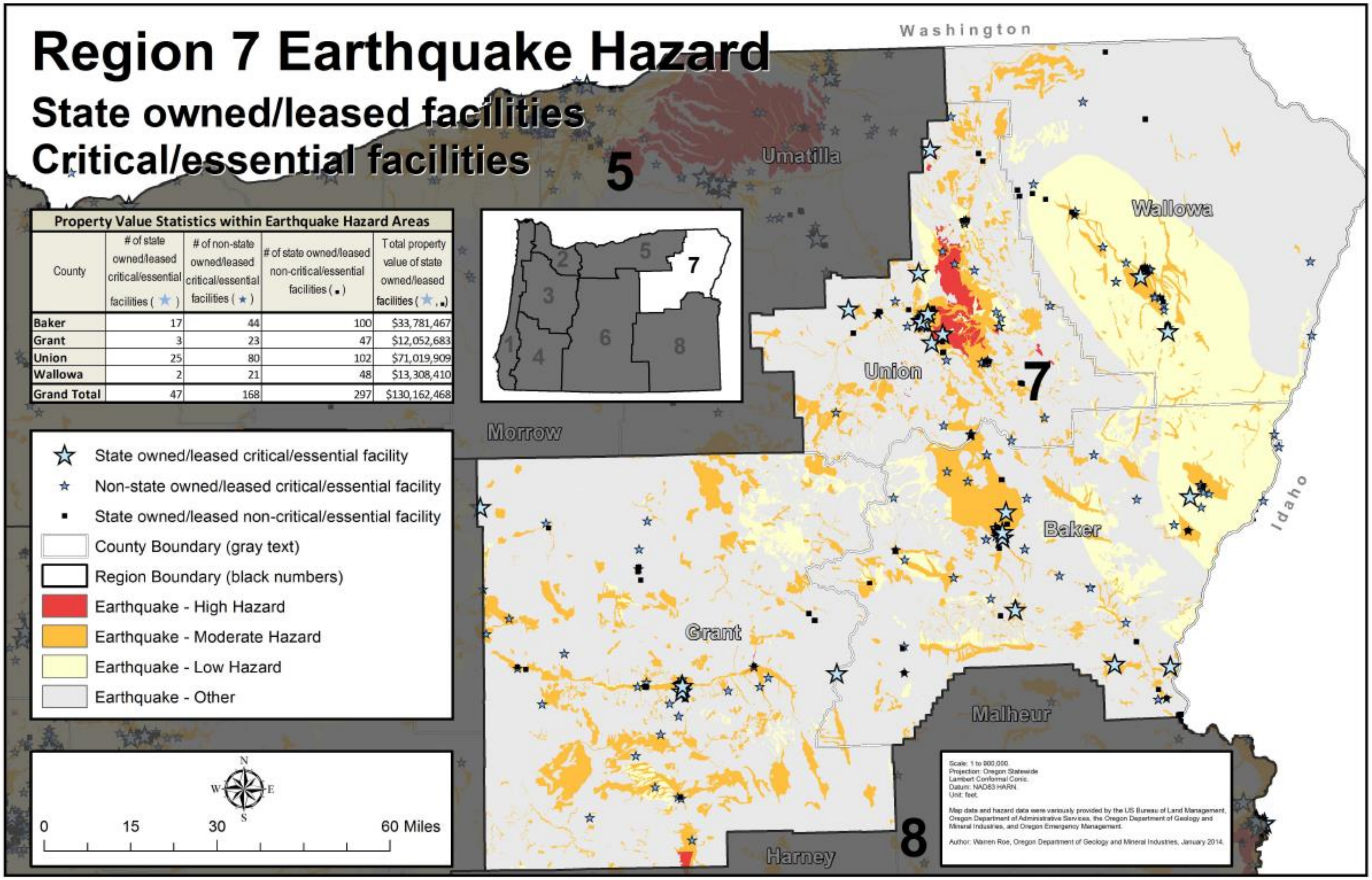
Source: Wang and Clark (1999)

STATE-OWNED/LEASED FACILITIES AND CRITICAL AND ESSENTIAL FACILITIES

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of 5,693 state facilities evaluated, 344 totaling $130 million fall into an earthquake hazard zone in Region 7 (**Figure 2-213**). Among the 1,141 critical/essential state facilities, 47 are in an earthquake hazard zone in Region 7. Additionally, 168 non-state critical/essential facilities in Region 7 are located in an earthquake hazard zone.

Figure 2-213. State-Owned/Leased Facilities and Critical/Essential Facilities in an Earthquake Zone in Region 7



Property Value Statistics within Earthquake Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Baker	17	44	100	$33,781,467
Grant	3	23	47	$12,052,683
Union	25	80	102	$71,019,909
Wallowa	2	21	48	$13,308,410
Grand Total	47	168	297	$130,162,468

Source: DOGAMI

SEISMIC LIFELINES

According to the Oregon Department of Transportation's (ODOT) Oregon Seismic Lifeline Report (OSLR; see **Appendix 9.1.13**), the projected impacts of a CSZ event are considered negligible in this part of the state. Therefore, this region was not part of the OSLR study. However, ODOT did provide the following descriptions of general impacts a CSZ would have on Region 8's seismic lifelines, and the region's overall vulnerability.

REGIONAL IMPACT. Within this region, adverse impacts from the CSZ event and secondary hazards (landslides, liquefaction, etc.) are not anticipated, but damage to I-84 to the west and damage to the Columbia River's freight functions could impact the region's economy.

REGIONAL LOSS ESTIMATES. Losses in this region are expected to be nonexistent to low locally. Economic disruption from major losses in the larger markets of the state will affect the economy in this region.

MOST VULNERABLE JURISDICTIONS. Vulnerability of this whole region to a CSZ event is low. Loss of life, property, and business are not expected to be issues in this area. However, impacts to import and export infrastructure and basic supply lines could have short- to mid-term economic impacts. With an intact surface transportation system to the east, adaptation is expected to be relatively easy.

Floods

Characteristics

The Blue Mountain area of northeastern Oregon is quite distinct from the rest of the state in landform and climate. Nevertheless, its principal flood problems are similar to those found elsewhere in Oregon. The most damaging floods have occurred during the winter months, when warm rains from tropical latitudes melt mountain snow packs. Such conditions were especially noteworthy in February 1957, February 1963, December 1964, and January 1965. Somewhat lesser flooding has been associated with ice jams, normal spring runoff, and summer thunderstorms. Heavily vegetated stream banks, low stream gradients (e.g., Grande Ronde Valley), and breeched dikes have contributed to past flooding at considerable economic cost. Region 7 counties also have experienced flooding associated with low bridge clearances, over-topped irrigation ditches, and natural stream constrictions such as Rhinehart Gorge between Elgin and Imbler in Union County.

Historic Flood Events

Table 2-460. Significant Historic Floods Affecting Region 7

Date	Location	Description	Type of Flood
1894*	NE Oregon	widespread flooding	not recorded
1910*	NE Oregon	widespread flooding	not recorded
1917*	NE Oregon	widespread flooding	not recorded
1932*	NE Oregon	widespread flooding	not recorded
1935*	NE Oregon	widespread flooding	not recorded
May 1948	Columbia Basin / NE Oregon	unusually large mountain snow melt produced widespread flooding	snow melt
Dec. 1955 – Jan. 1956	Snake and Columbia basins	warm rain melted snow; runoff on frozen ground	rain on snow
Dec. 1964	entire state	widespread, very destructive flooding; warm rain, melted snow; runoff on frozen ground	rain on snow
Jan. 1974	much of state	warm rain / melted snow / runoff on frozen ground	rain on snow
Feb. 1986	entire state	warm rain / melted snow / runoff on frozen ground	rain on snow
June 1986	Wallowa County	severe thunderstorm / rain and hail / flash flooding	thunderstorm
May 1991	Union and Baker Counties	warm rain / melted snow; considerable damage to cropland and highways; a number of bridges destroyed	rain on snow
May 1998	eastern and central Oregon	persistent rains; widespread damage	rain on snow
July 2004	Union	$5,000 in property damage	
May 2008	Union and Wallowa Counties	flooding along Catherine Creek and Grande Ronde River damaged roads in Union County, causing $30,000 in damages; in Wallowa County the Imnaha River crested above flood stage	rain on snow
May 2011	Grant and Union Counties	heavy rainfall on above-average snowpack caused flooding to low lying areas of Grant and Union Counties; over $2.6 in property damage	rain on snow

Source: Taylor and Hatton (1999)

Source: Taylor and Hannan, 1999, The Oregon Weather Book, pp. 96-103; and FEMA, Baker County Flood Insurance Study (FIS), 06/03/88; FEMA, Grant County Flood Insurance Study (FIS) 05/18/82; FEMA, Union County Flood Insurance Study (FIS), 04/03/96; FEMA, Wallowa County Flood Insurance Study (FIS), 02/17/88.

Source: Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org

Source: U.S. Department of Commerce. National Climatic Data Center. Available from http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms

Table 2-461. Principal Flood Sources by County in Region 7

Baker County	Grant County	Union County	Wallowa County
Powder River	North Fork John Day River	Grande Ronde River	Wallowa River
Old Settler's Slough	South Fork John Day River	Catherine Creek	Minam River
Pine Creek	Middle Fork John Day River	North Powder River	Lostine River
Eagle Creek	Canyon Creek	Little Creek	Grande Ronde River
Summit Creek	Cottonwood Creek	Gekeler Slough	Wenaha River
Rock Creek	Prairie Creek	Taylor Creek	Imnaha River
Mill Creek		Fresno Creek	Hurricane Creek
Marble Creek		Clark Creek	Prairie Creek
Stices Gulch		Indian Creek	
Snake River		Wolf Creek	
Burnt River			

Sources: FEMA, Baker County Flood Insurance Study (FIS), 06/03/88; FEMA, Grant County Flood Insurance Study (FIS) 05/18/82; FEMA, Union County Flood Insurance Study (FIS), 04/03/96; FEMA, Wallowa County Flood Insurance Study (FIS), 02/17/88.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 7 will experience flooding is shown in **Table 2-462**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-462. Local Probability Assessment of Flooding in Region 7

	Baker	Grant	Wallowa	Union
Probability	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Oregon's most severe flooding occurs between November and February and most floods are associated with a period of intense warm rain on a heavy mountain snow pack. These periods of flooding coincide with La Niña conditions during the winter months when very moist subtropical air follows a heavy, wet snowfall. Climate records indicate that La Niña conditions occur on average about every 3 to 6 years. Climatologists speculate that Oregon has moved from a long-term El Niño period (1975–1994) with milder, drier air, to a long-term La Niña period, characterized by cool, wet weather, abundant snow, and floods. A historical overview of flooding is shown in **Table 2-460**.

All of the Region 7 counties have Flood Insurance Rate (FIRM) maps; however, old maps do not reflect present flood conditions. The most recent FIRM maps are as follows:

- Baker, June 3, 1988;
- Grant, May 18, 1982;
- Union, April 3, 1996; and
- Wallowa, February 17, 1988.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the region's vulnerability to flooding is shown in **Table 2-463**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-463. Local Vulnerability Assessment of Floods in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	M	H	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The Oregon Department of Land Conservation and Development (DLCD) created a countywide flood vulnerability index by compiling data from NOAA's Storm Events Database and from FEMA's National Flood Insurance Program. Data were calculated statewide for the period 1978 through 2013 for five input datasets: number of events, structure and crop damage estimates in dollars and NFIP claims number and dollar amounts. The mean and standard deviation were calculated for each input. Then, each county was assigned a score ranging from 0 to 3 for each of these inputs according to **Table 2-464**.

Table 2-464. Scoring for Vulnerability Index

Score	Description
3	county data point is greater than 2.5 times standard deviation for the input data set
2	county data point is greater than 1.5 times standard deviation for the input data set
1	county data point is within standard deviation
0	no data reported

Source: DLCD

DLCD summed the scores for each of the five inputs to create a county-by-county vulnerability index. The maximum possible score is 15. A score over 6 indicates that at least one variable significantly exceeds average values.

The counties in this region all received a flood vulnerability score of 5. These are all very low population counties, so the low vulnerability score may be misleading with respect to a flood's effect on the population centers in the region.

FEMA has identified two Repetitive Loss properties in Region 7, neither of which is a Severe Repetitive Loss property (FEMA NFIP BureauNet, http://bsa.nfipstat.fema.gov/, accessed 12/1/2014).

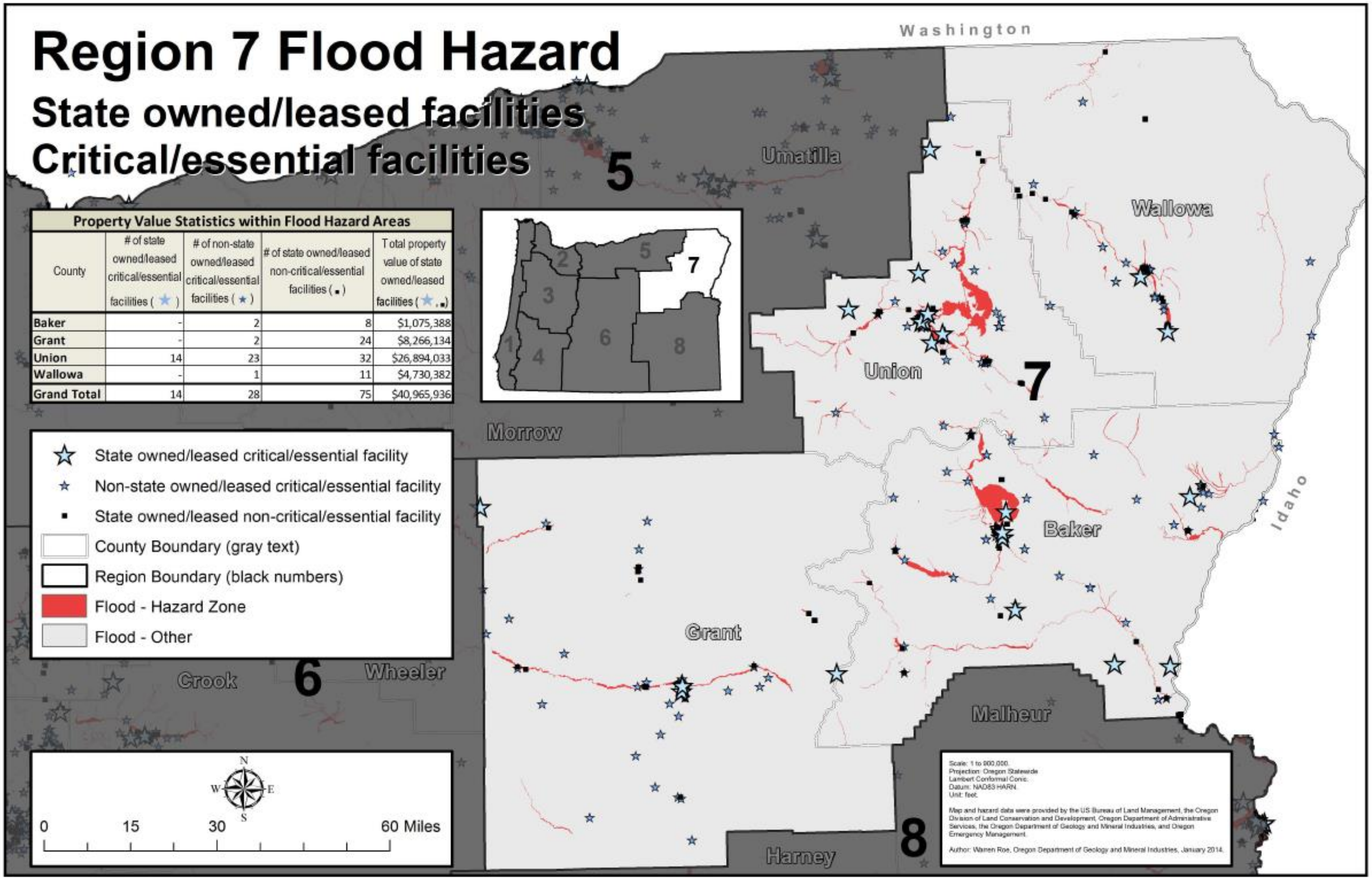
Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS) Program, which results in reduced flood insurance costs. No Region 7 communities participate in the CRS Program.

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of the 5,693 state facilities evaluated, 89 are currently located within a flood hazard zone in Region 7 and have an estimated total value of $41 million (**Figure 2-214**). Of these, 14 are identified as a critical or essential facility. An additional 28 non-state-owned/leased critical/essential facilities are located in a flood hazard zone in Region 7.

Figure 2-214. State-Owned/Leased Facilities and Critical/Essential Facilities in a Flood Hazard Area in Region 7



Property Value Statistics within Flood Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Baker	-	2	8	$1,075,388
Grant	-	2	24	$8,266,134
Union	14	23	32	$26,894,033
Wallowa	-	1	11	$4,730,382
Grand Total	14	28	75	$40,965,936

Source: DOGAMI

Landslides

Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. In general, the Blue Mountains and Wallowa Mountains have a moderate to high incidence of landslides. On occasion, major landslides sever major transportation routes such as U.S. or state highways and rail lines, causing temporary but significant economic damage.

Landslides occur throughout Region 7 but to a much lesser extent than in western Oregon. In general, northeastern Oregon soil profiles are shallow and rainfall is less frequent and intense than in the western portion of the state. Most Region 7 landslides occur within the I-84 corridor, OR-82 (Union County), OR-86 (Baker County), OR-19 (Grant County), and OR-3 (Wallowa County). Notable slides include the 1984 Hole-in-the-Wall slide, which dammed the Powder River in Baker County, and the often-troublesome Whopper Slide near Elgin in Union County. In 1928, two people were killed in a landslide while working on a railroad near Baker City.

Historic Landslide Events

Table 2-465. Significant Landslides in Region 7

Date	Location	Description
May 2003	Grant County, Oregon	Property damage: $1,000

Source: Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 7 will experience landslides is shown in **Table 2-466**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-466. Local Probability Assessment of Landslides in Region 7

	Baker	Grant	Wallowa	Union
Probability	H	H	M	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Landslides are found in every county in Oregon. There is a 100% probability of landslides occurring in this region in the future. Although we do not know exactly where and when they will occur, they are more likely to happen in the general areas where landslides have occurred in the past. Also, they will likely occur during heavy rainfall events or during a future earthquake.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to landslides is shown in **Table 2-467**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-467. Local Vulnerability Assessment of Landslides in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	M	M	L	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

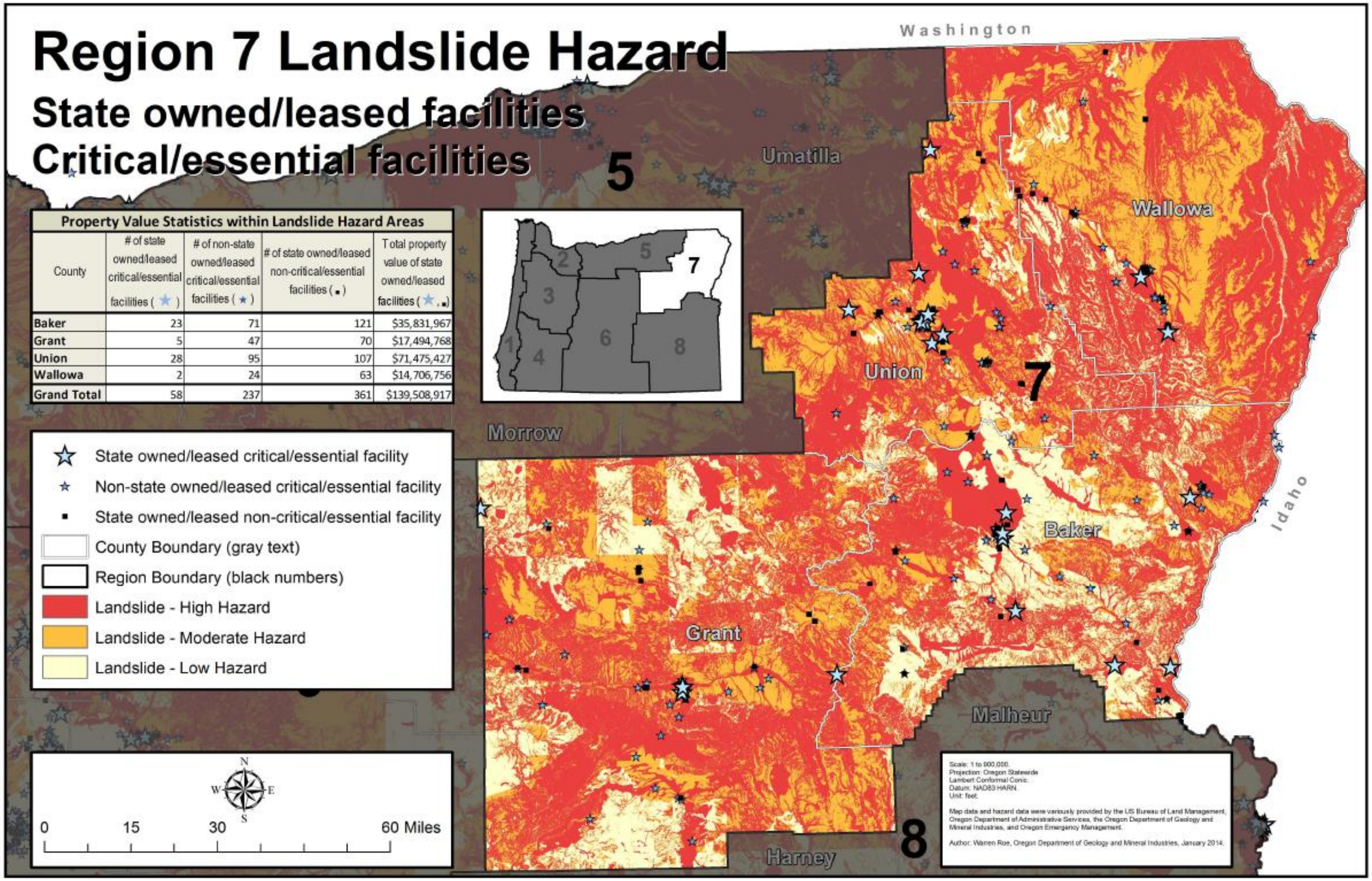
Although there are fewer historic landslides in this region than most others, the SLIDO-2 landslide inventory indicates a moderate to high hazard. Baker, Union, and Grant Counties all have approximately 500 mapped landslides in SLIDO-2. The communities located in areas of steeper slopes will likely have the highest vulnerability.

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 419 are located within landslide hazard areas in Region 7, and are valued at $139.5 million (**Figure 2-215**). This includes 58 critical or essential facilities. An additional 237 critical/essential facilities, not owned/leased by the state, are also located within a landslide hazard zone in Region 7.

Figure 2-215. State-Owned/Leased Facilities and Critical/Essential Facilities in a Landslide Hazard Zone in Region 7



County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Baker	23	71	121	$35,831,967
Grant	5	47	70	$17,494,768
Union	28	95	107	$71,475,427
Wallowa	2	24	63	$14,706,756
Grand Total	58	237	361	$139,508,917

Source: DOGAMI

Volcanoes

Characteristics

The volcanic Cascade Range is not within Region 7 counties; consequently, the risk from local volcano-associated hazards (e.g., lahars, pyroclastic flows, lava flows, etc.) is considered nil. However, there is some risk from volcanic ash. This fine-grained material, blown aloft during a volcanic eruption, can travel many miles from its source. For example, during the May 1980, Mount St. Helens eruption, the cities of Yakima and Spokane, Washington, 80 and 160 miles away, respectively, were inundated with ash. Ash can reduce visibility to zero and bring street, highway, and air traffic to an abrupt halt. The material is noted for its abrasive properties and is especially damaging to machinery.

Ashfall is largely controlled by the prevailing wind direction. The predominant wind direction over the Cascade Range is from west to east. Previous eruptions documented in the geologic record indicate most ashfall drifting to and settling in areas east of the Cascade volcanoes.

Historic Volcanic Events

Table 2-468. Historic Volcanic Events in Region 7

Date	Location	Description
May 1980	northeast Oregon	trace amounts of ashfall from Mount St. Helens

Source: Reports of local geologists present in northeast Oregon in May of 1980.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 7 will experience volcanic hazards is shown in **Table 2-469**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-469. Local Probability Assessment of Volcanic Activity in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	L	L	L	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Mount St. Helens remains a probable source of airborne ash. It has repeatedly produced voluminous amounts of this material and has erupted much more frequently in recent geologic time than any other Cascade volcano. It blanketed Yakima and Spokane, Washington during the 1980 eruption and again in 2004.

The eruptive history of the Cascade volcanoes can be traced to late Pleistocene times (approximately 700,000 years ago) and will no doubt continue. But the central question remains: When? The most recent series of events at Newberry Volcano, which occurred about 1,300 years ago, consisted of lava flows and ashfall. Newberry Volcano's recent history also includes pyroclastic flows and numerous lava flows. Volcanoes in the Three Sisters region, such as Middle and South Sister, and at Crater Lake have also erupted explosively in the past. These eruptions have produced pyroclastic flows, lava flows, lahars, debris avalanches, and ash. Any future eruptions at these volcanoes would most likely resemble those that have occurred in the past.

Geoscientists have provided some estimates of future activity in the vicinity of Newberry Caldera and its adjacent areas. They estimate a 1 in 3,000 chance that some activity will take place in a 30-year period. The estimate for activity at Crater Lake for the same time period is significantly smaller at 0.003 to 0.0003. In the Three Sisters region, the probability of future activity is roughly 1 in 10,000 but any restlessness would greatly increase this estimate.

The location, size, and shape of the area affected by ash are determined by the vigor and duration of the eruption and the wind direction. Because wind direction and velocity vary with both time and altitude, it is impossible to predict the direction and speed of ash transport more than a few hours in advance (Walder et al., 1999). Mount St. Helens is about 250 air miles from the City of Enterprise (Wallowa County), consequently placing that community at risk. Mount Jefferson, located about 150 miles west of the City of John Day, is a possible but unlikely source. The annual probability of 1 cm or more of ash accumulation within the Region 7 counties, from any Cascade volcano, is about 1 in 5,000 (Sherrod et al., 1997).

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to volcanic activity is shown in **Table 2-470**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-470. Local Vulnerability Assessment of Volcanic Activity in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	L	H	L	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The region's vulnerability to the effects of volcanic eruptions is low. Areas in Region 7 could be affected by ashfall from Cascade volcanic eruptions. Most of the region's people and infrastructure are located in the major cities along I-84, US-26, and US-395. The communities most vulnerable to volcano-related hazards in the region are La Grande, Baker City, and John Day.

Wildfires

Characteristics

The area has a significant history of human-caused fires in the Region 7. In addition, the prevalence of summer thunderstorms in the mountainous and timbered regions of eastern Oregon suggests the potential for lightning-caused fires. Most areas do not have structural fire protection available and some areas do not even have wildland fire protection.

While the rates of urban and rural residential development have declined statewide, they have increased in Eastern Oregon's non-federal forests, potentially impacting fire protection capability. There are now 3 times as many dwellings on non-federal wildland forest in Eastern Oregon as in 1975. Dwelling density is increasing at a faster rate in Eastern Oregon's fire-prone forests than in western Oregon's. Development ranges from homes with city services to seasonal-use recreational cabins. Many isolated clusters of private timberland have been bought and developed into home sites and recreational communities.

Historic Wildfire Events

Table 2-471. Significant Wildfires in Region 7

Year	Name of Fire	Location	Acres Burned	Remarks
1986	Clear	Baker, Grant, Union	6,000	lightning caused (?)
1988	Turner	Baker, Union, Grant	8,000	
1989	Dooley Mountain	Baker		
1989	Stices Gulch	Baker		
1996	Sloan's Ridge	Baker, Grant	10,000	
1996	Wildcat	Grant	10,303	
1999	Cummings Creek	Grant		
2000	Carrol Creek	Grant	3,197	
2000	Thorn	Wallowa	4035	
2001	Monument Complex	Grant		
2001	Horse Creek	Wallowa	16,309	
2002	Malheur Complex/Flagtail	Grant	21,641	
2003	Lightning Creek Complex	Wallowa	16,028	1 structure was lost
2007	Battle Creek Complex	Wallowa	79,299	
2007	Cottonwood Creek	Wallowa	8,100	
2013	Grouse Mountain	Grant	12,076	threatened the town of John Day

Sources: Wallowa-Whitman National Forest (Baker City), 2002; Oregon Department of Forestry, 2013

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 7 will experience wildfires is shown in **Table 2-472**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-472. Local Probability Assessment of Wildfire in Region 7

	Baker	Grant	Wallowa	Union
Probability	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

A combination of climate, fuels, and terrain make this region prone to wildfire. The poor ecological health of the forested ecosystem, particularly in the greater Blue Mountains area, is well documented in federal and scientific reports. Past timber management practices, fire exclusion, and the subsequent buildup of forest fuels have significantly changed the vegetation composition in this region over time. The simplification of stand structure (unnaturally dense) and shift in species composition over time, combined with low precipitation and competition for limited water and nutrients, increases the probability of insect, disease epidemics, and large-scale fire.

A significant number of lightning storms pass through during the summer and fall months, starting many fires that can easily strain wildland firefighting resources. With fuels and low relative humidity, the probability for large fires can significantly increase during lightning events. The number of days per season that these conditions exist is also important to consider.

Over three quarters of all fire starts are attributed to lightning, with a higher percentage of lightning starts on public lands than on private lands. ODF reports a slightly higher percentage of human-caused fires where human activity is more prevalent.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to wildfire is shown in **Table 2-473**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-473. Local Vulnerability Assessment of Wildfire in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	H	H	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Based on data from the 2013 West Wide Wildfire Risk Assessment, in Region 7, Grant, Union and Wallowa Counties have high percentages of wildland acres subject to Fire Risk, Fire Effects, and Fire Threat, making them especially vulnerable.

In addition, each year a significant number of people build homes within or on the edge of the forest (urban-wildland interface areas), thereby increasing vulnerability. These communities have been designated "Wildland-Urban Interface Communities" and are listed in **Table 2-474**.

A large wildfire could eliminate valuable timber or rangeland for grazing, which might affect local businesses and industry. Recreational areas that draw tourists would also be impacted. Wildlife habitat and diversity, as well as threatened and endangered species of fish, wildlife, and plant life could be annihilated or severely harmed in the long-term depending on the intensity of the wildfire. Water quality could be impacted if a moderate to high intensity wildfire burned through watersheds, affecting the health of fish and wildlife as well as domestic water supplies for residents.

Many communities in this area are located a long distance from fire stations, which will result in longer response times. There are areas with a single access road that could impair ingress and egress during emergencies. Many homes do not have defensible space and would be difficult to protect from and oncoming fire. Response efforts are further hindered by the lack of water resources in the most vulnerable locations.

Region 7 is characterized as having heavy fuel loading on forestlands with a high potential for crown fires, which are very difficult to extinguish. The slopes are steep and carry fire quickly to upland flashy fuels and crowns. Ignition potential is also high, as many people visit the area.

Table 2-474. Wildland-Urban Interface Communities by County in Region 7

Baker	Grant	Union	Wallowa
Anthony Lakes Resort	Austin	Camp Elkanah	Alder
Baker Valley	Bates	Cove	Eden
Bourne	Canyon City	Elgin	Enterprise
Cornucopia	Dayville	Hilgard	Flora
Durkee	Granite	Kamela	Freezeout Creek
Greenhorn	John Day	Medical Springs	Grouse
Halfway / Pine Valley	Long Creek	Morgan Lake	Hurricane Grange
Keating	Monument	Mt. Emily	Imnaha River Woods
Powder River	Mount Vernon	Palmer Junction	Imnaha
Rattlesnake Estates	Prairie City	Perry	Joseph
Richland	Seneca	South Fork Catherine Creek	Lostine
Sparta			Minam
Stices Gulch		Starkey	Prairie Creek
Sumpter / Sumpter Valley		Union	Promise
			South Fork Lostine River Subdivision
			Ski Run / Ski Run Road
			Troy
			Wallowa Lake Basin
			Wallowa Slope / Canyon

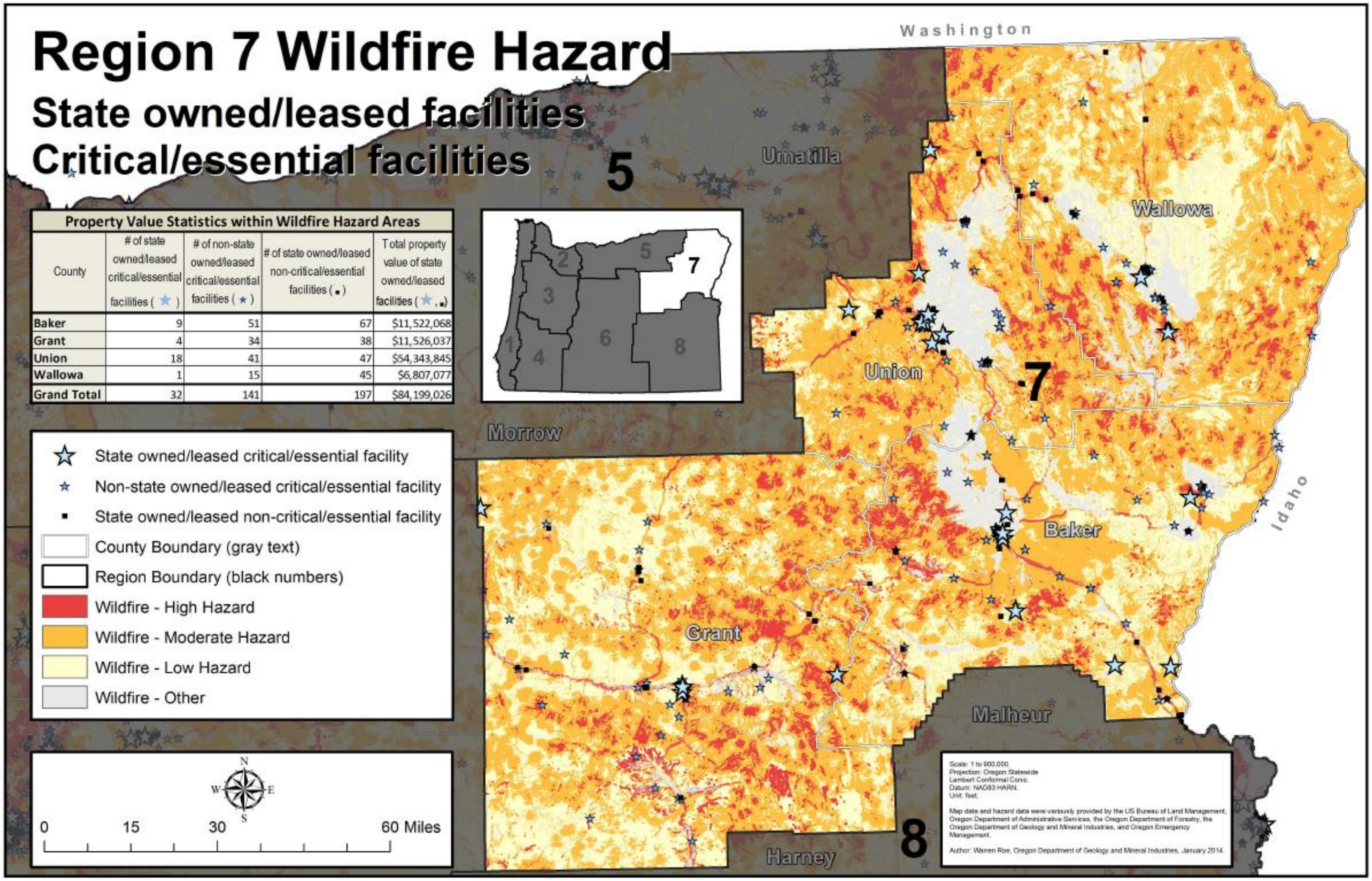
Source: Oregon Department of Forestry Statewide Forest Assessment, September 2006

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 229 are within a wildfire hazard zone in Region 7 and total roughly $84 million in value (**Figure 2-216**). Among those, 32 are state critical/essential facilities. An additional 141 non-state critical/essential facilities are also located in Region 7.

Figure 2-216. State-Owned/Leased Facilities and Critical/Essential Facilities in a Wildfire Hazard Zone in Region 7



Property Value Statistics within Wildfire Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Baker	9	51	67	$11,522,068
Grant	4	34	38	$11,526,037
Union	18	41	47	$54,343,845
Wallowa	1	15	45	$6,807,077
Grand Total	32	141	197	$84,199,026

Source: DOGAMI

Windstorms

Characteristics

Extreme winds (other than tornadoes) are experienced in all of Oregon's eight regions. The most persistent high winds occur along the Oregon Coast and the Columbia River Gorge, so much so that these areas have special building code standards. This is not the case in the Blue Mountains, although high winds in the valleys are not uncommon. For example, the residents of Union County's Grande Ronde Valley caution newcomers about living in the vicinity of Ladd Canyon, known for its high winds.

Historic Windstorm Events

Table 2-475. Historic Windstorms in Region 7

Date	Affected Area	Characteristics
Apr. 1931	northeast Oregon	unofficial wind speeds reported at 78 mph; damage to fruit orchards and timber
Nov. 10-11, 1951	statewide	widespread damage; transmission and utility lines; wind speed 40–60 mph; gusts 75–80 mph
Dec. 1951	statewide	wind speed 60 mph in Willamette Valley; 7-mph gusts; damage to buildings and utility lines
Dec. 1955	statewide	wind speeds 55–65 mph with 69-mph gusts; considerable damage to buildings and utility lines
Nov. 1958	statewide	wind speeds at 51 mph with 71-mph gusts; every major highway blocked by fallen trees
Oct. 1962	statewide	Columbus Day Storm; Oregon's most destructive storm to date; 116-mph winds in Willamette Valley; estimated 84 houses destroyed, with 5,000 severely damaged; total damage estimated at $170 million
Mar. 1971	most of Oregon	greatest damage in Willamette Valley; homes and power lines destroyed by falling trees; destruction to timber in Lane County
Jan. 1986	northeast Oregon	wind gusts 80–90 mph; heavy drifting snow in Ladd Canyon (Union County)
Dec. 1990	Wallowa County	severe wind storm
Mar. 1991	northeast Oregon	severe wind storm
Dec. 1991	northeast Oregon	severe wind storm
Dec. 1992	northeastern mtns., Oregon	severe wind storm
May 2003	Union County	$1,000 in property damage
June 2003	Wallowa County	$1,000 in property damage
July 2003	Union County	$30,000 in property damage
Oct. 2003	Wallowa County	$1,000 in property damage
Oct. 2003	Union County	$2,000 in property damage
Jan. 2004	Grant and Wallowa Counties	$500 in property damage
Feb. 2004	Union	$1,000 in property damage
Mar. 2004	Union County	$200 in property damage
July 2004	Union County	$300,000 in property damage
Nov. 2004	Union County	$1,000 in property damage
Jan. 2005	Union County	$10,000 in property damage
Nov. 2005	Union County	$100 in damages from a strong wind storm
Nov. 2006	Union and Wallowa Counties	$35,000 in damages from a wind storm with wind speeds measured at 80 mph; Morrow and Umatilla Counties also affected, causing a total storm damage of $70,000
Nov. 2007	Wallowa County	$500,000 in damages from a windstorm near Wallowa Lake State Park
July 2011	Union County	$2,000 in property damage

Sources: Taylor and Hatton (1999); Hazard Mitigation Team Survey Report, *Severe Windstorm in Western Oregon*, February 7, 2002 (FEMA-1405-DR-OR); Hazards and Vulnerability Research Institute (2007), The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database], Columbia, SC: University of South Carolina, http://hvri.geog.sc.edu/SHELDUS/.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 7 will experience windstorms is shown in **Table 2-476**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-476. Local Probability Assessment of Windstorms in Region 7

	Baker	Grant	Wallowa	Union
Probability	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The 100-year storm in Region 7 is defined as one-minute average winds of 90 mph. A 50 year storm is one-minute average winds of 80 mph. The 25-year event consists of average winds of 70 mph.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to windstorm is shown in **Table 2-477**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-477. Local Vulnerability Assessment of Windstorms in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	H	H	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Many buildings, utilities, and transportation systems within Region 7 are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It also is 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, which can affect emergency operations. In addition, uprooted 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. Many roofs have been destroyed when uprooted trees growing next to a house fall during a windstorm. In some situations, strategic pruning may be the answer. Prudent counties will work with utility companies to identify problem areas and establishing a tree maintenance and removal program.

Winter Storms

Characteristics

Severe winter weather in Region 7 can be characterized by extreme cold, snow, ice, and sleet. There are annual winter storm events in Region 7 with an average of 24 inches of snow; most communities are prepared for them. In the elevated areas of the Wallowa Mountains severe winter storms are more frequent and the snowfall is much heavier. Moderate to heavy snowfall is prepared for and expected on an annual basis in this region. Heavier snowfall is expected and planned for in the areas of the Wallowa Mountains of the region as the elevation gets higher.

Historic Winter Storm Events

Table 2-478. Severe Winter Storms in Region 7

Date	Location	Remarks
Dec. 1861	entire state	storm produced 1–3 feet of snow throughout Oregon
Dec. 1892	northern counties, Oregon	15–30 inches of snow fell throughout the northern counties
Jan. 1916	entire state	two storms; heavy snowfall, especially in mountainous areas
Jan. and Feb. 1937	entire state	deep snow drifts
Jan. 1950	entire state	record snowfalls; property damage throughout state.
Mar. 1960	entire state	many automobile accidents; two fatalities
Jan. 1969	entire state	heavy snow throughout state
Jan. 1980	entire State	series of string storms across state; many injuries and power outages
Feb. 1985	entire state	2 feet of snow in northeast mountains; downed power lines; fatalities reported
Feb. 1986	northeast mountains, Oregon	heavy snow; school closures; traffic accidents; broken power lines
Dec. 1988	northeast mountains, Oregon	three blizzards in a 4-week period; 15-foot drifts; wind over 60 mph
Feb. 1990	entire state	heavy snow throughout state
Jan. 1994	northeast mountains, Oregon	heavy snow throughout region
Jan. 1998	northeast Oregon	heavy snow throughout region
Winter 1998-99	entire state	one of the snowiest winters in Oregon history (snowfall at Crater Lake: 586 inches)
Jan. 2004	Union County	one fatality

Source: Taylor and Hatton (1999).

Source: Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section [2.2.2.4, Local and State Vulnerability Assessment Comparison]**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 7 will experience winter storms is shown in **Table 2-479**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-479. Local Probability Assessment of Winter Storms in Region 7

	Baker	Grant	Wallowa	Union
Probability	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Winter storms occur annually in Region 7. On the basis of historical data, severe winter storms could occur about every 4 years in this region. We can expect to have continued annual storm events in this region. However, there are no solid statistical data available upon which to base these judgments. There is no statewide program to study the past, present, and potential impacts of winter storms in the state of Oregon at this time.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to winter storms is shown in **Table 2-480**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-480. Local Vulnerability Assessment of Winter Storms in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	H	H	M	H

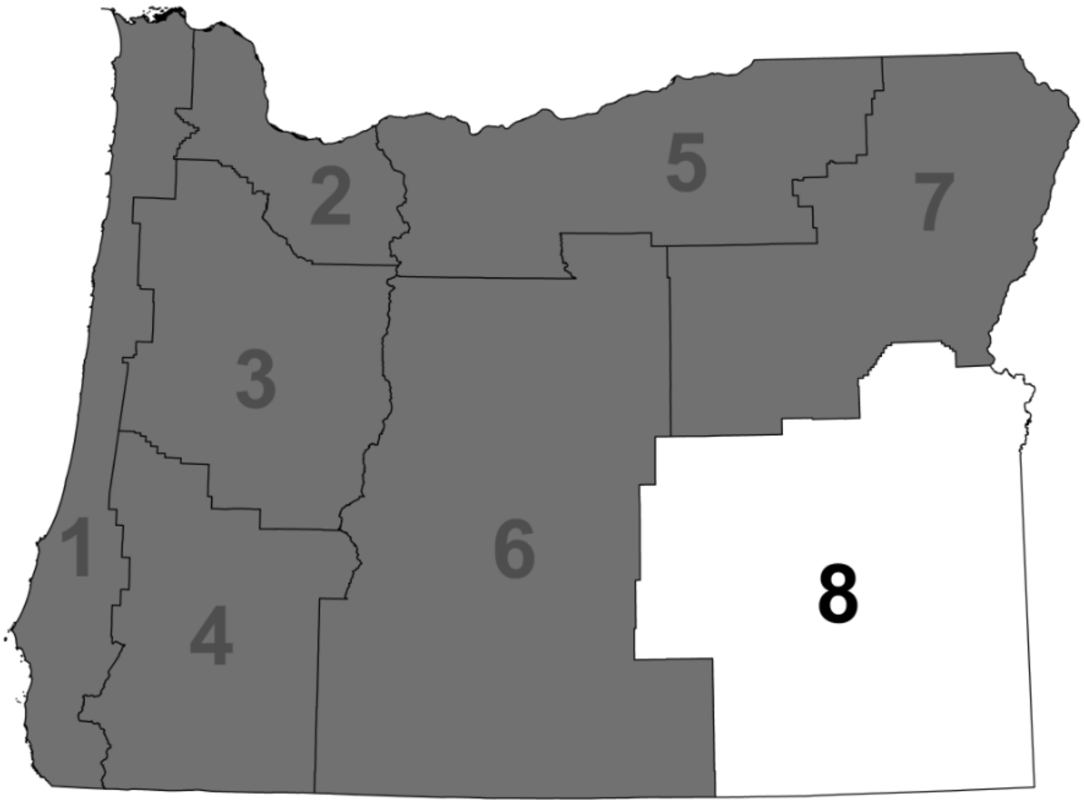
Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Region 7 counties are known for cold, snowy winters. This region is a gateway for neighboring states Washington and Idaho and for the commodity flow to those states. In general, the region is prepared for winter storm events, and those visiting the region during the winter usually come prepared. However, there are occasions when preparation cannot meet the challenge. Drifting, blowing snow has often brought highway traffic to a standstill. Also, windy, icy conditions have often closed mountain passes and canyons to certain classes of truck traffic. In these situations, travelers must seek accommodations, sometimes in communities where lodging is very limited. For local residents, heating, food, and the care of livestock and farm animals are everyday concerns. Access to farms and ranches can be extremely difficult and present a serious challenge to local emergency managers.

2.3.8 Region 8: Southeast Oregon

Harney and Malheur Counties



2.3.8.1 Summary

Profile

Region 8's demographic, economic, infrastructure, and development patterns indicate that some populations, structures, and places may be more vulnerable to certain natural hazards than others. Mitigation efforts directed at these vulnerabilities may help boost the area's ability to bounce back after a natural disaster.

Social vulnerability in Region 8 is driven by a declining population, low median household incomes, and high levels of poverty. In Harney County there are also a high percentages of seniors and people with disabilities. In Malheur County there are more tourists, higher percentages of people who do not speak English very well, a significant drop in already low incomes, and more family households with children.

This region is still recovering from the financial crisis that began in 2007. There are few key industries and employment sectors in Region 8. Regional wages remain below the state average. Harney County continues to suffer from high unemployment. Damage or service interruption to roads, bridges, rail systems, and ports can have devastating effects the region's economy. Roads and railways are susceptible to winter storms and flooding. Many of the bridges in the area are distressed or deficient.

Wells and rivers are primary sources of drinking water for the region. The quality of these water bodies can be threatened by regional agricultural practices that use pesticides and herbicides and by naturally occurring minerals in the soil. Malheur Lake is especially vulnerable to high mineral content.

Southeast Oregon has two power-generating facilities: one hydroelectric facility and one geothermal facility. Oil and natural gas pipelines and electrical transmission lines running through this region support the regional economy and are vulnerable to disruptions and damage from natural hazard events.

Region 8 is largely rural and is losing population. The region has a high percentages of mobile homes and homes built before floodplain management and seismic building standards. This coupled with the lack of modernized Flood Insurance Rate Maps (FIRMs) increases the vulnerability of development in Region 8.

Hazards and Vulnerability

Region 8 is affected by nine of the 11 natural hazards that affect Oregon communities. Coastal hazards and tsunamis do not directly impact this region.

Droughts: Droughts are common in Region 8 and have a significant economic impact on agricultural, livestock, and natural resources. The U.S. Department of Agriculture designated droughts in Malheur and Harney County as primary natural disasters in May and June of 2013. Malheur County is considered one of the counties most vulnerable to drought in Oregon.

Dust Storms: Dust storms occur when strong winds carry fine silt, sand, and clay particles into the air. These storms can travel hundreds of miles at speeds of at least 25 miles per hour and can reach heights of over 10,000 feet. Dust storms are most common over the areas of dry land that are prevalent within this region. Malheur County is considered one of the counties most vulnerable to dust storms in the state.

Earthquakes: Two types of earthquakes affect Region 8: (a) shallow crustal events and (b) earthquakes associated with volcanic activity. Region 8 is moderately vulnerable to earthquake-induced landslides, liquefaction, and ground shaking. There are 211 state-owned/leased facilities, valued at over $284.5 million, in this region. Of these, 53 are critical/essential facilities. An additional 153 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Floods: Floods affect Southeast Oregon in the form of riverine flooding often preceded by rapid snowmelt during unseasonably warm winters, ice jams, and closed basin playa flooding. Flash floods and associated summer thunderstorms are also possible. Both counties are considered to have a moderately low vulnerability to the flood hazard. However, the City of Burns has a high ratio of special flood hazard area to city area. There are 36 state-owned/leased facilities, valued at approximately $14.7 million, located in the region's flood hazard zone. Of these, six are considered critical/essential facilities. An additional 48 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Landslides: Landslides can occur throughout the region, though more tend to occur in areas with steeper slopes, weaker geology, and higher annual precipitation. In general, landslide vulnerability for Region 8 is low to moderate. However, there are some areas that have very high landslide risk: the Summer Lake area along OR-31, around Lakeview, and along US-395. There are 266 state-owned/leased facilities in this region, valued at over $303 million. Of these, 64 are critical/essential facilities. An additional 192 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Volcanoes: Though the volcanic Cascade Range is not in Region 8 and vulnerability to effects of volcanic eruptions is low, there is some threat of ashfall from Cascade volcanic eruptions. More locally, the region is also vulnerable to small eruptions of lava from the numerous youthful volcanic cones scattered across Harney and Malheur Counties. The communities in Southeast Oregon most vulnerable to volcanic activity are the Cities of Burns, Ontario, and Jordan Valley.

Wildfires: The region's arid climate, frequent lightning strikes, large tracts of ponderosa pine forests (primarily in the northern part of Harney County), and grasslands all contribute to Region 8's vulnerability to wildfire. Past management practices that suppressed all wildfires and favored growth of a brushy understory and accumulation of dead or dying trees have led to devastating fires today. State and federal agencies seek to alleviate the problem through a controlled burning program. Areas of higher vulnerability are within wildland-urban interface communities. There are 117 state-owned/leased facilities located in this region's wildfire hazard zone with a value of approximately $41 million. Of these, 19 are identified as critical/essential facilities. An additional 135 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Windstorms: Windstorms in Region 8 are commonly associated with thunderstorms. Wind storms can be especially problematic in burned areas, where dust becomes airborne reducing visibility and causing localized damage. Windstorms generally affect the region's buildings, utilities, tree-lined roads, transmission lines, residential parcels, and transportation systems along open areas such as grasslands and farmland. Small tornadoes also have the potential to impact this region.

Winter Storms: This region is known for winter storms that bring cold weather and 24 inches of snow annually. Moderate to heavy snowfall is expected in this region, and residents and tourists are usually prepared for them.

Climate Change

The most reliable information on climate change to date is at the state level. The state information indicates that hazards projected to be impacted by climate change in Region 8 include drought and wildfire. Climate models project warmer drier summers and a decline in mean summer precipitation for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, all eight regions are expected to be affected by an increased incidence of drought and wildfire. An increase in drought could result in the increase incidence of dust storms, though no current research is available on the direct effects of future climate conditions on the incidence of dust storms. Areas that have historically been both hotter and drier than the statewide average — such as Eastern Oregon counties — are at somewhat higher risk of increased drought and wildfire than the state overall. While winter storms and windstorms affect Region 8, there is little research on how climate change influences these hazards in the Pacific Northwest. For more information on climate drivers and the projected impacts of climate change in Oregon, see the section **Introduction to Climate Change**.

2.3.8.2 Profile

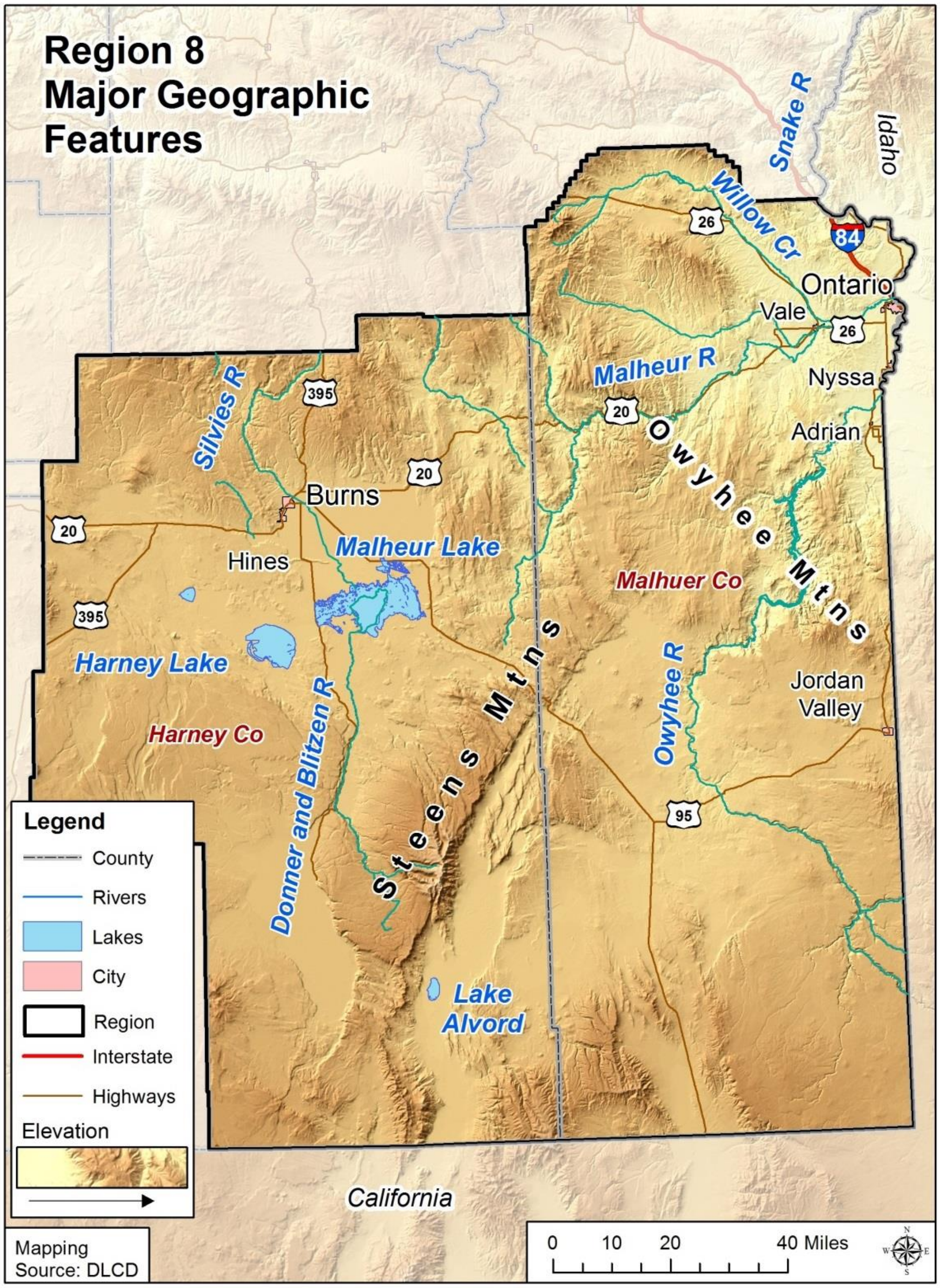
Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

Natural Environment

Geography

Region 8 is approximately 20,023 square miles in size and contains Harney and Malheur Counties. The region is bordered to the east by Idaho and to the south by Nevada and California. The Blue Mountains lie in the northern part of the region. Steens Mountain is a prominent landmass in the region and major rivers in the region include the Malheur and Owyhee.

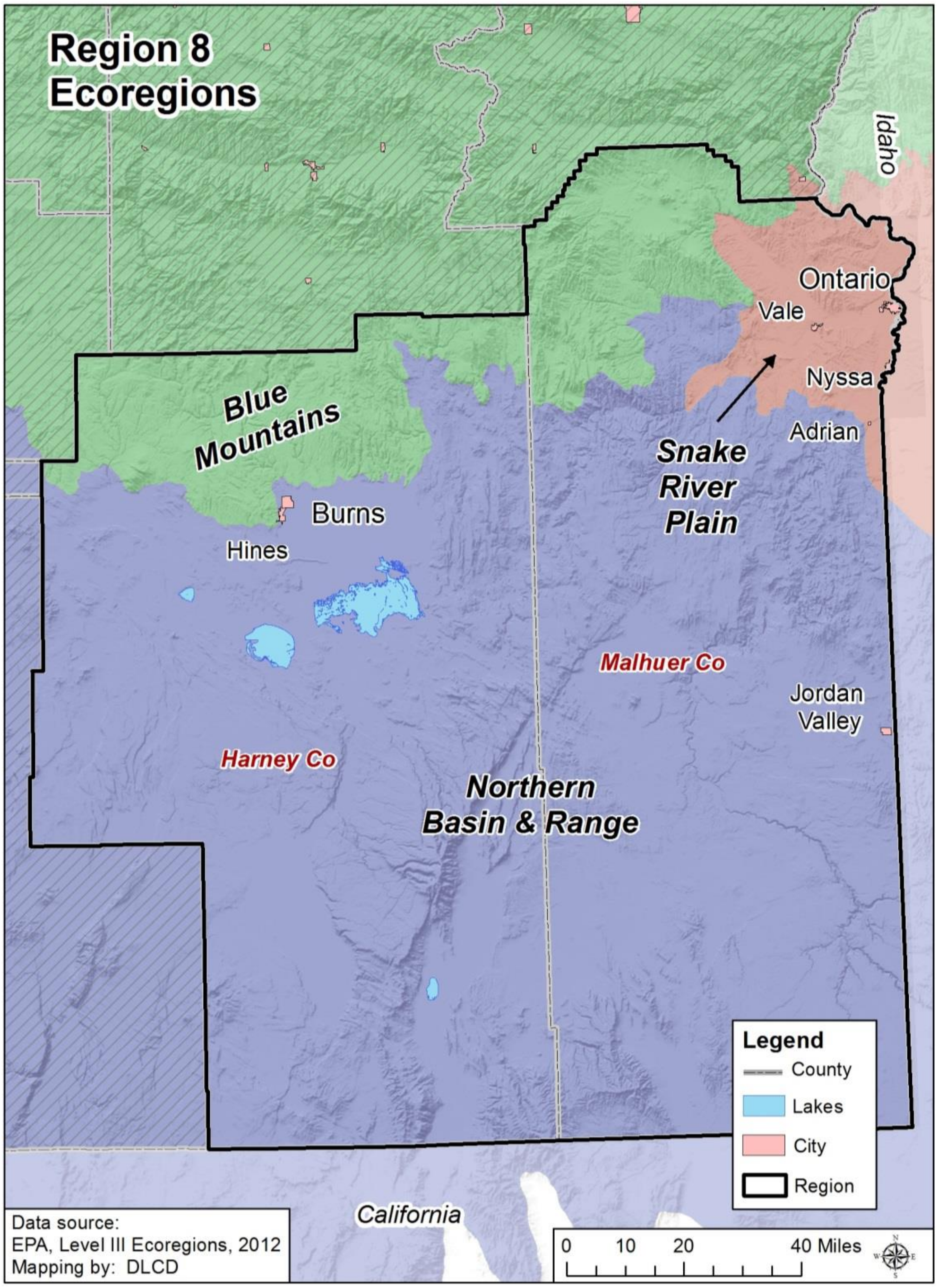
Figure 2-217. Region 8 Major Geographic Features



Source: Department of Land Conservation and Development, 2014

The U.S. EPA’s ecoregions are used to describe areas of ecosystem similarity. Region 8 is composed of three ecoregions: Northern Basin and Range, Blue Mountains, and Snake River Plain (**Figure 2-218**).

Figure 2-218. Region 8 Ecoregions



Blue Mountains: The Region 8 section of this ecoregion is complex and diverse having many sub-ecoregions with unique conditions. The landscape varies between steep sloped mountains of volcanic origin, scattered cinder cones, foothills, scattered buttes, and the Cold Basins, which contain cold, wet valleys, and basins. Forested areas may have ponderosa pine, mixed fir, or juniper canopies. Unforested areas are generally sagebrush steppes or wetlands with vegetation such as sedges and associated grasses. Land uses in the area are primarily livestock grazing and wildlife habitat (Thorson et al., 2003).

Northern Basin and Range: This ecoregion dominates Region 8 with dissected lava plains, rolling hills, alluvial fans, valleys, deep river canyons, and scattered mountains. Because of the ecoregion's location in the rain shadow of the Cascades and Blue Mountains, most areas are arid or semi-arid. Basaltic rock, tuffaceous rock, or volcanic ash are dominant rock types, while soil generally varies between sediments, alluvial, colluvial and fluvial deposits, and rock outcrops. Land cover varies between sagebrush steppe, grasslands, rare wetlands, aspen stands in riparian meadows, and unvegetated deserts. Land uses in this ecoregion include recreation, wildlife habitat including federal wildlife refuges, and limited livestock grazing (Thorson et al., 2003).

Snake River Plan: The Region 8 portion of the Snake River Plain ecoregion is classified as the "Unwooded Alkaline Foothills" and "Treasure Valley," which are underlain by volcanic and sedimentary rocks with alkaline lacustrine sediments and alluvium, loess, lacustrine and alluvial fan deposits at the surface. The landscape includes valleys, incised rivers, canals, rolling foothills, hills, benches, alluvial fans, and badlands. The land cover is dominated by sagebrush steppe with Wyoming big sagebrush, basin big sagebrush and associated grasses. Land uses in this ecoregion include croplands (potatoes, onions, beets, alfalfa, hay, wheat and sugar) as well as pastureland and wildlife habitat (Thorson et al., 2003).

Climate

Climate refers to the temperatures, weather patterns, and precipitation in the region. This section covers historic climate information. For estimated future climate conditions and possible impacts refer to the **State Risk Assessment** for statewide projections.

Region 8 has diverse ecoregions with varying climatic conditions. The majority of the region's land is in the Northern Basin and Range ecoregion. The region's predominantly arid climate supports limited agricultural activities, primarily livestock grazing. The region is subject to droughts, floods, landslides, and wildfires. When considering the climate, snowfall should also be taken into account. Flooding can be a direct result of rain-on-snow events. Likewise, the amount of snowpack in a region can also impact the ability of communities to cope with drought. **Table 2-481** shows mean annual precipitation and temperatures for the three ecoregions in Region 8. Temperature and precipitation vary widely by sub-ecoregion and microclimates. For more detailed and locally relevant climate data refer to the Oregon Climate Service.

Table 2-481. Average Precipitation and Temperature Ranges in Region 8 Ecoregions

Ecoregion	Mean Annual Precipitation Range (inches)	Mean Temperature Range (°F) January min/max	Mean Temperature Range (°F) July min/max
Northern Basin and Range*	6–45	17/42	42/88
Blue Mountains*	9–35	16/39	43/84
Snake River Plain*	8–12	19/35	57/96

*Data have been generalized from all the sub-ecoregions of the ecoregion in Region 8.

Source: Thorson et al. (2003)

Demography

Population

Population forecasts are an indicator of future development needs and trends. Community demographics may indicate where specific vulnerabilities may be present in the aftermath of a natural hazard (Cutter et al., 2003). If a population is forecast to increase substantially, a community's capacity to provide adequate housing stock, services, or resources for all populations after a disaster may be stressed or compromised.

Overall, between 2000 and 2013, Region 8 lost population. Harney County lost a greater share of its population than Malheur County. By 2020, the region is expected to grow at about half the rate of the state with Malheur County projected to grow at a higher rate than Harney.

Table 2-482. Population Estimate and Forecast for Region 8

	2000	2013	Percent Change (2000 to 2013)	2020 Projected	Percent Change (2013 to 2020)
Oregon	3,421,399	3,919,020	14.5%	4,252,100	8.5%
Region 8	39,224	38,700	-1.3%	40,127	3.7%
Harney	7,609	7,260	-4.6%	7,404	2.0%
Malheur	31,615	31,440	-0.6%	32,723	4.1%

Source: Population Research Center, Portland State University, 2013; U.S. Census Bureau, 2000 Decennial Census. Table DP-1; Office of Economic Analysis, Long-Term Oregon State's County Population Forecast, 2010-2050, 2013

Tourists

Tourists are not counted in population statistics and are therefore considered separately in this analysis. Tourism activities in Region 8 are largely centered on outdoor activities (hiking/backpacking, visiting national/state parks etc.), touring (traveling to experience scenic beauty, history and culture), and special events (such as fairs, festivals or sporting events) (Longwoods Travel USA., 2011d). Note that the Longwoods Travel Report includes all of the Region 8 counties; Baker, Grant, Union, and Wallowa (Region 7); and Morrow, Umatilla, and parts of Gilliam Counties within the Eastern Region. Approximately 8% (2.2 million) of all overnight visitor trips to Oregon included time within Region 8. Three fourths of all trips to the region occur between April and September, and the average travel party contains 3.8 persons. The average trip length is 4.3 nights (Longwoods Travel USA., 2011d).

Annually there are about twice as many tourists in Malheur County than Harney County. Visitors to Malheur County are more likely to stay in hotels, motels, or private homes. In Harney County visitors are just as likely to be lodged in hotels, motels, private homes, or other accommodations.

Difficulty locating or accounting for travelers increases their vulnerability in the event of a natural disaster. Furthermore, tourists are often unfamiliar with evacuation routes, communication outlets, or even the type of hazard that may occur (MDC Consultants, n.d.). Targeting natural hazard mitigation outreach efforts to places where tourists lodge can help increase awareness and minimize the vulnerability of this population.

Table 2-483. Annual Visitor Estimates in Person Nights in Region 8

	2011		2012		2013	
	Number	Percent	Number	Percent	Number	Percent
Region 8	874	—	892	—	866	—
Harney	249	100%	259	100%	251	100%
Hotel/Motel	84	33.7%	93	35.9%	87	34.7%
Private Home	74	29.7%	74	28.6%	70	27.9%
Other	91	36.5%	92	35.5%	94	37.5%
Malheur	625	100%	633	100%	615	100%
Hotel/Motel	221	35.4%	228	36.0%	214	34.8%
Private Home	307	49.1%	308	48.7%	303	49.3%
Other	97	15.5%	97	15.3%	98	15.9%

Source: Oregon Travel Impacts: 1991–2013, April 2014. Dean Runyan Associates, http://www.deanrunyan.com/doc_library/ORImp.pdf

Persons with Disabilities

Disabilities appear in many forms. While some disabilities may be easily identified, others may be less perceptible. Disabled populations, while difficult to identify and measure, are disproportionately affected during disasters (Cutter et al., 2003). More people in Region 8 identify as having a disability than do people throughout the state. Most of the region's people with disabilities, both children (under 18) and seniors (65 and older), reside in Harney County. More than half of Harney County's seniors report a disability, and over 40% of Malheur County's do as well. Local natural hazard mitigation plans should specifically target outreach programs toward helping disabled residents better prepare for and recover from hazard events.

Table 2-484. People with a Disability by Age Groups in Region 8, 2012

	Total Population*	With a Disability		Under 18 Years with a Disability		65 Years and Over with a Disability	
	Estimate	Estimate	Percent	Estimate	Percent**	Estimate	Percent**
Oregon	3,796,881	511,297	13.5%	39,439	4.6%	200,374	37.8%
Region 8	35,427	5,991	16.9%	411	4.3%	2,694	46.2%
Harney	7,219	1,532	21.2%	120	7.4%	736	54.2%
Malheur	28,208	4,459	15.8%	291	3.7%	1,958	43.7%

*Total population does not include institutionalized population

**Percent of age group

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Homeless Population

Population estimates of the homeless in Oregon are performed each January. These are rough estimates and can fluctuate with many factors, including the economy or season. The overwhelming majority of homeless are either single adult males or families with children. Communities located along major transportation corridors, such as I-84, tend to have higher concentrations of homeless populations (Thomas et al., 2008). The numbers of homeless people in Region 8 increased from 2009 to 2010, and then decreased by 2011. Almost all homeless persons in the region live in Malheur County.

Extra attention is needed to care for and serve homeless communities. Some homeless people choose to remain hidden or anonymous, making it especially difficult to mitigate harm to them from natural hazard events. Accessible shelter and social services are key emergency considerations for the homeless community.

Table 2-485. Homeless Population Estimate for Region 8

	2009	2010	2011	3-Year Average
Oregon	17,122	19,208	22,116	19,482
Region 8	205	124	56	128
Harney	3	16	3	7
Malheur	202	108	53	121

Source: Oregon Point in Time Homeless Count, Oregon Housing and Community Services. http://www.oregon.gov/ohcs/pages/ra_point_in_time_homeless_count.aspx

Gender

There are 8% more males than females in Region 8 (U.S. Census Bureau; n.d.). 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 (Cutter et al., 2003).

Age

The senior population in Malheur County is similar to that of the state. A 5% greater share of the population in Harney County is 65 years and older. Senior citizens may require special consideration due to sensitivity to heat and cold, reliance upon transportation to obtain medication, and comparative difficulty in making home modifications that reduce risk to hazards. In addition, the elderly may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to the elderly (Morrow, 1999).

Similar to the state, about one quarter of the region's population are children. Special considerations should be given to young children, schools, and parents during the natural hazard mitigation process. Young children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities. Parents may lose time from work and money when their children's childcare facilities and schools are impacted by disasters (Cutter et al., 2003).

Table 2-486. Population by Vulnerable Age Groups, in Region 8, 2012

	Total Population	Under 18 Years Old		65 Years and Older	
	Estimate	Estimate	Percent	Estimate	Percent
Oregon	3,836,628	864,243	22.5%	540,527	14.1%
Region 8	38,416	9,543	24.8%	6,085	15.8%
Harney	7,359	1,646	22.4%	1,404	19.1%
Malheur	31,057	7,897	25.4%	4,681	15.1%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP05

Language

Almost 11% of the people in Malheur County do not speak English “very well.” The number of people in Harney County who do not speak English “very well” is negligible. Outreach materials used to communicate with and plan for this community should take into consideration their language needs.

Table 2-487. English Usage in Region 8, 2012

	Speak English "Very Well"		Speak English Less Than "Very Well"	
	Estimate	Percent	Estimate	Percent
Oregon	3,376,744	93.8%	224,905	6.2%
Region 8	32,743	91.5%	3,055	8.5%
Harney	6,925	99.4%	40	0.6%
Malheur	25,818	89.5%	3,015	10.5%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Income

The impact of a disaster in terms of loss and the ability to recover varies among population groups. “The causes of social vulnerability are explained by the underlying social conditions that are often quite remote from the initiating hazard or disaster event” (Cutter, 2006, p. 76). Historically, 80% of the disaster burden falls on the public. Of this number, a disproportionate burden is placed upon those living in poverty. People living in poverty are more likely to be isolated, are less likely to have the savings to rebuild after a disaster, and are less likely to have access to transportation and medical care.

Median household incomes in Malheur County have been particularly impacted since the financial crisis that began in 2007 — a 12% decrease between 2009 and 2012. Harney County’s decrease in median household income over the same period is about the same as the state’s.

Table 2-488. Median Household Income in Region 8

	2009	2012	Percent Change
Oregon	$52,474	$50,036	-4.6%
Region 8	N/A	N/A	N/A
Harney	$41,506	$39,674	-4.4%
Malheur	$42,260	$37,191	-12.0%

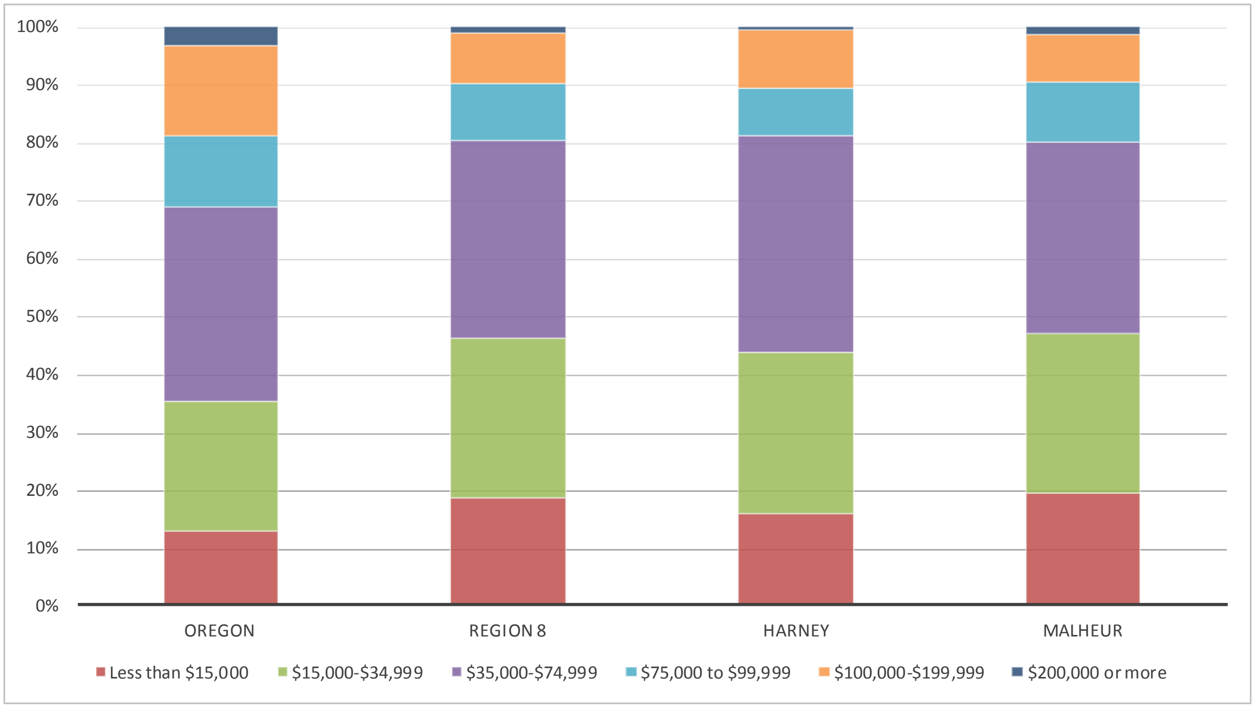
Note: 2009 dollars are adjusted for 2012 using Bureau of Labor Statistics’ Consumer Price Index Inflation Calculator.

N/A = data not aggregated at the regional level.

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates. Table DP03.

Eleven percent more of Region 8’s households earn less than $35,000 annually compared to households statewide. Also compared to the state, 22% fewer of the region’s households are in upper income brackets, earning more than $75,000.

Figure 2-219. Median Household Income Distribution in Region 8, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP03

Eight percent more individuals and about 12% more children in Region 8 live in poverty than the state overall. One quarter of Malheur County's population lives in poverty. Child poverty increased by more than 56% in Harney County between 2009 and 2012. Overall, the poverty rate in both counties increased more than twice as fast as the state's.

Table 2-489. Poverty Rates in Region 8, 2012

	Total Population in Poverty			Children Under 18 in Poverty		
	Number	Percent	Percent Change*	Number	Percent	Percent Change*
Oregon	584,059	15.5%	17.7%	175,303	20.6%	17.6%
Region 8	8,372	23.8%	44.8%	3,024	32.3%	31.8%
Harney	1,379	19.1%	39.0%	467	29.0%	56.7%
Malheur	6,993	25.0%	46.1%	2,557	33.0%	28.1%

Percent change since 2009

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates, Table S1701

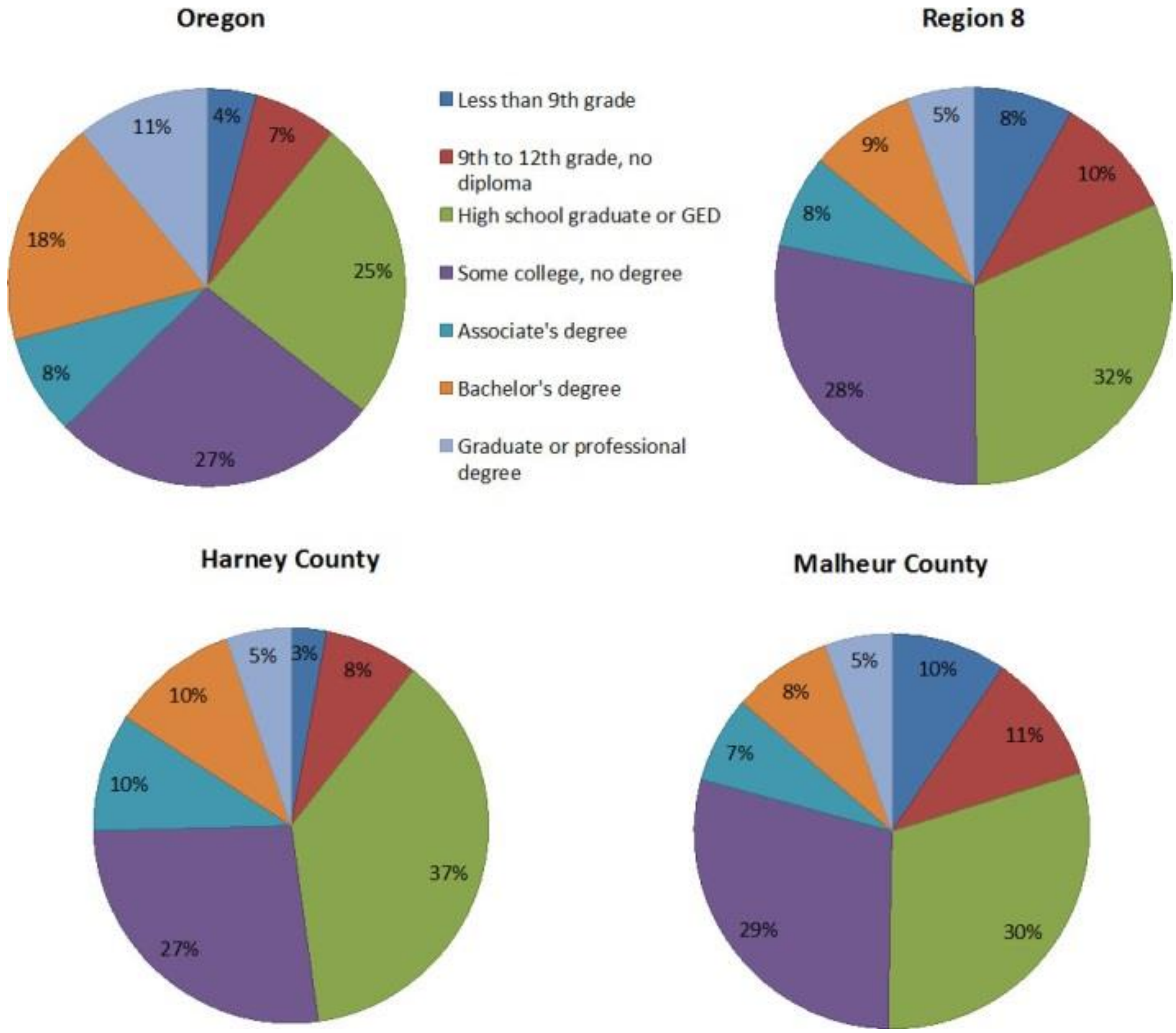
Low-income populations require special consideration when mitigating loss from a natural hazard. Often, those who earn less have little to no savings and other assets to withstand economic setbacks. When a natural disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the natural disaster. To reduce the compounded loss incurred by low-income populations post-disaster, mitigation actions need to be specially tailored to ensure safety nets are in place to provide further support to those with fewer personal resources (Cutter et al., 2003).

Education Level

Studies (Cutter et al., 2003) show that education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings. The region has a 7% higher share of high school graduates (including GEDs) and a 15% lower share of persons with a college degree compared to state percentages.

Education can influence the ability to access resources, while lack of resources may constrain the ability to understand warning information (Cutter et al., 2003). Therefore, levels of education within the region should be considered when designing hazard outreach materials to local communities.

Figure 2-220. Educational Attainment in Region 8, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Housing Tenure

Wealth can increase the ability to recover following a natural disaster (Cutter et al., 2003), and homeownership, versus renting, is often linked to having more wealth. Renters often do not have personal financial resources or insurance to help recover post-disaster. On the other hand, renters tend to be more mobile and have fewer assets at risk. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable due to natural disaster events.

Similar to statewide numbers, about 36% of housing units in the region are rentals. The share of vacant units in Malheur County is almost double the share statewide vacancies state. Harney County has a greater share of seasonal and recreational homes (U.S. Census Bureau, 2008–2012 American Community Survey, Table DP04 and Table B25004).

Table 2-490. Housing Tenure in Region 8, 2012

	Total Occupied Units	Owner Occupied		Renter Occupied		Vacant*	
		Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	945,824	62.5%	566,894	37.5%	105,417	6.3%
Region 8	13,320	8,567	64.3%	4,753	35.7%	1,654	10.7%
Harney	3,186	2,045	64.2%	1,141	35.8%	350	9.2%
Malheur	10,134	6,522	64.4%	3,612	35.6%	1,304	11.2%

*Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04 and Table B25004.

Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households. Region 8 is predominantly composed of family households. Roughly one third of households in Malheur County have families with children. Similar to statewide numbers, there are about twice as many single-parent households headed by females than by males.

Table 2-491. Family vs. Non-family Households in Region 8, 2012

	Total Households	Family Households		Nonfamily Households		Householder Living Alone	
	Estimate	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	964,274	63.7%	548,444	36.3%	421,620	27.9%
Region 8	13,320	9,090	68.2%	4,230	31.8%	3,637	27.3%
Harney	3,186	2,119	66.5%	1,067	33.5%	877	27.5%
Malheur	10,134	6,971	68.8%	3,163	31.2%	2,760	27.2%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Table 2-492. Family Households with Children by Head of Household in Region 8, 2012

	Family Households with Children		Single Parent (Male)		Single Parent (Female)		Married Couple with Children	
	Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	415,538	27.5%	35,855	2.4%	93,575	6.2%	415,538	27.5%
Region 8	4,018	30.2%	400	3.0%	853	6.4%	4,018	30.2%
Harney	784	24.6%	83	2.6%	171	5.4%	784	24.6%
Malheur	3,234	31.9%	317	3.1%	682	6.7%	3,234	31.9%

Note: The table shows the percent of total households represented by each family household structure category.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Social and Demographic Trends

This analysis shows that Region 8 has a greater number of people than the state average who are predisposed to be particularly vulnerable during a hazard event, because:

- Population is declining, with marginal growth expected by 2020.
- Less than 20% of the population reports a disability, but of these over 50% are children and seniors.
- In Malheur County a high percentage of the population does not speak English "very well."
- Region 8 has low median household incomes overall; Malheur County has suffered a significant drop.
- The region has high poverty levels.
- Malheur County has a higher percentage of family households with children than the state overall.

Economy

Employment

Employment status and salary level may impact the resilience of individuals and families in the face of disasters as well as their ability to mitigate against natural hazards (Cutter et al., 2003). "The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster" (Cutter et al., 2003). The region is still recovering from the financial crisis that began in 2007. Recent statistics show that nonfarm job counts are down in the region's counties (Tauer, 2014). Harney County's unemployment rate is 5% higher than the state's. Salaries are only 72% of the state average.

Table 2-493. Unemployment Rates in Region 8, 2009–2013

	2009	2010	2011	2012	2013	Change (2009–2013)
Oregon	11.1%	10.8%	9.7%	8.8%	7.7%	-3.4%
Region 8	11.9%	11.7%	11.1%	10.5%	9.4%	-2.5%
Harney	16.1%	15.7%	14.7%	12.8%	12.3%	-3.8%
Malheur	10.7%	10.7%	10.2%	9.9%	8.7%	-2.0%

Source: Oregon Employment Department, 2014

Table 2-494. Employment and Unemployment Rates in Region 8, 2013

	Civilian Labor Force	Employed Workers		Unemployed	
	Total	Total	Percent	Total	Percent
Oregon	1,924,604	1,775,890	92.3%	148,714	7.7%
Region 8	15,727	14,245	90.6%	1,482	9.4%
Harney	3,129	2,743	87.7%	386	12.3%
Malheur	12,598	11,502	91.3%	1,096	8.7%

Source: Oregon Employment Department, 2014

Table 2-495. Employment and Payroll in Region 8, 2013

	Employees	Average Pay	Percent State Average
Oregon	1,679,364	$45,010	100%
Region 8	14,572	$32,171	71.5%
Harney	2,175	$32,786	72.8%
Malheur	12,397	$32,063	71.2%

Source: Oregon Employment Department, 2014

Employment Sectors and Key Industries

In 2013 the five major employment sectors in Region 8 were: (a) Government; (b) Trade, Transportation, and Utilities; (c) Education and Health Services; (d) Natural Resources and Mining; and (e) Leisure and Hospitality. Table 2-496 shows the distribution of total employment across all sectors. Region 8 is composed of Oregon Employment Department Region 14 (Southeast Oregon). The Southeast Oregon Region (Grant, Harney, Malheur) is expected to have a 9% increase in employment between 2012 and 2022 (Oregon Employment Department, n.d.b).

Table 2-496. Covered Employment by Sector in Region 8, 2013

		Harney		Malheur	
Industry	**Region 8**	**Employment**	**Percent**	**Employment**	**Percent**
Total All Ownerships	14,572	2,175	100%	12,397	100%
Total Private Coverage	71.3%	1,184	54.4%	9,200	74.2%
Natural Resources & Mining	9.2%	166	7.6%	1,172	9.5%
Construction	1.8%	66	3.0%	202	1.6%
Manufacturing	6.2%	(c)	-	897	7.2%
Trade, Transportation & Utilities	22.5%	352	16.2%	2,932	23.7%
Information	1.4%	13	0.6%	186	1.5%
Financial Activities	2.4%	56	2.6%	297	2.4%
Professional & Business Services	3.7%	82	3.8%	454	3.7%
Education & Health Services	12.7%	178	8.2%	1,672	13.5%
Leisure & Hospitality	9.0%	222	10.2%	1,096	8.8%
Other Services	2.3%	44	2.0%	291	2.3%
Private Non-Classified	0.0%	(c)	-	(c)	-
Total All Government	28.7%	991	45.6%	3,197	25.8%
Federal Government	3.1%	243	11.2%	216	1.7%
State Government	9.2%	130	6.0%	1,215	9.8%
Local Government	16.4%	618	28.4%	1,767	14.3%

Note: (c) = confidential, information not provided by Oregon Employment Department to prevent identifying specific businesses.

Source: Oregon Employment Department, 2013

Each industry faces distinct vulnerabilities to natural hazards. Identifying key industries in the region enables communities to target mitigation activities toward those industries' specific sensitivities. Each of the primary private employment sectors has sensitivity to natural hazards, as follows.

Trade, Transportation, and Utilities: Retail Trade is the largest employment subsector within the Trade, Transportation, and Utilities sector. Retail Trade is vulnerable to disruptions in the disposable income of regional residents and to disruptions in the transportation system. Residents' discretionary spending diminishes after natural disasters as spending priorities tend to focus on essential items. Disruption of the transportation system could sever connectivity of people and retail hubs. Retail businesses are concentrated in the larger cities of the region.

Education and Health Services: The industries in these sectors play important roles in emergency response in the event of a disaster. Health care is a relatively stable revenue sector regionally with an increasing distribution of businesses primarily serving a local and aging population.

Natural Resources and Mining: The primary industries within this sector regionally are largely crop and animal production. These industries tend to fluctuate seasonally and are vulnerable to a variety of natural hazard (winter storms, floods, etc.). Further, to the loss of farm production, wages could be lost due to natural disasters. In addition, these industries are dependent upon transportation systems that are vulnerable to disasters.

Leisure and Hospitality: This sector primarily serves regional residents with disposable income and tourists. The behavior of both of these social groups would be disrupted by a natural disaster. Regional residents may have less disposable income and tourists may choose not to visit a region with unstable infrastructure.

Revenue by Sector

In 2007 Trade (Retail and Wholesale), Manufacturing, and Healthcare and Social Assistance were the highest revenue grossing industries in Region 8. (Note that revenue data from the 2012 Economic Census will not be released prior to the publication of this Plan.) Combined, these three industries generated over $691 million (89% of total revenue) for the region. Trade (Retail and Wholesale) is the largest grossing reported sector in the region. Note: Due to the small size and few industries in the region the collected data are withheld in several categories to avoid disclosing data for individual companies. Data are aggregated to the county level.

Table 2-497. Revenue of Top Industries (in Thousands of Dollars) in Region 8, 2007

	Total Revenue (in Thousands)	Trade (Retail and Wholesale)	Manufacturing	Health Care and Social Assistance
Oregon	$277,017,733	44.4%	24.1%	7.3%
Region 8	$778,079	73.9%	—	14.9%
Harney	$114,461	79.1%	—	D
Malheur	$663,618	73.0%	D	17.5%

Source: U.S. Census, Economic Census. 2007, Table ECO700A1. Notes: D = Withheld to avoid disclosing data for individual companies; data are included in higher level totals, and "-" = data not provided.

Sectors that are anticipated to be major employers in the future warrant special attention, especially in the hazard mitigation planning process so the workforce and employers can be more prepared to respond and adapt to needs that arise after a natural hazard event. Between 2012 and 2022, the largest job growth in Region 8 is expected to occur in the following sectors: (a) Natural Resources and Mining; (b) Education and Health Services; (c) Trade, Transportation, and Utilities (including retail trade); (d) Government; and (e) Leisure and Hospitality (Oregon Employment Department, 2014).

Identifying sectors with a large number of businesses and targeting mitigation strategies to support those sectors can help the region's resiliency. The Trade, Transportation, and Utilities sector includes the most businesses in Region, 20.2% of all businesses. Government (particularly local government) has the second most number of businesses. Natural Resources and Mining, Education and Health Services, and the Leisure and Hospitality round out the top five sectors in the region (Oregon Employment Department, 2012). While many of these are small businesses, employing fewer than 20 employees, collectively they represent almost two thirds of the businesses in the region. Due to their small size and large collective share of the economy, these businesses are particularly sensitive to temporary decreases in demand, such as may occur following a natural hazard event.

Economic Trends and Issues

Current and anticipated financial conditions of a community are strong determinants of community resilience, since a strong and diverse economic base increases the ability of individuals, families, and communities to absorb impacts of a disaster and recover more quickly. The economic analysis shows that Region 8 is particularly vulnerable during a hazard event due to the following characteristics:

- Consistently higher unemployment in Harney County, and
- Lower regional wages.

Region 8 is still recovering from the financial crisis that began in 2007. The health care industry sector and the region's service and professional occupations sectors spur much of the growth in employment within the region. Supporting the growth of dominant industries and employment sectors, as well as emerging sectors identified in this analysis, can help the region become more resilient to economic downturns that often follow a hazard event (Stahl et al., 2000).

Infrastructure

Transportation

Roads

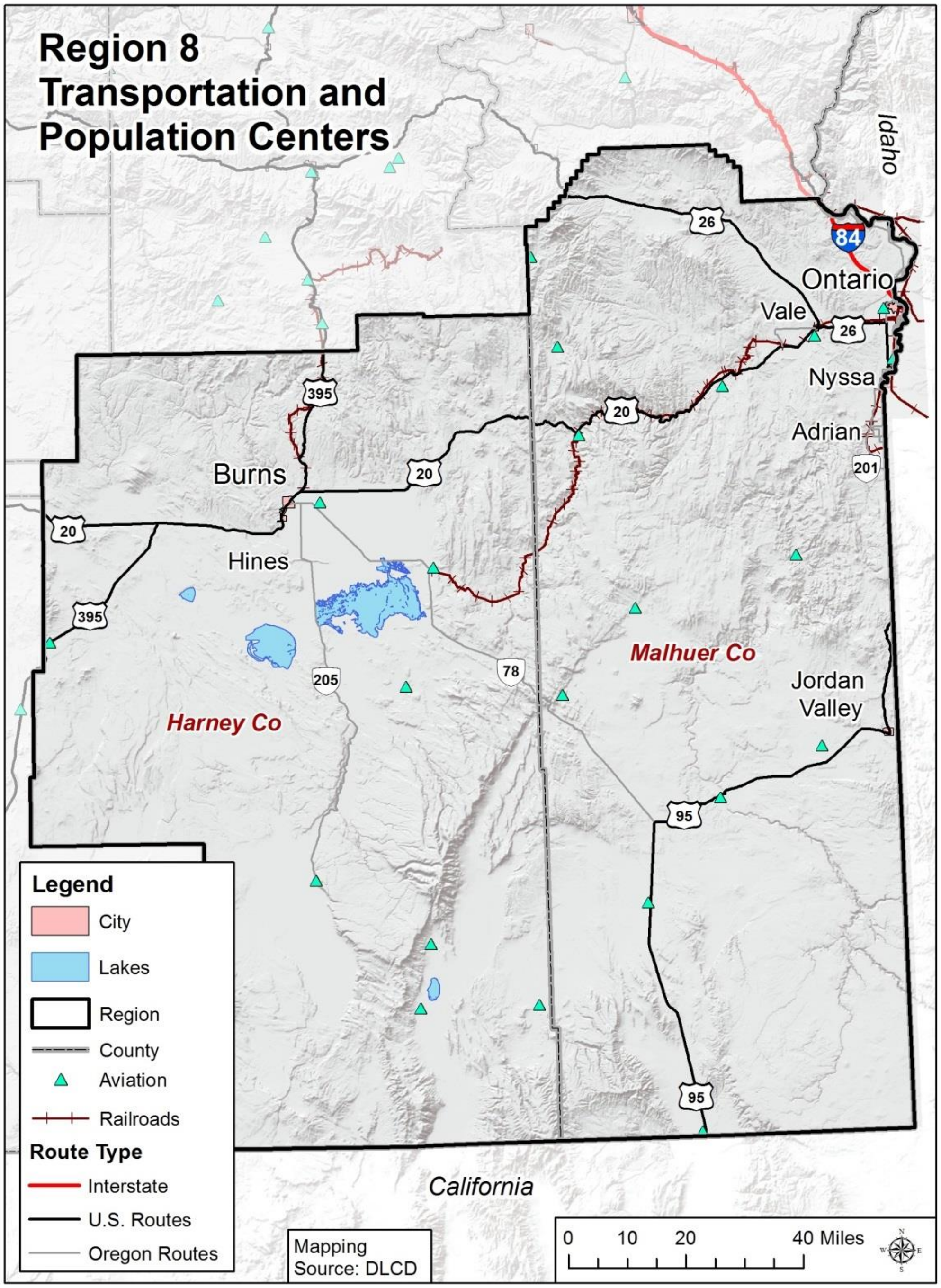
The largest population bases in Region 8 are located along the region's major highways: I-84, US-20, US-26, and US-95. I-84 runs north-south and is the main passage for automobiles and trucks traveling east of the Cascade Range between Portland and Idaho. **Figure 2-221** shows Region 8's highways and population centers. US-20, US-26, and US-95 provide access east and west into Idaho and central Oregon counties. US-395 provides access into Lake County. Additional access is provided within Idaho to adjacent counties via US-30 and US-95.

Region 8's growing population centers bring more workers, automobiles, and trucks onto roads. A high percentage of workers driving alone to work coupled with interstate and international freight movement create additional stresses on transportation systems. Some of these include added maintenance, congestion, oversized loads, and traffic accidents.

Natural hazards and emergency events can further disrupt automobile traffic, create gridlock, and shut down local transit systems, making evacuations and other emergency operations difficult. Hazards such as localized flooding can render roads unusable. Likewise, a severe winter storm has the potential to disrupt the daily driving routine of thousands of people.

According to the Oregon Department of Transportation's (ODOT's) Seismic Lifeline Report (**Appendix 9.1.13**), the projected impacts of a CSZ event are considered negligible in this part of the state. However, economic disruption from major losses in the larger markets of the state will affect the economy in this region. For information on ODOT's Seismic Lifeline Report findings for Region 8, see **Seismic Lifelines**.

Figure 2-221. Region 8 Transportation and Population Centers



Source: Oregon Department of Transportation, 2014

Bridges

Because of earthquake risk in Region 8, the seismic vulnerability of the region'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 region's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or are part of regional and local systems that are maintained by the region's counties and cities. For information on ODOT's Seismic Lifeline Report findings for Region 8, see **Seismic Lifelines**.

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 (ODOT, 2012, 2013). The region has a lower percentage of bridges that are distressed and/or deficient than the state overall

Table 2-498. Bridge Inventory for Region 8

	State Owned			County Owned			City Owned			Other Owned			Area Total			Historic
	Di	ST	%D*	De	ST	%D	De	ST	%D	De	ST	%D	D	T	%D	Covered
Oregon	610	2,718	22%	633	3,420	19%	160	614	26%	40	115	35%	1,443	6,769	21%	334
Region 8	7	111	6%	17	176	10%	0	0	0%	0	0	0%	24	287	8%	3
Harney	2	37	5%	9	71	13%	0	0	0%	0	0	0%	11	110	10%	0
Malheur	5	74	7%	8	105	8%	0	0	0%	0	0	0%	13	177	7%	3

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.

Source: ODOT (2012, 2013)

Railroads

Railroads that run through Region 8 support cargo and trade flows. The region's major freight rail providers are the Union Pacific (UP) and the Burlington Northern-Santa Fe (BNSF) railroads. The rail line follows the I-84 corridor and another non-Class I rail line provides access to the City of Vale. There are no active rail lines in Harney County. There are two rail yards in the region — in Ontario and Nyssa — operated by UP (Cambridge Systematics, 2014). There is no passenger rail available in Region 8.

Oregon's rail system is critical to the state's economy, energy, and food systems. Rail systems export lumber and wood products, pulp and paper, and other goods produced in Oregon and products from other states that are shipped to and through Oregon by rail (Cambridge Systematics, 2014).

Rails are sensitive to icing from winter storms that can occur in Region 8. Disruptions in the rail system can result economic losses for the region. The potential for harm from rail accidents can also have serious implications for local communities, particularly if hazardous materials are involved.

Airports

There are no commercial airports in the region, however. There are several general aviation public airports including the Burns and Ontario Municipal airports.

In the event of a natural disaster, public and private airports are important staging areas for emergency response activities. Public airport closures will impact the region's tourism industries, as well as the ability for people to leave the region by air. Businesses relying on air freight may also be impacted by airport closures.

Table 2-499. Public and Private Airports in Region 8

	Number of Airports by FAA Designation				
	Public Airport	Private Airport	Public Helipad	Private Helipad	Total
Region 8	6	17	0	1	24
Harney	1	8	0	0	9
Malheur	5	9	0	1	15

Source: FAA Airport Master Record (Form 5010), 2014

Energy

Electricity

The region is served by several investor-owned, public, cooperative, and municipal utilities. The Bonneville Power Administration is the area's wholesale electricity distributor. Idaho Power is the primary investor-owned utility company serving Harney and Malheur Counties. The region's electric cooperatives include the Harney Electric Cooperative (Harney, Malheur), and the Oregon Trail Electric Cooperative (Harney).

Table 2-500 lists electric power-generating facilities that are within Region 8. The region has two power-generating facilities: one hydroelectric power facility and one geothermal facility. There is no power-generating facilities in Harney County. In total the power-generating facilities have the ability to produce up to 40 megawatts (MW) of electricity.

Table 2-500. Power Plants in Region 8

	Hydro-electric	Natural Gas	Wind	Coal	Other*	Total
Region 8	1	0	0	0	1	2
Harney	0	0	0	0	0	0
Malheur	1	0	0	0	1	2
Energy Production (MW)	35	0	0	0	5	40

*"Other" includes biomass, geothermal, landfill gas, solar, petroleum, and waste.

Source: Army Corps of Engineers; Biomass Power Association; Calpine Corporation; Eugene Water and Electric Board; Iberdola Renewables; Idaho Power Company; Klamath Energy LLC; Oregon Department of Energy; Owyhee Irrigation District; Form 10K Annual Report (2013), PacifiCorp; Form 10K Annual Report (2013), Portland General Electric; U.S. Geothermal, Inc.

Hydropower

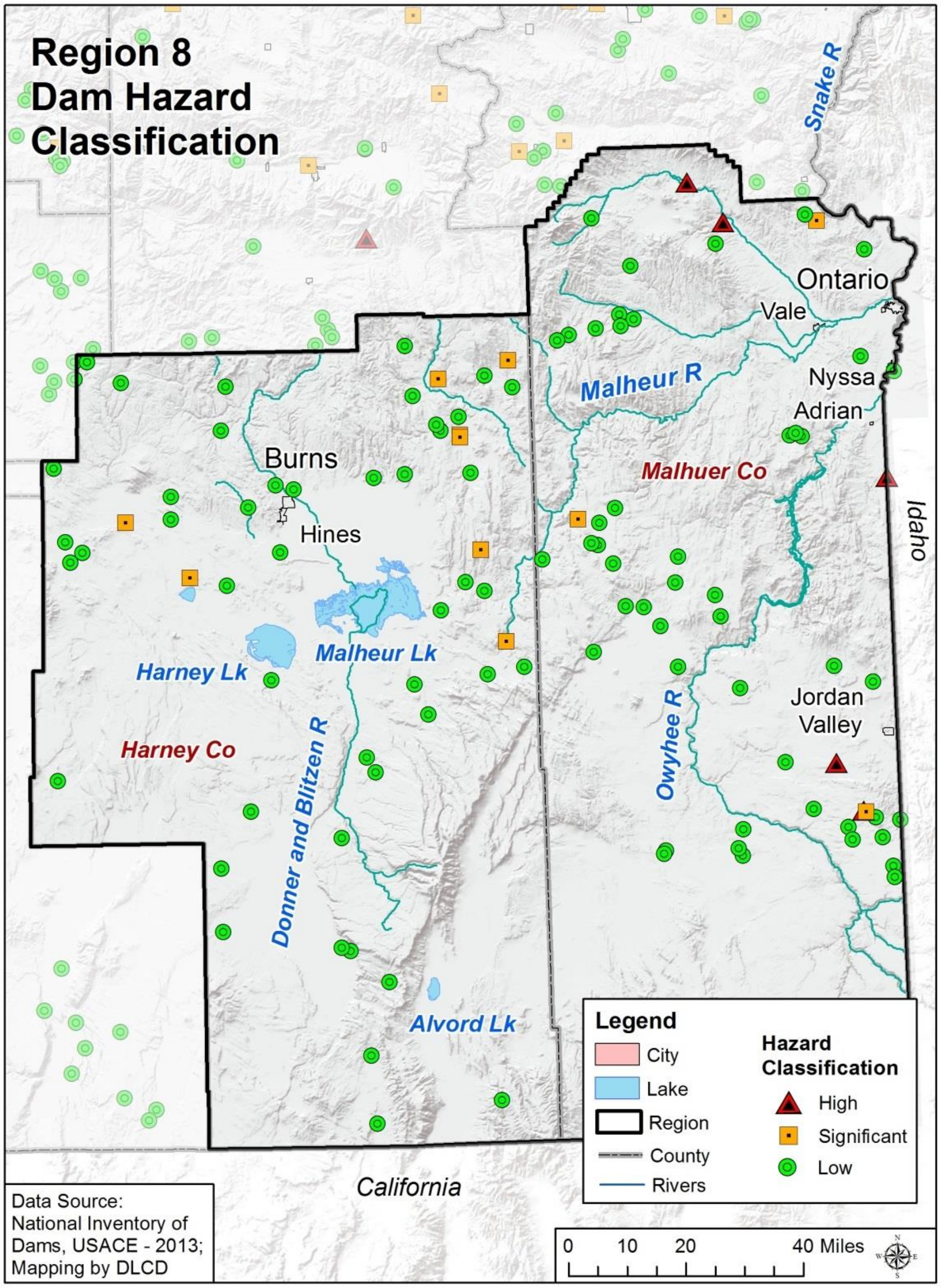
There are several major dams owned by Idaho Power along the Lower Snake River just north of the Region 8, which produce a significant amount of hydropower. Minor dam failures can occur at any time. Most dam failures result in minor damage to structures and pose little or no risk to life safety. However, the potential for severe damage and fatalities does exist. The Oregon Water Resources Department maintains an inventory of all large dams located in Oregon (using the National Inventory of Dams (NID) threat potential methodology). **Table 2-501** lists the number of dams included in the inventory. Most dams in the region are located in Malheur County (146). All 10 of the High Threat Potential dams are within Malheur County. There are also 13 Significant Threat Potential dams in the region.

Table 2-501. Threat Potential of Dams in Region 8

	Threat Potential			Total Dams
	High	Significant	Low	
Region 8	10	13	216	239
Harney	0	9	84	93
Malheur	10	4	132	146

Source: Oregon Water Resources Department, Dam Inventory Query, 2014

Figure 2-222. Region 8 Dam Hazard Classification

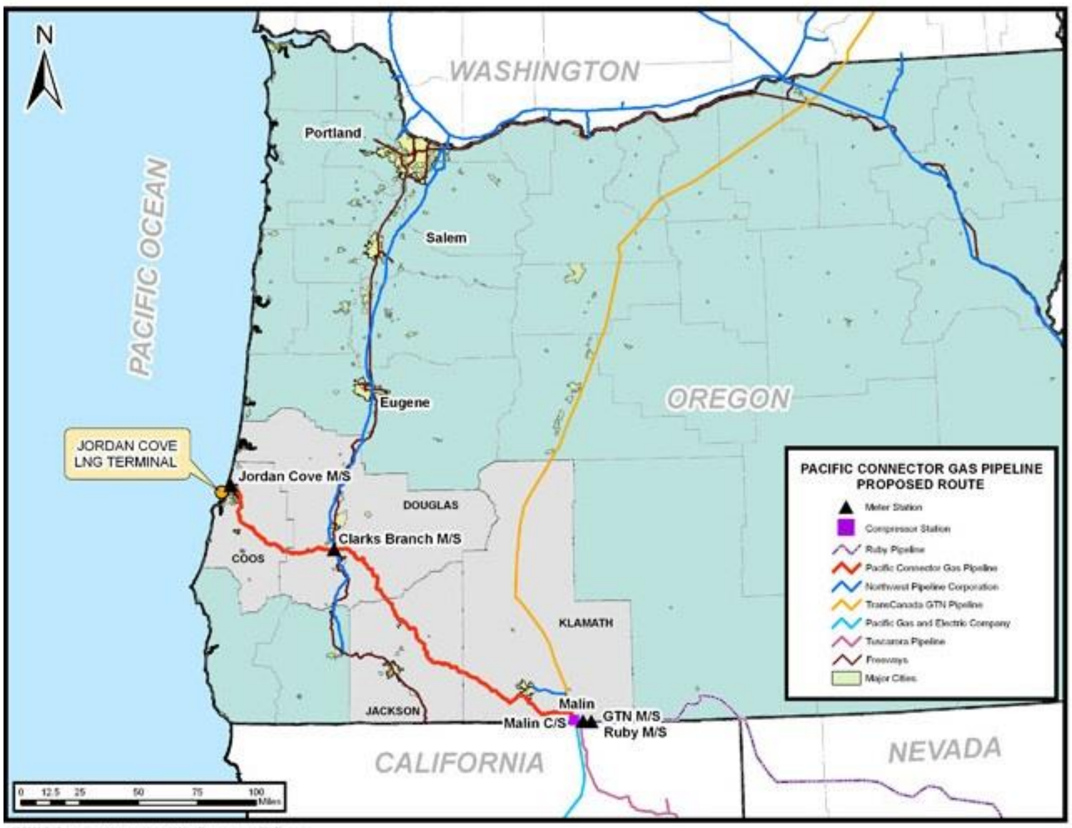


Source: National Inventory of Dams, USACE, 2013

Natural Gas

Although natural gas does not provide the most energy to the region, it does contribute a significant amount of energy to the region's energy portfolio. Liquefied natural gas (LNG) is transported via pipelines throughout the United States. **Figure 2-223** shows the Northwest Pipeline, which runs through Malheur County (near Ontario, shown in blue). (http://www.northwest.williams.com/NWP_Portal/extLoc.action?Loc=FilesNorthwestother&File=pipelineInfo.html). LNG pipelines, like other buried pipe infrastructure, are vulnerable to earthquakes and can cause danger to human life and safety, as well as environmental impacts in the case of a spill.

Figure 2-223. Liquefied Natural Gas Pipelines in Region 8



Source: Williams Corporation

Utility Lifelines

The northeast corner of Malheur County is an important throughway for oil and gas pipelines and electrical transmission lines. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy. These lines may be vulnerable to severe but infrequent natural hazards such as earthquakes.

Region 8 primarily receives oil and gas from Alaska by way of the Puget Sound through pipelines and tankers. The electric, oil, and gas lifelines that run through the region are both municipally and privately owned (Loy et al., 1976).

The network of electrical transmission lines running through Region 8 is operated primarily by Idaho Power, Pacific Power, and regional electrical cooperatives (and supplied by the Idaho Power Company and Bonneville Power Administration) and primarily facilitates local energy production and distribution (Loy et al., 1976). Most of the natural gas Oregon uses originates in Alberta, Canada. The Williams Company owns the main natural gas transmission pipeline in southeastern Oregon.

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio). Region 8 is part of the Lake-Harney Operational Area under The Oregon State Emergency Alert System Plan (Oregon OEM, 2013). There is a memorandum of understanding between these counties that facilitates the launching of emergency messages. Counties in these areas can launch emergency messages by contacting the Oregon Emergency Response System (OERS), which in turn creates emergency messages to communities statewide.

Beyond day-to-day operations, maintaining communication capabilities during disaster events and other emergency situations helps to keep citizens safe by keeping them informed of the situation’s status, areas to avoid, and other procedural information. Additionally, responders depend on telecommunications infrastructure to be routed to sites where they are needed.

Television

Television serves as a major provider for local, regional, and national news and weather information and can play a vital role in emergency communications. The Oregon State Emergency Alert System Plan does not identify a local primary station for emergency messages; however, messages are provided via the three state primary networks: Oregon Public Broadcasting (Portland), KOBI TV (Medford), and KWAX-FM (Eugene).

Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband service providers serve Region 8. Broadband technology including mobile wireless is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless, and mobile wireless. Internet service is readily available throughout most parts the region with a smaller number of providers and service types available in the more remote parts of the region (NTIA, n.d.). Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

Wireless providers sometimes offer free emergency mobile phones to those impacted by disasters, which can aid in communication when landlines and broadband service are unavailable.

Radio

Radio is readily available to those who live within Region 8 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Radio transmitters for the Eastern Oregon Operational Area are:

Local Primary Station:

- KBHN-FM, 1230 KHZ (Burns); and

State Primary Station:

- KOBN-FM, 90.1 MHZ (Burns).

Ham Radio

Amateur radio, or ham radio, is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). ARES District 6 provides service to Region 8. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (Oregon Office of Emergency Management, n.d.). The official ham emergency station calls for Region 8 are (American Relay Radio League Oregon Chapter, www.arrloregon.org):

- Harney County: KF7CIS; and
- Malheur County: K&RHB.

Water

Water infrastructure includes drinking water, stormwater, and wastewater systems. All of these systems possess some level of vulnerability to natural hazards that can have repercussions on human health, ecosystems, and industry.

Drinking Water

In southeastern Oregon, the majority of municipal drinking water is supplied from groundwater wells, including in the cities of Burns and Hines. The City of Ontario primarily draws its drinking water from the Snake River. The City of Nyssa also has water rights for municipal water on the Snake River as a secondary water source. The City of Vale primarily relies on the Malheur River for drinking water and has groundwater wells as a backup water source. Rural areas in Malheur County draw drinking water from the Owyhee River, Beulah Reservoir, and Billy Creek. In Harney County, rural drinking water is drawn primarily from groundwater wells.

Irrigation water is generally pulled from surface sources and distributed through established irrigation districts in Malheur County. In Harney County, irrigation water is drawn from a combination of groundwater wells and surface sources including the Silvies, Donner und Blitzen River, and smaller tributary creeks.

There are several threats to the region’s water quality and quantity. In Malheur County agricultural products such as pesticides and herbicides leech nitrates into ground and surface water. Other concerns for water quality in Malheur County include naturally occurring arsenic and phosphorus in the soil and bacterial contaminants such as *Escherichia coli* (*E. coli*). Naturally occurring arsenic and other minerals threatens water quality in Harney County. Mineral concentrations become higher in proximity to Malheur Lake and during drought seasons, increasing water quality threats in Harney County.

Water shortages have become common in Region 8. 2011 was the last year with a predictable water supply. The region had drought declarations for three consecutive years, from 2012 to 2014.

Low levels of snowpack can lead to severe shortages in a region that is already subject to annual shortages. Low precipitation levels can lead to low levels of groundwater recharge, which could impact both agricultural and municipal supplies. Additionally, no new water rights are available for surface water, although groundwater rights are still available in Malheur County.

At the time of this writing, water supply in irrigation districts is not meeting demand to sustain local agricultural operations. In 2014, irrigation water supplies are expected to be unavailable two and a half months less than usual. This is compounded by the fact that Harney County currently has no above-ground reservoir for municipalities or rural residents.

Underground water supplies and aging or outdated infrastructure such as reservoirs, treatment facilities, and pump stations can be severed during a seismic event. Rigid materials such as cast iron may snap under the pressure of liquefaction. More flexible materials such as polyvinyl chloride (PVC) and ductile iron may pull apart at joints under the same stresses. These types of infrastructure damages could result in a loss of water pressure in municipal water supply systems, limiting access to potable water. This can lead to unsanitary conditions that may threaten human health. Lack of water can also impact industry, such as the manufacturing sector. Moreover, if transportation infrastructure is impacted by a disaster event, repairs to water infrastructure will be delayed.

Stormwater and Wastewater

In urbanized areas severe precipitation events may cause flooding that leads to stormwater runoff. A non-point source of water pollution, stormwater runoff can adversely impact drinking water quality. It can also lead to environmental issues such as increasing surface water temperatures that can adversely affect habitat health. Furthermore, large volumes of fast-moving stormwater that enter surface waterways can cause erosion issues.

Stormwater can also impact water infrastructure. Leaves and other debris can be carried into storm drains and pipes, which can clog stormwater systems. In areas where stormwater systems are combined with wastewater systems (combined sewers), flooding events can lead to combined sewer overflows (CSOs). CSOs present a heightened health threat as sewage can flood urban areas and waterways. Underground stormwater and wastewater pipes are also vulnerable to damage by seismic events.

In Region 8, county and building codes (city and county) emphasize use of centralized storm sewer systems to manage stormwater. Low impact development (LID) mitigation strategies can alleviate or lighten the burden to a jurisdiction's storm sewer system by allowing water to percolate through soil onsite or detaining water so it enters the storm sewer system at lower volumes, at lower speed, and at lower temperatures. LID strategies are not required any community in Region 8. Promoting and requiring decentralized LID stormwater management strategies could help reduce the burden of new development on storm sewer systems, and increase a community's resilience to many types of hazard events.

Infrastructure Trends and Issues

Physical infrastructure is critical for everyday operations and is essential following a disaster. Lack or poor condition of infrastructure can negatively affect a community's ability to cope with, respond to, and recover from a hazard event. Diversity, redundancy, and consistent maintenance of infrastructure systems help create system resiliency (Meadows, 2008).

Damage or service interruption to roads, bridges, and rail systems can have devastating effects the region's economy. Hazards such as flooding and winter weather can close the highways that connect communities in Region 8 to the rest of the state and neighboring states. Eight percent of all bridges in Region 8 are distressed or deficient. In Malheur County there are two rail yards, and rails that support cargo and trade flows and are vulnerable to icy conditions.

The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards. Two power-generating facilities are located here, a hydroelectric and a geothermal facility. The majority of the region's dams are located in Malheur County. Ten have High Threat Potential dams and 13 have Significant Threat Potential. The northeast corner of Malheur County is an important throughway for oil and gas pipelines and electrical transmission lines. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards.

Decentralization and redundancy in the region's telecommunication systems can help boost the area's ability to communicate before, during, and after a disaster event. It is important to note that broadband and mobile telephone services may not cover areas that are distant from major transportation routes. This may present a communication challenge in the wake of a hazard event. Encouraging residents to keep AM/FM radios available for emergency situations could help increase the capacity for communicating important messages throughout the region.

Drinking water is primarily sourced from groundwater wells, the Snake River, Malheur River Owyhee River, Beulah Reservoir, and Billy Creek. These water bodies are vulnerable to pollution from agricultural pesticides and herbicides. Naturally occurring mineral concentrations become higher in proximity to Malheur Lake and during drought seasons, increasing water quality vulnerability in Harney County. No communities in the region require low impact development (LID) regulations.

Built Environment

Development Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's program is 19 land use goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards (Department of Land Conservation and Development, website: http://www.oregon.gov/).

Settlement Patterns

The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people or an "urban cluster" of at least 2,500 people (but less than 50,000). Wheeler County does not meet either definition; therefore all of its population is considered rural even though the county has incorporated cities.

Contrary to statewide patterns of urban growth and rural decline between 2000 and 2010, Region 8's urban populations shrank by about 13% and rural populations grew by roughly 15%. Harney County experienced a greater increase in housing units in both urban and rural communities. The region's population is clustered around the I-84 corridor and the cities of Burns, Hines, Ontario, and Vale.

Table 2-502. Urban and Rural Populations in Region 8

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	2,694,144	3,104,382	15.2%	727,255	726,692	-0.1%
Region 8	23,194	20,283	-12.6%	16,030	18,452	15.1%
Harney	4,330	4,131	-4.6%	3,279	3,291	0.4%
Malheur	18,864	16,152	-14.4%	12,751	15,161	18.9%

Note: The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people, or an "urban cluster" of at least 2,500 people (but less than 50,000). Grant and Wallowa Counties do not meet either definition, therefore all of their populations are considered rural even though the counties include incorporated cities.

Source: U.S. Census Bureau. 2000 Decennial Census, Table P002 and 2010 Decennial Census, Table P2

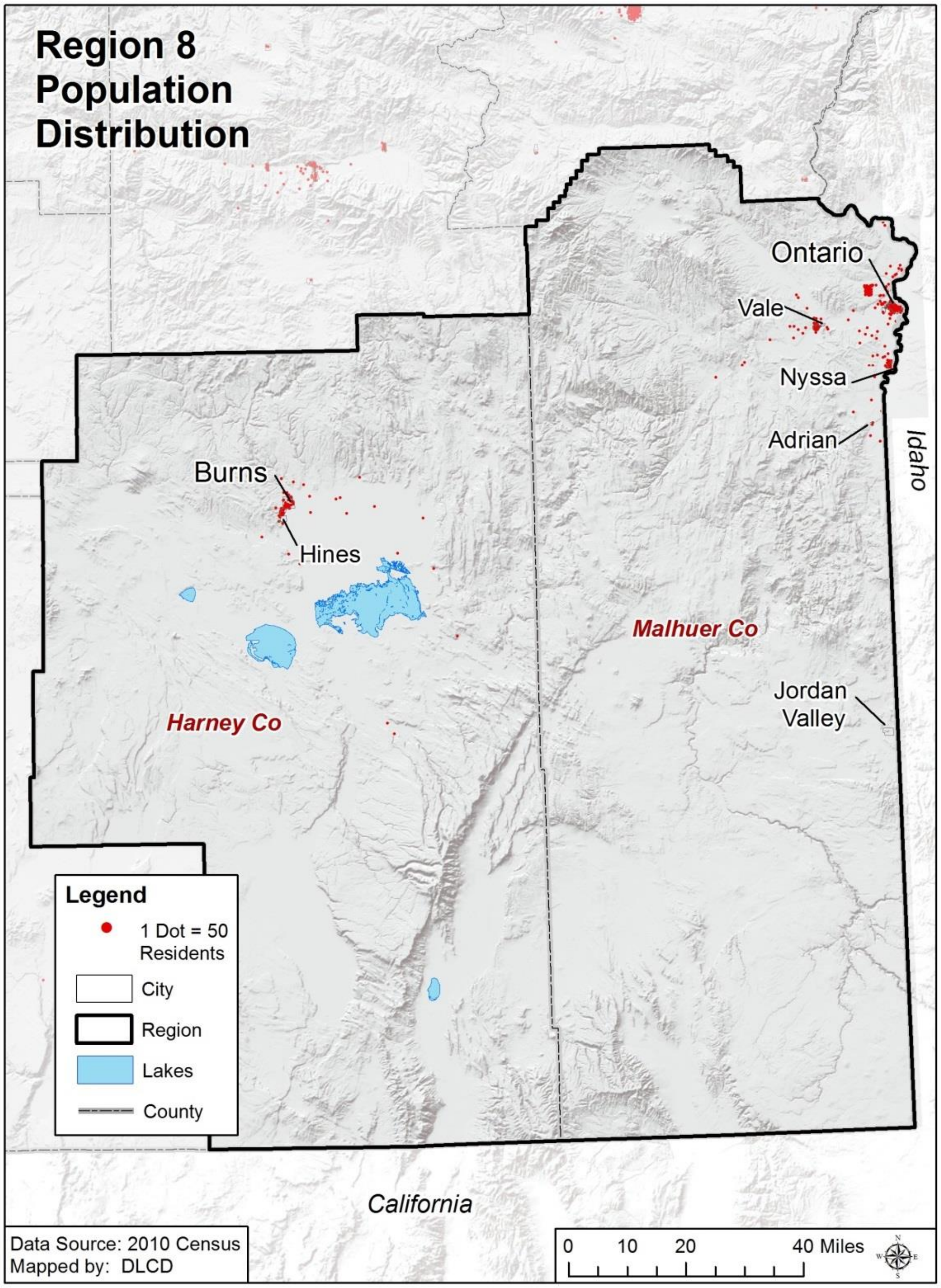
Table 2-503. Urban and Rural Housing Units in Region 8

	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 8	8,186	8,453	3.3%	6,580	7,074	7.5%
Harney	1,990	2,111	6.1%	1,543	1,724	11.7%
Malheur	6,196	6,342	2.4%	5,037	5,350	6.2%

Note: The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people, or an "urban cluster" of at least 2,500 people (but less than 50,000). Grant and Wallowa Counties do not meet either definition, therefore all of their populations are considered rural even though the counties include incorporated cities.

Source: U.S. Census Bureau. 2000 Decennial Census, Table H002 and 2010 Decennial Census, Table H2

Figure 2-224. Region 8 Population Distribution



Source: U.S. Census, 2012

Land Use and Development Patterns

Similar to Region 7, the past 40 years have seen a slower pace of development of private land in Region 8 than in western Oregon. In this time period very little loss of private land in forest, agriculture, and range uses occurred. Land use programs have limited rural residential and urban development and have maintained large parcel sizes. Demand for large-scale development has historically been very low. To the extent it has occurred, it has generally been located along existing transportation corridors (DLCD, internal communications, 2014).

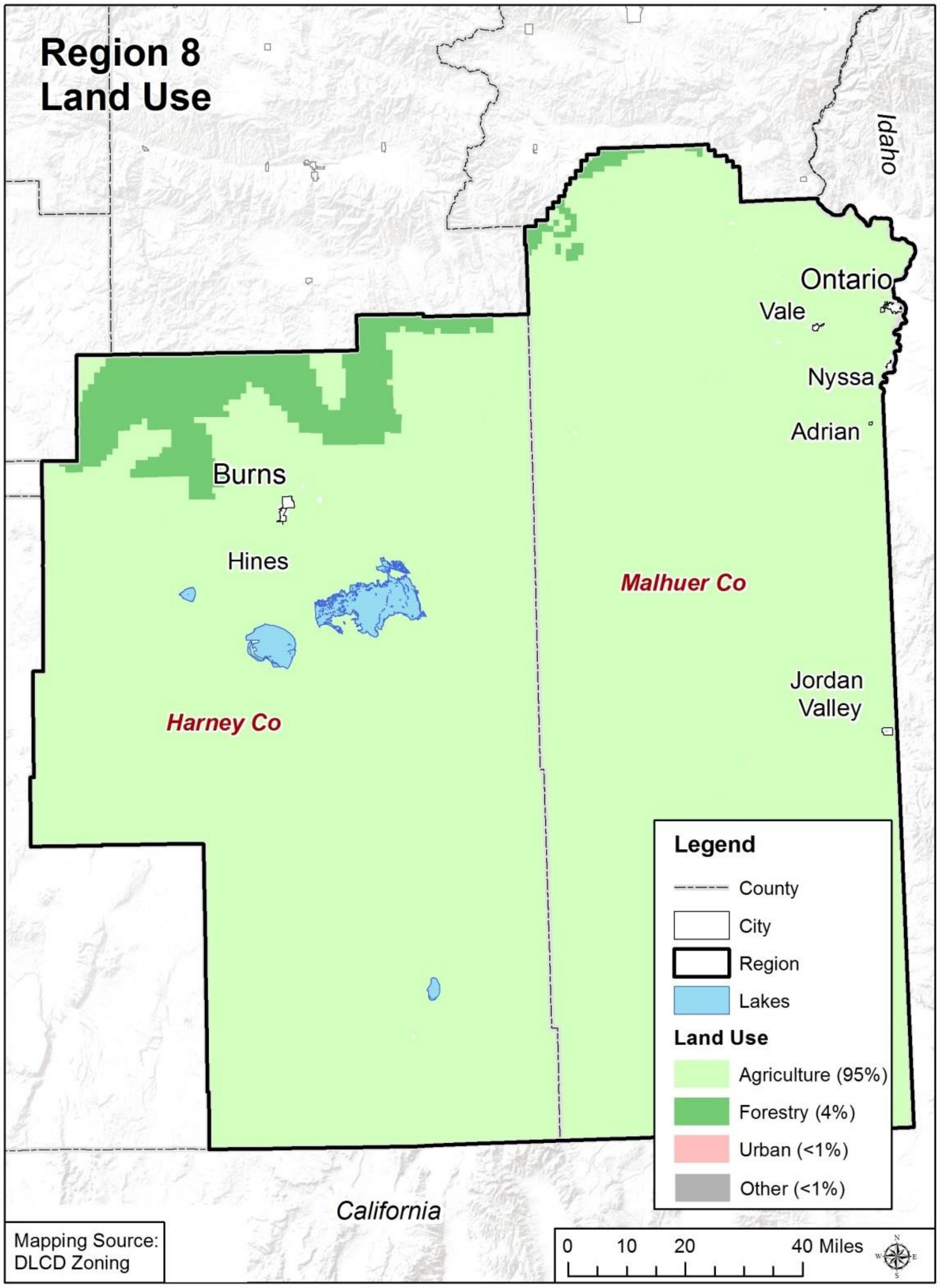
Malheur County's land ownership is just more than one fifth privately owned (22% private land) and a little less than four fifths publically owned (73% federal land and 4.5% state land). Harney County is similar, with 72% federal land, 25% private, and 3% state land.

Overall, Region 8 is overwhelmingly rangeland, with the Bureau of Land Management (BLM) controlling over 70% of the land. The land cover is largely grasslands and shrubs. Irrigated fields in the county's northeast corner, known as Western Treasure Valley, are the center of intensive and diversified farming.

The region's wide-open spaces have a total of only seven incorporated cities. Ontario, relatively close to the Boise, Idaho, metropolitan area is economically active. Burns-Hines is an important center for commerce as well as tourism. Timber and logging remained important to that local economy until the 1990s, when the area's last lumber mill closed for lack of timber.

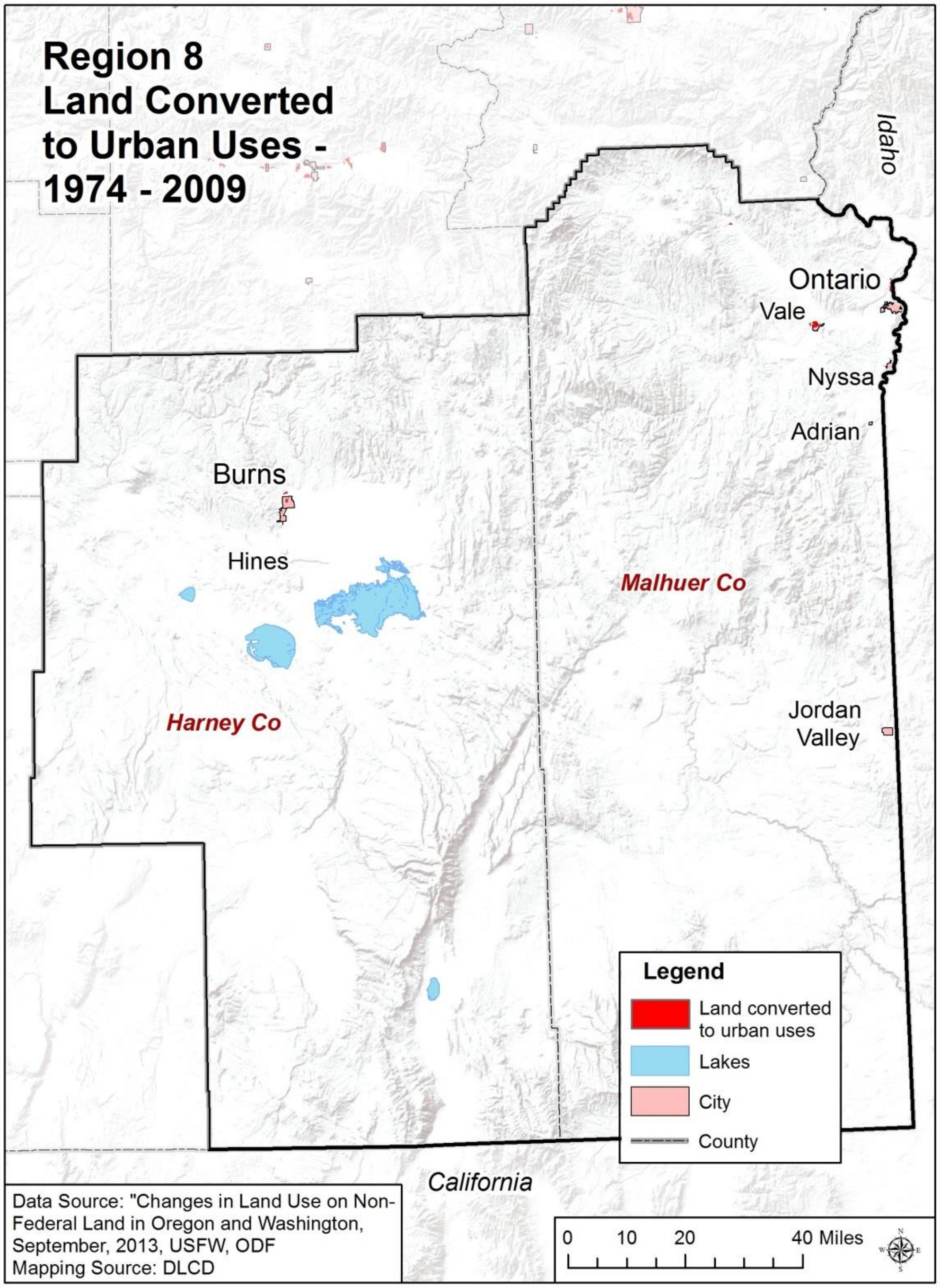
The Bureau of Land Management is considering a management plan designed protect the habitat of the sage grouse, possibly tightening uses of its land and capping how much human disturbance is allowed on the bird's core habitat. A number of stakeholders are working together to address loss of habitat while hoping to minimize potential impact on rangeland users.

Figure 2-225. Region 8 Land Use



Source: Department of Land Conservation and Development, 2014

Figure 2-226. Region 8 Land Converted to Urban Uses, 1974–2009



Source: Land Use Change on Non-Federal Land in Oregon and Washington, September, 2013, USFS, ODF

Housing

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. Similar to the state, about two thirds of the region's housing stock is single-family homes. In contrast to overall state numbers, the region has about half the percentage of multi-family homes and more than double the percentage of mobile homes. Notably, 30% of homes in Harney County are mobile units. In natural hazard events such as earthquakes and floods, mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of Emergency Services, 1997).

Table 2-504. Housing Profile for Region 8, 2012

	Total Housing Units	Single Family		Multi-Family		Mobile Homes	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	1,140,319	68.1%	460,852	27.5%	139,768	8.4%
Region 8	15,490	10,423	67.3%	1,968	12.7%	3,094	20.0%
Harney	3,815	2,324	60.9%	346	9.1%	1,145	30.0%
Malheur	11,675	8,099	69.4%	1,622	13.9%	1,949	16.7%

Note: The percentages listed above do not reflect the number of structures that are built within special flood hazard areas, or that are at risk of seismic damage.

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25024

Aside from location and type of housing, the year structures were built (Table 2-505) has implications. Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for the Cascadia earthquake fault (Judson, 2012). Therefore, homes built before 1994 are more vulnerable to seismic events.

Also in the 1970s, FEMA began assisting communities with floodplain mapping as part of administering 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. Regionally, about 45% of the housing stock was built prior to 1970, before the implementation of floodplain management ordinances. About 80% of the housing stock was built before 1990 and the codification of seismic building standards.

Table 2-505. Age of Housing Stock in Region 8, 2012

	Total Housing Units	Pre 1970		1970 to 1989		1990 or later	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	609,062	36.4%	518,569	31.0%	545,962	32.6%
Region 8	15,490	6,784	43.8%	5,491	35.4%	3,215	20.8%
Harney	3,815	1,682	44.1%	1,139	29.9%	994	26.1%
Malheur	11,675	5,102	43.7%	4,352	37.3%	2,221	19.0%

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25034

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. **Table 2-506** shows the initial and current FIRM effective dates for Region 8 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, **Flood** section.

Table 2-506. Community Flood Map History in Region 8

	Initial FIRM	Current FIRM
Harney County	Apr. 17, 1984	Apr. 17, 1984
Burns	Aug.15, 1984	Dec. 22, 1998
Hines	Sep. 28, 1984	Nov. 3, 1989
Burns-Paiute Reservation	Sep. 28, 1984	Sep. 28, 1984
Malheur County	Sep. 29, 1986	Sep. 29, 1986
Adrian	Sep. 19, 1984	Sep. 19, 1984
Jordan Valley	Sep. 19, 1984	Sep. 19, 1984
Nyssa	Dec. 14, 1982	Dec.14, 1982 (M)
Ontario	Apr. 17, 1984	Apr. 17, 1984
Vale	Sep. 4, 1987	Sep. 4, 1987

(M) = no elevation determined; all Zone A, C and X.

Source: Federal Emergency Management Agency, Community Status Book Report

State-Owned/Leased and Critical/Essential Facilities

In 2014 the Department of Geology and Mineral Industries updated the 2012 Oregon NHMP inventory and analysis of state-owned/leased facilities and critical/essential facilities. Results from this report relative to Region 8 can be found in **Table 2-507**. The region contains 4.1% of the total value of state-owned/leased facilities and critical/essential facilities.

Table 2-507. Value of State-Owned/Leased Critical and Essential Facilities in Region 8

	Total Property Value (State Facilities)	Percent State Total
Oregon	$7,339,087,023	100%
Region 8	$302,954,349	4.1%
Harney	$25,925,826	0.4%
Malheur	$277,028,523	3.8%

Source: The Department of Geology and Mineral Industries

Built Environment Trends and Issues

The trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. Region 8 is largely a rural county with urban development focused along I-84 and around the population centers of Burns, Hines, Ontario, and Vale. The region is losing population and most new population is in the smaller rural communities. The region's housing stock is largely single-family homes, with only about one half the state's percentage of multi-family homes. The region has more than double the state's percentage of mobile homes — Harney County has almost 4 times statewide numbers. About 45% of the homes were built before 1970 and floodplain management standards; 80% were built before 1990 seismic standards. None of the region's FIRMs has been modernized or updated. The region's share of state-owned facilities is mostly within Malheur County.

2.3.8.3 Hazards and Vulnerability

Droughts

Characteristics

Droughts are a common occurrence in Region 8 and can have a significant economic impact on agricultural, livestock, and natural resources. In 2013, for example, most irrigation reservoirs started the season at a third of capacity, with some irrigation districts running out of water by mid to late June. The Governor has declared a drought emergency in Region 8 numerous times since 1992. In May and June of 2013, the U.S. Department of Agriculture designated Malheur and Harney Counties as primary natural disaster areas due to damages and losses caused by drought.

Because of late winter 2014 reservoir storage levels and predicted streamflow forecasts, the Natural Resources Conservation Service predicted water shortages for the summer of 2014. Governor Kitzhaber issued drought emergencies for both Malheur and Harney Counties. Owyhee Reservoir peaked at 197,000 acre-feet in 2014. In December, the Capitol Press reported that irrigation water supplies for Malheur County farms that rely on water from the Owyhee Project began to run out in July and were completely shut off by August, two months earlier than normal (http://infoweb.newsbank.com/resources/openurl?ctx_ver=z39.88-2004&rft_dat=news/1522AB0187C74988&rft_id=info:sid/infoweb.newsbank.com&rft_val_format=info:ofi/fmt:kev:mtx:ctx&svc_dat=NewsBank&req_dat=0DC38C612B5C2835).

Historic Drought Events

Table 2-508. Historic Droughts in Region 8

Year	Location	Description
1930s	statewide	generally, a very dry period for much of Oregon; Malheur County experiences its most extreme drought years in 1931, 1934, and 1935
1988	Regions 7, 8	extreme drought for Malheur County (PDSI value of -4.14); this was also a severe drought year for northeast Oregon
1992	statewide	Governor declared drought emergency for all 36 counties in Oregon. 1992 was a severe drought year for Malheur County.
1994	Regions 4–8	in 1994, Malheur County received a Governor drought declaration, along with 10 other counties located within regions 4, 5, 6, and 7
2001	eastern and southern Oregon	Governor-declared drought emergency for Harney County and 17 other counties throughout the state
2002	eastern and southern Oregon	Governor-declared drought emergency for Malheur and Harney Counties; total of 23 counties under a drought emergency during 2002
2003	eastern and southern Oregon	Governor-declared drought emergency issued for Malheur and Harney Counties; most counties remain under a drought emergency from the 2001 and 2002 declarations through June 2003
2004	Regions 5–8	Governor-declared drought emergency issued for Malheur County, along with three counties from neighboring regions
2007	Regions 6–8	Governor-declared drought emergency issued for Malheur and Harney County, along with four other counties in Region 6 and 7
2013	Region 5–8	Governor-declared drought emergency issued for Malheur County, along with four other counties in neighboring regions
2014	Regions 4, 6–8	Governor-declared drought emergency issued for Malheur and Harney Counties, along with eight other counties in other regions

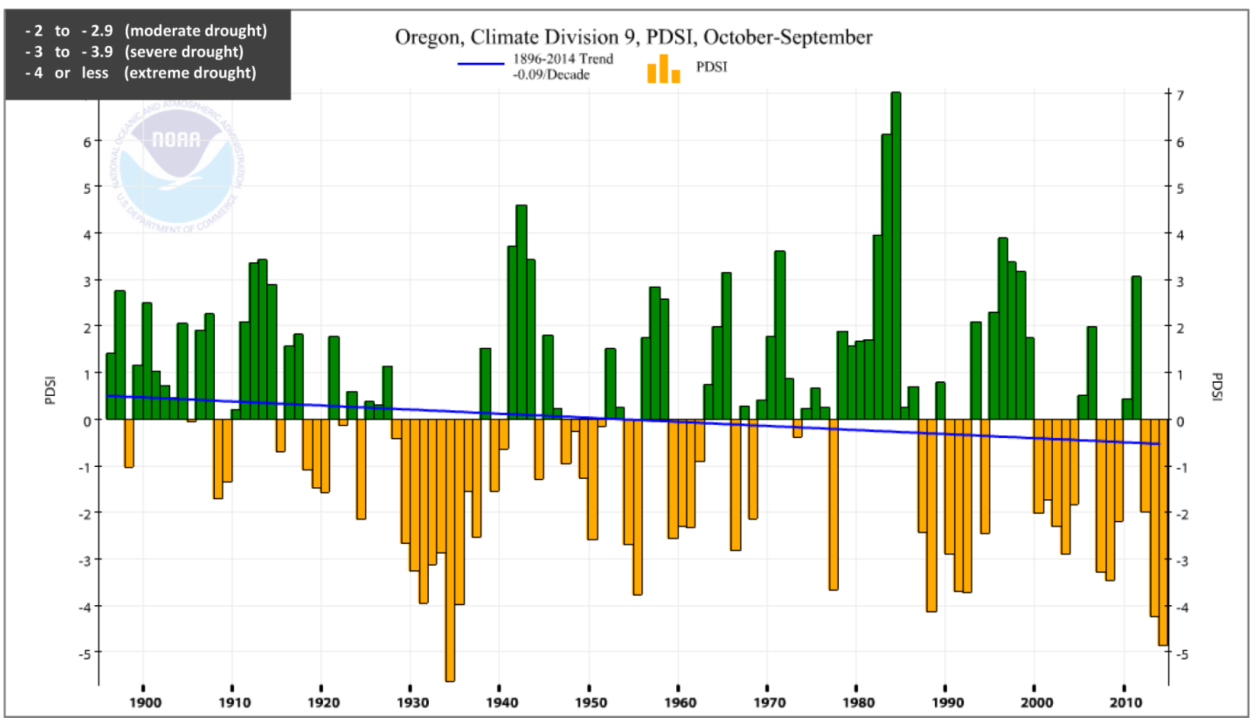
Sources: Taylor and Hatton (1999); and the Oregon Secretary of State's Archives Division. NOAA's Climate at a Glance. Western Regional Climate Center's Westwide Drought Tracker http://www.wrcc.dri.edu/wwdt. Personal Communication, Kathie Dello, Oregon Climate Service, Oregon State University.

Historical drought information can also be obtained from the National Climatic Data Center, which provides historical climate data showing wet and dry conditions, using the Palmer Drought Severity Index (PDSI) that dates back to 1895. The PDSI is not the best indicator of water availability for Oregon as it does not account for snow or ice (delayed runoff), but it has the advantage of providing the most complete, long-term drought record.

Figure 2-227 shows years where drought or dry conditions affected the south eastern area of Oregon, known as Climate Division 9, which encompasses Malheur County only.

Based on this index, 1934 was a very extreme drought year for Malheur County (PDSI: -5.63). Water Years 1931, 1935, 1988, and 2013 were also extreme drought years. Malheur County has experienced a combined total of 31 years of moderate, severe, or extreme drought conditions during this period of record, more than any other climate region in the state.

Figure 2-227. Palmer Drought Severity Index for Region 8



Source: National Climatic Data Center, http://www.ncdc.noaa.gov/cag/

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the probability that Region 8 will experience drought is shown in **Table 2-509**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-509. Local Probability Assessment of Drought for Region 8

	Harney	Malheur
Probability	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Despite impressive achievements in the science of climatology, estimating drought probability and frequency continues to be difficult. This is because of the many variables that contribute to weather behavior, climate change and the absence of long historic databases. Oregon has yet to undertake a comprehensive risk analysis for drought on a statewide basis to determine probability or vulnerability for a given community.

With that said, the likelihood that Malheur and Harney County will experience drought conditions in the near future is very likely. As mentioned, the Governor has declared drought in both counties on several occasions since 1992. During the 100-year period of 1895-1995, both counties experienced severe or extreme drought conditions 10–15% of the time.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to drought is shown in **Table 2-510**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-510. Local Vulnerability Assessment of Drought for Region 8

	Harney	Malheur
Vulnerability	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Oregon has not undertaken a comprehensive statewide analysis to identify which communities are most vulnerable to drought. However, based on a review of drought declarations issued by the Governor, Malheur County could be considered one of the communities most vulnerable to drought and its related impacts. Since 1992, Malheur County has been under an emergency drought declaration on eight different occasions: 1992, 1994, 2002, 2003, 2004, 2007, 2013, and most recently, in February 2014. Harney County shares a similar recurrent pattern of drought emergencies: 1992, 2001, 2002, 2003, 2007, and 2014, and can also be considered vulnerable to drought-related impacts.

Ranching, farming, and other agricultural activities greatly contribute to the economy of both counties. Malheur County ranks fourth in the state for agricultural sales, with $373 million in gross farm and ranch sales in 2012. Drought can have a significant impact on the agricultural community and associated businesses that rely on this industry.

Dust Storms

Characteristics

There is little about the dust storms in this region that differs from the description in the State Risk Assessment, **Dust Storms** section, except to note that agricultural practices likely play less of a role here than in Region 5. All the same, Region 8 farmers, ranchers, homeowners, resort properties, and wildlife sometimes find themselves vying for limited water. This competition for scarce water can affect the locations and amounts of dust lifted into the atmosphere, and blown on the wind.

Historic Dust Storm Events

Table 2-511. Historic Dust Storms in Region 8

Date	Location	Description
Aug. 2012[1]	Harney and Malheur Counties	a massive dust storm due to 50–60 mph winds produced by thunderstorms eventually blew on into Idaho; some media reports indicate this event darkened the skies in some areas for more than 2 hours
Mar. 2013[2]	Malheur County	dust from this storm is reported to have accelerated snowmelt in a Southwestern Idaho mountain range; “Nobody on our staff has ever witnessed anything similar,” said Adam Winstral, Research Hydrologist with the U.S. Department of Agriculture

Sources:

(1) Dust, an emerging problem in the Great Basin: insights from 2012, January 23, 2013; YouTube, Brenda Burns, published August 6, 2012 and Zeronieo, published August 14, 2012; Mother Recounts Her Encounter with an Oregon Dust Storm, Yahoo Voices, August 8, 2012

(2) The Oregonian (oregonlive.com) and Associated Press, March 29, 2013; Idaho Statesman (Rocky Barker), March 28, 2013

Brenda Burns and her family were traveling through Malheur County around 4:30 p.m. on August 5, 2012 when they noticed something ominous in the distance. What they saw was a massive wall of dust heading in their direction. According to ktvb.com, the massive dust storm that started in Eastern Oregon packed winds between 50 to 60 miles an hour, and carried the debris into Idaho. “It took about 27 minutes to totally overtake our position,” said Mrs. Burns. “It was so wide… that it cut us off from returning the way we came… We really had no direction to go… The initial cloud blackout lasted about 30 minutes, but we were inside the dust storm for over two and a half hours… At one point my husband and I thought maybe it was some kind of pyroclastic cloud. It really looked that ominous. It was very frightening…”

“Mother Recounts Her Encounter with an Oregon Dust Storm,” *Yahoo Voices*, August 8, 2012

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the probability that Region 8 will experience dust storms is shown in **Table 2-512**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-512. Local Probability Assessment of Dust Storms for Region 8

	Harney	Malheur
Probability	—	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The fact that the two storms noted in the Historic Events table (**Table 2-511**) both occurred within the most recent few years of record suggests that the probability of these events may be increasing in Region 8. This hypothesis would benefit from more research.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to dust storms is shown in **Table 2-513**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-513. Local Vulnerability Assessment of Dust Storms for Region 8

	Harney	Malheur
Vulnerability	—	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

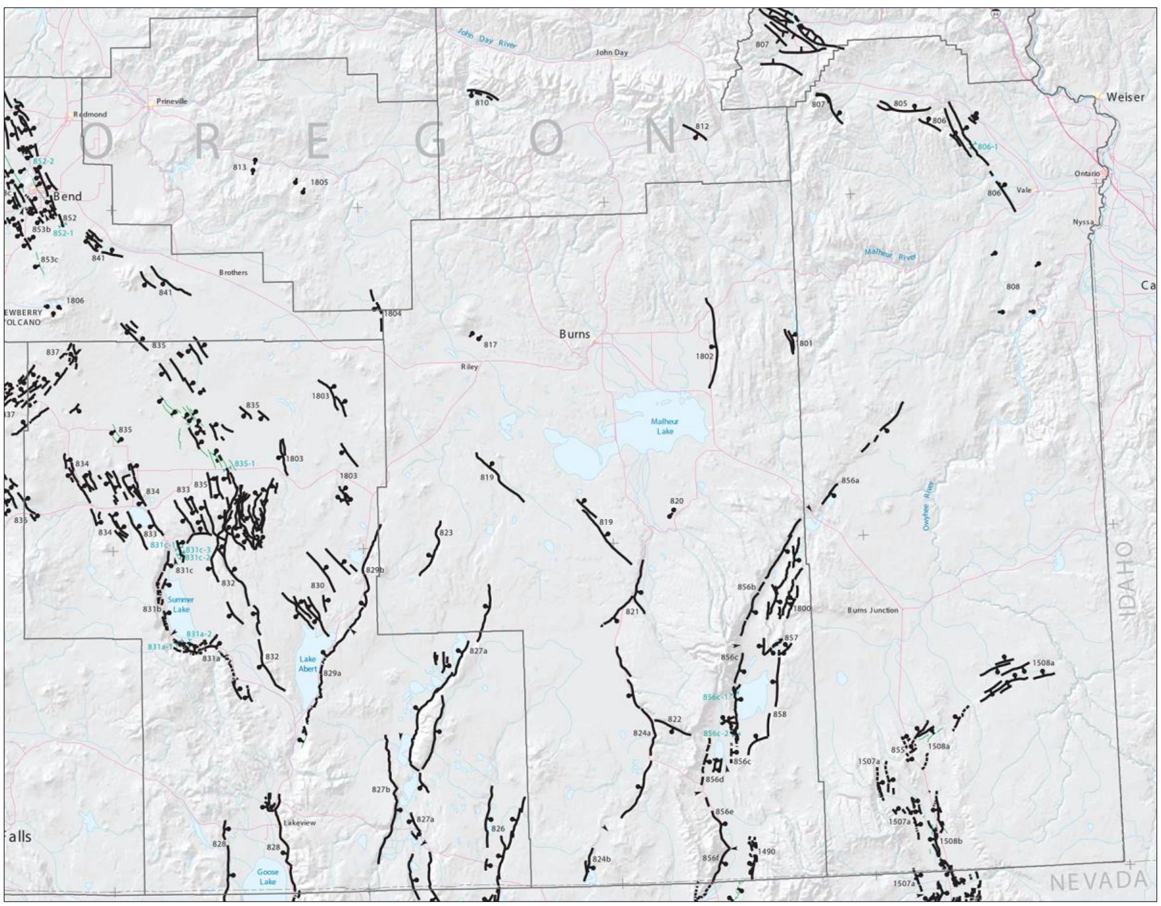
Malheur County is most vulnerable to dust storms in this region. Harney County is also vulnerable. Poor visibility leading to motor vehicle crashes is the worst potential impact of these storms; often these crashes result in fatalities and major injuries. Other impacts include poor air quality, including dust infiltration of equipment and engines, loss of productive soil, and an increase in fine sediment loading of creeks and rivers.

Earthquakes

Characteristics

The geographic position of this region makes it susceptible to earthquakes from two sources: crustal events and volcanic-earthquakes. Generally, crustal faults can produce earthquakes with magnitudes up to roughly M7.0. Because only certain faults have been studied in detail and determined to be active, there may be many more crustal faults in the region capable of producing earthquakes which have not yet been identified. [Figure 2-228](#) shows the locations of faults in Region 8.

Figure 2-228. Quaternary Faults and Folds in Region 8

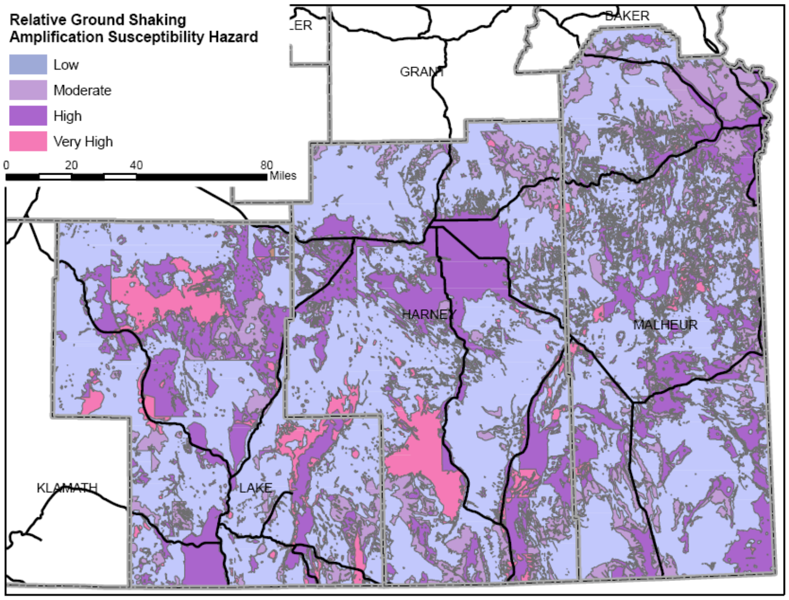


Source: Modified from Personius et al. (2003)

When all of these earthquake sources are added together, the general earthquake hazard in the region can be displayed as a whole and is reflected in the USGS national seismic hazard maps. When compared to the rest of the United States, most of the region is within a relatively moderate seismicity area.

Figure 2-229 displays the relative ground shaking amplification hazard throughout Region 8.

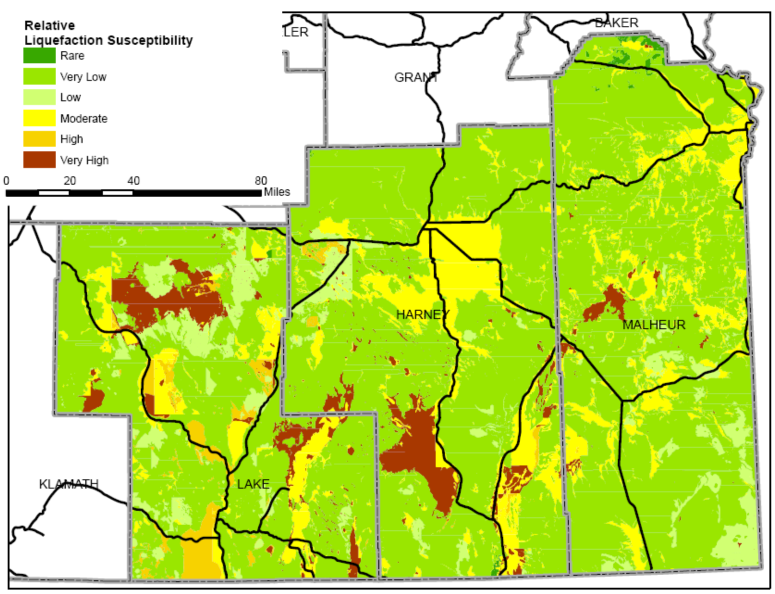
Figure 2-229. Relative Ground Shaking Amplification Hazard in Region 8



Source: Burns (2007)

During seismic shaking, deposits of loose saturated sands can be subjected to contraction resulting in an increase in pore water pressure. If the increase in pore water pressure is high enough, the deposit becomes "liquefied," losing its strength and its ability to support loads. Figure 2-230 displays the relative liquefaction hazard throughout Region 8.

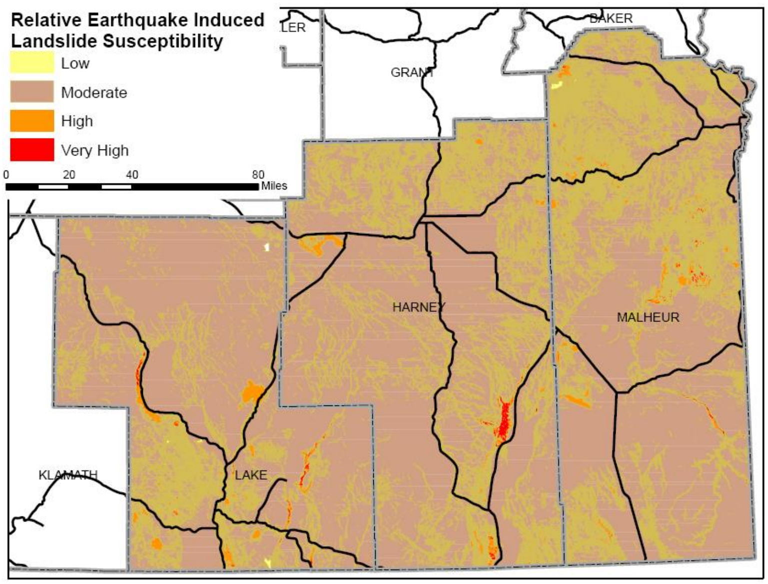
Figure 2-230. Relative Liquefaction Susceptibility Hazard in Region 8



Source: Burns (2007)

Strong ground shaking can also cause landslides and reactivate dormant landslides. Commonly, slopes that are marginally stable prior to an earthquake become unstable and fail. Some landslides result from liquefaction that causes lateral movement of soil, or lateral spread. Figure 2-231 displays the relative earthquake induced landslide hazard throughout Region 8.

Figure 2-231. Relative Earthquake Induced Landslide Susceptibility Hazard in Region 8



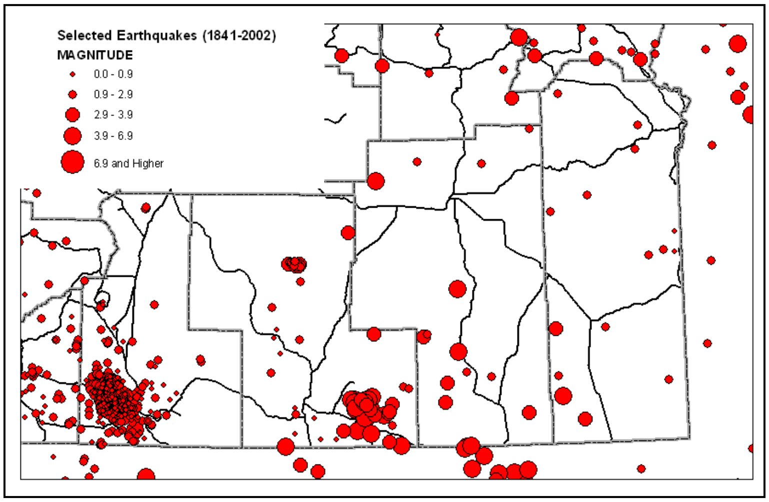
Source: Burns (2007)

Region 8 has experienced many earthquakes. Several earthquake sequences (swarms) have occurred in the region within the last 20 years. There are also identified faults in the region that have been active in the last 20,000 years. The region has also been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered outside the area. Figure 2-232 maps earthquakes in the region from 1841 to 2002, and Table 2-514 provides a general history of earthquakes in Oregon.

When all of these earthquakes sources are added together, the general earthquake hazard in the region can be displayed as a whole and is reflected in the USGS national seismic hazard maps. When compared to the rest of the United States, most of the region is within a relative moderate seismicity area.

Figure 2-232 displays over 1,000 earthquakes that have been recorded in the region during the last century. Because the instrument network in the region was very sparse until the mid-2000s, it is likely that thousands of earthquakes have occurred in the region but were not recorded.

Figure 2-232. Selected Earthquakes in Region 8, 1841–2002



Source: Niewendorp and Neuhaus (2003)

Historic Earthquake Events

Table 2-514. Significant Earthquakes Affecting Region 8

Date	Location	Magnitude	Comments
Approximate years: 1400 BCE*, 1050 BCE, 600 BCE, 400, 750, 900	offshore, Cascadia Subduction Zone	probably 8-9	these are the midpoints of the age ranges for these six events
Jan. 26, 1700	offshore, Cascadia Subduction Zone	about 9	generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Nov. 23, 1873	near Brookings, Oregon at the Oregon-California border	6.8	may have been an intraplate event because of lack of aftershocks; felt as far away as Portland and San Francisco
Mar. 1893	Umatilla	VI-VII (Modified Mercalli Intensity)	damage: unknown
July 15, 1936	Milton-Freewater	6.4	damage: $100,000 damage (in 1936 dollars); two foreshocks and many aftershocks felt
Apr. 13, 1949	Olympia, Washington	7.1	fatalities: eight; damage: $25 million damage (in 1949 dollars); cracked plaster, other minor damage in northwest Oregon
Jan. 1951	Hermiston	V (Modified Mercalli Intensity)	damage: unknown
Nov. 5, 1962	Portland/ Vancouver	5.5	shaking up to 30 seconds; damage: chimneys cracked, windows broken, furniture moved
Apr. 12, 1976	near Maupin	4.8	sounds described as distant thunder, sonic booms, and strong wind
Apr. 25, 1992	Cape Mendocino, California	7.0	subduction earthquake at the triple-junction of the Cascadia Subduction Zone and the San Andreas and Mendocino faults
Mar. 25, 1993	Scotts Mill	5.6	center: Mount Angel-Gates Creek fault; damage: $30 million, including Molalla High School and Mount Angel church
Sep. 20, 1993	Klamath Falls	5.9 and 6.0	fatalities: two; damage: $10 million, including county courthouse; rockfalls

*BCE: Before Common Era.

Sources: Wong and Bolt (1995); Pacific Northwest Seismic Network

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 8 will experience earthquakes is shown in **Table 2-515**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-515. Local Probability Assessment of Earthquakes for Region 8

	Harney	Malheur
Probability	L	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

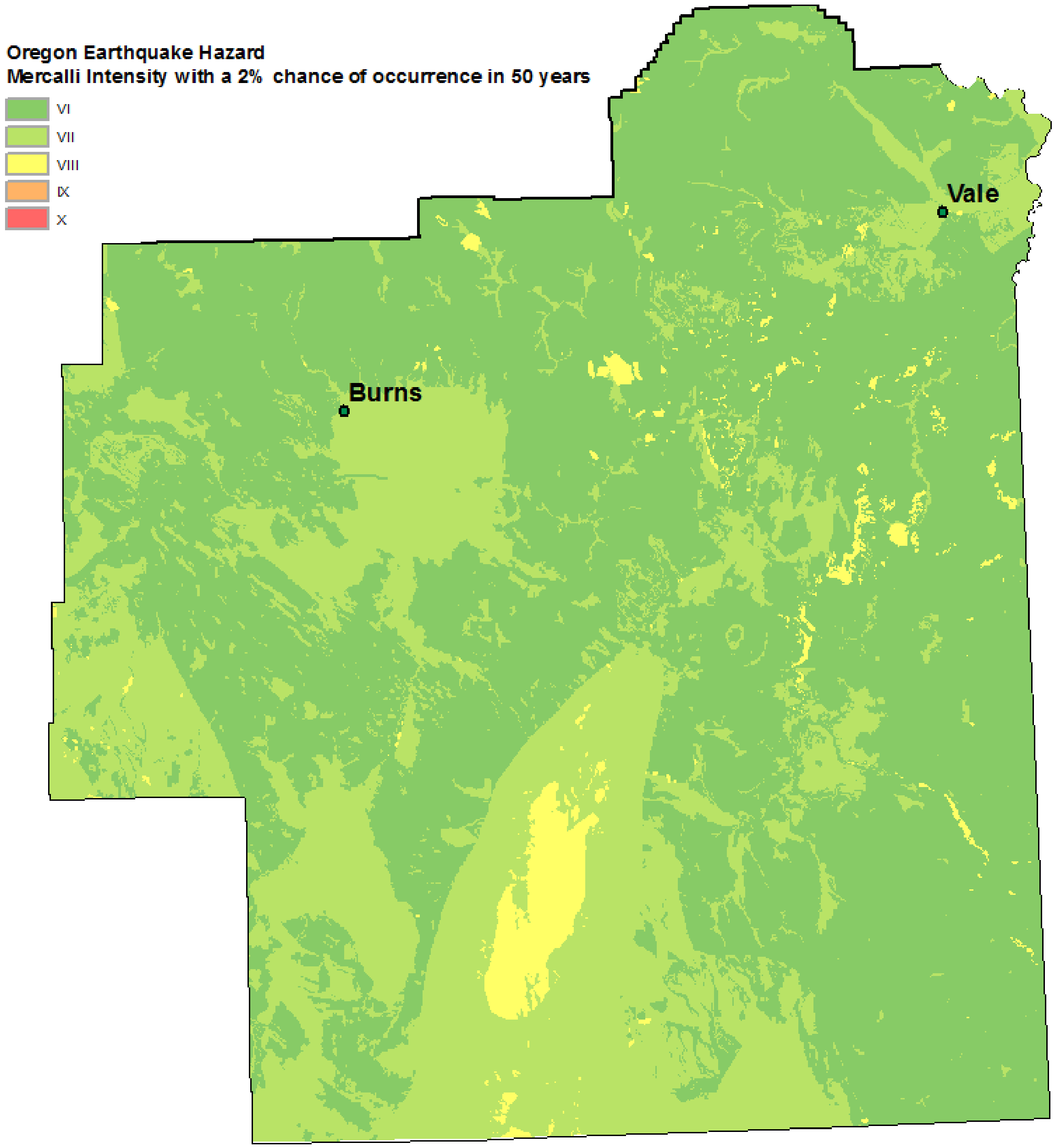
State Assessment

The probability of damaging earthquakes varies widely across the state. In Region 8, the hazard is dominated by local faults and background seismicity.

The probabilistic earthquake hazard for Region 8 is depicted in **Figure 2-233**. This map shows the expected level of earthquake damage that has a 2% chance of occurring in the next 50 years. The map is based on the 2008 USGS National Seismic Hazard Map and has been adjusted to account for the effects of soils following the methods of Madin and Burns (2013). In this case, the strength of shaking calculated as peak ground acceleration and peak ground velocity is expressed as Mercalli intensity, which describes the effects of shaking on people and structures. This map incorporates all that is known about the probabilities of earthquake on all Oregon faults, including the Cascadia Subduction Zone.

The Cascadia subduction zone is responsible for most of the hazard shown in **Figure 2-233**. The paleoseismic record includes 18 M8.8–9.1 megathrust earthquakes in the last 10,000 years that affected the entire subduction zone. The return period for the largest earthquakes is 530 years, and the probability of the next such event occurring in the next 50 years ranges from 7 to 12%. An additional 10–20 smaller M8.3–8.5 earthquakes affected only the southern half of Oregon and northern California. The average return period for these is about 240 years, and the probability of a small or large subduction earthquake occurring in the next 50 years is 37–43%.

Figure 2-233. Probabilistic Earthquake Hazard in Region 8



Color zones show the maximum level of earthquake shaking and damage (Mercalli Intensity Scale) expected with a 2% chance of occurrence in the next 50 years. A simplified explanation of the Mercalli levels is:

VI	Felt by all, weak buildings cracked;
VII	Chimneys break, weak buildings damaged, better buildings cracked;
VIII	Partial collapse of weak buildings, unsecured wood frame houses move;
IX	Collapse and severe damage to weak buildings, damage to wood-frame structures; and
X	Poorly built structures destroyed, heavy damage in well-built structures.

Source: Madin and Burns (2013)

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to earthquakes is depicted **Table 2-516**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-516. Local Vulnerability Assessment of Earthquakes for Region 8

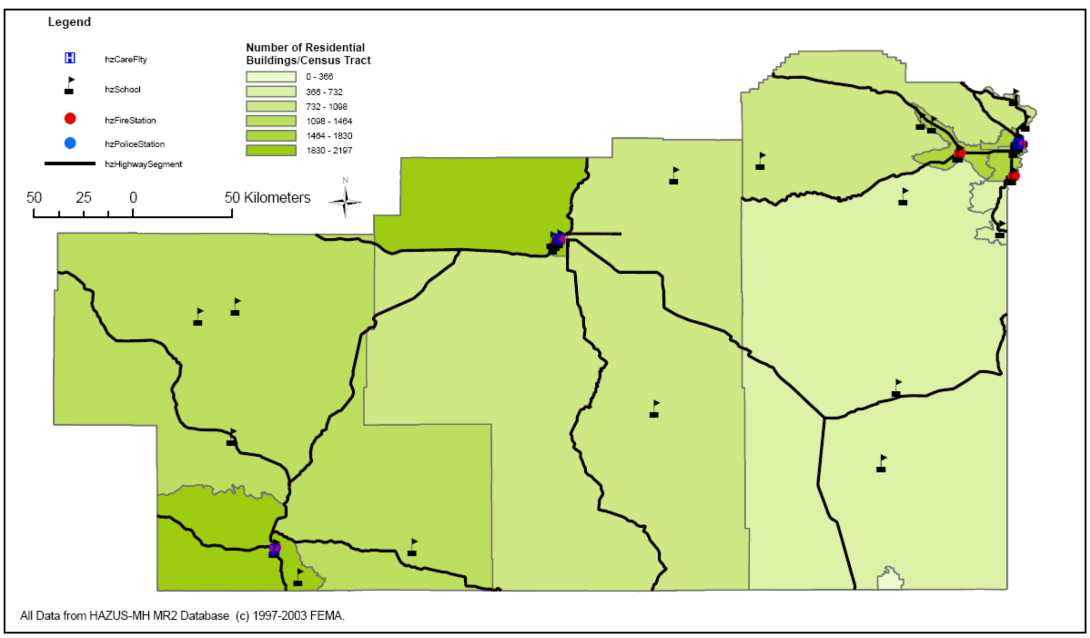
	Harney	Malheur
Vulnerability	L	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Region 8 is moderately vulnerable to earthquake hazards from earthquake-induced landslides, liquefaction, and ground shaking. Most of the region's people and infrastructure are located in the major cities along I-84, US-20, and US-395. **Figure 2-234** shows a map of the generalized exposure of buildings to earthquakes in Region 8.

Figure 2-234. Region 8 Generalized Earthquake Exposure



Source: Hazus-MH MR2 database, Burns, 2007.

The Oregon Department of Geology and Mineral Industries (DOGAMI) has developed two earthquake loss models for Oregon based on the two sources of seismic events: (a) a M6.9 arbitrary crustal event, and (b) 2,500 year probabilistic driving earthquake scenario. Both models are based on Hazus-MH, a computer program used by the Federal Emergency Management Agency (FEMA) as a means of determining potential losses from earthquakes. The arbitrary crustal event is based on a potential M6.9 earthquake generated from an arbitrarily chosen fault using the Hazus software, and assuming a worst-case scenario. The 2,500-year probabilistic driving earthquake does not look at a single earthquake; instead, it encompasses many faults and potential earthquake sources, each with a 2% chance of producing an earthquake in the next 50 years. The analysis assumes that each fault will produce a single "average" earthquake during this time.

DOGAMI investigators caution that the analysis contains a high degree of uncertainty and should be used only for general planning purposes. Despite their limitations, the analysis does provide some approximate estimates of damage. Results are found in Table 2-517, Table 2-518, Table 2-519, Table 2-520, Table 2-521, and Table 2-522.

Table 2-517. School and Emergency Response Buildings' Collapse Potential in Region 8

	Level of Collapse Potential			
County	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Harney	5	3	7	3
Malheur	16	6	5	23

Source: Lewis (2007)

Table 2-518. Building, Transportation, and Utility Exposure in Region 8

County	Building Exposure	Transportation Exposure	Utility Exposure	Total Exposure
Harney	$448,000,000	$2,281,900,000	$733,200,000	$3,463,100,000
Malheur	$1,441,000,000	$4,396,900,000	$810,300,000	$6,648,200,000
Region Total	$1,889,000,000	$6,678,800,000	$1,543,500,000	$10,111,300,000

Source: W. J. Burns (DOGAMI), 2007 (unpublished), Geologic hazards of the southeast Oregon region

Table 2-519. Building, Transportation, and Utility Losses in Region 8 Associated with a 2,500-Year Probable M6.5 Driving Earthquake Scenario

County	Building Losses	Transportation Losses	Utility Losses	Total Losses	Loss Percent of Total
Harney	$9,260,000	$21,600,000	$2,000,000	$32,860,000	0.9%
Malheur	$143,370,000	$47,000,000	$19,680,000	$210,050,000	3.2%
Region Total	$152,630,000	$68,600,000	$21,680,000	$264,590,000	2.6%

Source: W. J. Burns (DOGAMI), 2007 (unpublished), Geologic hazards of the southeast Oregon region

Table 2-520. Building, Transportation, and Utility Losses in Region 8 Associated with a (M) 6.9 Arbitrary Crustal Earthquake Event

REGION 8 County	Building Losses	Transportation Losses	Utility Losses	Total Losses	Loss Percent of Total
Harney	$1,600,000	$39,200,000	$390,000	$41,191,000	1.1%
Malheur	$453,470,000	$114,100,000	$36,820,000	$604,390,000	9.0%
Region Total	$455,070,000	$153,300,000	$37,210,000	$645,581,000	6.4%

Source: W. J. Burns (DOGAMI), 2007 (unpublished), Geologic hazards of the southeast Oregon region

Table 2-521. Estimated Losses in Region 8 Associated with a M6.9 Arbitrary Crustal Earthquake Event

Region 8 Counties	Harney	Malheur
Injuries (5 pm time frame)	3	444
Death (5 pm time frame)	0	28
Displaced households	0	1,224
Economic losses from buildings	$1.6 mil	$453.47 mil
Operational day after quake:		
Fire stations	0%	25%
Police stations	0%	50%
Schools	29%	48%
Bridges	98%	93%
Economic losses to:		
Highways	$29.8 mil	$107.10 mil
Airports	$8.6 mil	$4.8 mil
Communications	$0.04 mil	$0.03 mil
Debris generated (million tons)	0	0

Source: W. J. Burns (DOGAMI), 2007 (unpublished), Geologic hazards of the southeast Oregon region

Table 2-522. Estimated Losses in Region 8 Associated with a 2,500-Year Probable M6.5 Driving Earthquake Scenario

Region 8 Counties:	Harney	Malheur
Injuries (5 pm time frame)	3	106
Deaths (5 pm time frame)	0	5
Displaced Households	2	357
Economic losses from buildings	$9.26 m	$143.37 m
Operational the day after the quake		
Fire stations	100%	100%
Police stations	100%	100%
Schools	100%	100%
Bridges	100%	100%
Economic Losses to /for:		
Highways	$14.3 m	$34.3 m
Airports	$6.9 m	$11.8 m
Communication systems	$ 0.01 m	$0.01 m
Debris generated (million tons)	0	0

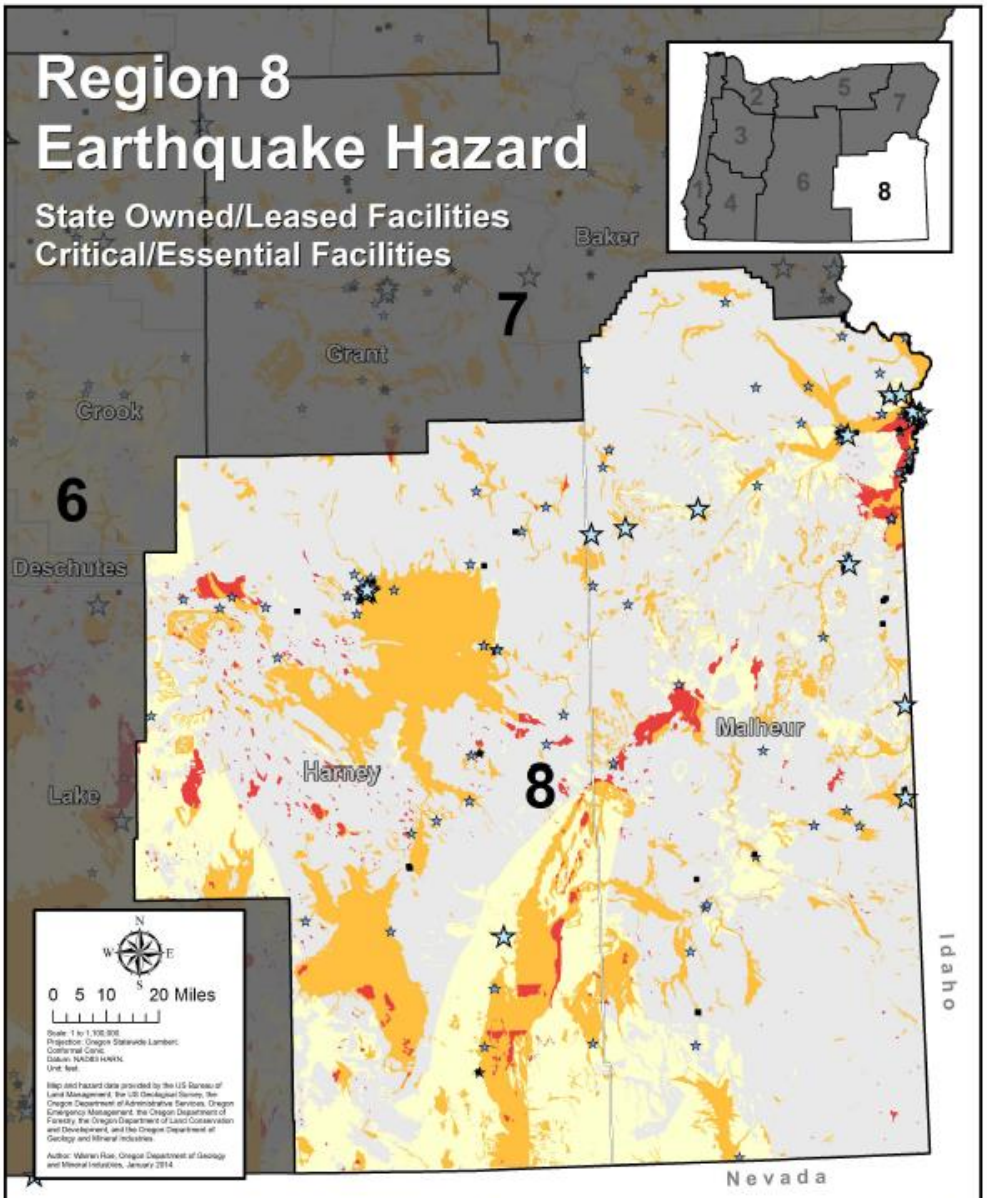
Source: W. J. Burns (DOGAMI), 2007 (unpublished), Geologic hazards of the southeast Oregon region

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of 5,693 state facilities evaluated, 211 valued at $284.5 million are located in an earthquake hazard zone in Region 8 (**Figure 2-235**). Among the 1,141 critical/essential state facilities, 53 are in an earthquake hazard zone in Region 9. Additionally, 153 non-state critical/essential facilities in the region are located in an earthquake hazard zone.

Figure 2-235. State-Owned/Leased Facilities and Critical/Essential Facilities in an Earthquake Zone in Region 8



Property Value Statistics within Earthquake Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Harney	6	47	20	$8,766,168
Malheur	47	106	138	$275,802,145
Grand Total	53	153	158	$284,568,313

Source: DOGAMI

SEISMIC LIFELINES

Because the projected impacts of a CSZ event are considered negligible in this part of the state, this region was not part of the Oregon Department of Transportation's (ODOT) Oregon Seismic Lifeline Report (OSLR; **Appendix 9.1.13**).

REGIONAL IMPACT. Within this region, significant adverse impacts from the CSZ event and secondary hazards (landslides, liquefaction etc.) are not anticipated.

REGIONAL LOSS ESTIMATES. Losses in this region are expected to be nonexistent to low. Economic disruption from major losses in the larger markets of the state will affect the economy in this region.

MOST VULNERABLE JURISDICTIONS. Vulnerability of this whole region to a CSZ event is low. Loss of life, property and business are not expected to be issues in this area. However, impacts to import and export infrastructure and basic supply lines could have short- to mid-term economic impacts. With an intact surface transportation system to the east, adaptation is expected to be relatively easy.

Floods

Characteristics

Although flooding occurs throughout Oregon, the climate, local geology and the relatively low population of Region 8 lessen its effects. Region 8 contains a variable landscape that greatly influences flood conditions. The region is subject to a variety of flood conditions, including: (a) spring runoff from rain and melting snow, (b) warming and rain during the winter months, (c) ice-jam flooding, (d) local flash flooding, and (e) closed basin playa flooding.

Most flooding throughout the region is linked to the spring cycle of melting snow. However, rain-on-snow events, associated with La Niña years in which cool, moist weather conditions are followed by a system of warm, moist air from tropical latitudes, can quickly melt foothill and mountain snow causing floods. Some of Oregon's most devastating floods are associated with these events.

Ice jams on the Snake and Malheur rivers have created flood conditions in the past. Ice jams happen during the winter and early spring, while the river is still frozen. Sudden warming of higher altitude snow and ice results in increased runoff and break-up of river ice. On the way downstream, floating ice can "jam" in a narrow reach of the drainage or against a road crossing, causing a dam. Subsequent breach of the dam releases a torrent of water.

Summer thunderstorms are common throughout the region. During these events, normally dry gulches quickly become raging torrents, a flash flood. Although flash flooding occurs throughout Oregon, local geology in the region can increase this hazard. Bedrock, composed mostly of igneous rocks, is exposed at the surface throughout much of the region. Consequently, runoff is increased significantly.

Many parts of Harney and Malheur Counties are characterized by interior drainage or closed basins called playas. Some playas contain lakes that grow and diminish with the seasons and from year to year. Harney and Malheur lakes are good examples. At times, they are almost dry, but conditions change with prolonged periods of rainfall or snowmelt. Since the water has nowhere to go except into the lakes, the lakes just keep filling up until they overflow. Evaporation is the primary way the water levels recede and it can take years to significantly reduce swollen lake levels through this slow process.

With some exceptions, Malheur County is physically different. This area contains the Owyhee uplands and the Snake River plains, whose streams flow into the Snake River, a tributary of the Columbia. Several reaches of the Snake River have flood control structures. Consequently, it is less of a problem than other rivers in the region.

The interior drainage or closed basin lakes and creeks and rivers in southeastern Oregon have a long history of flooding (**Table 2-523**). Most of the lake water originates from high mountain snowpack above the basin. Flooding follows winters with deep snow accumulation. Such was the case in 1982 and subsequent years, when high lake levels caused economic damage within the region (especially in Harney County). Farms, ranches, homesteads, utilities, highways, and a railroad branch line are at risk.

Unusually warm winter conditions, as in 1957 and 1964, produced severe flooding.

Historic Flood Events

Table 2-523. Significant Flood Events in Region 8

Date	Location	Description	Remarks
1897	Harney County	severe flooding on Silvies River	flood of record on the Silvies River (300-year flood)
1904	Harney and Malheur Counties	severe flooding on Silvies and Malheur Rivers	
1910	Malheur County	severe Malheur River flooding	flood of record on the Malheur River
1921	Harney County	severe flooding on Silvies River	
1943	Harney County	severe flooding on Silvies River	
1952	Harney and Malheur Counties	severe flooding on Jordan Creek, the Silvies and Malheur rivers	
Feb. 1957	Harney and Malheur Counties	severe flooding on Jordan Creek, the Silvies and Malheur rivers	warm rain on snow / frozen ground
Dec. 1964	entire state	severe flooding throughout region	warm rain on snow / frozen ground
1982	Harney County	severe flooding from Harney and Malheur lakes	Long history: not the first lake floods; others floods followed
Dec. 1985	Malheur County	ice jam flooding	40 miles of ice on Snake River between Farewell Bend and Ontario; at least 35 people evacuated
June 1989	Malheur County	flash flood; crops damaged; high winds	vicinity of Nyssa
Mar. 1993	Malheur and Harney Counties	widespread flooding in rural areas; highways closed	warm rain on heavy snow pack; flood of record on Owyhee River
May 1998	Malheur and Harney Counties	widespread flooding. Mudslides in Malheur County	persistent rain on mountain snow pack
May 2005	Harney County	$10,000 in property damage	
Apr. 2011	Harney County	widespread basin flooding	Oregon DOT closed and breached U.S. 20 at milepost 132.6 on April 8, 2011, for flood relief; the breach was done at the request of Harney County Emergency Operations Center to avoid damage to nearby residences; larger culverts were later installed

Sources: FEMA, Malheur County Flood Insurance Study (FIS), 09/29/86; Harney County FIS, 12/22/98; Taylor and Hatton. (1999). The Oregon Weather Book, p. 96-103; Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org

Table 2-524. Principal Flood Sources in Region 8

Harney County	Malheur County
Silvies River	Snake River
Silver Creek	Malheur River
Silver Lake	Bully Creek
Cow Creek	Willow Creek
Donner und Blitzen River	Jordan Creek
McCoy Creek	Indian Creek
Trout Creek	Clover Creek
Whitehorse Creek	Owyhee River
Harney Lake	Cottonwood Creek
Malheur Lake	

Sources: FEMA, Malheur County Flood Insurance Study (FIS), 09/29/86; FEMA, Harney County FIS, 12/22/98

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 8 will experience flooding is shown in **Table 2-525**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-525. Local Probability Assessment of Floods for Region 8

	Harney	Malheur
Probability	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Table 2-523 provides some indication of flooding in Region 8 (not all flooding is shown). Significant flooding occurs regularly, at least once every 5-7 years.

In Region 8 counties, the Federal Emergency Management Agency (FEMA) has mapped the 10, 50, 100, and 500-year floodplains, corresponding to 10%, 2%, 1%, and 0.2% chance, respectively, 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.

All of the Region 8 counties have Flood Insurance Rate Maps (FIRM); however, the maps are old. The FIRM maps were issued at the following times:

- Harney: April 17, 1984, and
- Malheur: September 29, 1986.

A remapping initiative is underway in Harney County.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the region's vulnerability to flooding is shown in Table 2-526. See the State Risk Assessment for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-526. Local Vulnerability Assessment of Floods for Region 8

	Harney	Malheur
Vulnerability	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The Oregon Department of Land Conservation and Development (DLCD) created a countywide flood vulnerability index by compiling data from NOAA's Storm Events Database and from FEMA's National Flood Insurance Program. Data were calculated statewide for the period 1978 through 2013 for five input datasets: number of events, structure and crop damage estimates in dollars and NFIP claims number and dollar amounts. The mean and standard deviation were calculated for each input. Then, each county was assigned a score ranging from 0 to 3 for each of these inputs according to Table 2-527.

Table 2-527. Scoring for Vulnerability Index

Score	Description
3	county data point is greater than 2.5 times standard deviation for the input data set
2	county data point is greater than 1.5 times standard deviation for the input data set
1	county data point is within standard deviation
0	no data reported

Source: DLCD

DLCD summed the scores for each of the five inputs to create a county-by-county vulnerability index. The maximum possible score is 15. A score over 6 indicates that at least one variable significantly exceeds average values.

Both Harney and Malheur Counties received a flood vulnerability score of 5. This low score is likely misleading because flood risks do exist in the population centers located along US-20 and US-395. The City of Burns is one of the top 10 cities in terms of the ratio of Special Flood Hazard Area to city area.

FEMA has identified no Repetitive Loss properties in Region 8 (FEMA NFIP BureauNet, http://bsa.nfipstat.fema.gov/, accessed 12/1/2014).

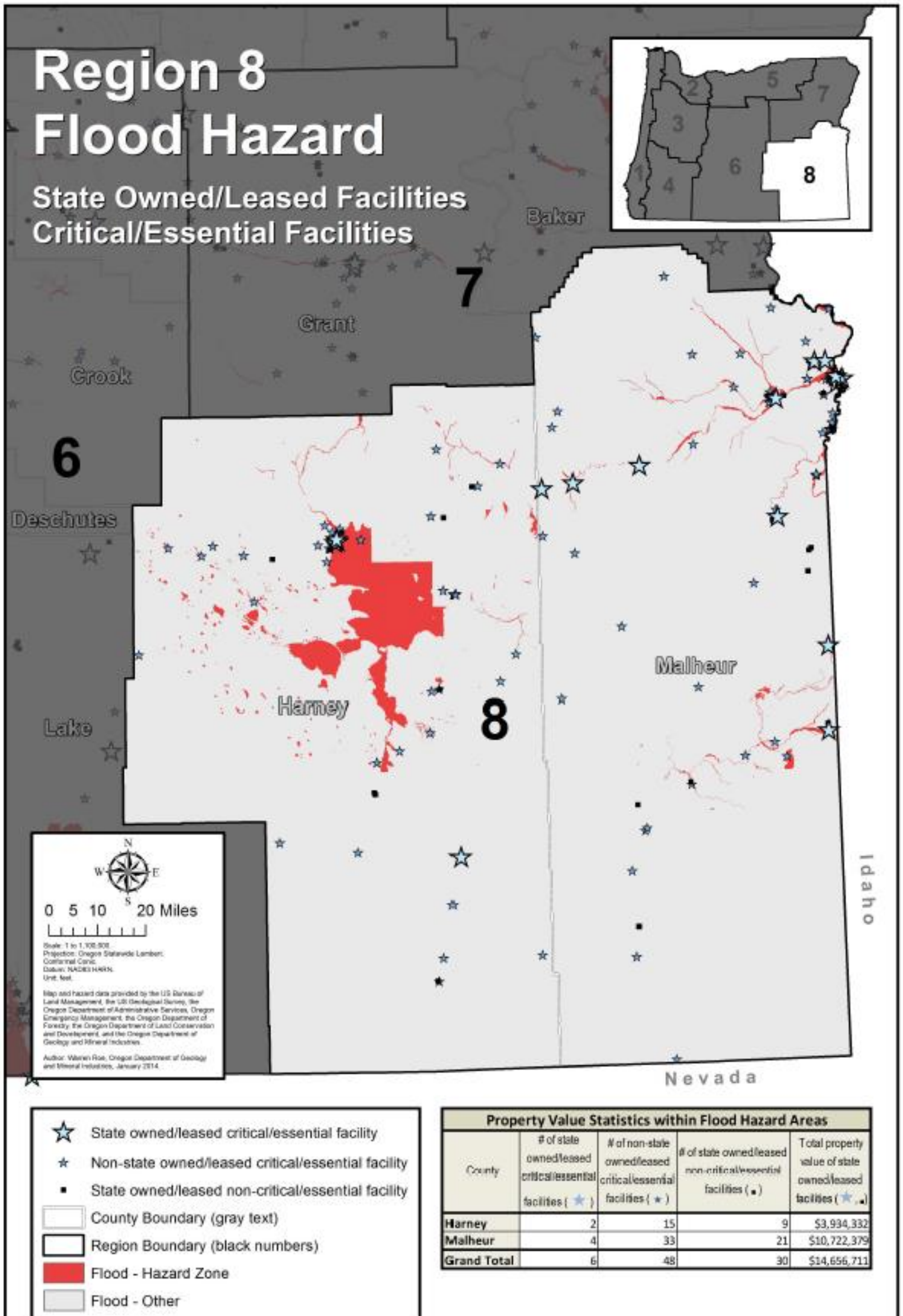
Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS) Program, which results in reduced flood insurance costs. No Region 8 communities participate in the CRS Program

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of the 5,693 state facilities evaluated, 36 are currently located within a flood hazard zone in Region 8 and have an estimated total value of $14.7 million (**Figure 2-236**). Of these, 6 are identified as a critical or essential facility. An additional 48 non-state-owned/leased critical/essential facilities are located in a flood hazard zone in Region 8.

Figure 2-236. State-Owned/Leased Facilities and Critical/Essential Facilities in a Flood Hazard Zone in Region 8



Property Value Statistics within Flood Hazard Areas				
County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Harney	2	15	9	$3,934,332
Malheur	4	33	21	$10,722,379
Grand Total	6	48	30	$14,656,711

Source: DOGAMI

Landslides

Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. On occasion, major landslides sever major transportation routes such as U.S. or state highways and rail lines, causing temporary but significant economic damage.

Historic Landslide Events

There are no readily known significant landslides in this region.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 8 will experience landslides is shown in **Table 2-528**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-528. Local Probability Assessment of Landslides for Region 8

	Harney	Malheur
Probability	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The probability of future landslides in the southeastern Oregon region is moderate. The probability of an area to have a landslide is increased depending on the factors that reduce the stability without causing failure. When several of these factors are combined, such as an area with steep slopes, weak geologic material, and previous landslide movement, the probability of future landsliding is increased. There is a strong correlation between intensive winter rainstorms and the occurrence of rapidly moving landslides (debris flows).

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to landslides is shown in **Table 2-529**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-529. Local Vulnerability Assessment of Landslides for Region 8

	Harney	Malheur
Vulnerability	L	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

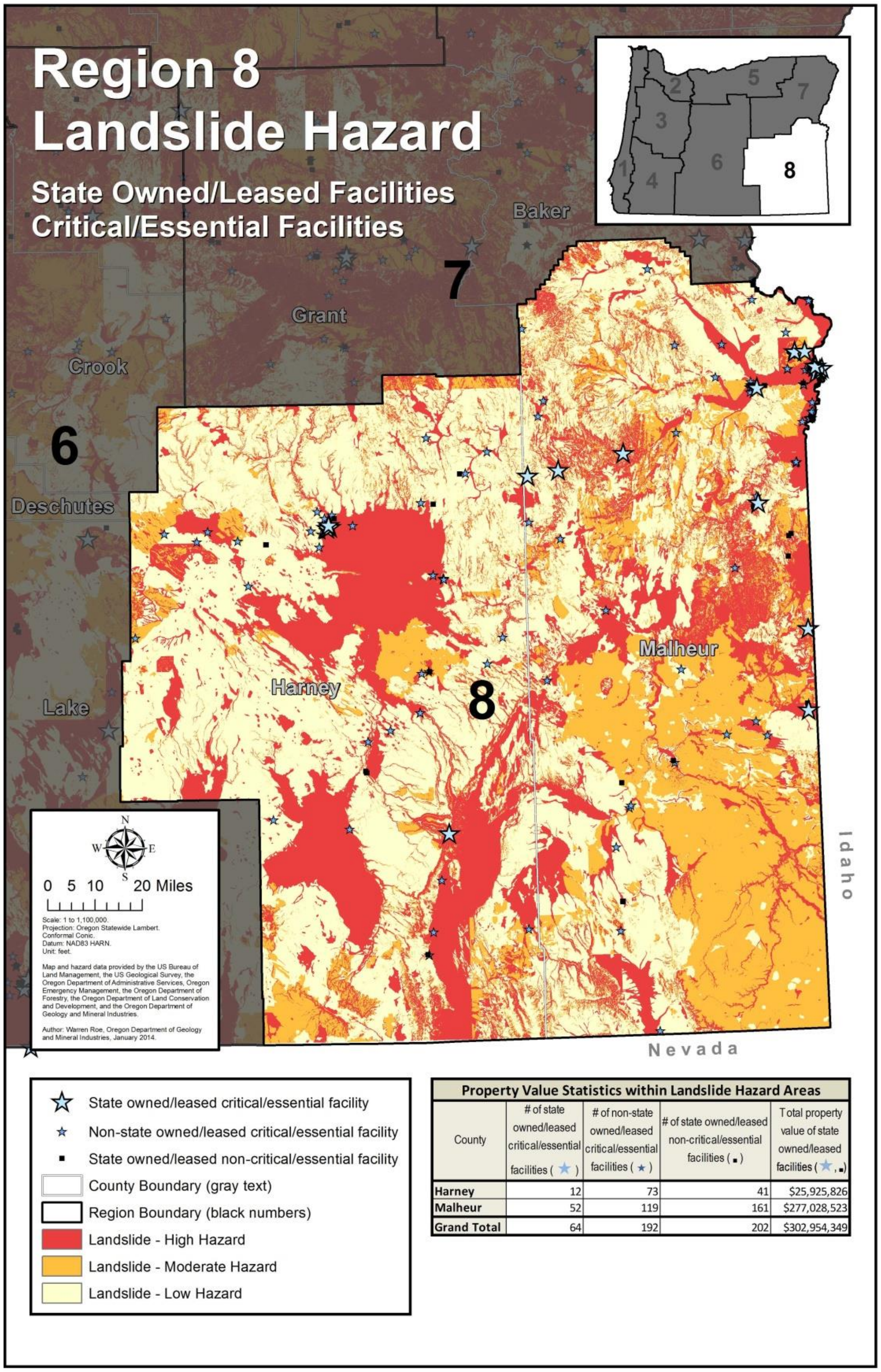
Landslides pose significant threats to people and infrastructure. Landslides have caused damage and loss in Region 8, and it is very likely that they will again. Most of the people and infrastructure in Region 8 are located in one of the major cities in the region which are located along highways. The generalized landslide hazard for the region is low to moderate; however, there are areas within the region that have very high hazard risk, such as the Summer Lake area along OR-31, around Lakeview, and along US-395.

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 266 are currently located within a landslide hazard zone in Region 8 and have an estimated total value of $303 million (**Figure 2-237**). Of these, 64 are identified as a critical or essential facility. An additional 192 non-state-owned/leased critical/essential facilities are located in a flood hazard zone in Region 8.

Figure 2-237. State-Owned/Leased Facilities and Critical/Essential Facilities in a Landslide Hazard Zone in Region 8



Property Value Statistics within Landslide Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (■)	Total property value of state owned/leased facilities (★, ■)
Harney	12	73	41	$25,925,826
Malheur	52	119	161	$277,028,523
Grand Total	64	192	202	$302,954,349

Source: DOGAMI

Volcanoes

Characteristics

The volcanic Cascade Range is not within Region 8 counties, but there is some risk from volcanic ash derived from these volcanoes. This fine-grained material, blown aloft during a volcanic eruption, can travel many miles from its source. For example, during the May 1980, Mount St. Helens eruption, the cities of Yakima and Spokane, Washington, 80 and 160 miles away, respectively, were inundated with ash. Ash can reduce visibility to zero and bring street, highway, and air traffic to an abrupt halt. The material is noted for its abrasive properties and is especially damaging to machinery.

Ashfall is largely controlled by the prevailing wind direction. The predominant wind direction over the Cascade Range is west to east. Previous eruptions documented in the geologic record indicate most ashfall drifting to and settling in areas east of the Cascade volcanoes. Geologic hazard maps have been created for most of the volcanoes in the Cascade Range by the U.S. Geological Survey Volcano Hazards Program at the Cascade Volcano Observatory in Vancouver, Washington and are available at http://volcanoes.usgs.gov/observatories/cvo/.

Besides the distant Cascade volcanoes to the west, there are numerous examples of local volcanic activity throughout southeastern Oregon, such as the abundant thermal hot springs, and some large volcanic fields (e.g., Diamond and Jordan Craters), which attest to its not too distant volcanic past. Jordan Craters, located about 36 miles southwest of Adrian, is thought to have erupted lava roughly 3,200 years ago.

Historic Volcanic Events

Table 2-530. Historic Volcanic Events in Region 8

Date	Location	Description
< 7,000 YBP	Diamond Craters, eastern Oregon	lava flows and tephra in Diamond Craters field
< 3,200 YBP	Jordan Craters, eastern Oregon	lava flows and tephra in Jordan Craters field

Note: YBP is years before present.

Source: Source: U.S. Geological Survey, Cascades Volcano Observatory: http://volcanoes.usgs.gov/observatories/cvo/

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local

probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 8 will experience volcanic hazards is shown in **Table 2-531**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-531. Local Probability Assessment of Volcanic Activity in Region 8

	Harney	Malheur
Probability	L	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Mount St. Helens remains a probable source of ash. It has repeatedly produced voluminous amounts of this material and has erupted much more frequently in recent geologic time than any other Cascade volcano. It blanketed Yakima and Spokane, Washington, during the 1980 eruption and again in 2004. The location, size, and shape of the area affected by ash are determined by the vigor and duration of the eruption and the wind direction.

The eruptive history of the nearby Cascade volcanoes to this region can be traced to late Pleistocene times (approximately 700,000 years ago) and will no doubt continue. But the central question remains: When? The most recent series of events at Newberry Volcano, which occurred about 1,300 years ago, consisted of lava flows and ashfall. Newberry Volcano's history also includes pyroclastic flows and numerous lava flows. Volcanoes in the Three Sisters region, such as Middle and South Sister, and at Crater Lake have also erupted explosively in the past. These eruptions have produced pyroclastic flows, lava flows, lahars, debris avalanches, and ash. Any future eruptions at these volcanoes would most likely resemble those that have occurred in the past.

Geoscientists have provided some estimates of future activity in the vicinity of Newberry Caldera and its adjacent areas. They estimate a 1 in 3,000 chance that some activity will take place in a 30-year period. The estimate for activity at Crater Lake for the same time period is significantly smaller at 0.003 to 0.0003. In the Three Sisters region, the probability of future activity is roughly 1 in 10,000 but any restlessness would greatly increase this estimate.

Local eruptions within Region 8 occurred most recently at Diamond Craters about 6000 years ago and younger activity at Jordan Craters dates after 3,200 years ago. These events consisted of short-lived effusion of basaltic lava and blanketing of the surrounding landscape with basaltic ash. These volcanoes are now extinct, but future eruptions in Southeast Oregon will occur. However, neither the timing nor the location of such events can be forecast in the absence of volcanic unrest.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to volcanic hazards is shown in **Table 2-532**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-532. Local Vulnerability Assessment of Volcanic Activity in Region 8

	Harney	Malheur
Vulnerability	L	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The region's vulnerability to the effects of volcanic eruptions are low. Areas within Region 8 could be affected by ashfall from Cascade volcanic eruptions and more locally by small eruptions of lava from the numerous youthful volcanic cones scattered across Harney and Malheur Counties. Most of the region's people and infrastructure are located in the major cities along I-84, US-20, and US-395. The most vulnerable communities are Burns, Ontario, and Jordan Valley. The region's total exposure for buildings and transportation systems alone is roughly $15 billion.

Wildfires

Characteristics

Southeastern Oregon contains large tracts of ponderosa pine forests, primarily in the northern part of Harney County. Less extensive forests occur in Malheur County near Ironside and in scattered mountain ranges throughout the region. These areas are highly vulnerable to wildfire because of natural aridity and the frequency of lightning strikes. Grasslands, which naturally cover most of the region, also are problematic. Wildfire always has been a part of these ecosystems. Past management practices, which included the suppression of all wildfires, has favored the growth of a brushy understory and the accumulation of dead or dying trees. This leads to devastating fires. State and federal agencies seek to alleviate the problem through a controlled (i.e., prescribed) burning program. **Table 2-533** lists some of the significant wildfires that have occurred in the region.

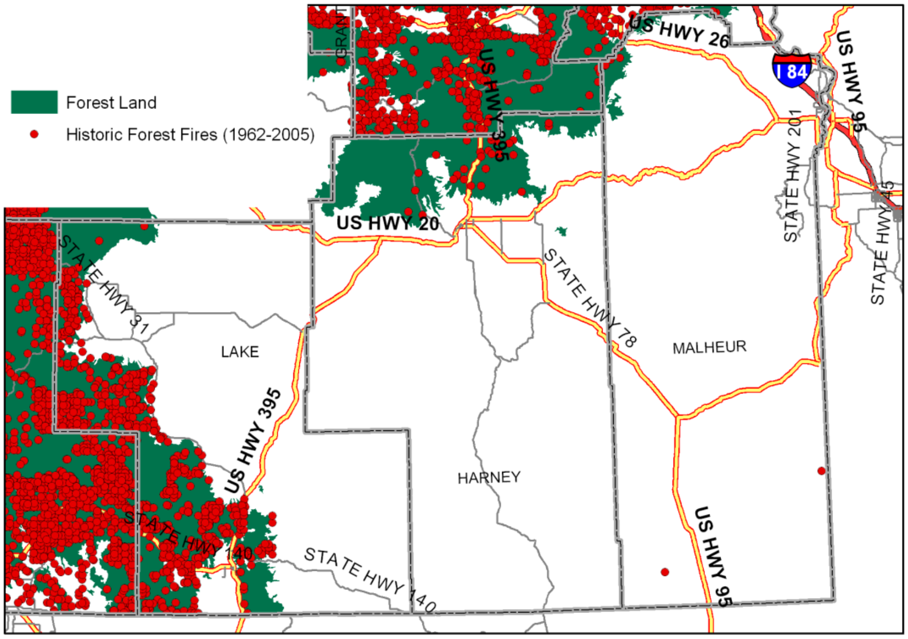
Historic Wildfire Events

Table 2-533. Significant Wildfires in Region 8

Date	Name of Fire	Location	Acres Burned
1998	Ontario	Malheur County	
2000	Jackson	Malheur County	79,875
2001	Sheepshead	Malheur County	51,452
2007	Egley	Harney	140,360

Source: Oregon Department of Forestry, 2013

Figure 2-238. Historic Forest Fires in Region 8



Point locations for ODF statistical fires from 1962 to 2005. The point locations for the fires were derived from ODF's FIRES database. Data from the Oregon Department of Forestry.

Source: The Oregon Department of Forestry Database and extent of forested land (http://egov.oregon.gov/ODF/GIS).

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 8 will experience wildfire is shown in **Table 2-534**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-534. Local Probability Assessment of Wildfire for Region 8

	Harney	Malheur
Probability	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The forests and grasslands of Region 8 are highly susceptible to wildfire and many of the cities and unincorporated communities, in addition to rangelands and agricultural lands, are vulnerable to its effects. Wildfires are an annual occurrence and have varied in size from under 10 acres to over 100,000 acres.

Most wildfires started by lightning. Human causes are mostly associated with abandoned campfires, debris burning, or fires started along the interstate and highways (faulty vehicle equipment, cigarettes tossed out of windows of vehicles, etc.).

Hilly or mountainous topography exacerbates wildfire hazards. These areas can cause a wildfire to spread rapidly and burn larger areas in a shorter period of time, especially as fires migrate uphill. Wildfire has been known to move at speeds of 30 mph or higher on grasslands.

Large fires have, at times, exceeded the capability of structural and wildland resources, not only calling for the declaration of the Conflagration Act, but also requiring National Incident Management Teams to manage fires at the project fire level.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to wildfire is shown in **Table 2-535**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-535. Local Vulnerability Assessment of Wildfire for Region 8

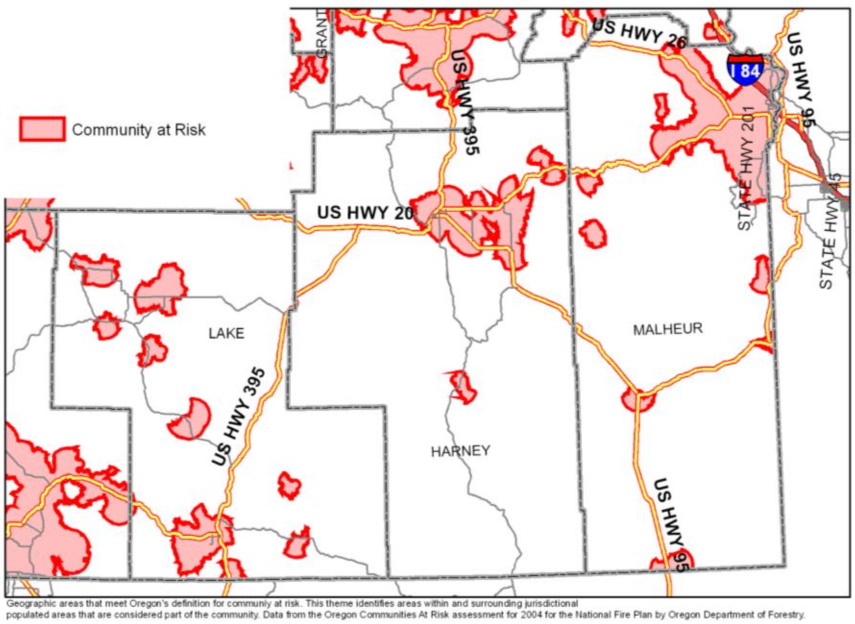
	Harney	Malheur
Vulnerability	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The generalized wildfire hazard for the region is moderate to high; however, there are areas within the region that have a very high hazard. Most of the region's people and infrastructure are located in the major cities along I-84, US-20, and US-395 (**Figure 2-239**). The region's total exposure for buildings and transportation systems alone is roughly 11.5 billion dollars.

Figure 2-239. Region 8 Communities at Risk of Wildfire



Source: ODF

Preliminary analyses indicate a high likelihood of damage and losses from future wildfire in the region. Threatened assets include businesses, farmland, ranchland, grazing land, and hunting and recreation land. Action should be taken to reduce the damage and losses through pre-disaster mitigation and prepare for effective emergency response after the disaster. Special action should be taken for critical facilities including schools and emergency facilities and infrastructure such as roadways.

Wildland fire protection in unincorporated areas is protected by Rangeland Fire Protection Associations or BLM. Where the majority of BLM land is leased for ranching operations, large wildfires can have significant economic impacts on ranchers' stock and range allotments, as burned land is unfit for grazing use for several years after a fire.

Known sage-grouse habitat is a top wildfire suppression priority in this region. Rangeland Protection Associations and Oregon Department of Forestry are planning to implement, prior to January 2015, conservation measures to reduce the negative impacts of wildland fire on sagebrush plant communities within the range of the sage-grouse.

The communities in Region 8 are particularly vulnerable because they are scattered throughout the landscape on large acreages with highly flammable vegetation. Many communities have no structural fire protection, and wildland agencies would have extended response times.

Table 2-536. Wildland-Urban Interface Communities in Region 8

Harney	Malheur
Andrews	Adrian
Blitzen	Arock
Burns-Hines	Brogan
Crane	Danner
Diamond	Harper
Drewsey	Jamieson
Fields	Jordan Valley
Frenchglen	Juntura
Narrows	McDermitt
Double O	Nyssa Heights
	Ontario Heights
	Oregon Slope
	Vale
	Ironside

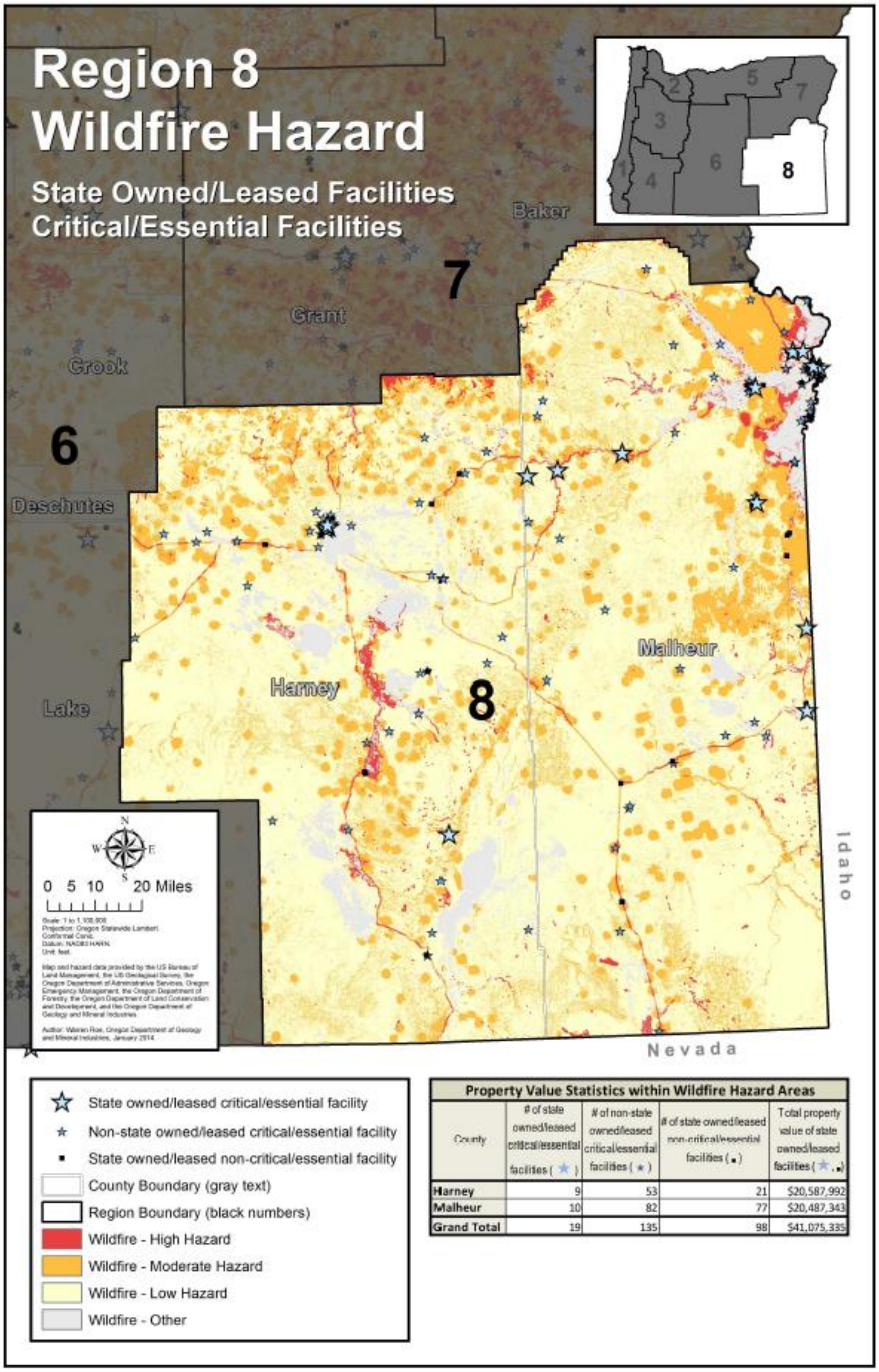
Source: Oregon Dept. of Forestry Statewide Forest Assessment September, 2006

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 117 are within a wildfire hazard zone in Region 8 and total roughly $41 million in property value (**Figure 2-240**). Among those, 19 are state critical/essential facilities. An additional 135 non-state critical/essential facilities are also located in Region 8.

Figure 2-240. State-Owned/Leased Facilities and Critical/Essential Facilities in a Wildfire Hazard Zone in Region 8



Property Value Statistics within Wildfire Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (■)	Total property value of state owned/leased facilities (★, ■)
Harney	9	53	21	$20,587,992
Malheur	10	82	77	$20,487,343
Grand Total	19	135	98	$41,075,335

Source: DOGAMI

Windstorms

Characteristics

High winds in the intermountain areas of Region 8 are not uncommon. There is little in the way of mountain protection for much of these counties; the landscape is flat and open with the exception of a few areas. Winds in Harney and Malheur Counties are often associated with thunderstorms, which have strong outflow and coincidentally strong surface winds. Windstorms can be problematic in burned areas, where dust may be lifted and transported across the landscape, causing reductions in visibility and localized damage.

Tornadoes

Small to moderate sized tornadoes have been recorded in virtually every area of Oregon. Six have been recorded in Region 8 (**Table 2-537**), but others probably have occurred. Wind speeds have varied; estimates are somewhere between 40 to 112 mph, corresponding to "gale" (F0 on the Fujita Scale of Tornado Intensity) and "moderate" (F1 on the Fujita Scale) tornadoes. Damage was estimated to be an amount between $5,000 and $50,000 (Taylor and Hatton 1999).

Historic Windstorm Events

Table 2-537. Historic Windstorms in Region 8

Date	Affected Area	Characteristics
Apr. 1931	northeast Oregon	unofficial wind speeds reported at 78 mph; damage to fruit orchards and timber
Nov. 10-11, 1951	statewide	widespread damage; transmission and utility lines; Wind speed 40–60 mph; Gusts 75–80 mph
Dec. 1951	statewide	wind speed 60 mph in Willamette Valley; 75-mph gusts; damage to buildings and utility lines
Dec. 1955	statewide	wind speeds 55–65 mph with 69 mph gusts; considerable damage to buildings and utility lines
Nov. 1958	statewide	wind speeds at 51 mph with 71 mph gusts; every major highway blocked by fallen trees
Oct. 1962	statewide	Columbus Day Storm; Oregon's most destructive storm to date.; 116-mph winds in Willamette Valley; estimated 84 houses destroyed, with 5,000 severely damaged; total damage estimated at $170 million
Aug. 1966	Malheur County	tornado between Nyssa and Ontario; telephone poles and some farm buildings destroyed
June 1967	Malheur County	two tornadoes reported; some damage
June 1969	Malheur County	tornado reported 40-60 miles south of Jordan Valley (Malheur County)
Mar. 1971	most of Oregon	greatest damage in Willamette Valley; homes and power lines destroyed by falling trees; destruction to timber in Lane County
Apr. 1974	Malheur County	tornado path parallel to Oregon- Idaho border; farm building destroyed
Nov. 1981	statewide	60-mph winds common throughout state
Jan. 1990	statewide	severe wind storm
Jan. 1991	most of Oregon	severe wind storm
Dec. 1991	NE and central Oregon	severe wind storm
Dec. 1992	northeastern mountains, Oregon	severe wind storm
May 1994	eastern Oregon	strong winds in Treasure Valley area (Ontario); blowing dust caused many car accidents
May 2005	Malheur County	hail storm causes $3,000 in crop damage
July 2006	Harney County	wind storm produces winds of 75 mph
Aug. 2006	Harney County	three high wind storms in Harney County with winds measured at 67, 58 and 58 mph, respectively
Aug. 2007	Harney County	high wind storm produces winds of 58 mph
Apr. 2010	Harney County	75-mph winds caused $200,000 in property damage, including 52 downed power poles

Source: Taylor and Hannan, 1999, *The Oregon Weather book;* The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org

Table 2-538. Tornadoes Recorded in Region 8

County	Date	Location	Damage
Malheur	Aug. 1966	Adrian to Oregon border just north of Ontario, Oregon	several farm buildings destroyed; trees uprooted; telephone poles displaced
Malheur	June 1967	13 miles west of Sheaville, Oregon	two tornadoes; limited in extent and duration; one damaging; the other, no damage
Malheur	June 1967	remote	some damage
Malheur	June 1969	40–60 miles west of Jordan Valley, Oregon	grain fields damaged
Malheur	Apr. 1974	10 miles SW of Nyssa, Oregon	farm buildings destroyed

Source: Taylor and Hatton, 1999, pp. 123-137

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 8 will experience windstorms is shown in **Table 2-539**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-539. Local Probability Assessment of Windstorms for Region 8

	Harney	Malheur
Probability	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The 100-year storm in this region is defined as one-minute average winds of 75 mph. A 50-year storm includes winds of 65 mph. A 25-year storm has winds of up to 55 mph.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to windstorm is shown in **Table 2-540**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-540. Local Vulnerability Assessment of Windstorms for Region 8

	Harney	Malheur
Vulnerability	L	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Many buildings, utilities, and transportation systems within Region 7 are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It also is 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, which can affect emergency operations. In addition, uprooted or shattered trees can down power 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. Many roofs have been destroyed when uprooted trees growing next to a house fall during a windstorm. In some situations, strategic pruning may be the answer. Prudent counties will work with utility companies to identify problem areas and establishing a tree maintenance and removal program.

Winter Storms

Characteristics

Within the State of Oregon, Region 8 communities are known for cold, snowy winters. Winter weather in Region 8 can be characterized by extreme cold, snow, ice, and sleet. There are annual winter storm events in Region 8 with an average of 24 inches of snow; most communities are prepared for them. Moderate to heavy snowfall is prepared for and expected on an annual basis in this region.

Historic Winter Storm Events

Table 2-541. Significant Winter Storms in Region 8

Date	Location	Remarks
Dec. 1861	entire state	storm produced 1–3 feet of snow throughout Oregon
Dec. 1892	northern counties, Oregon	15–30 inches of snow fell throughout the northern counties
Jan. 1916	entire state	two storms; heavy snowfall, especially in mountainous areas
Jan. and Feb. 1937	entire state	deep snow drifts
Jan. 1950	entire state	record snowfalls; property damage throughout state
Mar. 1960	entire state	many automobile accidents; two fatalities
Jan. 1969	entire state	heavy snow throughout state
Jan. 1980	entire state	series of string storms across state; many injuries and power outages
Feb. 1985	entire state	2 feet of snow in northeast mountains; downed power lines; fatalities reported
Feb. 1986	central /eastern Oregon	heavy snow; traffic accidents; broken power lines
Mar. 1988	entire state	strong winds; heavy snow
Feb. 1990	entire state	heavy snow throughout state
Nov. 1993	Cascade Mountains, Oregon	heavy snow throughout region
Feb. 1994	southeastern Oregon	heavy snow throughout region
Winter 1998-99	entire state	one of the snowiest winters in Oregon history (snowfall at Crater Lake: 586 inches)

Source: Taylor and Hatton, 1999, p. 118–122

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local

probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 8 will experience winter storms is shown in **Table 2-542**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-542. Local Probability Assessment of Winter Storms for Region 8

	Harney	Malheur
Probability	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

On the basis of historical data, severe winter storms could occur about every 4 years in this region. We can expect to have continued annual storm events in this region. However, there are no solid statistical data available upon which to base these judgments. There is no statewide program to study the past, present, and potential impacts of winter storms in the state of Oregon at this time.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to winter storms is shown in **Table 2-543**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-543. Local Vulnerability Assessment of Winter Storms for Region 8

	Harney	Malheur
Vulnerability	M	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Within the State of Oregon, Region 8 communities are known for cold, snowy winters. This is advantageous in at least one respect: in general, the region is prepared, and those visiting the region during the winter usually come prepared. However, there are occasions when preparation cannot meet the challenge. Drifting, blowing snow has often brought highway traffic to a standstill. Also, windy, icy conditions have often closed mountain passes and canyons to certain classes of truck traffic. In these situations, travelers must seek accommodations, sometimes in communities where lodging is very limited. Local residents also experience problems. During the winter, heating, food, and the care of livestock and farm animals are everyday concerns. Access to farms and ranches can be extremely difficult and present a serious challenge to local emergency managers. Road closures due to winter weather are more common in this region. In general, the impacts of winter storms to southeastern Oregon communities are less significant because communities are prepared for long winters.

Chapter 3 MITIGATION STRATEGY

In This Chapter

The Oregon NHMP Mitigation Strategy is divided into five sections:

1. **Introduction:** States the purpose of the mitigation strategy.
2. **Mission, Vision, and Goals:** Presents Oregon's natural hazard mitigation mission, vision, and goals, and describes the review and revision of the goals that guide the selection of mitigation actions. Discusses the links between the risk assessment, goals, and mitigation actions and demonstrates how the goals guide the selection of mitigation actions.
3. **Mitigation Actions:** Includes the following components:
    - Mitigation Actions: Describes the process for identifying, evaluating, and prioritizing cost-effective, environmentally sound, and technically feasible mitigation actions and activities the state is considering implementing over the next 5 years (Priority); that the state implements as part of its agencies' regular work programs (Ongoing); and that the state has or will not implement (Removed). Presents the 2015 Priority, Ongoing, and Removed mitigation action tables. Descriptions of the mitigation actions in the tables explain how each action contributes to the overall mitigation strategy. Identifies changes in mitigation action priorities from the 2012 Plan. A crosswalk shows the disposition of the 2012 mitigation actions in the 2015 Plan. Three tables and a score sheet demonstrating key phases of the process are located in **Appendices 9.2.1, 9.2.2, 9.2.3, and 9.2.4**.
    - Funding Sources for Mitigation Actions: Current and potential sources of funding for mitigation actions are discussed briefly in this section and more fully in the State Capability Assessment section of this chapter. They are also noted on the Priority and Ongoing mitigation action tables. The sources of funding used to implement mitigation actions since approval of the 2012 Oregon NHMP are noted on the Ongoing and Removed mitigation action tables in this chapter.
    - Mitigation Successes: Describes successful mitigation actions throughout Oregon from 2012 through 2014.
4. **Capability Assessment:**
    - State: Assesses the state's capability to carry out the mitigation strategy through its pre- and post-disaster hazard management policies (including those related to development in hazard-prone areas), programs, and funding capabilities. Discusses changes in these capabilities since approval of the 2012 Oregon NHMP.
    - Local: Generally describes and analyzes in table format the effectiveness of local mitigation policies, programs, and capabilities. Also in table format, indicates status of local jurisdictions' NHMPs and participation in the National Flood Insurance and CRS Programs.
5. **Coordinating State and Local Mitigation Planning:** Describes the state's support of local mitigation planning through funding and technical assistance, as well as the way the state prioritizes funding for local mitigation planning and projects. Describes the processes the state uses to review local NHMPs and to coordinate and link local NHMPs to the Oregon NHMP.

3.1 Introduction

The purpose of this chapter is to establish Oregon's mission and vision for mitigation planning, and to present the State's strategy for achieving that vision. The mission, vision, and goals are purposefully aspirational, providing the foundation for the state's overall mitigation strategy. The culture of our state is influenced by its rich natural resources and pioneering spirit. Oregon has often taken a leading role in the development of innovative and progressive strategies to address issues that impact our residents, our economy and our natural and built environment. The Oregon Beach Bill (1967), the Oregon Bottle Bill (1971) and the Oregon Land Use Program (1973) are but three historical examples of Oregon's visionary spirit.

As it relates to natural hazard mitigation, Oregon is no less visionary. The state adopted its first natural hazards mitigation plan in 1992 with subsequent updates occurring in 2000, 2004, 2006, 2009, 2012, and now 2015. In addition, Oregon's Clackamas County adopted the nation's first FEMA-approved natural hazards mitigation plan under DMA2K in 2002. Hazard mitigation planning as a foundation for risk reduction project activities is a top priority in Oregon when using available state funding, post-disaster FEMA mitigation grants, and non-disaster FEMA grant funding.

Given the current economic climate, it is important to acknowledge that state resources are limited. Oregon is not unique in that regard. Even so, Oregon is committed to remaining at the forefront of mitigation planning and will continue to innovate and leverage limited resources to reduce losses resulting from natural hazards. The mitigation strategy presented herein reflects that commitment.

3.2 Mission, Vision, and Goals

Requirement 44 CFR §201.4(c), *To be effective the plan must include the following elements:*
(3) A Mitigation Strategy that provides the State's blueprint for reducing the losses identified in the risk assessment. This section shall include:
(i) A description of State goals to guide the selection of activities to mitigate and reduce potential losses.

MISSION — Create a disaster-resilient state of Oregon.

VISION — Natural hazard events result in no loss of life, minimal property damage, and limited long-term impacts to the economy.

GOALS

1. Protect life and reduce injuries resulting from natural hazards.
2. Minimize public and private property damages and the disruption of essential infrastructure and services from natural hazards.
3. Increase the resilience of local, regional, and statewide economies.
4. Minimize the impact of natural hazards while protecting, restoring, and sustaining environmental processes.
5. Enhance and maintain state capability to implement a comprehensive statewide hazard loss reduction strategy.
6. Document and evaluate Oregon's progress in achieving hazard mitigation.

7 Motivate the public, private sector, and government agencies to mitigate against the effects of natural hazards through information and education.

8 Eliminate development within mapped hazardous areas where the risks to people and property cannot be mitigated.

9 Minimize damage to historic and cultural resources.

10 Increase communication, collaboration, and coordination among agencies at all levels of government and the private sector to mitigate natural hazards.

11 Integrate local NHMPs with comprehensive plans and implementing measures.

3.2.1 Goals: Review and Revision

At its April 2014 meeting, the State IHMT reviewed the eight 2012 Oregon NHMP goal statements (Goals 1–8) and decided to revise Goal 4 to reflect the state's focus not only on protecting and restoring the environment, but also on sustaining environmental processes.

At the same meeting, the State IHMT discussed topics addressed by county-level NHMP goals but not by Oregon's: (a) cultural and historic resource protection, (b) better collaboration and coordination between all levels of government and the private sector, and (c) integration of NHMPs with local comprehensive plans. More information is provided in **Section 3.5.3.2** and **Table 3-18**. The State IHMT adopted Goals 9–11 addressing these topics, better aligning and coordinating State and local natural hazards mitigation plans.

3.2.2 Goals: Linking the Risk Assessment and Mitigation Actions

Natural hazard mitigation plan goals link the risk assessment and mitigation actions, guiding the direction of future natural hazard risk reduction and loss prevention activities.

The risk assessment speaks directly to protection of life and property, infrastructure and services, and local, regional, and state economic resilience, the topics of Goals 1, 2, and 3. The vulnerability assessments for each hazard and the potential loss estimates highlight the importance of informing and educating citizens about the risks and what they can do to reduce potential losses, including eliminating development where risks cannot be mitigated, the topics of Goals 7 and 8. Environmental stewardship, the topic of Goal 4, plays a role in mitigating some hazards, and must be considered in designing mitigation projects. While not specifically called out in the goal language, mitigation of repetitive loss and severe repetitive loss properties is unquestionably supported by Goals 1, 2, 4, and 8. Goals 1, 2, and 4 set policy direction for reducing harm to people, property, and the environment respectively. Goal 8 is more specific, setting policy direction for prohibiting development in or moving development out of hazard areas under certain circumstances. These are clear connections between the information in the risk assessment and the existing goals.

Goals 5 and 6 are more administrative in nature. Goal 5 focuses on the state's ability to implement the Plan, the subject of the *Capability Assessment* element of the *Mitigation Strategy*. Goal 6 focuses on documenting and evaluating progress in achieving mitigation, elements of the *Mitigation Strategy* and the *Planning Process*.

The information in the risk assessment also supports these statements:

A. More data are available for some hazards, resulting in a more robust risk analysis for those hazards.

B. There is a clear need to develop a statewide standardized risk assessment methodology across all hazards.

C. Similarities and differences between state and local level vulnerability assessments have not been analyzed. Some state and local vulnerability assessments are quite consistent, while others are starkly inconsistent. Communication and education among state and local staff responsible for assessing vulnerability would improve understanding and consistency.

D. Several hazards are related to one another through cause and effect (e.g., earthquakes and tsunamis, floods and landslides, drought and wildfires) or through shared drivers (e.g., El Nino Southern Oscillation (ENSO)), indicating opportunity for increasing interagency collaboration and efficiencies in research and mitigation activities.

E. Some state-owned/leased buildings or critical/essential facilities and their contents cannot be accurately identified using available state data. Property values are not available for critical/essential facilities that are not state owned/leased. Local knowledge could be helpful in improving the state data by more accurately identifying buildings and their contents and determining which buildings and critical/essential facilities should be prioritized for mitigation. The state data could be useful at the local level as well. This opportunity for state and local collaboration could improve risk assessments and loss estimates at both levels.

These statements address issues covered by Goals 1, 2, 3, 7, and 8. In particular, they raise an important question concerning Goal 5, the state's capability to implement a comprehensive statewide hazard loss reduction strategy. The State currently recognizes 11 hazards, obligating it to address each one, and strives to do so as fully and equitably as possible. Due to staffing, funding, data availability, access to expertise, or other reasons, some hazards cannot be addressed to the same extent as others. Prioritizing hazards would allow resources to be strategically targeted. At the same meeting, the IHMT decided to consider prioritizing hazards for the next Plan update.

These statements also suggest a few new mitigation actions:

1. Analyze the similarities and differences between state and local vulnerability assessments.
2. Schedule three opportunities for state and local dialogue on local vulnerability assessments in the next year to improve consistency and mutual understanding.
3. Collaborate with local governments to improve the accuracy of potential loss totals by more accurately identifying critical/essential facilities, and determining their property values.
4. Improve state agency procedures for tracking data on state-owned/leased buildings and critical/essential facilities.
5. Develop an improved methodology for gathering data and identifying the communities most vulnerable to drought.
6. Establish a program for studying winter storms and their impacts statewide. Install snowfall sensors throughout the state to develop annual snowfall data.

The IHMT decided further to include these mitigation actions with a few revisions as follows in the 2015 Plan:

1. Analyze the similarities and differences between state and local vulnerability assessments. (Same)
2. Schedule three opportunities *over the life of this Plan* for state and local dialogue on vulnerability assessments to improve consistency and mutual understanding. *(Revised)*
3. Collaborate with local governments *to develop a database of non-state-owned critical/essential facilities and their property values. (Revised)*
4. Improve state agency procedures for tracking data on state-owned/leased buildings and critical/essential facilities. (Same)
5. Develop an improved methodology for gathering data and identifying the communities most vulnerable to drought *and related impacts*. *(Revised)*
6. Establish a program for studying winter storms and their impacts statewide. *As a part of that program, develop a system for gathering snowfall data statewide. (Revised)*

Later in the process, new mitigation actions #1 and #2 were combined. The mitigation action tables (Priority, Ongoing, and Removed) demonstrate the link between the goals and mitigation actions by noting the goal(s) that each mitigation action addresses.

3.3 Mitigation Actions

Requirement 44 CFR §201.4(c), To be effective the plan must include the following elements:

(3) A Mitigation Strategy that provides the State's blueprint for reducing the losses identified in the risk assessment. This section shall include:

(iii) An identification, evaluation, and prioritization of cost-effective, environmentally sound, and technically feasible mitigation actions and activities the State is considering and an explanation of how each activity contributes to the overall mitigation strategy. This section should be linked to local plans, where specific local actions and projects are identified.

(iv) Identification of current and potential sources of Federal, State, local, or private funding to implement mitigation activities.

3.3.1 Identification, Evaluation, and Prioritization

Mitigation actions are detailed recommendations for activities that the state is considering implementing to reduce risk and prevent loss from natural hazards.

The 2015 Oregon NHMP mitigation actions were developed through a process that began with reviewing the 2012 Plan mitigation actions to establish their implementation status (not started, progressing, completed, not being pursued) and evaluating them against several criteria:

1. Statutory (cost-effective, technically feasible, environmentally sound),

2. SMART (specific, measurable, achievable, realistic, time-oriented), and

3. Whether they were integrated with related state initiatives (e.g., Oregon Resilience Plan, Oregon Climate Change Adaptation Framework, Oregon Plan for Salmon and Watersheds, etc.).

As a result of this evaluation process, the mitigation actions were placed into one of three categories: priority, ongoing, or removed. Priority actions are those the state aspires to begin or complete. Ongoing actions are those the state is doing in the normal course of business, continually over a long period of time. Removed actions are those that have been completed; will not be completed for various reasons; have been replaced by other actions; are not mitigation actions; or have been determined not to be within the State's purview. A table has been created for each category.

Also as a result of this evaluation, many actions were broken into their component parts and placed on the appropriate tables. For example, LP-5, *Establish a system of special zones, procedures, restrictions, and conditions to limit development in tsunami inundation zones* was broken into four component parts:

1. *Develop* land use guidance and best practices for local governments for reducing risk within tsunami inundation zones.
2. *Provide* land use guidance and best practices for reducing risk within tsunami inundation zones to local governments.
3. *Assist* local governments in implementing the land use guidance and best practices for reducing risk within tsunami inundation zones.
4. *Monitor* the effectiveness of the land use guidance and best practices for reducing risk within tsunami inundation zones provided to local governments.

The first two parts — develop guidance and provide it to local governments — have been done, and they are entered on the *Removed* table. The last two — assist local governments in using the guidance and monitor its effectiveness — have not, and will continue to be implemented for many years to come. They have been entered on the *Ongoing* table. While this approach results in more actions, it facilitates tracking, reporting, and highlighting achievements.

The next task was to prioritize the actions on the *Priority* table. This was done in two steps. First, each action was scored according to the statutory criteria (cost-effective, technically feasible, and environmentally sound) and STAPLEE (social, technical, administrative, political, legal, economic, and environmental). A score sheet was developed that weighted all the criteria except cost-effectiveness and political support. The score totals were considered to be an indication of cost-effectiveness — the higher the score the more cost-effective the action.

The political criterion was covered in the second step. State agency managers who would be responsible for implementing the actions were asked to provide their agency's level of support for the actions for which their agency was identified as the lead. A rating of *1* indicated that the action is likely to be funded and undertaken during the life of the 2015 Plan. A rating of *3* indicated that although the action is important and the agency wants to accomplish it, the action is unlikely to be funded or undertaken during the life of the 2015 Plan. A rating of *2* indicated uncertainty about the likelihood of funding or accomplishment.

The Progress and Initial Evaluation, Prioritization, and Level of Support tables and Prioritization Score Sheet illustrating these key points in the development of the final 2015 Plan Mitigation Action Tables are presented in **Appendices** 9.2.1, 9.2.2, 9.2.3, and 9.2.4, respectively.

Each priority action was then ranked according to its political rating first and then its score. Where tied, the number of hazards addressed was considered next, then the number of Plan goals addressed, then the target date, and finally the original action number. The State IHMT members agreed that ongoing actions #79 - #82 are so important and representative of the essence of the State's natural hazard mitigation program that they should be listed first. The rest of the ongoing actions were ranked using first the number of hazards addressed, then the number of goals addressed, then the original action number. Removed actions are listed in the same order as they appear in the 2012 Plan, with new or revised but removed actions inserted in association with related 2012 actions. These inserted new or revised actions were removed because they were already done. To avoid confusion in subsequent updates they were assigned the letters A–G instead of numbers.

3.3.2 Mitigation Action Tables: Priority, Ongoing, Removed

The 2015 Oregon NHMP mitigation actions are arranged in a series of three tables: *Priority*, *Ongoing*, and *Removed* (**Table 3-1**, **Table 3-2**, and **Table 3-3**, respectively). On each table, mitigation actions are numbered and presented as a brief statement with a longer description that explains its contribution to the overall mitigation strategy of the 2015 Plan. The goal(s) and hazard(s) each action addresses are identified. The *Priority* table includes the individual action item scores, ratings, and final ranking. On the *Priority* and *Ongoing* tables, other state initiative(s) with which an action is integrated is identified.

Current and potential funding sources are also identified. For actions on the *Priority* table, the funding sources should be understood primarily as potential sources since the State budget for the 2015-2017 biennium is still being developed and many are based on outside grant funding that is still uncertain. More of the funding sources for actions on the *Ongoing* table are stable, but again should be considered primarily as potential sources. On the *Removed* table, funding sources for actions that have been completed are identified.

A crosswalk (**Table 3-4**) has been developed to aid in demonstrating how the 2012 Plan's mitigation actions are represented in the 2015 plan.

3.3.3 Changes in Mitigation Action Priorities

The 2012 Plan's priority mitigation actions were recommended to and confirmed by the State IHMT. The recommendation was made by a subcommittee of the State IHMT based on existing knowledge about probability and vulnerability. Twenty-three of the 148 mitigation actions are identified as priority actions. The 2015 Plan identifies 78 priority mitigation actions and 71 ongoing mitigation actions for a total of 149. The 2015 Plan's priority mitigation actions were ranked less subjectively, using a numerical scoring method.

To meet SMART (Specific, Measurable, Achievable, Realistic, Time-oriented) criteria, several of the 2012 Plan's actions were revised or split into two or more actions. Because there is not a clear action-for-action relationship between the two lists of actions, it is difficult to provide a meaningful accounting or statistics describing how the mitigation action priorities may have changed. Nevertheless, it is possible to make some statements.

Of the 2012 Plan's 23 priority actions:

- Two were completed as stated.
- Three more were split into a total of twelve parts. Of those, three actions were completed; three actions are ongoing; and six are priority actions in the 2015 Plan.

- Eight more remain among the 2015 priority actions.
- Four others were removed because they are covered by 2015 priority actions.
- Three were removed because they are covered by ongoing actions.
- Three of the 2012 priority actions were considered not to be mitigation actions at all for the 2015 Plan. Two are administrative in nature and one is a recovery action.

Completed 2012 priority actions indicate that those priorities did not change. The majority of the remainder are in the top 40% (ranked between 1 and 31) of 2015 priority actions. Taken together and considered generally, this indicates that the priorities of the 2012 and 2015 plans are still largely aligned.

In terms of themes, however, continued alignment between the two sets of mitigation actions becomes clear. The shared priorities include:

- Obtaining legislative support for implementation of natural hazards policies and mitigation actions;
- Implementing Statewide Goal 7, including supporting local government integration of NHMPs with comprehensive plans; and developing, distributing, and assisting local governments with implementing risk reduction techniques and model codes;
- Enhancing coordination of state and local mitigation planning;
- Enhancing implementation of the Community Rating System statewide;
- Inventorying and protecting state-owned/leased buildings from natural hazards; and
- Improving reliability and resiliency of critical infrastructure statewide.

3.3.4 Funding Sources for Mitigation Actions

Oregon's mitigation activities are funded directly and most visibly through sources such as FEMA's Pre-Disaster Mitigation Grant, Flood Mitigation Assistance, Public Assistance, and Hazard Mitigation Grant Programs, as well as NOAA grants with state, local, or private funds providing the non-federal cost share. The State's Seismic Rehabilitation Grant Program is a direct funding source for earthquake mitigation projects. The Oregon Disaster Assistance Loan and Grant account provides post-disaster mitigation funds to local governments and school districts. The Governor's 2015–2017 budget includes funding for beginning development of the new risk assessment concept methodology and for providing grants to local governments to support local NHMP development and updates through its existing Technical Assistance Grant Program. Final State budget decisions will be made by the Oregon Legislature after this Plan is complete. More indirect and less visible funding comes from state general funds through in-kind activities and other state funds. More detailed information about mitigation funding sources is in the State Capability Assessment, **Funding Sources** section.

Table 3-1. Priority Mitigation Actions

2015 MITIGATION ACTIONS—PRIORITY

Action Item			PRIORITY	Score	Level of Support	Goal												Hazard												Integrated	Implementation			
#	Statement	Description	RANK	Score ≈ Benefit-Cost	1 = Likely by 3/2020 2 = Not sure 3 = Unlikely by 3/2020	1 - Protect Life	2 - Protect Property	3 - Inc Ec Resilience	4 - Protect Env	5 - Enh OR Capability	6 - Evaluate Progress	7 - Info & Ed	8 - Elim Haz Area Dev	9 - Cultural & Hist Res	10 - Agency Coord	11 - NHMP/Comp Plan	# Goals	Coastal Hazards	Drought	Dust Storms	Earthquakes	Floods	Landslides	Tsunamis	Volcanic Hazards	Wildfires	Windstorms	Winter Storms	# Hazards	Other Initiative	Lead	Support	Current or Potential Funding Source(s)	Target Date
1	Develop and fund a legislative package for general funds or lottery funds to match federal funding for local hazard mitigation planning, including additional funds for DLCD Technical Assistance Grants.	Continue — and enhance where possible — state technical and planning grant assistance to cities and counties for addressing issues associated with local hazards.	1	28	1	X	X	X	X	X		X	X	X		X	9	X	X	X	X	X	X	X	X	X	X	X	11	Oregon Local Disaster Assistance Loan and Grant Account.	DLCD	OEM	State-OEM, DLCD	2015
2	Create a "Clearinghouse" for natural hazards data.	Emergency responders and community planners alike need access to the best and most current natural hazards data that is available. This project would be a cooperative effort between authoritative data sources — DLCD, DOGAMI, OEM, OWRD, and federal partners (FEMA, USACE, NWS, USGS) — and would include: • Establishing a single point of online access to reliable data, maps, and information about natural hazards; • Developing, in conjunction with DAS-GEO, a "portal" to distribute this data; • Developing a multi-agency State of Oregon flood hazard website; • Providing an ongoing inventory and assessment of existing natural hazards data; and • Creating a central library for natural hazard risk assessments.	2	23	1	X	X			X		X	X	X	X	X	8	X	X	X	X	X	X	X	X	X	X	X	11	Risk MAP; Risk Plan; Framework Implementation Teams; OEM's Master Data Set; Local Natural Hazards Mitigation Plans; Governor's interagency collaboration initiative; Goal 7 implementation; NFIP; DEQ's IRIS database; etc.	DLCD	DAS-GEO, DEQ, DOGAMI, OWRD, OEM, FEMA, USACE, NDWS, USGS	FEMA, State-DAS-GEO	2016
3	Enroll three coastal communities in the Tsunami Ready Program each year.	The Tsunami Ready Program is a program sponsored by the National Weather Service that is designed to provide communities with incentives to reduce their tsunami risk. Cannon Beach was the first community for Oregon. Under a proposed plan through the National Tsunami Hazard Mitigation Program (NTHMP), three communities per year will be added to the rolls of the program. This program is currently evolving through a review process being carried out by the NTHMP National Coordinating Committee. OEM is the primary point of contact for more information about the Tsunami Ready Program.	3	23	1	X	X	X				X			X		5							X					1	Oregon Resilience Plan	OEM	DOGAMI	NOAA	2018

2015 MITIGATION ACTIONS—PRIORITY

Action Item			PRIORITY	Score	Level of Support	Goal												Hazard												Integrated	Implementation			
#	Statement	Description	RANK	Score ≈ Benefit-Cost	1 = Likely by 3/2020 2 = Not sure 3 = Unlikely by 3/2020	1 - Protect Life	2 - Protect Property	3 - Inc Ec Resilience	4 - Protect Env	5 - Enh OR Capability	6 - Evaluate Progress	7 - Info & Ed	8 - Elim Haz Area Dev	9 - Cultural & Hist Res	10 - Agency Coord	11 - NHMP/Comp Plan	# Goals	Coastal Hazards	Drought	Dust Storms	Earthquakes	Floods	Landslides	Tsunamis	Volcanic Hazards	Wildfires	Windstorms	Winter Storms	# Hazards	Other Initiative	Lead	Support	Current or Potential Funding Source(s)	Target Date
4	Complete a hazard mitigation policy legislative needs assessment	The Oregon NHMP contains a number of specific policy recommendations. In addition, the state of Oregon maintains a number of policies related to natural hazards and the mitigation thereof. It is unclear at this time what legislative action may be needed in order to fully implement existing and proposed mitigation actions. The State IHMT recommends completing an assessment of the potential legislation needed to implement hazard mitigation policies.	4	22	1	X	X	X	X	X	X	X	X	X	X	X	11	X	X	X	X	X	X	X	X	X	X	X	11	NFIP, Goal 7	OEM	State IHMT Agencies	State-OEM	2015
5	Develop model risk reduction techniques and ordinances for landslide-prone communities	Techniques can involve requiring geological or geotechnical studies for new development, stormwater control for neighborhoods on hillsides, strict land use ordinances for active landslides, working with infrastructure operators to increase reliability of services after storms, and more.	5	22	1	X	X	X				X	X		X	X	7						X						1	Statewide Planning Goal 7	DLCD	DOGAMI	State-DLCD	2015
6	Form an Oregon Landslide Workgroup.	An Oregon Landslide Workgroup will be created to prioritize areas for new mapping projects, to promote landslide hazard awareness through education & outreach, to develop and influence policy at the federal state, and local levels, and to assist in response & recovery efforts during disasters.	6	22	1	X	X	X		X		X			X	X	7						X						1	Statewide Planning Goal 7	DOGAMI		State-DOGAMI	2015
7	Through FEMA's Risk MAP program, update 1,000 miles of streams with lidar-based flood mapping.	FEMA's Risk MAP program funds revisions of Flood Insurance Studies and Flood Insurance Rate Maps. The State should focus on updating these products so they are based on high quality topographic data (e.g., lidar). Lidar-derived streams are a by-product of high quality topographic data. These more accurately located streams will assist in the improvement of a community's flood maps to more accurately show flood risk to life and property. The State should continue to pursue Risk MAP funds for this purpose.	7	22	1	X	X					X	X		X	X	6					X							1	NFIP	DLCD, DOGAMI		FEMA	2016
8	Create a new lidar-based statewide landslide susceptibility map.	DOGAMI will develop a statewide landslide susceptibility map of Oregon as part of the Oregon Geographic Information Council (OGIC) Framework Data Development Program. This map will be used by the Oregon Landslide Workgroup (#6, Priority) to prioritize locations for more detailed Landslide Inventory and Susceptibility Maps.	8	22	1	X	X	X				X	X				5						X						1	Statewide Planning Goal 7	DOGAMI		DAS-GEO	2015
9	Upgrade the Oregon Landslide Warning System.	The current warning system needs updating to include rainfall thresholds from local rainfall gauges. A permanent real-time website will be constructed to show the areas under a landslide warning that will include guidance on what people should do to help protect their life and property from a landslide.	9	22	1	X	X			X		X			X		5						X						1		DOGAMI		DOGAMI, USGS	2020

2015 MITIGATION ACTIONS—PRIORITY

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10	Implement the Rapid Assessment of Flooding Tool (RAFT)	The RAFT has been funded and developed by the U.S. Army Corps of Engineers (USACE) through FY 14 for $115,000. The goal of the RAFT is to take real time flood forecasts and relate them to flood frequency curves from FEMA, USGS, and OWRD. This will help decision makers prioritize real-time flood fighting assistance. The tool will also incorporate other important decision-influencing factors, possibly including structures in danger of flooding, population affected, and likelihood of levee failure. The RAFT is intended to work in concert with and feed data to other emergency management tools, such as OEM's RAPTOR. The RAFT is in very early development, and the scope and schedule are under development. Once RAFT is completed, OEM will have operational oversight when the ECC is activated.	10	22	1	X	X								X		3					X							1	Silver Jackets	Silver Jackets	DLCD, OEM, DOGAMI, OWRD	FEMA, USACE	2016
11	Develop guidance for local Gov'ts on how to use Goal 7 together with other pertinent Statewide Land Use Planning Goals to classify lands subject to natural hazards in the buildable lands inventory and adjust urban growth boundaries in a manner that minimizes or eliminates potential damage to life, property, and the environment while continuing to provide for efficient development patterns.	Goal 7 discourages new development in areas subject to natural hazards. Goal 14 and other Statewide Land Use Planning Goals encourage development within urban growth boundaries. Local Gov'ts need guidance on how to classify lands subject to natural hazards in their buildable lands inventories and adjust urban growth boundaries to protect life, property, and the environment from natural hazards while providing for efficient development patterns within urban growth boundaries. This guidance will assist local Gov'ts in integrating local natural hazards mitigation plans with comprehensive plans.	11	21	1	X	X	X	X				X		X	X	7	X	X	X	X	X	X	X	X	X	X	X	11	Statewide Planning Goals	DLCD	DOGAMI, ODF	State-DLCD	2020
12	Assist one coastal community per year in considering vertical evacuation structures and improved evacuation routes due to evacuation constraints.	Use the anisotropic path modeling to measure the time needed to evacuate all parts of the maximum-considered Cascadia tsunami inundation zone in order to evaluate the need for vertical evacuation structures and improvements in evacuation routes. These actions will provide guidance to communities on the best locations to build vertical evacuation structures that will save lives in a catastrophic tsunami event. The results will also inform communities of priority evacuation routes needing additional signage or way-finding markers. The planned communities are: 2014 = Seaside 2015 = Warrenton 2016 = Rockaway Beach 2017 = Siletz Bay area 2018 = Pacific City	12	21	1	X		X				X			X	X	5	X			X			X					3	Oregon Resilience Plan	DOGAMI	OEM	NOAA	2018

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13	Produce new lidar-based flood hazard maps	Lidar-based flood hazard maps are produced for counties or watershed as funding is provided. These maps have newly delineated flood zones based on new detailed studies, new coastal analysis, and/or delineation of existing zones based on new topography data (lidar). Lidar-based flood hazard maps are being produced or are anticipated to be produced for: • Silvies Watershed • Lower Columbia River/Sandy River Watershed • Clatsop County • Tillamook County • Lincoln County • Curry County • Lane County • Douglas County	**13**	21	1	X	X	X				X	X				5					X							1	NFIP, Risk MAP	DOGAMI	DLCD	FEMA, Local Gov'ts	2018
14	Create an informational website for the new Base Flood Elevation Determination Service.	Create website that describes the state's base Flood Elevation Determination Service. Website will include brochure, pricing, map of completed determinations, and data clearinghouse for completed determinations.	**14**	21	1	X	X					X	X				4					X							1	NFIP, Risk MAP	DOGAMI	DLCD	State-DOGAMI	2015
15	Develop new standardized risk assessment methodology across all hazards, at the state and local levels.	Oregon does not have a clear and common methodology to identify the most vulnerable populations across all hazards at the state and local levels. In 2013, the State IHMT Risk Assessment Subcommittee in partnership with the OPDR and the U of O InfoGraphics Lab developed a model concept, work plan, and budget. Pending funding, this model could be fully developed between 2014 and 2019 and then be used to inform the 2020 Oregon NHMP. Upon full development, the model will allow state and local Gov'ts to strategically target mitigation resources.	**15**	20	1	X	X							X	X		4	X	X	X	X	X	X	X	X	X	X	X	11	Oregon Resilience Plan, NFIP, Risk MAP, Oregon Climate Change Adaptation Framework, Oregon Health Authority	DLCD	DEQ, OEM, DOGAMI, OHA, UO, BusOR-IFA, FEMA	FEMA, State-DLCD, OEM, DOGAMI, OHA, UO, BusOR-IFA	2019
16	Complete a Climate Change Vulnerability Assessment and Adaptation Pilot for north coast highways.	The goal of ODOT's pilot is to conduct a regional vulnerability assessment and prepare options for adaptation actions and priorities. In coordination with ODOT Maintenance, the project will collect and map vulnerability and risk data based on climate science, asset conditions, and known and anticipated natural hazards. Hazard sites will be selected within a study corridor for more detailed analysis. Based on engineering and technical reviews, adaptation measures will be developed for vulnerable infrastructure and assembled into a coastal adaptation implementation plan. ODOT received a Federal Highway Administration grant to conduct the project, scheduled for completion in fall 2014.	**16**	20	1	X	X								X		3	X			X	X	X	X					5	Oregon Resilience Plan, NFIP, Risk MAP, Oregon Climate Change Adaptation Framework, Oregon Health Authority	ODOT	OCCRI, DOGAMI, DLCD	FHWA	2015

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17	Request LCDC to include Local Natural Hazards Mitigation Planning as a priority for DLCD Technical Assistance Grant awards to use as match for federal funds when available.	The Land Conservation and Development Commission (LCDC) awards Technical Assistance Grants to local Gov'ts to support local planning efforts in certain priority land use topic areas which at this time do not include natural hazard mitigation. If LCDC were to include natural hazards mitigation planning as a priority topic area, local Gov'ts would have the opportunity to compete for funding and the state would be better able to provide technical assistance for natural hazards mitigation planning.	**17**	19	1	X	X	X	X	X		X	X			X	8	X	X	X	X	X	X	X	X	X	X	X	11	Oregon Local Disaster Assistance Loan and Grant Account.	DLCD		State-DLCD	2015
18	Develop a process for implementing Goal 7.	Under Goal 7, DLCD is responsible for notifying local Gov'ts if new hazard information requires a local response. The process for determining which information should trigger local land use evaluations and notifying local Gov'ts, however, remains untested. DLCD will implement the process, review the results, and determine whether any changes are necessary. This action is necessary to ensure that local Gov'ts evaluate new hazard information and take necessary action to protect life and property.	**18**	19	1	X	X	X					X			X	5	X	X	X	X	X	X	X	X	X	X	X	11	Local Natural Hazards Mitigation Plans	DLCD	DOGAMI	State-DLCD	2017
19	Work with Business Oregon to introduce in 2015 legislation allowing reconstruction of structures that cannot feasibly be retrofitted.	Revise SRGP legislation or develop an alternate funding mechanism to help replace schools and emergency facilities that are too structurally deficient for cost-effective retrofit and need to be replaced instead. This would also include structures in the "local" tsunami inundation zone that should not be retrofit in-place but, rather, rebuilt on natural high ground.	**19**	19	1	X	X	X									3				X			X					2	Oregon Resilience Plan	BusOR-IFA	OEM	State-SRGP	2015
20	Add at least five jurisdictions, with emphasis on coastal jurisdictions, to the Community Rating System (CRS) program during the life of each Oregon NHMP.	The CRS, part of the NFIP, is a program that rewards communities for going above and beyond the minimum requirements of the NFIP in minimizing potential losses due to flooding. Participating in the CRS benefits the jurisdiction with extra flood protection and benefits property owners by lowering flood insurance rates. See the CRS Information Center at: http://training.fema.gov/EMIWeb/CRS/ for more information. Each year DLCD conducts community assistance visits in an average of five NFIP communities. During this process, qualified jurisdictions will be encouraged to participate in CRS or strengthen CRS ratings. DLCD will also create a "pathway to CRS" schedule for each jurisdiction for which it conducts a community assistance visit. The state has also started CRS Users' Groups (#C, Removed and #112, Ongoing) to encourage greater participation in the CRS program.	**20**	19	1	X	X	X				X					4					X							1	NFIP	DLCD		FEMA-CAP-SSSE	2020

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21	Update the inventory of shoreline protective structures.	Update the inventory of existing and new coastal engineering (shore protection) structures on the Oregon Coast in order to provide local Gov'ts and applicable agencies an important coastal management tool to address anticipated increasing coastal erosion.	**21**	19	1	X	X										2	X											1	NFIP, Risk MAP	OPRD	DLCD	NOAA, State-OPRD	2015
22	Develop flood protection standards for state-owned/leased buildings.	According to the SB 814 Task Force (Oregon Legislature, 1997 Session), there is a need to develop and effectively implement a strict standard governing the siting, construction, and leasing of buildings occupied by state agencies in flood-prone areas.	**22**	19	1	X	X										2					X							1	NFIP	DAS-CFO	DLCD	State-DAS-CFO	2020
23	Update the state's Peak Discharge Estimation Program.	Peak discharge estimation tools can help determine the magnitude and frequency of floods. The state's program provides engineers and land managers with the information needed to make informed decisions about development in or near watercourses. The Peak Discharge Estimation Program is based on a modified version of the U.S. Geological Survey's "Bulletin 17b." The U.S. Geological Survey is in the process of updating this bulletin. OWRD's methodology will need to be brought up to date to reflect these recent findings.	**23**	19	1	X	X										2					X							1	Integrated Water Resource Strategy	OWRD	ODOT OEM	State-OWRD	2020
24	Develop evacuation plans for ports and harbors at the rate of one per year.	Ports and harbors are the haven for commercial and recreational fishing and recreational boating industries. They are often the major centers of economic activity in coastal communities that have bays. To protect the vessels from tsunami damage requires a unique evacuation plan for both distant and local tsunamis. The plans should be integrated with community evacuation plans. The Oregon State University Extension Sea Grant Program has identified this as a major issue in their pilot project in Yaquina Bay. Their project is titled *Reducing Earthquake and Tsunami Hazards in the Pacific Northwest Ports and Harbors.* For distant tsunami events and storm surge events that can occur during any winter, evaluate potential port and harbor mitigation retrofit projects that protect and strengthen floating and anchored infrastructure such as piers, bulkheads and landings.	**24**	18	1	X	X	X							X		4	X			X			X					3	Oregon Resilience Plan, OSU Extension Sea Grant Program	DOGAMI	DLCD, OPDR	NOAA	2018
25	Integrate the GIS database of tsunami safe zones and assembly areas into local government databases.	Assist counties not only with how to integrate the data, but also how the data can be used for tsunami evacuation planning.	**25**	18	1	X						X			X	X	4	X						X					2	Oregon Resilience Plan	OEM	DOGAMI	NOAA, State, Local Gov'ts	2015

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26	Incorporate text addressing hazard mitigation into natural resource agencies' guidance and process documents focusing on environmental quality to ensure that natural resources are protected in the design and construction of hazard mitigation projects.	Government and private nonprofit agencies in Oregon must address complex issues associated with flood hazard mitigation in the context of clean drinking water, riparian habitat, watershed health, fisheries, wetlands protection, and overall environmental quality. An important plan related to this effort is the *Oregon Plan for Salmon and Watersheds.* Solutions require multi-agency and intergovernmental efforts. While the decisions and projects will vary with each disaster, the state will continue its efforts to develop appropriate policies and criteria to ensure that these are considered along with hazard mitigation needs. This includes guidance on large wood placement, restoration after flood events, and habitat-friendly methods to accomplish pre- and post-disaster hazard mitigation. Watershed assessments being completed around the state by local watershed councils will be used in the evaluation of flood hazards and floodplain processes.	26	18	1				X						X	X	3	X				X							2	Oregon Plan for Salmon & Watersheds	ODFW, DSL	OEM, DLCD	USFWS, State-ODFW, DSL, OEM, DLCD, DEQ, OHA	2015
27	Develop a statewide strategy to encourage the purchase of flood insurance.	It's well-known that well-insured communities recover faster. A strategy will help the state direct information to under-insured areas thereby reducing vulnerability, facilitating recovery, and increasing access to "increased cost of compliance" funding.	**27**	18	1	X	X	X				X	X		X		6					X							1	NFIP, CRS	DLCD	OEM	FEMA-CAP-SSSE	2020
28	Establish a web page where building owners can register their interest in participating in acquisition programs for flood-damaged buildings.	FEMA funds can be used to buyout repetitive loss and severe repetitive loss properties in the floodplain. The paperwork and process to achieve a buyout are lengthy and complex. First and foremost, a property owner must be willing to sell. Buyout funds could be more efficiently and effectively spent if willing sellers were identified and paperwork prepared before funds became available. This registry would augment the state's current outreach efforts, making it easy for willing sellers to identify themselves and for the state to prepare for and execute buyouts.	**28**	18	1	X	X	X				X			X		5					X							1	NFIP	OEM	DLCD	FEMA-CAP-SSSE, State-OEM, DLCD	2015
29	Strengthen the existing Community Rating System (CRS) rating of at least five jurisdictions, with emphasis on coastal jurisdictions, during the life of each Oregon NHMP.	The CRS, part of the NFIP, is a program that rewards communities for going above and beyond the minimum requirements of the NFIP in minimizing potential losses due to flooding. There are a number of measures a community can implement to obtain a CRS rating, and most communities do not implement them all. As a community implements more CRS flood protection measures, its CRS rating is strengthened, and the community is rewarded with better flood protection and lower flood insurance rates.	**29**	18	1	X	X	X				X					4					X							1	NFIP	DLCD		FEMA-CAP-SSSE	2020

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30	Provide technical assistance to local Gov'ts to help integrate hazard mitigation plans with local comprehensive plans.	Local NHMPs are often adopted as an appendix to the comprehensive plan or separately and are therefore in practice not used to their full potential. By assisting local Gov'ts in integrating the two plans, hazard mitigation will be more easily and meaningfully implemented in local land use planning practice.	**30**	17	1	X	X	X	X			X	X			X	7	X	X	X	X	X	X	X	X	X	X	X	11	Statewide Planning Goal 7	DLCD, OPDR		FEMA-PDM, Risk MAP, State-DLCD	2015
31	Improve state agency procedures for tracking data on state-owned/leased buildings and critical or essential facilities.	Create a policy standard for facilities data collection required from state agencies on an annual basis. Develop a facilities data framework standard that best enables hazard mitigation analysis; incorporate data into DAS-CFO DataMart and make available to partner agencies at will.	**31**	17	1	X	X	X		X					X		5	X	X	X	X	X	X	X	X	X	X	X	11	Oregon Resilience Plan	DAS-CFO, DAS-CIO	DOGAMI	State-DAS-CFO, DAS-CIO	2016
32	Request and compile seismic and flood information for personnel-occupied buildings from other agencies.	Determine flood and earthquake damage and losses expected to occur to the state-owned building inventory and provide advice on higher education buildings. Produce information to enable development of statewide priorities and strategies to guide mitigation of earthquake risk, to protect lives during an earthquake, and to preserve ongoing operations after an earthquake. Use accepted methods to determine building type, construction and occupancy, to estimate damage and losses due to various earthquake scenarios and probabilities relating to building codes.	**32**	17	1	X	X								X		3				X	X							2	Oregon Resilience Plan, NFIP	DAS-CFO	DOGAMI	State-DAS-CFO, Local Gov'ts	2020
33	Request seismic and flood information from landlords as part of analyzing potential leased spaces going forward in new leases and potential renewals.	Determine flood and earthquake damage and losses expected to occur to the state-owned building inventory including higher education buildings. Produce information to enable development of statewide priorities and strategies to guide mitigation of earthquake risk, to protect lives during an earthquake, and to preserve ongoing operations after an earthquake. Use accepted methods to determine building type, construction and occupancy, to estimate damage and losses due to various earthquake scenarios and probabilities relating to building codes.	**33**	17	1	X	X										2				X	X							2	Oregon Resilience Plan, NFIP	DAS-EAM	DOGAMI	State-DAS-EAM, Local Gov'ts	2020
34	Lidar survey the State's ROW (rights of way), west of the Cascade Range, to determine where landslide potential exists.	The acquired information can improve critical infrastructure resilience in the face of landslide events, by providing useful information to planners, design professionals and decision makers prior to delivery system construction.	**34**	17	1	X	X	X				X	X				5						X						1	Statewide Planning Goal 7	DOGAMI	ODOT	State-ODOT	2015

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35	Investigate/inventory DAS-owned buildings for seismic risk.	Determine earthquake damage and losses expected to occur to the state-owned building inventory and provide advice on higher education buildings. Produce information to enable development of statewide priorities and strategies to guide mitigation of earthquake risk, to protect lives during an earthquake, and to preserve ongoing operations after an earthquake. Use accepted methods to determine building type, construction and occupancy, to estimate damage and losses due to various earthquake scenarios and probabilities relating to building codes.	35	17	1	X	X										2				X								1	Oregon Resilience Plan	DAS-CFO	DOGAMI	State-DAS-CFO	2016
36	Host at least one workshop or other educational opportunity on a biennial basis in communities where a Volcano Coordination Plan has been adopted.	The State of Oregon will actively work to increase the public's knowledge of the volcano hazard in Oregon.	36	16	1	X	X					X	X				4								X				1	Statewide Planning Goal 7	OEM	DOGAMI	State-OEM	2018
37	Achieve 100% state agency participation in the Great Oregon ShakeOut	Practicing to "drop, cover, and hold" is critical in reducing injury and loss of life in the workplace and home during an earthquake. The more people practice the drill, the better they will respond to a real event. State agencies are setting an example by conducting a drill annually. The State of Oregon will have 100% State agency participation in the Great Oregon ShakeOut and will encourage schools and universities to participate.	37	16	1	X	X					X			X		4				X								1	Oregon Resilience Plan	OEM		NEHRP, State-EMPG	2018
38	Fund and provide technical assistance for local Gov'ts to engage in evacuation route planning and project implementation.	After a Cascadia Subduction Zone earthquake, a tsunami could arrive within minutes. It is essential that residents and visitors be able to quickly move to high ground. Some evacuation planning is already underway. Local Gov'ts need funding and technical assistance to begin or continue to engage in evacuation planning.	38	15	1	X									X	X	3	X			X			X					3	OSSPAC, Statewide Planning Goal 7, ORS 455	DOGAMI	OEM, DLCD	NOAA	2016
39	Install real-time monitoring capabilities on the remaining 51 state-operated stream gages, with the goal of making the network 100% real-time by the year 2020.	The availability of timely and accurate data from stream gages is essential for flood forecasting, for prediction of imminent flood hazards, and for response to flood emergencies. Today, 178 of the state's 229 stream gages provide real-time data. Upgrade the state's existing stream gaging network, with the goal of installing real-time capability on all remaining gages.	39	15	1	X	X										2					X							1	Integrated Water Resource Strategy; Silver Jackets	OWRD		State-OWRD	2020

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40	Implement better way-finding solutions for tsunami evacuation. Create hardened and improved evacuation routes to include elevated safe areas above the level of modeled inundation.	After a Cascadia Subduction Zone earthquake, a tsunami could arrive within minutes. It is essential that residents and visitors be able to quickly move to high ground on foot. This requires clearly marked and safe routes that pedestrians are able to navigate even in dark and stormy weather. Where high ground is available, projects should be identified that will enable Oregon to establish new standards and guidelines for methods to harden and mark way-finding of tsunami evacuation routes to natural high ground. Where natural high ground is not within the expected evacuation time, evaluate the retrofit of existing facilities and/or construction of new facilities that rise above the level of tsunami inundation and can serve as safe haven refuges.	40	14	1	X						X					2	X			X			X					3	Oregon Resilience Plan	OEM	DOGAMI	NOAA-NTHMP, Local Gov'ts	2015
41	Develop an incentive or subsidy program for retrofit of one and two family residences	Design a system of grants or tax credits to encourage homeowners to retrofit residences to minimize displaced post-earthquake shelter demand and reduce population loss during recovery. At the same time, take advantage of weatherization measures such as energy audits, cash rebates, and tax credits to help keep the cold out during winter.	41	14	1	X	X	X									3				X								1	Clean Energy Works; Portland Homeowner Seismic Retrofit Project; Certified local contractors	OEM	BusOR-IFA	FEMA, Local Gov'ts	2018
42	Request the Oregon Legislature to fund the State Disaster Loan and Grant Account" immediately following a presidentially declared disaster or other disaster.	The State Disaster Loan and Grant Account includes an account that can be used to fund local government and school district mitigation projects after a Presidentially declared disaster. The Oregon Legislature may authorize deposits to the account when requested.	42	11	1	X	X	X									3	X	X	X	X	X	X	X	X	X	X	X	11	DLCD Technical Assistance Grants	OEM	BusOR-IFA	State-EMPG	2015
43	Review and adjust State IHMT membership.	As state and agency priorities and personnel change, agency membership should be reviewed and adjusted, and member agencies should be encouraged to budget for participation in State IHMT activities. In late 2014, Emergency Support Functions were reassigned, and the new structure should be considered when reviewing State IHMT membership. When membership is aligned with its goals and mitigation actions, the State IHMT will provide better oversight and leadership of the state's mitigation strategy and programs.	43	23	2	X	X	X	X	X	X	X	X		X		9	X	X	X	X	X	X	X	X	X	X	X	11	OSSPAC, OWEB	OEM	OPDR, DLCD, DOGAMI	State-EMPG	2017
44	Establish formal and official authority for the State IHMT	Since its formation, the State IHMT has continued to play a major role in hazard mitigation activities, including the development of this hazard mitigation plan. There is strong agreement that the State IHMT is important, should be continued, and ought to be made permanent because it is the only state body focused on coordination of natural hazard mitigation. It is recommended that the State IHMT be formally and officially established.	44	23	2	X	X	X	X	X	X	X	X		X		9	X	X	X	X	X	X	X	X	X	X	X	11	OSSPAC	OEM	OPDR, DLCD, DOGAMI	State-EMPG	2017

2015 MITIGATION ACTIONS—PRIORITY

Action Item			PRIORITY	Score	Level of Support	Goal												Hazard												Integrated	Implementation			
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45	Develop a system for prioritizing and ranking state-owned facilities, including critical facilities, for mitigation.	Create an evaluation framework for determining a comprehensive list of critical state-owned facilities in terms of local and regional service needs in the event of a natural disaster; prioritize these critical facilities based on mitigation needs by disaster type; and evaluate each critical facility on the basis of investment cost and potential relocation/decommission in locations with increased hazard risk.	45	23	2	X	X	X									3	X	X	X	X	X	X	X	X	X	X	X	11	Oregon Resilience Plan	DOGAMI, DLCD, OEM	DAS-CFO	State-DAS-CFO	2020
46	Provide the updated *Planning for Natural Hazards: Oregon Technical Resource Guide* to local Gov'ts.	To encourage communities to use *Planning for Natural Hazards: Oregon Technical Resource Guide* it must be provided to them.	46	22	2	X	X	X	X	X		X	X	X	X	X	10	X	X	X	X	X	X	X	X	X	X	X	11	Goal 7, NFIP, Risk MAP, Oregon Resilience Plan, Oregon Climate Change Adaptation Framework	DLCD	OPDR, OEM	FEMA, State-DLCD	2020
47	Produce Coastal Development Handbook	Produce a *Coastal Development Handbook* that addresses coastal process and hazards, beach and shoreland public policy, buying oceanfront property [what to look for, what questions to ask], building on oceanfront property, choosing appropriate hazard mitigation techniques, and choosing and using geotechnical consultants and engineers.	47	22	2	X	X	X	X	X		X	X			X	8	X			X	X	X	X					5	Statewide Planning Goals 5 & 7	DLCD	DOGAMI, OPRD	NOAA, FEMA, State-DLCD	2020
48	Evaluate the impact of climate change on landslides.	The precipitation-triggered landslides will increase or decrease with changes in climate. Evaluation of this change will be important for the future of Oregon.	48	22	2	X	X						X				3						X						1	Oregon Climate Change Adaptation Framework	DOGAMI		NOAA, State-DOGAMI	2016
49	Create new lidar-based Landslide Inventory and Susceptibility Maps, especially near population centers.	DOGAMI will create these maps in cooperation with local jurisdictions. Specific methods and priority locations are still to be determined. The locations will be determined by the Oregon Landslide Workgroup (#6, Priority). These new maps will enable communities to introduce development restrictions or recommend mitigation strategies in areas highly susceptible to landslides.	49	21	2	X	X	X				X	X				5						X						1	Statewide Planning Goal 7	DOGAMI		State-DOGAMI, Local Gov'ts	2040
50	Update *Planning for Natural Hazards: Oregon Technical Resource Guide*.	*Planning for Natural Hazards: Oregon Technical Resource Guide* was published in 2000 and needs to be updated.	50	20	2	X	X	X	X	X		X	X	X	X	X	10	X	X	X	X	X	X	X	X	X	X	X	11	Statewide Planning Goal 7	DLCD, OPDR	OPDR	FEMA, NOAA, State-DLCD	2020
51	Facilitate self-sustaining outreach programs staffed by Community Emergency Response Teams (CERT) in each coastal population center aimed at creating a culture of preparedness and response for both local Cascadia and distant tsunami events.	Establish Community Emergency Response Teams (CERT). These teams will work to save lives and restore communities following a major disaster. Encourage CERT to use outreach techniques tested in a 2005 pilot study of Seaside (#1 priority = door-to-door education; #2 priority = community evacuation drill; #3 = K-12 education supplemented by workshops targeted at specific user groups such as the lodging industry). Create measures of sustainability and success.	51	20	2	X		X				X			X		4	X			X			X					3	Oregon Resilience Plan	OEM	DOGAMI	NEHRP, NOAA	2018

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52	Determine the effectiveness of and the feasibility of using the Emergency Alert System (EAS) in dust prone areas to provide timely information to the traveling public about dangerous blowing dust conditions and make improvements if needed.	ODOT and OSP have primary responsibility for activating the traffic advisory components of the dust storm response plan for the Mid-Columbia Region. The National Weather Service can also activate EAS from their forecast offices in Pendleton, Boise, Medford, and Portland. Many local emergency program managers can also activate the system. Providing this information can save lives in the event of a dust storm.	52	20	2	X											1			X									1	National Weather Service	ODOT, OSP	OEM	NOAA, State-ODOT, OSP, Local Gov'ts	2017
53	Add at least three new flood inundation forecast points to the National Weather Service's Flood Inundation Mapping website and the USGS's Flood Inundation Mapper before 2018.	The National Weather Service (NWS) Advanced Hydrologic Prediction Service (AHPS) has developed inundation mapping sites for various stream gage locations nationwide. Currently there are none in Oregon. This is a useful tool for understanding potential inundation areas based on NWS forecasts. NWS: http://water.weather.gov/ahps/inundation.php; USGS: http://wim.usgs.gov/fimi/)	53	19	2	X	X								X		3					X							1	National Weather Service, Silver Jackets	DOGAMI	OWRD	USGS, USACE, NOAA-NWS	2017
54	Support and implement the actions in the February 2013 Oregon Resilience Plan and recommended in the Oregon Resilience Plan Task Force's October 2014 report.	The Oregon Resilience Task Force was established by Senate Bill 33. It was tasked to facilitate a comprehensive and robust plan to implement the strategic vision and roadmap of the Oregon Resilience Plan for responding to the consequences of naturally occurring seismic events associated with geologic shift along the Cascadia subduction zone. The Task Force's report was delivered to the legislature on October 1, 2014.	54	18	2	X	X	X				X					4				X			X					2	Oregon Resilience Plan	OEM	BCD, ODE, DOGAMI, ODF, OHA, DLCD, ODOT, OPDR, PUC, UO, OSU, PSU	State-OEM	2017
55	Use DAS-CFO data and investigation/inventory of seismic and flood risk to DAS-owned/leased buildings in an effective, routine decision-making process for building occupancy, maintenance, use and potential mitigation treatments.	This information over time can provide for strategic and responsible voluntary flood and seismic upgrades in areas of greatest need for reasonable cost as a part of broader facilities management.	55	17	2	X	X										2				X	X							2	Oregon Resilience Plan, NFIP	DAS-CFO	DAS-EAM, DOGAMI	State-DAS-CFO	2020
56	Identify, prioritize, and map areas susceptible to rapid channel migration	Identify areas susceptible to rapid channel migration. Prioritize those areas' susceptibility and rank their risk from a rapid channel migration event. Create channel migration zone and risk maps for the areas determined to have the highest risk for rapid channel migration.	56	17	2	X	X	X				X	X				5					X							1	NFIP, Risk MAP, Statewide Planning Goal 7	DOGAMI		State-DLCD	2015

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57	Prepare model coordination protocols for local Floodplain Managers and Building Officials.	Local government Floodplain Managers and Building Officials are often unaware of the other's role in floodplain management and how they could work together to better manage floodplain development and mitigate flood hazards. Providing model protocols for the two positions to coordinate would increase each one's awareness of the other's role, ultimately enhancing local flood hazard mitigation.	57	17	2	X	X						X		X		4					X							1	NFIP, ORS 455	DLCD	DCBS-BCD	FEMA	2016
58	Develop a database of non-state-owned critical/essential facilities and their property values.	FEMA requires the state's plan to: (a) identify critical facilities located in the identified hazard areas, and (b) estimate the potential dollar losses to those structures. Data for non-state-owned critical facilities are incomplete and lack standardization, therefore creating a wide margin of error. Identifying local non-state-owned critical facilities and gathering descriptive data for these structures will help increase the quality of the data, resulting in a more precise understanding of state and regional vulnerabilities and mitigation priorities.	58	16	2										X		1	X	X	X	X	X	X	X	X	X	X	X	11	Oregon Resilience Plan	OEM, DAS-GEO	DOGAMI	FEMA, State-OEM, DAS-GEO	2020
59	Schedule three opportunities over the life of this Plan for state-local dialogue on vulnerability assessments to improve consistency and mutual understanding.	Traditionally, local jurisdictions have used the OEM Hazard Analysis Methodology to update LNHMP vulnerability assessments. State agencies with hazard oversight use a wide range of methods to conduct statewide vulnerability assessments for the Oregon NHMP. The results are varying degrees of similarities and differences among local and state vulnerability scores. This dialogue is intended for the state and local Gov'ts to educate each other on the rationale behind the differing scores and to identify ways to better align local and state vulnerability assessments.	59	16	2										X		1	X	X	X	X	X	X	X	X	X	X	X	11	Statewide Planning Goal 7	OEM	DLCD	State-OEM, DLCD	2020
60	Identify funding to support various public transportation providers and local jurisdictions to conduct comprehensive vulnerability assessments of their transportation facilities and services.	OSSPAC, in the Oregon Resilience Plan has identified an immediate near-term need to inventory and assess vulnerability and mitigation opportunities for local street networks, transit assets, ports, airports, and railroads. The Oregon Resilience Task Force in its October 2014 report to the Oregon Legislature suggested ongoing funding inventory, assessment, and mitigation. These activities would serve to reduce vulnerability to a Cascadia Subduction Zone event.	60	16	2	X	X	X							X		4				X			X					2	Oregon Highway Plan (OHP); The Oregon Resilience Plan	ODOT	DOGAMI	FEMA, State-ODOT	2016

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61	Install High Water Mark (HWM) signs after flood events and co-locate stage crest gages on select HWM signs.	HWM signs installed in high visibility areas increase the general public's awareness of flood risk and drive flood mitigation actions in communities. They spark conversations about past floods and are a good entry point for discussions promoting mitigation actions such as elevating buildings, purchasing flood insurance, and participating in FEMA's Community Rating System Program. Stage crest gages co-located with select HWM signs will capture new high-water data when floods occur.	**61**	15	2	X	X					X			X		4					X							1	NFIP	Silver Jackets	OEM, DLCD	USACE, FEMA	**2020**
62	Develop incentives to increase the rate of replacement of 6 times seismically deficient buildings	Develop tax incentives, permit facilitation, and other means to increase the natural rate of building turnover.	**62**	14	2	X	X	X									3				X								1		OEM		State-OEM	2017
63	Identify areas on the coast that will be "islands", or cut off, from other cities or critical recovery resources following a Cascadia Subduction Zone earthquake & tsunami.	Produce GIS database of resources in each "island" expected to be isolated after a Cascadia Subduction Zone (CSZ) earthquake and resulting tsunami in order to preplan for response. Shape files are to be imported into RAPTOR, Oregon Explorer, and other GIS tools. This action item supports the local community's ability to prepare for and sustain or recover function following a CSZ earthquake and tsunami.	**63**	23	3	X	X	X									3				X			X					2	Oregon Resilience Plan	OEM	DOGAMI	NOAA, State and Local Gov'ts	2018
64	Evaluate sediment impacts to Oregon's water resources.	Oregon has unique water resources, some of which are for drinking water. Landslides can have a great impact on this resource by input of large amounts of sediment. Evaluation of erosion potential by watershed would help the regulators and providers identify areas for mitigation.	**64**	22	3	X		X		X							3						X						1	DEQ and ODFW Water Quality Programs	DOGAMI	DEQ, OHA	Federal, State-DEQ, OHA, and Local Gov'ts	2018
65	Prioritize mitigation and retrofit projects on seismic lifelines.	ODOT Seismic Lifelines Evaluation, Vulnerability Synthesis and Identification Report provides recommended priority corridors but does not provide sufficient detail to actually prioritize retrofit investment packages. Engineering evaluations and cost estimation are ongoing on a funding-available basis and will inform that prioritization process.	**65**	22	3	X	X										2				X								1	Oregon Highway Plan (OHP); The Oregon Resilience Plan	ODOT		FHWA, STATE-ODOT	2020
66	Provide funding and technical assistance to local Gov'ts to use the new guidance on classifying lands subject to natural hazards in their buildable lands inventories and adjusting urban growth boundaries.	Local Gov'ts need funding and technical assistance to be able to use the new guidance on how to classify lands subject to natural hazards and adjust urban growth boundaries to protect life, property, and the environment from natural hazards while providing for efficient development patterns within urban growth boundaries. Comprehensive Plan amendments are likely to result. This funding and technical assistance will promote integration of local natural hazards mitigation plans with comprehensive plans.	**66**	21	3	X	X		X				X		X	X	6	X	X	X	X	X	X	X	X	X	X	X	11	Statewide Planning Goals	DLCD		State-DLCD	2018

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67	Initiate an outreach strategy to encourage local jurisdictions to disseminate volcano preparedness educational materials.	Increase the ability of Oregonians to prepare for and recover from volcanic hazards.	**67**	20	3	X	X	X				X			X		5								X				1	Goal 7	OEM	DOGAMI	State-OEM	**2020**
68	Develop guidance on determination of mudslides triggers and relation to rain or flood events	Work with FEMA Region 10, DOGAMI, and other interested parties to develop scientifically and legally-based guidance on when mudflows are to be considered part of a rain or flood event pursuant to the NFIP. Address the definition of mudflow, regulatory factors, scientific understanding of mudslides, and implications for flood insurance.	**68**	20	3	X	X			X							3					X							1	NFIP	DLCD, DOGAMI		FEMA, State-DOGAMI, DLCD	2018
69	Update the 2000 Guidelines for conducting site-specific geohazard investigations.	The state has guidelines for conducting site-specific seismic investigations. The guidelines date from 2000 and need to be updated. The update should expand the scope of the guidelines to cover site-specific investigations for all geohazards. This will improve local government implementation of development regulations in areas subject to geohazards.	**69**	19	3	X	X						X				3	X			X		X		X				4	Statewide Planning Goal 7	DOGAMI		State-DOGAMI	2018
70	Conduct a pilot project on two coastal estuaries to develop a framework for modeling sea level rise and to assess the overall impact of sea level rise on the estuaries.	Implement sea level rise modeling for the pilot study areas. Study results will be used to guide a future, more comprehensive and coast-wide assessment of sea level rise impacts. Once completed, the results can be used minimize future damage or loss of property and the environment.	**70**	19	3	X	X	X				X	X				5	X											1	Oregon Climate Change Adaptation Framework	DOGAMI	DLCD	NOAA through OSU	2016
71	Coordinate development of a post-disaster scientific and technical clearinghouse with other state and federal agencies, higher education, and associations.	When an earthquake, flood, tsunami, or other disaster strikes the state, there will be an influx of scientists and engineers from inside and outside the state to study the event and offer help. There needs to be a coordination of their efforts to put them to use in the most efficient and effective way possible. This clearinghouse will work with the emergency coordination center established immediately after the earthquake, flood, tsunami, or other disaster.	**71**	18	3	X	X			X	X	X			X		6	X	X	X	X	X	X	X	X	X	X	X	11	Silver Jackets	DOGAMI	OEM, DLCD	FEMA, USGS, USACE, NOAA, State-DOGAMI, OEM	2018
72	Update DOGAMI Special Paper 29 (Wang and Clark, 1999)	Update 1999 Special Paper 29, Earthquake Damage In Oregon: Preliminary Estimates of Future Earthquake Losses, a statewide damage and loss estimation study (Wang and Clark, 1999). This update, at a minimum, should incorporate damage and loss estimates for a magnitude 9 Cascadia earthquake, an exposure analysis of tsunami hazards, and probabilistic hazards including updated probabilistic earthquake ground motions and flooding zones. School and emergency facilities from the 2007 DOGAMI database should be incorporated.	**72**	18	3	X	X										2				X	X		X					3	Oregon Resilience Plan	DOGAMI		State-DOGAMI	2018

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73	Develop probabilistic multi-hazard risk maps for the Oregon Coast	Consider and examine combinations and permutations of multi-hazard risk exposure and maps for the entire Oregon Coast.	73	17	3	X	X	X				X	X				5	X			X	X	X	X		X	X	X	8	Oregon Resilience Plan, NFIP, Risk MAP, Oregon Climate Change Adaptation Framework	DOGAMI		NOAA, State-DOGAMI	2020
74	Lidar survey the State's ROW (rights of way), west of the Cascade Range, to determine where seismic fault potential exists.	The acquired information can improve critical infrastructure resilience in the face of seismic events, by providing useful information to planners, design professionals and decision makers prior to delivery system construction.	74	17	3	X	X	X		X		X	X				6				X								1	Oregon Resilience Plan	DOGAMI	ODOT	State-ODOT	2018
75	Assess hazards associated with active crustal faults newly discovered by statewide lidar program.	Particularly in central and eastern Oregon, the major earthquake hazards result from poorly known crustal faults. Lidar has greatly expanded the ability to find these faults, which should be systematically evaluated for their potential to generate damaging earthquakes using trenching, geophysical and field studies. This action would help communities prepare and mitigate for newly defined hazard areas in central and eastern Oregon.	75	15	3	X	X					X					3				X								1	Oregon Resilience Plan	DOGAMI		USGS, State-DOGAMI	2020
76	Establish process for assigning inspection teams to needed areas for post-disaster facility inspection.	Work with OEM, local government building officials, and emergency planners to establish an effective process for assigning inspection teams to needed areas and educating local Gov's regarding the circumstances and process for initiating BCD and state involvement.	76	14	3	X	X	X							X		4					X							1	NFIP, Oregon Recovers	DLCD	OEM	FEMA-CAP-SSSE	**2020**
77	Develop an improved methodology for gathering data and identifying the communities most vulnerable to drought and related impacts.	Although we know that areas in Oregon have suffered from drought, there has not been a coordinated effort to systematically characterize how frequently droughts have occurred, or the impact on Oregonians and ecosystems. Communities are beginning to plan for worst case drought scenarios and need better information about the frequency, duration, and intensity of previous droughts in order to assess the appropriate response. Comprehensive information is not currently available by region, or statewide.	77	11	3	X	X	X		X						X	5		X										1	Goal 7	OWRD, OCCRI	OEM	State-OWRD, OEM, OCCRI	2017
78	Establish a program for studying winter storms and their impacts statewide. As a part of that program, develop a system for gathering snowfall data statewide.	Establish a network of snow accumulation tracking stations at strategic locations throughout the state to provide data tracking of snowfall accumulation over the short term and long term in order to develop statistics for studying snow level trends across the state.	78	10	3	X	X			X					X		4											X	1	Climate Change Adaptation Framework	ODOT	OEM, NOAA-NWS	NOAA-NWS, State-OCCRI	2020

Table 3-2. Ongoing Mitigation Actions

2015 MITIGATION ACTIONS—ONGOING																															
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79	Continue to refine statewide natural hazard identification and characterization.	The Oregon NHMP identifies the types of natural hazards affecting Oregon, their geographic extent, history and probability of occurrence, and as they may be affected by climate change. Throughout the life of the Plan, new and continuing research studies and projects provide new data and analysis, improving our ability to identify and understand Oregon's natural hazards and their probability of occurrence. To advance hazard mitigation in Oregon, it is important for the State to plan, budget, and take advantage of opportunities that arise for continued research and new studies to enhance our knowledge of Oregon's natural hazards.	X	X	X	X	X		X	X		X	X	9	X	X	X	X	X	X	X	X	X	X	X	11	Oregon Resilience Plan; Goal 7; NFIP; Risk MAP; Oregon Climate Change Adaptation Framework; Integrated Water Resources Strategy; Community Wildfire Protection Plans, Seismic Lifeline Studies	DOGAMI, ODF, OWRD, OEM, ODOT, OHA	FEMA, NOAA, BLM, OCCRI, OCS, Other State IHMT Agencies	FEMA, NOAA, BLM, National Fire Plan, State-DOGAMI, ODF, OWRD, OEM, ODOT	**ONGOING**
80	Continue to refine the State's risk assessment methodology and statewide assessments of natural hazard exposure, vulnerability, and potential losses.	At the core of the Oregon NHMP is a statewide risk assessment of exposure and vulnerability, and an estimate of potential dollar losses to state-owned/leased buildings, infrastructure, and critical or essential facilities from natural hazard events. Schools, emergency facilities, water and waste water, dams and levees, transportation, telecommunications, and energy facilities are examples of structures, infrastructure, and facilities that could be exposed and vulnerable to natural hazards. Other examples include populations, businesses, and industries. At this time, the state does not have a standardized risk assessment methodology across all hazards at the state and local levels. To advance hazard mitigation in Oregon, it is important for the State to plan, budget, and take advantage of opportunities that arise for continued enhancement of the risk assessment, better enabling limited mitigation resources to be directed to the areas that most need them.	X	X	X	X	X		X	X	X	X	X	10	X	X	X	X	X	X	X	X	X	X	X	11	Oregon Resilience Plan; Goal 7; NFIP; Risk MAP; Oregon Climate Change Adaptation Framework; Integrated Water Resources Strategy; Community Wildfire Protection Plans, Seismic Lifeline Studies	DOGAMI, ODF, OWRD, OEM, ODOT, DLCD, OHA	FEMA, NOAA, BLM, OCCRI, OCS, OPDR, Other State IHMT Agencies	FEMA, NOAA, BLM, National Fire Plan, State-DOGAMI, ODF, OWRD, OEM, ODOT, DLCD	**ONGOING**
81	Continue to refine statewide identification and prioritization of the greatest risks from and communities most vulnerable to Oregon's natural hazards.	Identifying and prioritizing the greatest risks from and communities most vulnerable to natural hazard events will enable the state to leverage its limited mitigation resources in ways that efficiently protect life, property, and the environment from natural hazard events and facilitate recovery.	X	X	X	X	X		X	X	X	X	X	10	X	X	X	X	X	X	X	X	X	X	X	11	Oregon Resilience Plan; Goal 7; NFIP; Risk MAP; Oregon Climate Change Adaptation Framework; Integrated Water Resources Strategy; Community Wildfire Protection Plans, Seismic Lifeline Studies	DOGAMI, ODF, OWRD, OEM, ODOT, DLCD, OHA	FEMA, NOAA, BLM, OCCRI, OCS, OPDR, Other State IHMT Agencies	FEMA, NOAA, BLM, National Fire Plan, State-DOGAMI, ODF, OWRD, OEM, ODOT, DLCD	**ONGOING**

2015 MITIGATION ACTIONS—ONGOING

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82	Continue to develop and implement resilience initiatives statewide.	Natural hazard mitigation is a fundamental element of resilience. It is important for the state to plan, budget, and partner with other public and private entities to alleviate potential damage from natural hazard events before they occur by (a) improving the reliability of critical/essential facilities, services, and infrastructure during and after a natural hazard event; (b) developing evacuation routes and facilities; (c) informing the public; (d) planning for long-term recovery; and (e) taking other necessary actions.	X	X	X	X	X	X	X	X	X	X	X	11	X	X	X	X	X	X	X	X	X	X	X	11	Oregon Resilience Plan; Goal 7; NFIP; Risk MAP; Oregon Climate Change Adaptation Framework; Integrated Water Resources Strategy; Community Wildfire Protection Plans, Seismic Lifeline Studies	DOGAMI, ODF, OWRD, OEM, ODOT, DLCD, OHA	FEMA, NOAA, BLM, OCCRI, OCS, OPDR, Other State IHMT Agencies	FEMA, NOAA, BLM, National Fire Plan, State-DOGAMI, ODF, OWRD, OEM, ODOT, DLCD	**ONGOING**
83	Assist local governments in using the updated *Planning for Natural Hazards: Oregon Technical Resource Guide* to update their comprehensive plans and development regulations.	The original purpose of *Planning for Natural Hazards: Oregon Technical Resource Guide* was to assist communities in amending their comprehensive plans and development regulations to reduce risk from natural hazards, implementing Statewide Goal 7. The updated document will also be helpful in developing local hazard mitigation plans and integrating them with local comprehensive plans and development regulations.	X	X	X	X	X		X	X	X	X	X	10	X	X	X	X	X	X	X	X	X	X	X	11	Goal 7	DLCD	OPDR, OEM	FEMA, State-DLCD	**ONGOING - Not started**
84	Monitor the implementation of the updated *Planning for Natural Hazards: Oregon Technical Resource Guide* provided to local governments by tracking the number of jurisdictions that have used it.	Monitoring success of *Planning for Natural Hazards: Oregon Technical Resource Guide* will allow the State to adjust its approach and update the guidance as necessary, leading to better protection of life and property.	X	X	X	X	X		X	X	X	X	X	10	X	X	X	X	X	X	X	X	X	X	X	11	Goal 7	DLCD	OPDR, OEM	FEMA, State-DLCD	**ONGOING-Not started**
85	Provide support for development and update of local and state hazard mitigation plans.	The State provides support for development of local NHMPs and the state NHMP by managing federal grant funding in ways that assist the state and local governments with NHMP development and update tasks and processes.	X	X	X		X	X	X	X	X	X	X	10	X	X	X	X	X	X	X	X	X	X	X	11	Goal 7	OEM	DLCD, OPDR, DOGAMI	FEMA-PDM, HMGP, State-DLCD, Local Gov'ts	**ONGOING**
86	Improve and sustain public information and education programs aimed at mitigating the damage caused by natural hazards	While ongoing efforts are being made in this area, a strong message conveyed by several State IHMT Reports notes the need to strengthen and sustain public information, education, and training efforts by providing additional resources. Although commonly recognized that interest in reducing losses increase during and after events, there is an ongoing need to provide residents and key stakeholder groups (such as infrastructure operators) with hazard mitigation information. These reports cite the need to have timely seasonal information available, better methods to inform residents of sources of hazard mitigation information, use improved electronic methods (e.g., web sites), and materials oriented toward the intended users. This helps keep awareness levels higher, will stimulate actions by some, and reminds users to consider and include hazard mitigation measures in the contexts of regular activities, such as building a new home, relocating an office, or repairing a business.	X	X	X	X	X		X			X		7	X	X	X	X	X	X	X	X	X	X	X	11	Oregon Resilience Plan, NFIP, Risk MAP	OEM, DOGAMI	State IHMT Agencies	DOGAMI, NOAA, FEMA, USGS, STATE-EMPG, Local Gov'ts	**ONGOING**

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87	Continue to improve inventory of state-owned/leased buildings in all hazard areas.	Using DAS's data, DOGAMI developed an inventory of state-owned/leased buildings and identified those in hazard areas for the 2012 Plan and updated the inventory for the 2015 Plan. The data should be continuously updated by DAS-CFO to facilitate DOGAMI's inventory updates in future plan cycles.	X	X	X							X		4	X	X	X	X	X	X	X	X	X	X	X	11	Oregon Resilience Plan	DAS-CFO	DOGAMI	State-DAS-CFO	**ONGOING**
88	Encourage citizens to prepare and maintain at least two weeks' worth of emergency supplies.	State agencies should work with the American Red Cross and local emergency managers to encourage citizens to be prepared to survive on their own for at least two weeks.	X		X				X			X		4	X	X	X	X	X	X	X	X	X	X	X	11		OEM	OERS agencies	NEHRP, State-EMPG	**ONGOING**
89	Continue to assist local governments with GIS capability development	Assist local governments with GIS program development, including system planning, hardware/software costs, training, and data development in relation to all hazards mapping and regulation of coastal development.	X	X			X					X		4	X	X	X	X	X	X	X	X	X	X	X	11	Goal 7, NFIP, Risk MAP, Oregon Resilience Plan	DLCD, DAS-GEO	DOGAMI	FEMA-Risk MAP, State-DAS-GEO	**ONGOING**
90	Use lidar for statewide analysis of all natural hazards	Lidar is currently the best source of regional topographic data and allows for highly precise and accurate natural hazard mapping (landslide, flooding, volcanic hazards, channel migration zones, tsunami, geologic faults, etc.) and infrastructure inventories (buildings, utilities, lifelines, etc.). Many Oregon state agencies currently use lidar for natural hazard analyses and will continue to do so where lidar is available.	X	X			X						X	4	X	X	X	X	X	X	X	X	X	X	X	11	NFIP, Risk MAP, Goal 7, Oregon Resilience Plan	DOGAMI	DAS-GEO	State-DOGAMI and Local Gov'ts	**ONGOING**
91	Continue to act upon opportunities to advance the State's lifeline mitigation investment practice.	Expand upon the State's mitigation investment practice by (a) supporting efforts by jurisdictions and transportation districts to develop mitigation policy and retrofit plans for lifeline assets and service facilities; (b) continuing to advance design and maintenance standards and requirements for bridges and unstable slopes, transit, rail, ports, and priority lifeline airfields; (c) developing a temporary bridge installation policy and standards; (d) supporting research on retrofit methods and strategies for Cascadia subduction zone earthquake loads and tsunamis.	X	X	X		X					X		5	X			X	X	X	X					5	Oregon Highway Plan (OHP); The Oregon Resilience Plan	ODOT	OEM, DOGAMI, DLCD	FHWA, FTA, STATE-ODOT, OEM, DOGAMI, DLCD	**ONGOING**
92	Improve reliability and resiliency of critical infrastructure statewide by adopting industry-specific best practices, guidelines, and standards.	Lifeline Service Delivery Systems (critical infrastructure), including electric supply, natural gas, telecommunications, water/wastewater, hydraulic structures (e.g., dikes, levees, dams), transportation corridors, pipelines and petroleum fuels storage facilities, are all vital resources for a community's life-safety and economic viability. However, much of Oregon's existing critical infrastructure has not been designed or constructed to withstand the impact of severe natural disasters such as extreme wind & winter storms, major earthquakes, or large landslides. Lifeline Service Delivery Systems (critical infrastructure) should be evaluated statewide, and reliable and measurable performance objectives which insure the region's critical infrastructure can withstand future damage without crippling consequences should be instituted.	X	X	X		X							4				X	X	X				X	X	5	Oregon Resilience Plan, Oregon Highway Plan	OPUC, OWRD, ODOT	Other State IHMT Agencies	FEMA, State-OWRD, State Highway Fund, Private Utility Fees, Private Property Owners	**ONGOING**
93	Acquire statewide lidar coverage for the purpose of improving natural hazard mapping and infrastructure inventories.	Lidar is currently the best source of regional topographic data and allows for highly precise and accurate natural hazard mapping (landslide, flooding, volcanic hazards, channel migration zones, tsunami, geologic faults, etc.) and infrastructure inventories (buildings, utilities, lifelines, etc.). The state should continue to invest in lidar acquisition for the purpose of understanding risk to natural hazards at a local scale.	X	X			X							3				X	X	X	X	X				5	NFIP, Risk MAP, Goal 7, Oregon Resilience Plan	DOGAMI	State IHMT Agencies	FEMA, USGS, NRCS, BLM, State-DOGAMI and Local, Gov'ts	**ONGOING**

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94	Provide technical assistance and funding to local governments to evaluate the need and opportunities for inter-tie projects in Local Natural Hazards Mitigation Plans.	The capital expense associated with this action needs to be carried mostly by local governments, perhaps with some grant or low-interest loan funding provided by the state or federal governments. The role of the state in this action is to encourage local governments located proximate to one another, yet with separate water systems, to develop the physical capability to send water from one system to the other. Often during drought situations, one local government will have a bit of water to spare while a nearby government is struggling to meet its needs. Transferring water by truck is expensive and inefficient when compared to transferring water via pipeline. Water inter-ties are also effective mitigation for the flood and earthquake hazards where one system can serve as backup for another.	X	X	X		X					X		5		X		X	X							3	NFIP, Oregon Resilience Plan, Integrated Water Resources Strategy Action 7B	OWRD		State-OWRD, Local Gov'ts	**ONGOING**
95	Educate citizens about the different National Weather Service announcements.	State agencies should work with the National Weather Service and local governments to educate the public about the meaning of the different National Weather Service announcements: winter storm watch, winter storm warning, ice storm warning, heavy snow warning, blizzard warning, severe blizzard warning, dust storm and high wind warning.	X	X					X			X		4			X							X	X	3		Silver Jackets		NOAA-NWS, USGS	**ONGOING**
96	Continue to maintain the existing roster of qualified post-earthquake, flood, and wind inspectors with ATC-20 earthquake and ATC-45 flood & wind inspection training.	Continue to compile and maintain a list of individuals trained and certified for post-disaster inspection. Support the recruitment and training of qualified ATC-20 post earthquake inspectors and inspection teams.			X		X					X		3				X	X					X		3	NFIP, Oregon Resilience Plan	BCD	OEM, ODOT	State-BCD	**ONGOING**
97	Expand the state's stream gaging network. Seek stable funding for the operation, and maintenance of stream gages.	The availability of timely and accurate telemetered data from stream gages is essential for flood forecasting, for prediction of imminent flood hazards, and for response to flood emergencies. Streamflow data also provides basic hydrologic information for floodplain mapping and watershed management by communities throughout the state, and is critical for understanding and forecasting drought conditions. Numerous local, state and federal water management agencies rely on data from stream gages for effective management of projects and resources; the installation and maintenance of stream gages has traditionally been a responsibility of state and federal agencies. State agencies plan to work with their partners to ensure adequate funding and support for existing gages and for the installation of new gaging sites where needed. It is recommended that state agencies endeavor to leverage federal funding with state resources and local matching commitments to achieve a reliable network of stream gages around the state. The data from these gages is used to support the RAFT and Raptor tools highlighted in Action #10, Priority.	X	X		X	X					X		5		X			X							2	Integrated Water Resources Strategy Action 1B	OWRD		USFWS, State-OWRD, OWEB	**ONGOING**
98	Better coordinate, fund, and publicize programs to reduce the abundance of juniper trees in arid landscapes across Oregon	Juniper trees develop extensive root systems that draw critically needed water from arid soils, transpiring water vapor into the atmosphere, intensifying drought and increasing the risk of wildfire. There are programs in Oregon to reduce juniper trees from areas where their competition for groundwater resources is harmful, but these programs need to be better coordinated, funded, and publicized.	X		X	X			X			X		5		X							X			2	Sage Grouse Conservation Partnership	ODF	ODA, DEQ, ODFW, DSL, NRCS, OWEB	ODF, NRCS	**ONGOING**

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99	Educate homeowners about choosing ice and windstorm-resistant trees and landscaping practices to reduce tree-related hazards in future ice storms	Trees that don't stand up well to ice and wind, especially when planted near power lines, can cause power outages and other damage. Certain species of trees hold up better to winter's fury than others. Other factors, such as where a tree is planted and use of proper pruning techniques, can also help trees be more resistant to ice storm damage.	X	X		X			X					4										X	X	2	ODF Urban Forestry Strategy	ODF	PUC, OSU Ext.	ODF, OSU Ext.	**ONGOING**
100	Each year, ask the Governor to designate October to be Earthquake and Tsunami Awareness Month.	Practicing to "Drop, cover, and hold" is critical in reducing injury and loss of life in the workplace and home during an earthquake. The more people practice the drill, the better they will respond to a real event. A gubernatorial declaration will promote increased participation in the Great Oregon ShakeOut, or other annual earthquake Drop, Cover, and Hold On drill.	X	X					X			X		4				X			X					2	Oregon Resilience Plan	OEM	Governor's Office	NEHRP, State-EMPG	**ANNUALLY**
101	Continue to facilitate accessibility and use of the *Coastal Atlas* GIS resources.	Make the *Coastal Atlas* geographic information system (GIS) more useful for a wider audience, from local and state staff to interested citizens, by continuing to improve its data and tools, and providing training on how to access and use them.	X	X		X			X	X		X		6	X											1	Goal 7, Risk MAP, NFIP	DLCD, OPRD		NOAA, State-OPRD	**ONGOING**
102	Research the effects of changing ocean water levels and wave dynamics along the central and southern Oregon coast, and use that data to augment the coastal geomorphic database.	As recent research has shown, ocean water levels and wave dynamics along the Oregon coast are changing. These will, in turn, affect beach sand budgets and rates of erosion. More research must be done on alternative shore protection methods, effects of hard shore protection structures, near-shore circulation processes and sediment budgets, sea cliff erosion processes, and other hazard processes	X	X		X				X				4	X											1	NFIP, Risk MAP, Goal 7	DOGAMI, OSU	DLCD	NOAA (309)	**ONGOING**
103	Survey coastline to monitor erosion	Continue to periodically measure and monitor the Oregon coastline in order to document the response of Oregon's beach and bluffs to changes in ocean water levels (sea level rise and storm surges), storms (frequency and intensity), precipitation patterns that may threaten lives and property. Maintain a long-term, permanent Oregon Beach and Shoreline Mapping and Analysis Program (OBSMAP). The program will be a partnership with local, state, and federal agencies that have responsibility over coastal and ocean activities.	X	X		X						X		4	X											1	NFIP, Risk MAP, Goal 7	DOGAMI	OSU, DLCD, OPRD	NOAA, State-DOGAMI, OPRD, OSU, and Local Gov'ts	**ONGOING -** 30% of coast actively monitored; 60% monitored to a lesser degree.
104	Maintain the updated inventory of shoreline protection structures.	Maintain the inventory of existing and new coastal engineering (shore protection) structures on the Oregon Coast in order to provide local governments and applicable agencies an important coastal management tool to address anticipated increasing coastal erosion. It is anticipated that this inventory and information will assist in potential future policy changes to address a changing climate and associated coastal erosion impacts.	X	X		X								3	X											1		OPRD		Permit Fees	**ONGOING - Will begin after 21 (Priority) is completed.**
105	Implement the improved methodology for gathering data and identifying the communities most vulnerable to drought and related impacts.	Although we know that areas in Oregon have suffered from drought, there has not been a coordinated effort to systematically characterize how frequently droughts have occurred, or the impact on Oregonians and ecosystems. Communities are beginning to plan for worst case drought scenarios and need better information about the frequency, duration, and intensity of previous droughts in order to assess the appropriate response. Comprehensive information is not currently available by region, or statewide.	X	X	X		X						X	5		X										1	Integrated Water System Strategy	OWRD	OEM	State-OWRD, OEM	**ONGOING**

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106	Publicize and facilitate the implementation of both structural and non-structural seismic mitigation measures for home owners, business owners, renters, and contractors, including methods of reducing hazards	Working with federal partners, such as FEMA, and non-profit industry groups, such as AIA, Oregon will enhance education on structural and non-structural seismic mitigation measures by adopting the following actions: • Increase the number of educational opportunities by working with FEMA to offer courses from the National Earthquake Technical Assistance Program. • Work with the Construction Contractors Board, public and private sector lenders, private sector construction material suppliers and nonprofit organizations to develop programs to assist home and business owners and renters to implement innovative structural and non-structural seismic mitigation measures.	X	X	X				X				X	5				X								1	Oregon Resilience Plan	OEM	BCD	State-EMPG, Local Gov'ts	**ONGOING**
107	Provide information and technical assistance to implement mitigation of non-structural hazards in K-12 schools.	Provide training to school officials and teachers in reducing non-structural hazards in schools such as unsecured bookcases, filing cabinets, and light fixtures, which can cause injuries and block exits. The program should include a procedure for periodic life safety inspections of non-structural seismic hazards in schools that can be implemented by local fire department inspectors. BCD will have an important role in providing technical assistance in the development of educational materials.	X	X	X				X			X		5				X								1	Oregon Resilience Plan	OEM	OSSPAC, BCD, OSFM, ODE	NEHRP, State-SRGP	**ONGOING**
108	Each year, ask the Governor to designate the third Thursday of the month of October as the Great Oregon ShakeOut Day by proclamation.	Practicing to "drop, cover, and hold" is critical in reducing injury and loss of life in the workplace and home during an earthquake. The more people practice the drill, the better they will respond to a real event. A gubernatorial declaration will promote increased participation in the Great Oregon ShakeOut, or other annual earthquake Drop, Cover, and Hold On drill.	X	X					X			X		4				X								1	Oregon Resilience Plan	OEM	Governor's Office	NEHRP, State-EMPG	**ANNUALLY**
109	Include information about the benefits of purchasing earthquake insurance in public outreach materials and disseminate those materials through appropriate public outreach programs and venues.	Unlike flood insurance, which is underwritten by the U.S. Government (through the National Flood Insurance Program), earthquake insurance is offered by private sector agents, generally as a rider to a standard homeowner or business property insurance policy. Because earthquake insurance is a type of catastrophic coverage, most policies carry a high deductible, Oregon's Department of Consumer and Business Services Insurance Division offers information about earthquake insurance on its website and provides personal assistance through its insurance hotline. In addition, the Division is active in outreach activities, partnering with other agencies and organizations to bring insurance information to the public.	X	X	X				X					4				X								1	Oregon Resilience Plan	DCBS-ID	DOGAMI, OEM	State-DCBS-ID	**ONGOING**
110	Continue seismic rehabilitation of hospital, fire, and police facilities under the Seismic Rehabilitation Grant Program administered by Business Oregon's Infrastructure Finance Division.	Continue to rehabilitate to operational readiness in the event of an earthquake essential hospital buildings, fire, and police stations that pose a threat to occupant safety. Senate Bill 15 of the 2001 Legislative Session requires that rehabilitation or other actions to be completed by January 1, 2022. Senate Bills 2 to 5 (2005) provided the mechanism to accomplish some of these legislatively mandated tasks. Under SB 2, Oregon Department of Geology and Mineral Industries developed a seismic needs assessment database of emergency response facilities buildings. These data are being used by the Seismic Rehabilitation Grant Program to provide funding for seismic rehabilitation of eligible buildings (SB 3). Senate Bill 5 allows the State Treasury to sell Government Obligation Bonds to fund the program.	X	X	X		X							4				X								1	Oregon Resilience Plan	BusOR-IFA	OSSPAC, DOGAMI, BCD, OSFM (SB 3). OEM, OHD	State-BusOR-IFA	**ONGOING**

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111	Continue seismic rehabilitation of public schools buildings under the Seismic Rehabilitation Grant Program administered by Business Oregon's Infrastructure Finance Division.	Continue to rehabilitate to occupant life safety standards certain public school and community college buildings. Senate Bill 14 from the 2001 Session of the Oregon Legislature requires that the State Board of Education examine buildings used for both instructional and non-instructional activities, including libraries, auditoriums, and dining facilities in order to determine which buildings are in most need of additional analysis. Following the identification of high-risk buildings and additional analysis, high-risk buildings must be rehabilitated by January 1, 2032, subject to available funding. SJR 21 and 22 are bond measures (November 2002 election) which would provide funding to implement this proposed action. SB 2 to 5 (2005) provided the mechanism to accomplish some of these legislatively mandated tasks. Under SB 2, Oregon Department of Geology and Mineral Industries developed a seismic needs assessment database of K-12 and Community College public school buildings. These data are being used the SRGP to administer a grant program for seismic rehabilitation of eligible buildings (SB 3). SB 4 allows the State Treasury to sell Government Obligation Bonds to fund the program.	X	X	X		X							4				X								1	Oregon Resilience Plan	BusOR-IFA	OSSPAC, DOGAMI, BCD, ODE	State-BusOR-IFA	**ONGOING**
112	Continue implementing the Oregon CRS Users Group Program.	DLCD will continue to coordinate Oregon's two NFIP CRS Users' Groups. Each group will meet a minimum of three times per year to share floodplain best management practices and to receive technical support from the State, FEMA's Insurance Support Organization, and others as needed. The State anticipates that the support provided through the CRS Users' Groups will encourage more communities to participate in the CRS program and participating communities to strengthen their CRS ratings, resulting in greater protection from flood damage at lower cost to property owners.	X	X	X	X	X		X	X		X	X	9					X							1	NFIP, Goal 7, Local Natural Hazards Mitigation Plans	DLCD	FEMA, Local Gov'ts	FEMA, CAP-SSSE	**ONGOING**
113	Monitor the effectiveness of the statewide strategy to encourage the purchase of flood insurance by demonstrating that the number of flood insurance policies held throughout the state continues to increase.	Despite the statewide availability of flood insurance, coverage in place in most communities in Oregon varies from 10% to 20% of the homes and businesses located in the Special Flood Hazard Area (100-year floodplain). Not only does flood insurance reduce the financial vulnerability of individuals, families, businesses, government agencies, other organizations, and the community to the costs posed by flooding, but through the "increased cost of compliance" provision of flood insurance, it also provides funding for the elevation, flood-proofing, demolition, or relocation of homes and businesses when required due to "substantial damage" to the structure.	X	X	X	X	X		X	X				7					X							1	NFIP	DLCD	DCBS-ID	FEMA	**ONGOING - Start Date 2015**
114	Update the Model Ordinance for Flood Damage Prevention	FEMA Region 10 has approved for use in Oregon a model ordinance for flood damage prevention. DLCD views the model ordinance as a living document and will continue to work with Region 10 and other interested parties to develop model ordinance provisions that address issues such as "fish-friendly" floodplain management, reducing flood insurance costs, etc.	X	X	X	X	X					X	X	7					X							1	NFIP, Goal 7	DLCD	BCD	FEMA—CAP-SSSE, State DLCD, BCD	**ONGOING**
115	Maintain the Riparian Lands Tax Incentive Program	This program is administered by the ODFW. This program involves the preparation of a plan and agreement between the landowner and the ODFW. The plan details measures the landowner will implement to preserve, enhance, or restore the riparian areas. Landowners receive a complete property tax exemption for the riparian property (up to 100 feet from the top of stream bank or the edge of non-aquatic vegetation). This program helps reduce sediment and protect stream banks which helps reduce the filling of river and stream channels.	X	X		X	X						X	5					X							1	NFIP, DEQ-Water Quality	ODFW	ODR	State-ODFW	**ONGOING**

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116	Provide information and potentially resources to local governments for developing "flood fight" plans and protocols.	Several post-disaster mitigation strategy reports call for the development of flood fight plans and protocols in advance of flood emergencies. In addition to the state agencies potentially involved in flood fighting such as OEM and OWRD, environmental protection and habitat conservation agencies such as DEQ and ODFW should be involved in flood fight planning. At the federal level, the U.S. Army Corps of Engineers is a key partner. These plans and protocols might include improving emergency warnings, strengthening communications systems, stockpiling needed materials, preparing procedures for emergency vehicle access to flooded areas, and other related subjects, including ongoing public education efforts.	X	X					X			X		4					X							1	Silver Jackets	OEM	ODOT	USACE, State-EMPG	**ONGOING**
117	Continue the State's active Floodplain Management Outreach Program	DLCD has an active floodplain and natural hazards outreach program. The department publishes and distributes newsletters and other outreach information to local governments and other interested parties. DLCD also maintains a website which includes a link to this NHMP. The natural hazards website (http://www.oregon.gov/LCD/HAZ/index.shtml) contains information and links to floodplain management information including many of the documents and booklets prepared by FEMA. DLCD uses an email distribution service for its Natural Hazard Newsletter and other correspondence. The email distribution service affords interested subscribers a greater opportunity to obtain flood management and natural hazards information from DLCD in a timely manner and for DLCD to more readily share information from a variety of sources.	X	X					X			X		4					X							1	NFIP	DLCD		FEMA	**ONGOING**
118	Continue the State's active Floodplain Management Training Program	DLCD and other State IHMT participants conduct or sponsor training sessions and meetings throughout the year focused on up-to-date floodplain management practices and projects. DLCD will continue to deliver focused training to surveyors, building officials, real estate agents and planners as well as local floodplain managers. The interdependent relationships among these key players in providing comprehensive floodplain management will also be highlighted during trainings.	X	X					X			X		4					X							1	NFIP	DLCD		FEMA	**ONGOING**
119	Prepare text for local broadcast of one Public Service Announcement (PSA) each year on a seasonal topic.	PSAs are an effective method for disseminating pertinent seasonal information about hazard preparedness and mitigation.	X	X					X			X		4					X							1	NFIP	DLCD		FEMA	**ANNUALLY**
120	Assist local communities in securing funding to mitigate damage to repetitive flood loss properties or those substantially damaged by flooding.	The state maintains an inventory of high priority repetitively damaged buildings located in floodplains. DLCD and OEM have worked closely with communities to secure funding to mitigate buildings located in the flood hazard zone and to buyout properties located in the floodway. These agencies will continue to provide such expertise statewide where needed.	X	X			X					X		4					X							1	NFIP	OEM, DLCD	State IHMT Agencies	FEMA—CAP-SSSE, Local Gov'ts	**ONGOING**
121	Continue implementation of FEMA's Risk MAP program in Oregon, including building effective community strategies for reducing risk.	Measurably increase the public's awareness of flood and other natural hazards through a combination of regulatory and non-regulatory products, tools, community outreach. Address gaps in flood hazard data, identifying areas of dated and/or inconsistent mapping and updating high-priority areas with new mapping and innovative natural hazard mapping techniques that lead to actions that reduce risk to life and property. Provide support to help manage the FEMA Map Modernization projects that remain to be completed.	X	X			X					X		4					X							1	NFIP	DLCD	DOGAMI, OPDR, SILVER JACKETS	FEMA-Risk MAP	**ONGOING**

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122	Continue developing Emergency Action Plans for all remaining high hazard dams in Oregon.	In Oregon, money from FEMA grants and state funds is used to help dam owners create Emergency Action Plans (EAP). An EAP helps identify situations where a dam failure might occur, actions to take that could save the dam, if possible, and evacuation routes for a dam failure situation. There is an Oregon-specific EAP template available, designed for owners of remote dams that have limited personnel. Approximately 75% of state-regulated high hazard dams have, or are currently developing EAPs. There are 67 state regulated high hazard dams, and another 65 federal high hazard dams in which OWRD plays a coordinating role.	X	X			X					X		4					X							1	Integrated Water Resources Strategy Action 7a	OWRD	Silver Jackets	FEMA, State-OWRD	**ONGOING**
123	Implement flood protection standards for state-owned/leased buildings.	According to the Senate Bill 814 Task Force (Oregon Legislature, 1997 Session), there is a need to develop and effectively implement a strict standard governing the siting, construction, and leasing of buildings occupied by state agencies in flood-prone areas.	X	X										2					X							1	NFIP	DAS-EAM	DLCD	State-DAS-EAM	**2020**
124	Acquire existing homes and businesses seriously threatened or damaged by landslide hazards	When opportunities and funding become available (pre- and/or post-disaster) explore options for the acquisition of developed property, particularly homes, in areas of repetitive or ongoing landslide hazards. Acquired properties will be maintained as open space in perpetuity and may also provide a buffer for landslide movements and debris that could otherwise impact improvements such as transportation routes.	X	X			X					X		4						X						1	Goal 7	OEM	DOGAMI, ODF, DLCD	FEMA-HMGP, Local Resources	**ONGOING - and as opportunities (funding and project needs) arise**
125	Assist local governments in implementing the tsunami land use guidance.	The risk of tsunami hazard for Oregon's coastal communities is well-documented with the completion of comprehensive tsunami inundation maps developed by DOGAMI. The State of Oregon can assist affected communities with its implementation, leading to better protection of life and property from tsunamis.	X	X	X				X	X		X	X	7							X					1	Goal 7	DLCD		NOAA, State-DLCD	**ONGOING**
126	Monitor implementation of the tsunami land use guidance by tracking the number of jurisdictions that have used it.	The risk of tsunami hazard for Oregon's coastal communities is well-documented with the completion of comprehensive tsunami inundation maps developed by DOGAMI. Monitoring success of the guidance will allow the State to adjust its approach and update the guidance as necessary, leading to better protection of life and property.	X	X	X					X		X	X	6							X					1	Goal 7	DLCD		NOAA, State-DLCD	**ONGOING—Start Date 2015**
127	Continue to renew coastal communities' enrollments in the Tsunami Ready Program.	The Tsunami Ready Program is a program sponsored by the National Weather Service that is designed to provide communities with incentives to reduce their tsunami risk. Cannon Beach was the first community for Oregon. Under a proposed plan through the NTHMP, additional communities will be added until there is full participation. This program is currently evolving through a review process being carried out by the NTHMP National Coordinating Committee. OEM is the primary point of contact for more information about the Tsunami Ready Program.	X	X	X				X			X		5							X					1	Oregon Resilience Plan	OEM	DLCD, DOGAMI	NOAA, State-EMPG	**ONGOING**
128	Continue supporting school participation in annual tsunami evacuation drills.	Increase the ability of Oregonians to prepare for and recover from earthquakes and tsunamis on the Oregon Coast.	X	X	X				X			X		5							X					1	Oregon Resilience Plan, Goal 7	OEM, DOGAMI	DLCD, ODOT	NOAA, State-EMPG, DOGAMI	**ONGOING**

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129	Continue supporting local agencies and local non-profits, such as CERT, in participating in educational efforts such as door-to-door campaigns to educate those living or working in the inundation zone on how to respond to an earthquake and tsunami.	Increase the ability of Oregonians to prepare for and recover from earthquakes and tsunamis on the Oregon Coast.	X	X	X				X			X		5							X					1	Oregon Resilience Plan, Goal 7	OEM, DOGAMI	DLCD, ODOT	NOAA, State-EMPG, DOGAMI	**ONGOING**
130	Continue innovative outreach activities, such as tsunami evacuation route fun runs.	Increase the ability of Oregonians to prepare for and recover from earthquakes and tsunamis on the Oregon Coast.	X	X	X				X			X		5							X					1	Oregon Resilience Plan, Goal 7	OEM, DOGAMI	DLCD, ODOT	FEMA, NOAA, State-EMPG, DOGAMI	**ONGOING**
131	Continue to develop training and information packets and articles for local building officials informing them of their responsibilities and authority under ORS 455.446 and 455.447 and the State Building Code.	Statutes and the State Building Code limit construction of new essential facilities and special occupancy structures in the mapped tsunami inundation zone. Definitions of essential and special occupancy structures are in the Oregon State Structural Specialty Code. As personnel change and time passes, additional training and information for officials will be provided.	X	X			X		X			X		5							X					1	Oregon Resilience Plan	BCD, DLCD	DOGAMI, OEM	State-BCD, DLCD	**ONGOING**
132	Work with ODOT to replace or move existing Entering/Leaving Tsunami Hazard Zone signs to correspond with the XXL inundation line developed by DOGAMI.	Existing tsunami hazard zones signs are considered inadequate for placement along stretches of US-101, or on any roads, that are within the tsunami hazard zone. A single tsunami hazard zone sign will not indicate the boundaries of the inundation zone. Tsunami Hazard Zone signs should be located to correspond with the XXL inundation line developed by DOGAMI.	X	X					X			X		4							X					1	Oregon Resilience Plan	OEM	ODOT	NOAA, Local Gov'ts	**ONGOING**
133	Work with ODOT to develop additional signage as needed to increase awareness of the tsunami hazard.	Existing tsunami hazard zones signs are considered inadequate for placement along stretches of US-101, or on any roads, that are within the tsunami hazard zone. A single tsunami hazard zone sign will not indicate the boundaries of the inundation zone. There is need for increased public education program to let the public, including motorists who are not local residents, know what the signs mean and what actions they should take.	X	X					X			X		4							X					1	Oregon Resilience Plan	OEM	ODOT	NOAA, Local Gov'ts	**ONGOING**
134	Work with Oregon Parks & Recreation Department and Oregon Travel Experience to increase the number of interpretive educational installations along US-101.	Existing tsunami hazard zones signs are considered inadequate for placement along stretches of US-101, or on any roads, that are within the tsunami hazard zone. There is need for increased public education program to let the public, including motorists who are not local residents, know what the signs mean and what actions they should take.	X	X					X			X		4							X					1	Oregon Resilience Plan	OEM	OPRD, DOGAMI	NOAA, State–DOGAMI, L ocal Gov'ts	**ONGOING**
135	Develop volcanic hazard evacuation maps	Volcanic eruptions often produce lahars that travel down river valleys. Evacuation maps should include the hazard area as well as preferred evacuation routes and evacuation sites. USGS staff should support local and state agencies in this effort.	X	X	X				X			X		5								X				1	Oregon Resilience Plan	DOGAMI	ODOT, OEM	DOGAMI, USGS	**ONGOING**
136	Each year, ask the Governor to designate May to be Volcano Awareness Month by proclamation.	Working with federal partners, such as the USGS Cascades Volcano Observatory, the state of Oregon will increase the ability for citizens to respond to volcanic eruptions by increasing the level of awareness and preparedness in the public and governmental agencies.	X	X					X			X		4								X				1	Oregon Resilience Plan	OEM	Governor's Office	NEHRP, State-EMPG	**ANNUALLY**

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137	Support development, enhancement and implementation of local education programs designed to mitigate the wildfire hazard and to reduce wildfire losses, such as the Firewise Communities/NFPA Program and the annual Wildfire Awareness Week Campaign.	As part of its statewide fire prevention program, the Oregon Department of Forestry actively encourages and promotes local education and awareness programs that are designed to mitigate, or reduce the impacts of wildfires. This action reflects ODF's ongoing intentions to: (a) collaborate with agencies and organizations to promote consistency in the development and application of fire prevention standards,(b) work to make individuals aware of their personal accountability and responsibility for wildfire safety, (c) determine local resources and capacity, and (d) define needs and solutions required to increase capacity.	X	X					X			X		4									X			1		ODF	OSFM, BCD, DCBS-ID, DLCD, KOG, OSU Ext.	BLM-Title III, ODF, OSFM	**ANNUALLY**
138	Continue to increase the number of local governments using the Wildfire Hazard Zone process to mitigate wildfire risk and losses	The Wildfire Hazard Zone (WHZ) process allows local governments to require the use of fire resistant roofing materials in jurisdictions assessed to be at a high risk of wildland fire. Currently, only a few eligible entities have used the WHZ process. To promote additional use, an assessment will be made of the portions of the state where it appears the WHZ process will have the greatest benefit. Following this assessment, local governments in the areas identified will be educated on the desirability of implementing the process. Those governments that express an interest in applying the process will be assisted in completing the required analysis work.	X	X					X			X		4									X			1	Local Community Wildfire Protection Plan processes, Goal 7	ODF, BCD	OSFM	BLM-Title III, State-ODF	**ONGOING**
139	Continue to develop and increase the number of updated Community Wildfire Protection Plans (CWPPs) with the goal of aligning CWPP updates with 5-year NHMP updates, where possible.	The federal Healthy Forests Restoration Act (HFRA) includes statutory incentives for federal agencies to give consideration to the priorities of local communities as they develop and implement wildfire hazard mitigation projects. To become eligible for priority consideration under HFRA, a community must first prepare a *Community Wildfire Protection Plan* (CWPP). Most Oregon counties and many Oregon communities have completed CWPPs. To encourage the completion of additional CWPPs, as well as future updates of CWPP's counties and communities will be informed of the benefits to be gained from maintaining a CWPP and assistance will be offered to help facilitate the development and/or update of the plans. Because the majority of Counties refer to CWPP's as their Wildfire Chapters, aligning CWPP updates with NHMP updates will ensure consistency and promote efficiencies in planning processes.	X	X					X			X		4									X			1	Community Wildfire Protection Plans	ODF	OSFM	BLM-Title III, USDA-USFS & USDOI-National Fire Plan, FEMA-PDM	**ONGOING**
140	Continue to provide technical assistance in accessing funding for fire prevention or wildfire mitigation projects through Title III, the National Fire Plan, or other funding mechanisms.	Under the federal *Secure Rural Schools and Community Self-Determination Act of 2000* (Title III, Section 301(5) of PL 106-393, commonly known as *Title III*), counties have the ability to receive and spend federal funds for projects that educate homeowners about wildfire mitigation efforts they can apply on their property and for planning projects that increase the protection of people and property from wildfires. National Fire Plan and other funding mechanisms may also be available for assisting communities in preventing wildfires and implementing wildfire mitigation projects.	X	X					X			X		4									X			1		ODF	OSFM	National Fire Plan, State-ODF	**ONGOING**

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141	Implement the Oregon Forestland-Urban Interface Fire Protection Act ("Senate Bill 360") in all Oregon counties that meet criteria under the law.	The *Oregon Forestland-Urban Interface Fire Protection Act*, more commonly known as "Senate Bill 360," was enacted by the Oregon Legislature in response to the growing incidence of wildfire destroying homes and communities in Oregon's wildland-urban interface. The Act recognizes that individual property owners are in the best position to take mitigation actions which will have the most direct impact to whether or not a structure will survive a wildfire. Under this action item, the Act will be implemented county by county in those portions of the state, based on weather, fire incidence, fuels, or on the number of structures at risk. It has been Legislature's stated preference that implementation be accomplished with federal grant funds.	X	X			X					X		4									X			1	Goal 7	ODF	OSFM	State-ODF	**ONGOING**
142	Analyze wildfire ignition probability statistics to better target prevention efforts at the leading causes of fires.	There is currently no single database or common method of collecting fire cause information for wildfires occurring in Oregon. This results in different entities focusing their prevention and mitigation efforts on those causes which may not be the state's leading causes of fires. This likelihood can be lessened by developing a process to compare fire cause data collected by the Oregon Department of Forestry, the Office of the State Fire Marshal, and federal wildfire agencies. It is also important to understand the ignition probability from homes within and adjacent to the wildland interface because of the ignition risk to nearby wildlands. While there is no centralized database, wildland and structural fire agencies will continue to work collaboratively to determine leading fire causes and focus efforts statewide and locally to prevent future ignitions.	X	X			X					X		4									X			1	PNWCG	ODF	OSFM, KOG	State-ODF, OSFM	**ONGOING**
143	Collaborate through work groups within the Pacific Northwest Coordination Group (PNWCG) to continue collecting and analyzing wildfire occurrence data using the standardized statewide method and report to the state legislature as required.	Previously, data concerning the causes of wildfire incidents was collected and analyzed by at least two state agencies, five federal agencies, and numerous local fire departments. These agencies had no database standardization or common reporting requirements. A standardized data collection system has been developed and data collection and reporting continues collaboratively through work groups within the Pacific Northwest Coordination Group (PNWCG). The new system allows rapid identification of fire ignition trends and permits timely design and delivery of targeted prevention programs and activities.	X	X			X					X		4									X			1		ODF	PNWCG	State-ODF	**ONGOING**
144	Collaborate through work groups within the Pacific Northwest Coordination Group to encourage the U.S. Forest Service to allow the owners of long-term dwelling leases to apply mitigation standards adjacent to their dwellings.	In Oregon, several thousand seasonal homes, which are located in high-risk wildland-urban interface areas, are on lands owned by the U.S. Forest Service. Because these structures are located on ground owned by the federal government, they are not subject to the *Oregon Forestland-Urban Interface Fire Protection Act*. In many locations, even when the owners of these homes desire to complete wildfire mitigation practices, federal lease requirements totally or substantially prevent them from doing so. Under this action item, a survey will be made of all lease locations in Oregon and the federal mitigation limitation and prohibitions will be identified. This information will then be used to approach the appropriate federal officials with a request to change their policies or regulations, to allow for the application of mitigation practices on leased property.	X	X								X		3									X			1		ODF	OSFM	USFS	**ONGOING**

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145	Develop a single, comprehensive statewide method or process to collect and analyze wildfire occurrence data in a timely manner	Currently, data concerning the causes of wildfire incidents is collected and analyzed by at least two state agencies, five federal agencies, and numerous local fire departments. These agencies have no database standardization or common reporting requirements. This results in great difficulty, when attempting to determine the number of wildfires that occur in Oregon, when identifying fire cause trends, and generally in obtaining information concerning wildfire trends in a timely manner. Under this action item, all agencies responsible for suppressing wildfires will be requested to report incident occurrence information to a central data repository, in a standard format, and within prescribed reporting time limits. Such a system would allow for the rapid identification of fire ignition trends and would permit the timely design and delivery of targeted prevention programs and activities. The State Fire Marshal's Oregon All Incident Reporting System (OAIRS) may be a key component in the solution.		X					X					2									X			1		OSFM, ODF		State-OSFM, ODF	**ONGOING**
146	Continue to educate communities, workers, and the public about the role of proper tree pruning and care in preventing damage during windstorms.	Arboricultural groups, public agencies, and utilities should cooperate in promoting proper tree pruning and care practices that can reduce the risk of tree failure and property damage. Common messages refined by state level entities such as the Oregon Department of Forestry (ODF) and OSU Extension can help provide continuity and efficiency across the state. While implementation of this action largely takes place at the local government level, the state has a role in encouraging and providing incentives for best management practices. ODF maintains and implements a communication plan that includes educational initiatives aimed at improving tree health in cities. This includes a variety of products, including a bimonthly newsletter, a website, and brochures that help convey these messages. OSHA requires utilities to: • Provide training to crews working on power lines in worker safety and the identification of trees to prune or remove; and • Review regulations and standards for easement and right of way maintenance, and provide training to foresters and logging crews. Utilities should instruct homeowners in pruning of vegetation, tree care safety, and proper tree care for trees bordering utility corridors and public rights of way.	X	X		X			X			X		5										X		1	OSU Land Steward Program, Oregon Small Woodland Association Tree Schools	ODF	PUC, OEM, OSU Ext.	ODF, OSU Ext.	**ONGOING**
147	Use industry best practices to minimize impact and outages to service delivery system of overhead line operators, during windstorm events.	Implement outreach efforts through existing safety-related programs managed by the PUC in coordination with private and public utilities. Compliance with PUC administrative rules includes safety codes and vegetation management. The PUC provides administrative to support to the Oregon Utility Safety Committee where all utility operators (electric, natural gas, telecommunication & water) discuss safety issues and best practices.	X	X	X				X					4										X		1		PUC	ODF, ODOT, OR-OSHA	State-OPUC, Public and Private Utilities	**ONGOING**

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148	Educate citizens about safe emergency heating equipment.	Improper use of alternate heat sources during winter storms can cause fires. Ongoing efforts of the Office of State Fire Marshal and its work with local fire departments through the Life Safety Team (http://www.oregon.gov/OSP/SFM/Pages/CommEd_OLST.aspx). In addition, people can be killed by carbon monoxide emitted by fuels such as charcoal briquettes when used for heating homes. To reduce the threat of carbon monoxide poisoning, known as the silent killer, the 2009 Legislature passed HB 3450a requiring landlords to install carbon monoxide alarms in rentals with a carbon monoxide source and homeowners must ensure they are installed in homes at the time of sale, if the home has a source. Sources include gas heating or fireplaces, wood-burning fireplaces or stoves and attached garages. Partnerships for consistent public education messages and outreach are underway, and will include information on the dangers of introducing a carbon monoxide risk.	X	X					X			X		4											X	1		OSFM	OPH, BCD	State-OSFM	**ONGOING**
149	Continue educating motorists on safe winter driving, including how to be prepared for traveling over snowy and icy mountain passes.	Actions such as sanding, applying de-icing chemicals, and snowplowing do not make the road safe. Motorists must drive at speeds appropriate for the weather and road conditions, and be prepared to handle adverse conditions. Many drivers do not carry chains and do not know how or simply do not install them when conditions warrant. Also, many drivers are not prepared for a long wait in their car. Education programs would help save lives on snowy and icy roads.	X	X					X					3											X	1		ODOT	OSP	State-ODOT	**ONGOING**

Table 3-3. Removed Mitigation Actions

2015 MITIGATION ACTIONS—REMOVED

Action Item			Goal												Hazard												Implementation	
#	Statement	Description	1 - Protect Life	2 - Protect Property	3 - Inc Ec Resilience	4 - Protect Env	5 - Enh OR Capability	6 - Evaluate Progress	7 - Info & Ed	8 - Elim Haz Area Dev	9 - Cultural & Hist Res	10 - Agency Coord	11 - NHMP/Comp Plan	# Goals	Coastal Hazards	Drought	Dust Storms	Earthquakes	Floods	Landslides	Tsunamis	Volcanic Hazards	Wildfires	Windstorms	Winter Storms	# Hazards	Funding Source(s)	**REASON** for Removal and Comments
LP-4*	Promote a state disaster and hazard mitigation fund to assist local governments' mitigation and response efforts	The availability of funding to meet immediate emergency needs, including hazard mitigation activities, is a major concern. Federal assistance programs require various matching fund contributions from state and local applicants and are not guaranteed to exist in the future. Legislation has been considered to create such a fund, common to many states, so that financial commitments can be made quickly to support hazard mitigation. The federal Disaster Mitigation Act of 2000 (DMA2K) addresses hazard mitigation planning and projects. This legislation reinforces the importance of mitigation planning, and emphasizes implementing local actions to reduce risk before disasters occur. DMA2K established a federal Pre-Disaster Mitigation (PDM) Program and new requirements for the post-disaster Hazard Mitigation Grant Program (HMGP). Section 322 of DMA2K specifically addresses hazard mitigation planning at the state and local government levels. It identifies new requirements that allow HMGP funds to be used for planning activities, and increases the amount of HMGP funds available to states that have developed a comprehensive, “enhanced” mitigation plan prior to a disaster. States and local governments must have approved hazard mitigation plans in place in order to qualify to receive post-disaster HMGP funds. Mitigation plans must demonstrate that their proposed mitigation measures are based on a sound planning process that accounts for risk and capabilities. Establishing a state fund to assist local governments with hazard mitigation and response efforts would go a long way toward securing and leveraging federal funds.					X							1	X	X	X	X	X	X	X	X	X	X	X	11	State General Funds, other state funds	**DONE.**
LP-5*	Establish a system of special zones, procedures, restrictions, and conditions to limit development in tsunami inundation zones	Decisions on land use planning, siting of improvements, or capital expenditure for public and private infrastructure, critical lifeline facilities and residential, commercial, industrial and other development do not explicitly factor in potential tsunami-related hazards. Some method for factoring in tsunami hazard information is desirable. One possibility among many is implementation of a system of special zones, etc. that would include the means to determine the appropriate level of allowable activities. A thorough discussion of the policy implications of any proposed land use restrictions would need to precede any decisions. Such discussions would need to factor in the probabilities and areas potentially exposed to distant versus local tsunamis, economic and social coasts of any restrictions, and the potential benefits in terms of life and property saved. Any land use restrictions would need to be based on relatively sophisticated information and mapping that would include a determination of hazardous areas for both distant and local tsunami sources, an evaluation of the hazard, an evaluation of the severity, and the level of allowable risk. Detailed mapping for local Cascadia Subduction Zone tsunamis has been completed for six areas (Warrenton/Astoria, Seaside/Gearhart, Lincoln City, Newport, Coos Bay, and Gold Beach). Mapping for a worst case distant tsunami has been completed for Seaside/Gearhart. The adoption might involve amendment of DLCD’s Goal 7.		X	X					X				3							X					1	NOAA, State-DLCD, Local Governments	**REPLACED** by #A and B (Removed), 125 and 126 (Ongoing).

2015 MITIGATION ACTIONS—REMOVED

Action Item			Goal												Hazard												Implementation	
#	Statement	Description	1 - Protect Life	2 - Protect Property	3 - Inc Ec Resilience	4 - Protect Env	5 - Enh OR Capability	6 - Evaluate Progress	7 - Info & Ed	8 - Elim Haz Area Dev	9 - Cultural & Hist Res	10 - Agency Coord	11 - NHMP/Comp Plan	# Goals	Coastal Hazards	Drought	Dust Storms	Earthquakes	Floods	Landslides	Tsunamis	Volcanic Hazards	Wildfires	Windstorms	Winter Storms	# Hazards	Funding Source(s)	**REASON** for Removal and Comments
A (NEW)	Develop tsunami land use guidance for local governments for reducing risk within tsunami inundation zones. The guidance would include model comprehensive plan and code amendments (policies, procedures, incentives, best practices, restrictions, conditions, and a tsunami overlay zone).	The risk of tsunami hazard for Oregon's coastal communities is well-documented with the completion of comprehensive tsunami inundation maps developed by DOGAMI. The State of Oregon can assist affected communities by developing land use guidance for tsunami risk reduction.	X	X			X						X	4								X				1	NOAA, State-DLCD	**DONE.** New Tsunami Guidance completed by DLCD in December 2013.
B (NEW)	Provide the tsunami land use guidance to local governments.	The risk of tsunami hazard for Oregon's coastal communities is well-documented with the completion of comprehensive tsunami inundation maps developed by DOGAMI. The State of Oregon can assist affected communities by providing them with land use guidance for tsunami risk reduction.	X	X			X		X			X	X	6								X				1	NOAA, State-DLCD	**DONE.** New Tsunami Guidance issued by DLCD in January 2014.
LP-6*	Integrate hazard data into planning and regulations	Integrate new high-resolution hazard data into local planning and regulations. Special regulations should be established for proposed new critical facilities and/or infrastructure.	X	X		X			X					4	X			X	X	X	X	X	X			7	N/A	**COVERED** by #18 (Priority).
LP-7	Improve ocean shore and related permit process	Enhance where possible the involvement of key state agencies in the ocean shore permit and related permit processes (local government, U.S. Army Corps of Engineers, etc.).					X							1	X											1	N/A	**NOT A MITIGATION ACTION.**
LP-8 (REVISED)	Develop procedures for escorting vehicular traffic through dust storms	ODOT and OSP both have procedures for escorting traffic under various circumstances. ODOT especially has much experience escorting traffic. It may be possible to develop and implement procedures for escorting traffic through dangerous dust storm conditions.	X											1			X									1	N/A	**UNNECESSARY.** Part of Traffic Incident Management Plan which is all-hazard based.
LP-9	Obtain a secure source of funding for wildfire related use of the Emergency Conflagration Act	Currently, when the Conflagration Act is used to respond to wildfire related events, the funds expended by the Office of State Marshal must either be subsequently appropriated by the Oregon Legislature or be taken from an account available to the Office of State Fire Marshal. In the latter case, the result is that monies are used for a purpose for which it was not intended and other valuable programs and projects are negatively impacted. Under this action item, the Office of State Fire Marshal will work with the Oregon Legislature to identify and fund a secure source of funding that will pay the expenses incurred in the use of the Emergency Conflagration Act. Currently, within the budget process, the OSFM has identified the need to have funds held aside for responses.					X							1									X			1	N/A	**NOT A MITIGATION ACTION.**

2015 MITIGATION ACTIONS—REMOVED

Action Item			Goal												Hazard												Implementation	
#	Statement	Description	1 - Protect Life	2 - Protect Property	3 - Inc Ec Resilience	4 - Protect Env	5 - Enh OR Capability	6 - Evaluate Progress	7 - Info & Ed	8 - Elim Haz Area Dev	9 - Cultural & Hist Res	10 - Agency Coord	11 - NHMP/Comp Plan	# Goals	Coastal Hazards	Drought	Dust Storms	Earthquakes	Floods	Landslides	Tsunamis	Volcanic Hazards	Wildfires	Windstorms	Winter Storms	# Hazards	Funding Source(s)	**REASON** for Removal and Comments
LP-11	Work toward the floodplain management goals outlined in the Willamette River Legacy Program	The Governor's office has established a Willamette River initiative that lays out various goals for repairing water quality, restoring habitats, and supporting recreational opportunities. Several proposed actions would support sound floodplain management in the river basin. This includes a proposed action to protect existing functioning floodplains and reconnect historic floodplains, with a target of reconnecting 200 acres per year, 1,000 acres by 2010 focusing on tributary confluence areas between Eugene and Salem. Projected benefits of this action include reduced stream temperature, less severe flooding downstream, improved water quality, improved habitat, and increased natural storage of water. The Governor's office has identified potential funding sources as OWEB grants, CREP enrollments, 319 Grants (watershed restoration), Restoration and Enhancement Grants, Wetlands Reserve Program (WRP) and WREP, TNC utility customer salmon habitat grants, and BPA habitat compensation funds.				X								1					X							1	State-ODFW	**DONE.**
LP-13	Seek funding for the installation and operation of additional stream gages	The availability of timely and accurate telemetered data from stream gauges is essential for flood forecasting, for prediction of imminent flood hazards, and for response to flood emergencies. Stream gauging data also provide basic hydrologic information for floodplain mapping and watershed management by communities throughout the state. Numerous agencies of the federal government need data from stream gauges for effective management of projects and resources; therefore the installation and maintenance of stream gauges has traditionally been a responsibility of the federal government. State agencies plan to work with their federal counterparts to ensure adequate funding and support for existing gauges and for the installation of new gauging sites where required. It is recommended that state agencies endeavor to leverage federal funding with state resources and local matching commitments to achieve a reliable network of stream gauges around the state.	X	X			X							3		X			X							2	State-2013 Legislature provided funding for 1.75 FTE and 16 additional stream gages.	**DONE.**
LP-14	Seek funding to enhance capacity of state floodplain management program to better support implementation of the NFIP and higher regulatory standards.	DLCD and OEM provide various services to FEMA Region 10, local governments, other governmental agencies, and the general public in support of implementation of the NFIP in Oregon. While coordination and cooperation and pursuit of various federal funding opportunities have allowed the state to temporarily enhance the services provided in some areas, neither DLCD nor OEM have been able to secure funding to permanently enhance the work capacity of the two agencies. FEMA funding is supporting a permanent position focused on Risk MAP. The agencies could more fully serve the needs of local floodplain management programs and the citizens of Oregon if additional resources could be secured.	X	X	X		X							4					X							1	N/A	**NOT A MITIGATION ACTION.**
LP-18	Establish a method for verifying the adequacy of geotechnical site reports on an as-needed basis	Independent peer review by qualified and registered geotechnical professionals is one of the best methods of ensuring that site reports done for local governments, property owners, developers, and others are of an acceptable quality and adequately address landslide issues. It is recommended that peer review processes throughout the state be strengthened so landslide hazards are minimized.		X			X							2						X						1	N/A	**LOCAL LEVEL ACTIVITY.**

2015 MITIGATION ACTIONS—REMOVED

Action Item			Goal												Hazard												Implementation	
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C (NEW)	Initiate a Community Rating System (CRS) Users' Group Program for Oregon.	Communities in Oregon that participate in the NFIP's CRS Program lack a way to network with and learn from other CRS communities in the state. Users' groups would provide such a forum. The groups would be open to communities already participating in the CRS Program and to others interested in floodplain best management practices. The state anticipates that the CRS Users' Groups will facilitate and strengthen participation in the CRS Program, resulting in greater protection from flood damage at lower cost to property owners.	X	X	X	X	X		X	X		X	X	9					X								FEMA, CAP-SSSE	**DONE.** Two CRS Users' Groups (northern and southern Oregon) initiated in 2014.
EO-3*	Assist communities to adopt risk reduction techniques and ordinances	Techniques can involve requiring geological or geotechnical studies for new development, stormwater control for neighborhoods on slopes, strict land use ordinances for active landslides, working with infrastructure operators to increase reliability of services after storms, and more.	X	X	X				X					4						X						1	N/A	**COVERED** by #5, 11, 12, 20 (Priority), and others.
EO-4*	Encourage Oregon coastal communities to enroll in the NFIP's Community Rating System (CRS) which includes tsunami standards.	The CRS, included in the National Flood Insurance Program, is a FEMA program that provides incentives to communities to mitigate flood disasters. By enrolling in the CRS, communities, through specific actions, receive points that go toward a reduction in insurance rates. Tsunami actions are included in the CRS and have recently been revised by FEMA in conjunction with the Insurance Services Office (ISO). Contact DLCD, OEM, or FEMA for information about the CRS tsunami program.		X	X		X		X					4					X							1	N/A	**COVERED** by #20 and 29 (Priority).
EO-5	Improve hazard mitigation technical assistance for local governments and infrastructure operators	A DLCD-led review of the implementation of statewide planning Goal 7 resulted in the identification of several needs to strengthen local hazard mitigation efforts. These included providing current hazard information and technical assistance to local governments, improving communications between local governments and state agencies with respect to natural hazards, and providing hazard mitigation training.An ongoing need to provide technical assistance to local governments exists, and the State IHMT continues to look for ways to bridge the gaps between local planning, building, and emergency management programs, and between the local and state levels.Despite this recognition, implementation of such activities is difficult to fund and institutionalize. Through the Oregon Partnership for Disaster Resilience (OPDR) these issues have been addressed since 1999. OPDR has offered measurable outcomes on how increased communication, coordination, and collaboration between diverse partners (public and private) can assist the state and communities in reducing their risk and exposure to natural hazards.Various State IHMT partners will continue to look for opportunities to provide technical assistance in a manner that encourages coordination among various local programs and informs communities of assistance available. The State IHMT also continues to seek stable non-federal funding for OPDR.The State IHMT will endeavor to ensure that technical assistance materials provided by DLCD, OEM, DOGAMI, BCD, OPDR, PUC and other agencies support local officials' and infrastructure operator's understanding and use of hazard and risk information.					X		X					2	X	X	X	X	X	X	X	X	X	X	X	11	N/A	**COVERED** by #1, 17, 66 (Priority); 106 and 107 (Ongoing); and others.

2015 MITIGATION ACTIONS—REMOVED

Action Item			Goal												Hazard												Implementation	
#	Statement	Description	1 - Protect Life	2 - Protect Property	3 - Inc Ec Resilience	4 - Protect Env	5 - Enh OR Capability	6 - Evaluate Progress	7 - Info & Ed	8 - Elim Haz Area Dev	9 - Cultural & Hist Res	10 - Agency Coord	11 - NHMP/Comp Plan	# Goals	Coastal Hazards	Drought	Dust Storms	Earthquakes	Floods	Landslides	Tsunamis	Volcanic Hazards	Wildfires	Windstorms	Winter Storms	# Hazards	Funding Source(s)	**REASON** for Removal and Comments
EO-6	Develop and distribute local hazard mitigation planning guidance; provide plan development support	The Oregon Partnership for Disaster Resilience (OPDR) assists communities in developing and implementing local risk reduction plans and projects. Funding for planning-related activities comes from the Pre-Disaster Mitigation Grant Program, and 2012 marks the ninth year of regional planning efforts aimed at developing multi-jurisdictional natural hazards mitigation plans. As a direct result of OPDR activities, the majority of Oregon's counties maintain FEMA-approved natural hazards mitigation plans. On October 1, 2012, new FEMA local plan review procedures will be fully phased-in, and this will require outreach and training on a state-wide basis. In conjunction with PDM plan development assistance, OPDR develops and implements training programs that benefit communities, agencies, and partners in natural hazards risk reduction. For communities developing hazard mitigation plans, OPDR develops and facilitates a series of quarterly plan development workshops. The series includes workshops on developing planning processes; involving stakeholders and conducting public outreach; mapping community assets and assessing local risks and vulnerabilities; developing goals and action items; and developing strategies for plan implementation and maintenance. OPDR also hosts a two-part plan update training series and business continuity trainings. In addition to the trainings, OPDR provides communities with support, tools, and resources necessary to develop and/or update their natural hazards mitigation plans. Communities developing natural hazards mitigation plans receive a Pre-Disaster Mitigation Community Training Manual. The Training Manual offers technical information and resources to assist communities in the development of local mitigation plans, and is used in conjunction with OPDR's four-part work session series. Both the work sessions and manual synthesize the approaches developed by OPDR for Disaster Resilience, state and federal agencies, and other organizations to assist communities in developing natural hazards mitigation plans. OPDR has also created an addendum to the Training Manual to assist communities in the plan update process. OPDR plays an instrumental role in the packaging and distribution of scientific and technical knowledge. Based on information provided by State IHMT and OPDR members/agencies, OPDR develops and distributes regional profiles and risk assessments to local communities. The regional reports are part of the State's Enhanced Natural Hazards Mitigation Plan, and they also serve as regional resources for local planning initiatives. The regional profiles and risk assessments are maintained and updated in accordance with the State's Plan implementation and maintenance schedule. As such, the reports include and disseminate the most recent scientific and technical knowledge available at the time. Likewise, communities are encouraged to update the regional profiles and risk assessments with local data, as available. Additionally, OPDR's website hosts a number of useful resources for communities developing and/or updating natural hazards mitigation plans, including the searchable natural hazard mitigation action item database. The		X			X		X					3	X	X	X	X	X	X	X	X	X	X	X	11	N/A	**REPLACED** by #46 and 50 (Priority), 83, 84, and 85 (Ongoing).

2015 MITIGATION ACTIONS—REMOVED

Action Item			Goal												Hazard												Implementation	
#	Statement	Description	1 - Protect Life	2 - Protect Property	3 - Inc Ec Resilience	4 - Protect Env	5 - Enh OR Capability	6 - Evaluate Progress	7 - Info & Ed	8 - Elim Haz Area Dev	9 - Cultural & Hist Res	10 - Agency Coord	11 - NHMP/Comp Plan	# Goals	Coastal Hazards	Drought	Dust Storms	Earthquakes	Floods	Landslides	Tsunamis	Volcanic Hazards	Wildfires	Windstorms	Winter Storms	# Hazards	Funding Source(s)	**REASON** for Removal and Comments
		database includes action items from plans developed as part of the Pre-Disaster Mitigation Planning Grants covering the Mid/Southern Willamette Valley, Mid-Columbia, Southeast Oregon, Northeast Oregon, and Oregon Coast regional planning initiatives. Eventually, this database will host the action items from all local plans. Additional online resources include the state's enhanced natural hazards mitigation plan, links to regional planning initiatives, technical memos, links to state agencies' websites, and hazard-specific resources.																										
EO-8	Develop tsunami hazard and evacuation maps	Tsunami run-up areas and evacuation maps continue to be developed in conjunction with local governments. Tsunamis can dramatically affect coastal erosion and must be taken into account in planning activities.	X						X					2							X					1	**NOAA**	**DONE.**
EO-14 (REVISED)	Develop protocols for improving communication of hazardous blowing dust conditions between public safety answering points, ODOT, OSP, and local law enforcement agencies.	Community Solutions Team (CST) meetings in the Mid-Columbia Region of Oregon during the spring of 2000 identified that better communication between public safety answering points (PSAPs) about the existence and likely direction of travel of dust storms might have provided additional warning time for ODOT, OSP, and local law enforcement to stop travel on downwind highways likely to be affected. Protocols should be developed and training provided should be considered that would result in PSAPs relaying information, as appropriate, to ODOT, OSP, local law enforcement, and the downwind neighboring PSAP regarding reports of dust storms headed in a particular direction. This may provide additional time for ODOT and law enforcement agencies to briefly close stretches of highways in the path of the storm and/or for reader boards and other advisory systems to be activated with information. There are a number of issues and factors that would need to be addressed in determining the feasibility of developing protocols and training on them: ▪ Staffing/Costs — Some PSAPs do not have more than one or two people per shift on duty; when events such as dust storms happen, personnel sometimes find it difficult to keep-up with existing, ongoing protocols. ▪ Feasibility — If the only information PSAPs have is based on what they are told by callers or mobile police/fire units via radio, will they know enough about the direction of travel of the dust storm to issue reliable information? ▪ Technology — Is new technology needed to accomplish the task contemplated? 4 Liability — Would adding such protocols unnecessarily contribute to potential liability for PSAPs? Work with APCO/NENA — and especially local PSAPs in dust storm prone areas — to develop and train on communication protocols for dust storms.	X	X					X			X		4			X									1	N/A	**UNNECESSARY.** Existing protocols for hazardous weather traffic management are sufficient to use for dust conditions.

2015 MITIGATION ACTIONS—REMOVED

Action Item			Goal												Hazard												Implementation	
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EO-16	Provide additional information to the traveling public about dust storm driving safety	Among the ideas generated by the Community Solutions Team meetings in the spring of 2000 was to provide additional public education outreach in dust storm prone areas of the state, especially Morrow and Umatilla counties. Among the ideas were the following: (a) Provide dust storm driving information in safety rest area kiosks. (b) Develop, print, and distribute "table cards" to area restaurants and truck stops, providing information on driving when visibility is reduced (dust storms, fog, smoke, etc.), perhaps making similar information available at DMV offices. (c) Develop and distribute PSAs on the topic of driving in dust storm conditions to radio stations; stations would be encouraged to run these during peak periods when there is a strong possibility of high winds and blowing dust (Tri-Cities radio stations should be included). Determine the merit of these ideas and implement those that are likely to result in a better-informed traveling public, thereby increasing safety on Oregon's highways.	X						X					2			X									1	N/A	**COVERED** by #95 (Ongoing).
EO-18	Promote agricultural practices that are known to reduce erosion of soil by wind, thereby reducing the frequency and magnitude of dust storms	It is clear that certain agricultural practices reduce the frequency and amount of blowing dust, as well as reduce wind-caused soil erosion. Oregon Department of Agriculture should continue to work with farmers, agricultural associations, and soil and water conservation districts to further promote and implement (a) residue management, including no-till or direct seed farming; (b) cover crops and other BMPs (see below); (c) field strip cropping systems; and (d) landscape buffers/windbreaks. The most commonly used practice for both wind and water erosion control is residue management. This involves leaving some or all of the residue from the previous crop on the soil surface to provide cover and surface roughness to provide protection against erosion. Residue management involves tillage practices that do not turn the soil over thus burying the residue. Reduced tillage, minimum tillage, no-till, mulch till, and conservation tillage are all terms used to describe the various methods used to accomplish residue management. Other "best management practices" (BMPs) used in wind erosion prone areas include cover crops, annual or continuous cropping, and crop rotations. On irrigated land, a common practice is to irrigate soon after tillage to form a crust on the soil that reduces the potential for wind erosion. Field strip cropping systems can reduce exposed surface area by up to 50% on each field. Landscape buffers/windbreaks are likely the most expensive alternative because a series of properly spaced tree and shrub windbreaks requires the purchase of trees/shrubs and, because the trees/scrubs would likely need irrigation, some infrastructure development and maintenance costs. Additionally, to be effective, it needs to be done as a system, involving multiple ownerships. The Coordinated Resource Management System approach might be used to obtain cooperation and achieve coordinated implementation. The Columbia Plateau Wind Erosion/Air Quality Project, also known as the Columbia Plateau PM_{10} Project, has conducted years of research and has produced many fine publications. The latest report, *Farming with the Wind II* (Special Report XB1042) was released in Feb. 2004. For more information, see: http://pnw-winderosion.wsu.edu				X								1			X									1	State-ODA	**DONE.**

2015 MITIGATION ACTIONS—REMOVED

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EO-21	Provide information to local governments regarding adoption of programs and model ordinances for mitigation of existing, hazardous, unsecured buildings elements, such as parapets	Some common building features subject to earthquake damage and corresponding safety hazards include parapets, awnings, signs, decorative features, and masonry moldings. BCD has adopted the International Building Code (IEBC) as an alternate method, which was amended to support Portland's local ordinances on seismic design requirements for existing buildings. Local governments that wish to adopt hazard mitigation standards for existing buildings as permitted by ORS 455.020(4) should follow the City of Portland's local ordinance (Chapter 24.85 Seismic Design Requirements for Existing Buildings).	X	X	X				X					4				X								1	N/A	**NO AUTHORITY.** Not allowed under current law.
EO-23	Identify an Oregon institution to host the Advanced National Seismic System (ANSS) Interpretive Center in Oregon	The August 2001 implementation plan for the ANSS Pacific Northwest Region identifies a need for an institution in Oregon to interpret ANSS Oregon earthquake data and information products for users ranging from emergency managers and news media to research scientists. This project is, in part, a USGS effort mandated by Congress, which involves the purchase, installation, monitoring, and maintenance of strong motion seismographs.					X		X					2				X								1	N/A	**NOT BEING PURSUED.**
EO-24	Continue to improve the communication of historical information on stream flows during past El Niño and La Niña years to water managers throughout Oregon; historical data provides the earliest clue on where flooding may occur or where there could be water shortages.	Stream flow data from past El Niño and La Niña years can provide clues as to where the state is more likely than during an "average" year to experience water shortages or flooding. This information should be better communicated to water managers, floodplain managers, emergency managers, and others with an interest in stream flows. The apparent association of ENSO signals and stream flows shows up only in some basins and some years and thus cannot be relied on with certainty. A forecast based only on ENSO signals may be overly simplified, or in some cases, misleading. (For example) the SOI variable is significant in both the Wilson and Trask rivers but the La Niña variable is not significant in these two basins. Neither variable is significant in the Siletz (which has 60-plus years of record). Although (there is) a potential role for ENSO signals in flood planning, relevance will depend in part on the physical characteristics of individual watersheds and on the particular flow metrics of interest to floodplain managers. An apparently strong ENSO signal in a particular region may be of little use for some individual catchments in the region other factors can play major roles in whether a high flow results in a flood event. Along Oregon's coast, for example, floods in some smaller rivers that empty into bays often are caused by storm surges and high tides in concert with heavy precipitation. These surges and tides pile-up bay water and decrease the rate at which stream flows can be discharged to the open sea.	X	X					X					3					X							1	N/A	**NOT A MITIGATION ACTION.**
EO-25	Facilitate additional training on seismic design of structures and requirements of the State Building Code relating to hazard mitigation.	Facilitate the development of training courses for individuals involved in earthquake hazard mitigation and building design, construction, and inspection. Focus on audiences that include architects, engineers, contractors and code enforcement personnel. The workshops will also provide a forum for instruction on construction and retrofitting techniques to increase the seismic resistance of existing buildings.							X					1				X								1	N/A	**NO AUTHORITY.**

2015 MITIGATION ACTIONS—REMOVED

Action Item			Goal												Hazard												Implementation	
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EO-26	Draft model intergovernmental agreements to establish clear definitions of assistance and authority across jurisdictional lines or when state or federal resources are needed.	Create a model mutual aid agreement to be used by state and local governments when providing assistance across jurisdiction lines. Establish additional clear guidelines when local jurisdictions need additional state, federal, or special resources.	X	X										2	X	X	X	X	X	X	X	X	X	X	X	11	N/A	**NOT A MITIGATION ACTION.**
EO-30	Expand the Firewise Communities/NFPA program in Oregon	The national Firewise Communities/USA recognition program promotes a self-help approach by which local communities can improve their level of protection from wildfires. Within a community, the program is started when a fire service professional provides information about how the community can successfully coexist with wildfires, explains basic fire mitigation measures, and helps to complete a community assessment of their situation. The community then uses this information to develop and carry out a mitigation plan which is tailored to its unique location and situation. Currently, several of Oregon's communities have participated in the program. More will be encouraged to do so.	X	X	X	X			X					4									X			1	N/A	**COVERED** by #137 (Ongoing).
EO-31	Encourage increased commercial utilization of biomass materials from wildland-urban interface areas	For a variety of reasons, vegetative fuels in and adjacent to wildland-urban interface (WUI) areas are accumulating at historically high rates. The ability to properly, cost effectively, or ecologically dispose of such fuels, as a part of a comprehensive mitigation strategy, is often limited and may even be nonexistent in some locales. One way to address this problem is to encourage increased commercial utilization of biomass materials which are created by mitigation activities in WUI areas, such as by burning to create steam and electricity (co-generation). The development of the infrastructure to support such utilization requires significant marketing and investment. Under this action item, the desirability of entering such markets will be promoted to potential developers and investors.				X			X					2									X			1	N/A	**NOT BEING PURSUED.**
EO-32 (REVISED)	Continue Oregon's annual Wildfire Awareness Week campaign	Creating public awareness of the need to consider and to apply wildfire mitigation actions, such as hazardous fuels removal, on privately owned lands is one of the keys to the successful implementation of a comprehensive wildfire awareness program. In recent years, the states of Oregon and Washington have jointly conducted an annual wildfire awareness campaign, early in the spring. Under this action item, Oregon will devote more time, energy, and money to designing and conducting an annual wildfire awareness week campaign. The goal will be to make residents more aware of the wildfire risks they face and how they can help reduce that risk.	X	X	X	X			X					5									X			1	N/A	**COVERED** by #137 (Ongoing).

2015 MITIGATION ACTIONS—REMOVED

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EO-35	Floodplain Management Outreach	DLCD has an active floodplain and natural hazards outreach program. The department publishes and distributes newsletters and other outreach information to local governments and other interested parties. DLCD also maintains a website which includes a link to this NHMP. The natural hazards website (http://www.oregon.gov/LCD/HAZ/index.shtml) contains information and links to floodplain management information including many of the documents and booklets prepared by FEMA. DLCD uses an email distribution service for its Natural Hazard Newsletter and other correspondence. The email distribution service affords interested subscribers a greater opportunity to obtain flood management and natural hazards information from DLCD in a timely manner and for DLCD to more readily share information from a variety of sources. DLCD and other State IHMT participants also conduct or sponsor training sessions and meetings throughout the year focused on up-to-date floodplain management practices and projects. DLCD will continue to deliver focused training to surveyors, building officials, real estate agents and planners as well as local floodplain managers. The interdependent relationships among these key players in providing comprehensive floodplain management will also be highlighted during trainings.In addition to the on-going activities mentioned, DLCD will add the following to its outreach program. DLCD will prepare text for local broadcast two Public Service Announcements (PSAs) each year on a seasonal topic. DLCD will also complete and disseminate the Floodplain Management Administrative Procedures Guidebook to all 270 Oregon communities participating in the NFIP. This guidebook clarifies roles, responsibilities and actions to be taken by local communities. It will also be used during NFIP trainings given to local officials.	X	X	X		X	X	X					6					5							1	N/A	**REPLACED** by #117, 118, 119 (Ongoing), and D (Removed).
D (From EO-35)	DLCD will also disseminate the Floodplain Management Administrative Procedures Guidebook to all 270 OR communities participating in the NFIP.	This guidebook clarifies roles, responsibilities and actions to be taken by local communities. It will also be used during NFIP trainings given to local officials.	X	X	X		X	X	X			X		7					5							1	FEMA-CAP-SSSE	**DONE.**

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EO-36	Develop effective means and information to minimize erosion of soils and stream banks during flood events of varying magnitude	Several State IHMT Reports call attention to the need to systematically develop means and information to help minimize the effects of erosion from farmlands, stream embankments, slide areas, farm roads, and other locales. There is a need to promote effective erosion control techniques, including bioengineering of stream banks and planting of riparian vegetation, to help preserve soils, riparian zones, and habitats. Evaluate and use post-disaster funding opportunities (such as the Hazard Mitigation Grant Program) to study the efficacy of natural, bioengineering stream bank protection strategies. Potential projects could be the outcome of these studies and proposed treatments that demonstrate cost-effective solutions. DSL is the state agency responsible for issuing the required permits for instream work, and those required to build or repair a levee. DEQ is also involved in the permitting process with help from ODFW, USACE, and the NRCS. DEQ often requires bioengineering in conjunction with the issuance of a permit. DEQ is also responsible for setting water quality standards. ODFW is involved with riparian planting and restoration projects. Various state agencies have opportunities to participate in riparian protection or erosion prevention programs, and those efforts, when taken collectively, should help the state make progress with this action.				X			X					2					X							1	State-DSL	**DONE.**
EO-38	Complete an evacuation mapping GIS database	With funding from the National Tsunami Hazard Mitigation Program all existing evacuation maps are being entered into a GIS database. Data collected for future maps will also be entered into the database. This will provide not only a centralized location for all the evacuation maps but the ability to make maps and permanent signs with a similar format for all coastal areas. The long-term objective is to empower users to make their own evacuation maps through an interactive web site that allows placement of the evacuation zone on a variety of base maps at any scale desired.	X						X					2							X					1	NOAA-NTHMP	**DONE.**

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EO-40	Public information and education about tsunami preparedness and mitigation	Each year more people visit or move to the coast. There is thus a constant need for public education: what are the tsunami hazards, what to do in the event of a tsunami, and how to mitigate tsunami hazards. This is especially important in light of the problems some coastal counties had during the Nisqually Earthquake in Washington that was felt on the Oregon Coast and the Peru earthquake and tsunami where the Oregon Coast was twice in a tsunami watch.A systematic study of what educational strategies work the best was accomplished in a NTHMP-supported pilot study of Seaside, Oregon (see DOGAMI Open File Report O-05-10). According to polls conducted for this study, door-to-door outreach and evacuation drills were the most effective techniques. As demonstrated in the Seaside study, tsunami evacuation drills help people respond quickly and efficiently to a tsunami warning and generate local media attention to the issue. This is particularly important if a major earthquake is expected to trigger a near-source-generated tsunami. Tsunami surges may arrive within just a few minutes, so it is imperative for people to instinctively know where to evacuate to immediately after the shaking stops. Community Emergency Response Teams (CERT) are an effective means of doing door-to-door outreach and organizing evacuation drills. The long-term objective is to implement CERT in every coastal community.The Seaside format was used in Lincoln City to great success, showing the usefulness of the methods. Leveraging the various volunteers, such as CERT and Neighborhood Watch, is one of the most effective uses of scarce resources.As a result of post-disaster mitigation funding (HMGP) from DR-1964, there will be potential project opportunities to evaluate and demonstrate effective mitigation techniques that identify natural, high ground locations outside of the tsunami inundation zone as safe havens for evacuation.	X	X	X		X		X					5							X					1	N/A	**REPLACED** by #128, 129, and 130 (Ongoing).
EO-41	Coordinate an Oregon-specific distant tsunami warning workshop	The Oregon Distant Tsunami Working Group (ODTWG) is a partnership between Federal, State and Local agency representatives; local business partners and community members designed to reduce the impact of distant tsunamis on coastal Oregon communities. Led by the Oregon Office of Emergency Management (OEM), the ODTWG is Oregon's community-focused program to improve tsunami mitigation and preparedness of at-risk areas within Oregon. One goal of the Working Group will be to look at how response to a distant tsunami could be applied in the case of a local tsunami. The ODTWG includes Counties, Cities, the Oregon Office of Emergency Management, the National Weather Service, the Federal Management Agency, the Oregon Department of Geology and Mineral Industries, Media representatives and community members. This strong and active partnership enables all levels of government to work toward the common goal of saving lives of all people at risk for a tsunami at our state's coastline, and reducing damage to property and the economy.							X					1							X					1	NOAA, State-OEM	**DONE.**

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EO-42	Develop tsunami evacuation maps for all affected communities with established assembly areas	The key to effective tsunami mitigation is to insure that people know what to do and where to go in the event of a tsunami. Evacuation maps that are consistent and easy to read and that identify the safe areas, best evacuation routes and destination sites are critical. With the development of the GIS database the maps can be easily disseminated.	X						X					2							X					1	NOAA, State-DOGAMI, OEM	**DONE.**
EO-44 (REVISED)	Install tsunami signs in all affected coastal communities	Signs reinforce the evacuation maps and tsunami educational materials and are a very visible reminder of the tsunami hazard, where the hazard zone is and where the best evacuation routes are. A few communities have already installed hazard zone and evacuation route signs. Many counties have signs, but are waiting either for the time and/or money or development of evacuation maps before installing them. Robust signage that delineates evacuation routes leading to natural, high ground outside of the tsunami inundation zone is a low-cost, top mitigation priority.	X											1							X					1	**N/A**	**REPLACED** by #132, 133, and 134 (Ongoing).
EO-45	Encourage local emergency managers with potential volcanic hazards to include volcanoes in their response and natural hazards mitigation plans	State and local emergency managers plan responses for a variety of hazards, including volcanoes. Clackamas County, which includes the southwest portion of Mount Hood, was the first jurisdiction in the nation to complete a FEMA-approved natural hazards mitigation plan, which includes short and long-term proposed actions to mitigate the effects of volcanic eruptions. Local response plan chapters (annexes) developed for volcanic hazards should include pre-eruption through post-eruption sections.					X		X					2								X				1	N/A	**LOCAL ACTIVITY.** NHMP requirement for affected local governments.

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EO-47	Encourage communities to include volcano hazards, if appropriate, in their multi-hazard mitigation planning process	How a community might respond to volcano hazards depends on a number of things including proximity of the community to the volcano, the nature of the volcano hazards, local volcano history, what is at risk/vulnerable to volcano hazards, and the probability of when or if an event might occur.The difficulty in predicting how catastrophic volcano-associated hazards might be and how often they might occur creates a problem for land use planning solutions. Except for a few Oregon communities on or very near a volcano (e.g., Government Camp on Mount Hood), stringent standards solely based on the prospect of volcanic activity are not realistic. The best approach may be multi-hazards instead of treating volcano-associated hazards separately. A multi-hazard approach would take all natural hazards into consideration during a community's planning process. For example, prohibiting development in the 100-year (1%) floodplain ensures some degree of safety from flood, lahars, earthquake damage (e.g., liquefiable soils), and so on, while preserving the floodplain for natural and beneficial uses. In addition, siting standards for infrastructure and/or critical facilities would include volcano-associated hazards among other hazards to be avoided. DOGAMI published two special papers to help communities look at multi-hazard mitigation: Special Paper 31, Mitigating Geologic Hazards in Oregon: a Technical Reference Manual (Beaulieu and Olmstead, 1999a) and Special Paper 32, Geologic Hazards: Reducing Oregon's Losses (Beaulieu and Olmstead, 1999b). These publications have been widely distributed to local governments. Secondary effects also need to be incorporated into the multi-hazard framework. These effects include degradation or loss of habitat for endangered species (or species that may become endangered after a major eruption), the economic loss if timber resources are destroyed or made inaccessible, and the loss of surface water as a source of drinking water, irrigation, or for industrial needs. Each of these can have a long-lasting economic effect on Oregonians as well as create physical changes in the landscape made by an eruption.	X	X			X		X					4								X				1	N/A	**LOCAL ACTIVITY.** NHMP requirement for affected local governments.
EO-53 (REVISED)	Educate citizens about ways to weatherize their homes.	Weatherization measures can help keep the cold out during winter. Energy audits, cash rebates, and tax credits are available to help homeowners. Energy audits, cash rebates, and education are also provided by the Energy Trust of Oregon to customers of the regulated energy utilities with oversight by the OPUC.	X	X					X			X		4											X	1	FEMA, Local Governments	**COVERED** by #41 (Priority).
EO-54	Educate citizens about the dangers of hypothermia and other winter health conditions.	State agencies should work with the American Red Cross and local health authorities to educate citizens about the dangers of winter health conditions, including hypothermia, exhaustion, and heart attacks caused by overexertion.	X	X					X			X		4											X	1	N/A	**NOT A MITIGATION ACTION.**
EO-56	Educate motorists who plan to travel over mountain passes in winter about the need to be prepared	During the December 2003 closure of the Siskiyou Pass on I-5, ODOT and Oregon State Police freed many drivers only to have them spin out and get stuck again. If drivers would have had tire chains, and installed them when conditions warranted, clearing the pass would have been completed hours earlier. Many drivers were not prepared for a long wait in their car. Each year ODOT finds stranded motorists who either do not have or do not know how to install chains.	X						X					2											X	1	N/A	**COVERED** by #149 (Ongoing).

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EO-57 (REVISED)	Improve geotechnical report standards for the coast.	Numerous local jurisdictions have upgraded the geotechnical report standards for assessing the risk and mitigation measures for development proposed in coastal hazard area.	X	X			X		X			X	X	6	X					X						2	Professional Fees	**DONE.**
EO-59	Improve coastal erosion hazard mapping and inventories	Coastal hazard mapping is a long-term program for four reasons. One is budgetary. It is expensive to research and map information for such a dynamic system. Another reason is the dynamic nature of the Oregon coast. Beaches, dunes, and headlands change over relatively short (and longer) time spans. As headlands recede, for example, new maps with new shorelines and erosion rates need to be developed. New technology is the third reason. For example, the tsunami maps issued by DOGAMI are created with the help of sophisticated computer models and high resolution digital elevation models that were not available until a few years ago. Finally, different uses require maps of different scales. Mapping is one element needed in an inventory. Progress is being made by DOGAMI and DLCD to increase assistance to local governments in developing inventories based on sound technological research (Figure CE-6). While this process takes significant time to complete, there are a variety of strategies local governments and state agencies can use: • Inventory and catalog existing coastal natural hazards, studies, maps, digital data, and other information available from city, county, state, federal, university, private, and other resources. • Establish criteria and standards for collecting, reporting, and mapping information about chronic and catastrophic coastal natural hazards. • Develop standardized, detailed coastal hazard maps for priority areas along the Oregon Coast.	X	X			X		X					4	X				X	X						3	NOAA, State General Funds - DOGAMI, and Local Governments	**DONE.** Detailed coastal hazard mapping has been done for Tillamook, Lincoln, and Clatsop Counties, and the portion of Curry County from Gold Beach to Nesika Beach.
EO-60 (REVISED)	Better understand beach processes by developing a coastal geomorphic database.	Develop a coastal geomorphic database that describes the various morphological parameters of beaches, dunes, and bluffs present along the central to northern Oregon coast, specifically in Clatsop and Tillamook Counties.	X	X		X				X				4	X											1	NOAA 309	**DONE.**
EO-61	Mandate review for site-specific seismic hazard reports	Independent peer review by qualified and registered geotechnical and engineering geologic professionals is one of the best methods of ensuring that site reports done for local governments, property owners, developers, and others are of an acceptable quality and adequately address site issues associated with earthquake faults and earthquake-caused ground failures. A mandatory review requirement and funding/cost recovery mechanism are needed.		X			X		X					3				X								1	N/A	**LOCAL ACTIVITY.**

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EO-62	Install new Entering and Leaving Tsunami Hazard Zone signs in selected areas in the inundation zone along US-101.	Existing tsunami hazard zones signs are considered inadequate for placement along stretches of US-101, or on any roads, that are within the tsunami hazard zone. A single tsunami hazard zone sign will not indicate the boundaries of the inundation zone. US-101 often stays within the inundation zone for miles. Therefore ODOT, in collaboration with OEM, DOGAMI, and the coastal county emergency managers, designed the template for Entering and Leaving Tsunami Hazard Zone signs and placed the signs to identify the hazard zones. Resources for this project were limited, so signs are not present in every hazardous part of the coast highway system. A long-term goal is to complete this project and to reposition signs where new inundation mapping indicates a need. There is need for increased public education program to let the public, including motorists who are not local residents, know what the signs mean and what actions they should take. Additional/improved signage is proposed to reflect changes in maps by 2015.	X											1							X					1	N/A	**REPLACED** by #132, 133, and 134 (Ongoing).
E (NEW)	Refine coastal erosion risk mapping for Tillamook County and its cities to use a fully probabilistic approach.	Revise coastal erosion risk mapping and analysis for Tillamook County, and cities within the County, to use a fully probabilistic approach. Probabilistic modeling approaches will be used to better address uncertainty and allow local and state hazard managers to use the information to better manage uses based on relative risks. This will allow DLCD and DOGAMI to increase assistance to local governments in developing inventories based on sound technological research and in incorporating this information into their coastal management programs.	X	X					X	X		X		5	X											1	NOAA, State-DOGAMI	**DONE.**
F (NEW)	Establish Base Flood Elevation Determination Service	Establish state-approved service to provide Base Flood Elevations to surveyors for the purpose of completing Letters of Map Amendment under the National Flood Insurance Program. Base Flood Elevations are determined by DOGAMI by producing hydraulic models based on lidar topographic data. This is useful in areas where Base Flood Elevations have not been determined by FEMA, though Special Flood Hazard Areas have been mapped.	X	X			X					X		4					X							1	State- DOGAMI	**DONE.**

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CI-1*	Complete a statewide evaluation of the condition of levees, dikes, and dams built for flood control purposes	Several reports indicate a broad need to assess the capabilities, conditions, and maintenance of levees statewide to assess performance under flood conditions. As part of the FIRM modernization program, FEMA identified 12 levees in Oregon that are mapped as providing protection against flood waters, but may in fact be deficient. FEMA asked affected communities to complete an accreditation process to prove the levees are capable of controlling the 1% annual flood before they can be shown as providing protection against the 1% annual flood on the FIRM. Five communities managed to complete the accreditation The levees identified by FEMA by no means reflect the full inventory of levees in the state that provide flood protection, but which may be insufficiently or improperly maintained. Many of these levees are privately owned. One of the challenges identified during FEMA accreditation process was confusion over what kind of vegetation is appropriate to allow on levees and how it should be maintained. This is not a new concern. DEQ, ODFW, USACE, and other agencies have been discussing development of a guidance document on preferred levee types and appropriate use of vegetation. At a minimum, the federal agencies NRCS and USACE should be involved with the state agencies noted below in implementing this action item. Dams present another challenge. Regardless of whether a particular dam was designed and built for flood control, the presence of any large dam will serve to reduce the peak flow in the downstream river channel to some degree. Typically, the larger the structure, the greater the corresponding effects of reservoir flood routing and the greater the perceived reduction in short-term or periodic flooding. In Oregon, there are many examples of areas below such dams where development has encroached upon riparian areas that formerly were subject to periodic flooding. However, it is important to realize that long-term reduction in downstream flooding does not exist below most such dams. Runoff from large storms may need to be passed downstream to avoid the potential for dam failure. This sudden release of water may prove very damaging to downstream life and property. All dams and reservoirs which would likely result in direct loss of life in the event of failure and the associated sudden release of water are defined as "high hazard" structures. Maps illustrating the zone of downstream inundation area are required to be produced for these structures. The inundation zone shows the physical boundaries, water depths, and arrival times associated with the projected flood wave. Existing "high hazard" dams that have inundation maps will be inventoried and copies of these maps provided to local emergency managers for incorporation into local mitigation plans. High priority must be given to inundation mapping for existing "high hazard" dams that do not currently have inundation maps.	X	X	X									3					X							1	N/A	**COVERED** by #92 (Priority).
CI-1B (REVISED)	Complete statewide tsunami hazard identification.	Identify local and distant tsunami inundation zones.	X	X			X							3							X					1	NOAA, State-EMPG	**DONE.**

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CI-2* (REVISED)	Continue to conduct and improve risk assessments for state-owned properties	FEMA requires the state's plan to: (a) describe the types of state-owned or -operated critical facilities located in the identified hazard areas, and (b) present an estimate of the potential dollar losses to state-owned or -operated buildings, infrastructure, and critical facilities in the identified hazard areas. In addition, FEMA also requires that the state develop a comprehensive multi-year plan to mitigate the risks posed to existing buildings that have been identified as necessary for post-disaster response and recovery. Part of this risk assessment for state-owned property should be to identify (a) which facilities would be necessary for response and recovery efforts and (b) mitigation strategies for those priority facilities. Currently, the State Plan's assessment of state-owned properties consists of a 'low,' 'moderate,' or 'high' vulnerability ranking. Rankings are derived from county-wide hazard analysis scores that do not account for local variations in vulnerability. Likewise, the structural integrity and physical condition of the critical facilities are not yet considered. As such, the State IHMT will encourage the state to invest resources in performing more detailed vulnerability assessments for state-owned properties. The assessments may result in mitigation opportunities that reduce the state's vulnerability to natural hazards.	X	X	X									3	X	X	X	X	X	X	X	X	X	X	X	11	FEMA, State-DOGAMI, DLCD	**COVERED** by #45 (Priority).
CI-5* (REVISED)	Strongly encourage voluntary relocation of existing essential facilities, hazardous facilities, and special occupancy structures that are in the tsunami inundation zone.	A large tsunami (preceded by a locally devastating earthquake) would likely destroy many buildings in coastal communities that are located in the tsunami inundation zone. The damage would be from the combined effects of the forces from the tsunami surges, currents and debris as well as the earthquake hazards. Essential facilities and special occupancy structures, such as fire stations/hospitals and schools, and hazardous facilities are often located in the tsunami inundation zone. Because of the critical need of essential facilities during a disaster, the added danger from hazardous materials, and the importance of protecting children, these facilities and structures need to be relocated out of the inundation zone through some type of incentive program. A voluntary program can be implemented without statutory change; however, a mandatory program would require legislative support. After a tsunami disaster, the top priority would be to reconstruct essential facilities, special occupancy structures, and hazardous facilities out of the tsunami inundation zone as defined in the maps produced for ORS 455.466 and 455.467. Finally, when these facilities come up for replacement, they should be encouraged to build out of the tsunami inundation zone.	X	X	X				X				X	5							X					1	DOGAMI, OEM, DLCD, PDM, NEHRP, Local Governments	**COVERED** by #125 (Priority).
CI-10 (REVISED)	Promote vulnerability studies of critical infrastructure	Promote vulnerability studies of critical infrastructure (lifelines) to operators. Lifeline services, such as electricity, gas, and telecommunications, can be critical to a community's wellbeing. However, much of Oregon's infrastructure has not been designed to tolerate extreme conditions, such as severe storms, major earthquakes, or large landslides. Certain lifeline services should have reliable performance to ensure that the region can withstand future damage without crippling consequences. Critical infrastructure including energy and telecom utilities infrastructure require vulnerability studies in order to understand potential damages and consequences. Transportation, water, wastewater and other important services are also important.	X	X			X							3	X	X	X	X	X	X	X	X	X	X	X	11	N/A	**COVERED** by #34 and 74 (**Priority**), and 92 (**Ongoing**).

2015 MITIGATION ACTIONS—REMOVED

Action Item			Goal												Hazard												Implementation	
#	Statement	Description	1 - Protect Life	2 - Protect Property	3 - Inc Ec Resilience	4 - Protect Env	5 - Enh OR Capability	6 - Evaluate Progress	7 - Info & Ed	8 - Elim Haz Area Dev	9 - Cultural & Hist Res	10 - Agency Coord	11 - NHMP/Comp Plan	# Goals	Coastal Hazards	Drought	Dust Storms	Earthquakes	Floods	Landslides	Tsunamis	Volcanic Hazards	Wildfires	Windstorms	Winter Storms	# Hazards	Funding Source(s)	**REASON** for Removal and Comments
CI-11	Determine where additional aquifer studies might lead to greater water supplies and how to fund these studies	There are many areas in the state where the dynamics of the aquifers are not well understood. Studying these aquifers may reveal under-used water resources and other information useful to water managers. Determine which aquifers would benefit by detailed studies and how these studies can be funded.				X								1		X										1	N/A	**NOT A MITIGATION ACTION.** Investigations are an ongoing program under the Integrated Water System Plan.
CI-12 (REVISED)	Increase storage of water, especially off stream storage	The need to store water is very apparent to irrigators in Eastern Oregon who find creeks going dry during summer and early autumn. One way to avoid that common occurrence is by encouraging storage facilities where they are needed and where they are feasible to construct. In an initial study of potential reservoir locations, storage sites were identified that are very high in drainage basins so that the impact to anadromous fish would be minimal. High elevation, small stream type structures may be considered environmentally acceptable. ODA has also looked at diverting water away from streams through pipelines or canals into off-channel basins. These types of structures are more costly but don't have the impacts on fish passage that are often associated with instream structures. Other ideas include development of aquifer storage and recovery projects. Surface water from streams is diverted during times of abundance and injected into underground aquifers for storage. OWRD has developed an inventory of above-ground and below-ground storage opportunities: http://apps2.wrd.state.or.us/apps/planning/owsci/sw_project_search.aspx http://apps2.wrd.state.or.us/apps/planning/owsci/gw_project_search.aspx. These are also available from the following link, which includes introductory information: http://www.wrd.state.or.us/OWRD/LAW/owsci_info.shtml#Potential_Water_Storage_Sites. Land management practices that slow down or prevent runoff are also being employed by landowners such as creation of wetlands, catchment depressions, diversion dikes, or terraces. The idea is to simply retain water in the watershed. For additional information, see the following Oregon Department of Agriculture web site and the OWRD web site: http://www.oregon.gov/ODA/NRD/water_quality_front.shtml www.oregon.gov/OWRD ODA should work with private landowners and special districts to implement projects such as those described above.	X	X		X								3		X										1	State-OWRD	**LOCAL ACTIVITY.** State offers funding and technical assistance to local governments and other entities to build structural water storage facilities.

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CI-15	Require fish passage at all new and replaced structures	ODFW statutes require fish passage at all artificial barriers to fish migration. New structures, such as dams and culverts, are currently required to provide fish passage. Old structures that are replaced need to provide fish passage as well. DLCD, ODFW and OEM will continue to integrate FEMA's 1999 "Policy on Fish Enhancement Structures in the Floodway" policy memorandum into fish passage projects and design guidelines. ODFW will continue to ensure that projects meet fish-passage standards and are also designed with consideration of the need to pass wood and sediment. Standards that provide for fish passage should also provide better passage for floodwaters and organic materials. Efforts to replace structures proactively to ensure passage of fish and floodwaters/debris will be supported as feasible.				X								1					X							1	State-ODFW	**DONE.**
CI-16	Evaluate expected earthquake damage and system interruptions to existing lifelines and hydraulic structures, including dams	Lifelines include all essential transportation facilities and the associated bridges, tunnels, locks, and ferries, including airports and railways, petroleum and natural gas pipelines, electric transmission lines, water and sewage systems, "emergency operations and telecommunications infrastructure. The evaluation proposed would study the vulnerability of existing lifeline systems and hydraulic structures to a major seismic event, and estimate the expected damage and losses. Estimating the expected losses will include determining those systems that likely would experience a total loss of operation immediately following a major event, although the actual physical damage to the system may not be total or extensive. In order to implement this action, the State of Oregon will need to work with several federal agencies which are involved in ownership, authority, or responsibility for some of the structures and facilities cited. Detailed benefit-cost analyses (to include hazard damages to facilities, downstream impacts and economic loss of service) can be used to identify and prioritize potential mitigation projects (retrofits, intake relocations, or even new construction).	X	X										2				X								1	N/A	**COVERED** by #92 (Ongoing).

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CI-17	Encourage/require public entities adopt and follow ANSI National Tree Care Standards	This action requires additional scoping to determine how best to encourage and require state and local agencies to adopt and routinely implement ANSI A300, Tree Care Operations Standards. These national standards were developed by a diverse committee of tree care professionals from the private and public sectors and cover proper tree pruning, fertilization, and tree support systems. These standards set forth the requirements and recommendations for satisfactory tree care maintenance. Public entities and tree care companies who perform work according to ANSI A300 standards are following accepted industry practices for proper tree care maintenance operations, resulting in healthier trees with reduced tree hazards. For more information, see: http://www.ansi.org/news_publications/media_tips/tree_care.aspx?menuid=7 This action may result in a legislative concept for a future session of the Oregon Legislature, and may include an incentive such as limited liability when the standards are implemented. Currently, the state has not adopted the ANSI A300 standards, though several state agencies follow them voluntarily. As a first step, the lead and support agencies noted below will better publicize the standards and persuade additional agencies to voluntarily adopt them.	X	X	X									3										X	X	2	Private Utility Fees	**DONE.**
CI-18 (REVISED)	Introduce legislation in 2015 requiring all overhead facility operators to mitigate service outages due to natural hazards by installing emergency electrical energy generation units; using underground or buried facilities for initial construction in areas where other hazards (e.g., landslide, earthquake, flood) are unlikely cause damage to them; and instituting other mitigation and preparedness measures.	Previous incidents and events demonstrate that overhead facilities are vulnerable to severe storms. The impact of such an event creates safety issues and system outages which can cause serious concerns to customers, communities, and the public in general as a result of the increasing dependency upon service delivery systems and networks. As such, individuals, local government, communities and commercial enterprises should be encouraged to engage in preparedness efforts in support of service outage mitigation, including the installation of emergency electrical energy generation units. This effort is especially warranted at other critical infrastructure lifeline facilities, where additional health and environmental impacts are witnessed by the loss of commercial power (i.e., medical facilities and water-waste water treatment facilities). The PUC, in collaboration with industry stakeholders, strives to improve the safety and reliability of overhead lines (ORS 758-010-035) through improved design, construction, maintenance, and rights-of-way management. Additional consideration should be given to initial constructs, utilizing underground or buried techniques, as opposed to conversion of overhead lines as a reactionary solution, keeping in mind that underground and buried constructs are vulnerable to geologic and flooding events that may cause the same result, and impact that the conversion of the same facilities was intended to resolve.	X	X	X		X		X			X		6				X	X	X				X	X	5	N/A	**NO AUTHORITY.** The state has no authority to require placement of utilities above or below ground.

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LU-4*	Complete a model "Substantial Improvement/Substantial Damage" program to support local government regulation of floodplain development	DLCD and OEM are in the process of creating a Substantial Improvement/Substantial Damage (SI/SD) manual. The SI/SD Manual will include local ordinance language and companion guidance on administrative processes that can be used by local jurisdictions for cumulative tracking of substantial improvements. It will also address common implementation difficulties encountered at the local level, and suggest approaches that could be used by local governments to overcome those difficulties. The SI/SD Manual will be completed and integrated into Model Code and ongoing NFIP training.		X			X		X					3					X							1	FEMA—CAP-SSSE	**DONE.**
LU-9 (REVISED)	Change state land use laws to better connect use of land with water supply	Occasionally land is developed in Oregon utilizing well water without regard to other nearby existing uses. Land developments can reduce recharging of the aquifer that is under them due to sending runoff largely away from the development. Farmers have lost well water or been forced to develop deeper wells due to loss of aquifer water to the newly developed land in the vicinity. Oregon land use law needs to require that new developments not create water hardships on existing land uses and other beneficial uses of water.				X	X							2		X										1	N/A	**NOT A MITIGATION ACTION.**
LU-10	Work with the insurance industry to develop and apply a common standard of interface mitigation measures adjacent to dwellings	The *Oregon Forestland-Urban Interface Fire Protection Act* recognizes that individual property owners are in the best position to take mitigation actions which will have a direct relationship to whether or not their structures survive a wildfire. To that end, the Act required the development of standards that owners are to apply on their property. At the same time, some insurance companies have developed or adopted different standards which their customers must apply on their property in order to obtain or retain insurance coverage. Such a situation of "competing" standards is confusing to property owners and can hamper the application of effective mitigation measures. Under this action item, insurance companies will be encouraged to adopt the Act's standards or, rather than apply a different set of standards, that they will encourage their customers to comply with the Act.	X	X		X								3									X			1	N/A	**UNNECESSARY.** Insurers generally use NFPA 1144 Standards.
LU-11	Strongly encourage the adoption of State Building Code standards (or other incentives) for retrofitting, upgrading, protecting, essential facilities, hazardous facilities, and special occupancy structures in coastal communities that are vulnerable to tsunamis.	A large tsunami (and associated earthquake) would likely destroy many buildings in coastal communities that are located in the tsunami inundation zone. The damage would be from the combined effects of the forces from the tsunami surges, currents and debris, as well as the earthquake hazards. The State of Hawaii has adopted construction standards for buildings in tsunami zones. The National Tsunami Hazard Mitigation Program recently completed the document Designing for Tsunamis that outlines some of these issues. These documents could be evaluated and used as a starting point in developing standards. Although not under the jurisdiction of Building Code Standards, port and harbor facilities can benefit from lessons learned from DR-1964 and damages (distant generated tsunami impacts) at facilities in Brookings-Harbor, Depoe Bay, and Bandon. Such mitigation measure include strengthen pilings for floating docks, improved dock supports that facilitate unrestricted up-down movement during wave surges, and strengthened bulkhead walls that reduce scour from wave surges.	X	X					X					3X							X					1	N/A	**NO AUTHORITY.** Not allowed under current law.

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LU-12 (REVISED)	Establish and maintain a priority ranking system for properties for flood mitigation	The State's strategy for selecting properties for flood hazard mitigation projects is fourfold. It prioritizes projects that (a) are geographically balanced, (b) are in communities with a FEMA-approved local hazard mitigation plan, (c) address properties with sustained substantial damages or repetitive losses, and (d) provide communities with information and/or tools to evaluate properties suitable for mitigation, then to develop mitigation projects. Repetitive flood loss properties (those which have experienced multiple flood insurance claims) have been identified as high priority hazard mitigation projects by the NFIP. The state, working with local jurisdictions, will verify the FEMA-provided repetitive flood loss information at least once during this Plan's term and establish a priority ranking for properties that would benefit most from hazard mitigation by means of acquisition, relocation, elevation, or demolition. The state will maintain and review this list annually as a basis for selecting and funding hazard mitigation projects that directly benefit homeowners and businesses. The review of the repetitive lost list is tied to the FMA Program guidance that is updated annually with the state grant allocations. Following a major disaster declaration, these properties could be pre-approved by FEMA for hazard mitigation to include post-disaster mitigation funding from the Hazard Mitigation Grant Program that can often be expedited. Once the repetitive loss list is verified, DLCD and OEM will analyze and summarize the information in a geographic information system to discover spatial patterns associated with repetitive losses. Results will be shared with jurisdictions in which repetitive loss structures are located, with the recommendation that the loss areas be addressed in local hazard mitigation plans as potential mitigation action items (in concept but not by specific property address). DLCD will provide NFIP communities with RL properties the information necessary for them to identify and pre-qualify potential mitigation project opportunities that are cost-effective, environmentally sound and technically feasible. OEM will work with these communities in turning qualified potential projects into sub-grant applications. The Severe Repetitive Loss (SRL) grant program was authorized by the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004 to provide funding to reduce or eliminate the long-term risk of flood damage to severe repetitive loss (SRL) structures insured under the National Flood Insurance Program (NFIP). As of May 2011, there are nine identified SRL properties in Oregon, eight of which are insured with the NFIP. The State has been working closely with the property owner of the property with the highest number of losses (7) to mitigate against future loss. This mitigation project is projected to come to completion in 2011 using SRL grant funds (pending FEMA approval). DLCD and OEM will develop a plan for addressing the remaining SRL properties based upon experience with the 2011 mitigation project. Cost-effectiveness of mitigation must be proven for SRL properties and unfortunately the dollar losses suffered by the remaining SRL properties in Oregon may not allow mitigation to be funded using the SRL grant program	X	X			X					X		4					X							1	FEMA- CAP-SSSE, State-DLCD, OEM	**DONE.**

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		(or Federal mitigation grant programs). FEMA's Greatest-Savings-to-the-Fund (GSTF) calculation does not provide sufficient benefits to mitigate any of Oregon's SRL properties. Mitigation costs will likely exceed the GSTF calculation in all cases. Consequently, DLCD and OEM will evaluate the remaining SRL properties, including conducting screening benefit-cost analysis, to determine whether the remaining SRL properties qualify for priority ranking for mitigation action. Results will be shared with FEMA and local jurisdictions. Any decision to move forward will be made in consultation with local jurisdictions and property owners.																										
LU-14	Develop additional littoral cell plans	The state intends to pursue development of plans for additional sections of coastline, based on need and the level of risk to development.		X		X								2	X											1	N/A	**NOT BEING PURSUED.** Will not be undertaken during the life of this Plan.
LU-17	Organize a GIS tsunami database workshop	A GIS database of tsunami safe zones, evacuation routes, and evacuation sites is presently under construction. Once completed, it is important to integrate the data into county databases. The workshop would not only assist counties with how to integrate the data, but also how the data can be used for tsunami evacuation planning.					X							1							X					1	NOAA	**DONE.** Database is done and workshop has been held.
G (NEW)	Provide guidance to the maritime community for evacuation response for local Cascadia and distant tsunami events.	Tsunami model data including minimum flow depths and maximum flow velocities will be analyzed to determine port-specific maritime guidance.	X						X			X		3	X			X			X					3	NOAA	**DONE.**
MP-1*	State IHMT Agency Action Item Progress Reports	Prior to the April State IHMT meetings of each year, State IHMT priority functional category leads will submit progress briefs on all mitigation activities to OEM for review. Briefs will include a progress update on primary action item responsibilities, identification of agency success stories, suggestions for potential new action items and identification of any new or updated information that will be germane to the update of the state NHMP chapters or appendices. Leads will complete success stories for any completed actions at that time. Priority functional categories for the 2012–2015 planning period include: • Legislative/Policy • Education/Outreach and • Critical Infrastructure / Essential Public Facilities						X						1	X	X	X	X	X	X	X	X	X	X	X	11	N/A	**NOT A MITIGATION ACTION.**

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MP-2*	Develop post-disaster strategic reconstruction plans based on damage projections from a Cascadia Subduction Zone earthquake and tsunami.	A large Cascadia Subduction Zone (CSZ) earthquake/tsunami may destroy a significant percentage of the buildings in coastal communities, as well as much of the public and private infrastructure that ties them together. Reconstruction of buildings and associated infrastructure will be a massive, long-term undertaking, requiring a great deal of financial aid, planning, technical assistance and cooperation among agencies and the public. Although tragic, such a disaster will also present communities with an opportunity to physically redesign and reshape themselves, creating safer places for people to live and work.A state post disaster planning and recovery task force would be established to plan for reconstruction and to oversee post disaster reconstruction. The Cascadia Region Earthquake Workgroup has recently developed a detailed damage scenario for a CSZ event using Hazus (Hazards U.S. loss estimation software program) and other information to supplement the Hazus data. For example, Hazus does not take into account tsunami damage. This scenario could be used as the basis for developing reconstruction plans.		X	X	X	X							4				X			X					2	N/A	**NOT A MITIGATION ACTION.**
MP-3*	Monitor hazard mitigation implementation	It is recommended that OEM establish and maintain a formal process to ensure that actions in this Plan are being properly implemented. By monitoring implementation of successful mitigation projects, important data can be obtained to support loss avoidance studies that quantify the benefits of mitigation. Monitoring of floodplain and landslide property acquisitions (funded by FEMA mitigation grants) is required and must be reported to FEMA every 3 years. Although not a federal requirement, monitoring of floodplain property elevations will ensure compliance with meeting NFIP flood insurance requirements. Hazard mitigation implementation may also be reviewed and this Plan revised following any Presidential emergency or major disaster declaration. At one time this was a requirement of federal law, but it now is simply a good idea, especially if interest in the event has provided both resources and opportunity for mitigation.					X	X						2	X	X	X	X	X	X	X	X	X	X	X	11	N/A	**NOT A MITIGATION ACTION.**
MP-4	Maintain a statewide action item database	OPDR hosts a searchable action item database on its website that identifies the actions from existing local natural hazards mitigation plans. During the 2009 Oregon NHMP update, revisions were made to the action item database to allow for local actions to be categorized underneath the state plan goals. This will allow the state or FEMA to quickly sort local actions by the various state plan goals. This function will allow for easier reporting on the State of Oregon's progress toward reducing risk and can be organized under the six Oregon NHMP goals. OPDR is working to add the state plan goal references to actions that are currently listed and is also working to add the actions of new plans as they are developed. Maintaining this database is time and resource intensive; therefore, all local actions may not be categorized during this Plan update. This will be an ongoing task for OPDR and OEM staff. Action Item Database: http://csc.uoregon.edu/opdr/actionitems/	X	X	X	X	X							5	X	X	X	X	X	X	X	X	X	X	X	11	N/A	**NOT A MITIGATION ACTION.**

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MP-5 (REVISED)	Complete implementation of NFIP Map Modernization program in Oregon.	Work cooperatively with FEMA to ensure that the NFIP map modernization program is fully implemented in Oregon, giving high priority to remapping of coastal areas due to age of existing FIRM maps and potential severity of flooding and related erosion hazards.		2 2	3	X	X					X	X				4					X					FEMA, DOGAMI, DLCD	**COVERED** by #121 (Ongoing).
MP-6	Establish a Silver Jackets Program	The State IHMT should consider establishing a joint state-federal flood mitigation subcommittee, which is tied to a national USACE initiative called "Silver Jackets" (Oregon is not required to adopt this name for the subcommittee). It would provide a forum where DLCD, DOGAMI, OEM, USACE, FEMA, USGS, and additional federal, state and sometimes local and Tribal agencies can come together to collaboratively plan and implement flood mitigation, optimizing multi-agency utilization of federal assistance by leveraging state/local/Tribal resources, including data/information, talent and funding, and preventing duplication among agencies. Objectives of this subcommittee might include: • Facilitate strategic life-cycle flood risk reduction, • Create or supplement a continuous mechanism to collaboratively solve state-prioritized issues and implement or recommend those solutions, • Improve processes, identifying and resolving gaps and counteractive programs, • Leverage and optimize resources, • Improve and increase flood risk communication and present a unified interagency message, and • Establish close relationships to facilitate integrated post-disaster recovery solutions. The State of Oregon will establish a "Silver Jackets", as a subcommittee to the State IHMT, with the primary intents of strengthening interagency relationships and cooperation, optimizing resources, and improving risk communication and messaging.		X	X	X	X		X					5					X							1	USACE, FEMA, USGS, NWS, State-OEM, DLCD	**DONE.**

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MP-7	Revise OEM Hazard Analysis Methodology	Each county in Oregon is required to conduct a hazard analysis within their communities. As part of the hazard analysis, each county develops risk scores for the natural hazards that affect their communities. These scores range from 24 (low) to 240 (high), and reflect the county's perceived risk for each particular hazard. The hazard analysis methodology was first developed by the Federal Emergency Management Agency (FEMA) circa 1983, and gradually refined by the Oregon Office of Emergency Management (OEM) over the years. The current methodology could be improved upon to allow for the integration of more detailed risk assessment information. Currently, communities are tasked with determining whether hazards have a 'high,' 'moderate,' or 'low' probability of occurrence; likewise, communities are asked to determine whether their community has a 'high,' 'moderate,' or 'low' vulnerability to each hazard. When better probability or vulnerability data is available, communities should be able to reflect these data in their hazard analyses. Additionally, OEM will work with OPDR to integrate the hazard analysis methodology with the three-phase risk assessment used and taught by OPDR with respect to the development of local natural hazards mitigation plans. In the development of local mitigation plans, the county's hazard analysis scores are typically referenced. If, however, the planning steering committee believes the scores should be different, the scores are simply changed, and the perceived validity of the OEM hazard analysis methodology is weakened. The integration of the analysis with the three-phase risk assessment should therefore be refined.					X							1	X	X	X	X	X	X	X	X	X	X	X	11	N/A	**NOT A MITIGATION ACTION.**
MP-8 (REVISED)	Track key performance measures toward a disaster resistant state.	State "benchmarks" for mitigation have been superseded by Key Performance Measures (KPMs), and are comprised of the following: DLCD KPM #9, "Percent of urban areas that have updated buildable land inventories to account for natural resource and hazard areas"; DOGAMI KPM #1, "Percent of communities and other stakeholders with hazard maps and risk studies for earthquake and landslide hazards"; DOGAMI KPM #2, "Percent target communities with official, reviewed evacuation map brochures"; DOGAMI KPM #3, "Percent target communities with standardized, 4-risk zone erosion hazard maps"; DOGAMI KPM #4, "Public awareness of geologic hazards and mitigation efforts"; DOGAMI KPM #9, "Percent of coastal communities provided with detailed tsunami inundation maps for local emergency planning"; OMD-OEM KPM #10, "Percent of Oregon coastal counties with complete evacuation plans"; and OMD-OEM KPM #12, "Percent of jurisdictions with approved hazard mitigation plans." In combination, these KPMs are moving Oregon toward the goal of developing a disaster resistant state, which institutionalizes hazard mitigation, including: the characterization of natural hazards; the presence of ordinances or standards at the local government level to mitigate natural hazards; and ongoing education on natural hazard mitigation.						X						1	X	X	X	X	X	X	X	X	X	X	X	11	N/A	**NOT A MITIGATION ACTION.**

2015 MITIGATION ACTIONS—REMOVED

Action Item			Goal												Hazard												Implementation	
#	Statement	Description	1 - Protect Life	2 - Protect Property	3 - Inc Ec Resilience	4 - Protect Env	5 - Enh OR Capability	6 - Evaluate Progress	7 - Info & Ed	8 - Elim Haz Area Dev	9 - Cultural & Hist Res	10 - Agency Coord	11 - NHMP/Comp Plan	# Goals	Coastal Hazards	Drought	Dust Storms	Earthquakes	Floods	Landslides	Tsunamis	Volcanic Hazards	Wildfires	Windstorms	Winter Storms	# Hazards	Funding Source(s)	**REASON** for Removal and Comments
MP-10	Improve statewide earthquake hazard datasets, develop more accurate and detailed risk datasets, make hazard and risk information widely and easily available	In order to assess the likely impact of future earthquakes, improved shaking models are needed, along with more accurate and detailed mapping of the distribution of soils that might amplify shaking or liquefy, and mapping of areas susceptible to coseismic landslides. These data should be combined with improved asset information to do risk studies using Hazus and exploring the use of GIS-based exposure analysis. Detailed hazard and risk mapping and modeling provides local and state governments with essential planning tools. Hazard and risk information should be made widely and easily available to planners, decision makers, and most importantly the general public. Easy to use interactive web tools with comprehensive earthquake and multi-hazard information should be deployed statewide.					X							1				X								1	N/A	**COVERED** by #2 (Priority).
MP-15	Work to improve forecasting for warning and hazard mitigation	State agencies plan to continue to work with the State Climatologist and the National Weather Service to better understand the nature and frequency of windstorms, and to improve communication of long and short range forecasts in order to allow for improved warnings and lead time for local governments to take effective hazard mitigation actions.	X											1										X		1	N/A	**REPLACED** by #10 and 53 (Priority).
MP-16	Seek funding for the installation and operation of additional precipitation gauges	The availability of timely and accurate telemetered data from rain (precipitation) gauges is essential for flash flood and debris flow forecasting. State agencies plan to work with their federal counterparts to ensure adequate funding and support for existing gauges and for the installation of new gauging sites where required. It is recommended that state agencies leverage federal funding with state resources and local matching commitments to achieve a reliable network of rain gauges in those areas that are susceptible to flash flooding and rapidly moving landslides (debris flows).	X	X			X							3		X			X						X	3	N/A	**COVERED** by #39 (Priority).
MP-17	Develop statewide resiliency plan consistent with intent of HR 3	Set realistic and achievable, graduated resiliency goals. Evaluate existing weaknesses in structures, infrastructure, systems and institutions to identify critical vulnerabilities that will severely hinder response and recovery from a future megathrust earthquake. Develop prioritized and graduated levels of mitigation activity with estimates of costs and benefits. Identify needed mandates, regulations, codes, incentives and educational and cultural changes needed to reach resiliency goals. Prepare written plan and report for 2013-2015 legislatures.	X	X	X		X							4				X								1	State-OEM, and other state agencies, Port of Portland, Volunteers	**DONE.**

2015 MITIGATION ACTIONS—REMOVED

Action Item			Goal												Hazard												Implementation	
#	Statement	Description	1 - Protect Life	2 - Protect Property	3 - Inc Ec Resilience	4 - Protect Env	5 - Enh OR Capability	6 - Evaluate Progress	7 - Info & Ed	8 - Elim Haz Area Dev	9 - Cultural & Hist Res	10 - Agency Coord	11 - NHMP/Comp Plan	# Goals	Coastal Hazards	Drought	Dust Storms	Earthquakes	Floods	Landslides	Tsunamis	Volcanic Hazards	Wildfires	Windstorms	Winter Storms	# Hazards	Funding Source(s)	**REASON** for Removal and Comments
MP-18	Support the completion of updated, digital floodplain mapping projects initiated through the FEMA Map Modernization Program (previously short-term action #1) and transition to FEMA's current Risk MAP program.	The state continues to participate in FEMA's national effort to update flood hazard maps, and through the 2004-2009 Map Modernization Program (Map Mod) the majority of flood maps for Oregon have now been issued in a new digital, countywide format. The state will continue to provide support to help manage the Map Mod projects that remain to be completed (Coos, Lane, Tillamook, and Washington Counties), and DLCD will continue to implement the map modernization management support strategy and activities by: 1. Establishing and maintaining a premier data collection and delivery system, 2. Achieving effective long-term management of flood hazard maps, 3. Building and maintaining mutually beneficial partnerships to accomplish mapping work, and 4. Expanding and better informing the flood map user community. Risk MAP (Mapping, Assessment, and Planning) is FEMA's new multi-year mapping program. The program builds on flood hazard data and maps produced through Map Mod while including the vision of building effective community strategies for reducing risk. In partnership with DOGAMI, FEMA contractors, and other state and local agencies, the objectives in Oregon's Risk MAP business plan include: 1. Addressing gaps in flood hazard data, identifying areas of dated and/or inconsistent mapping and updating high-priority areas with new mapping (Coos (remap), Curry, Lincoln, Tillamook, Clatsop, and Klamath Counties, as well as the Silvies Watershed and the Lower Columbia-Sandy Watershed — most projects contracted with DOGAMI); 2. Acquire new lidar topographic data for precise flood hazard mapping; 5. Measurably increase the public's awareness of flood and other natural hazards through a combination of regulatory and non-regulatory products, tools, community outreach, and innovative natural hazard mapping techniques (such as those developed by DOGAMI) that lead to actions that reduce risk to life and property; 6. Lead effective engagement in flood mitigation planning through partnerships and shared datasets; 7. Provide a coordinated multi-agency digital platform that includes data, links to data, applications, strategies, a digital library of flood hazard maps, and a web map depicting the most recent statewide Special Flood Hazard Area layer; 8. Coordinate events, project status, and actions; and 9. Align risk analysis programs and develop synergies.	X	X	X		X							4					X							1	N/A	**COVERED** by #121 (Ongoing)**.**
MP-19	New maps of precipitation intensity	A basic study of precipitation intensity will be done, including 24-hour isopluvials (2-, 5-, 10-, 50-, and 100-year maps), as well as development of probable maximum precipitation coverages for Oregon.		X			X							2		X			X						X	3	N/A	**NOT BEING PURSUED.**

2015 MITIGATION ACTIONS—REMOVED

Action Item			Goal												Hazard												Implementation	
#	Statement	Description	1 - Protect Life	2 - Protect Property	3 - Inc Ec Resilience	4 - Protect Env	5 - Enh OR Capability	6 - Evaluate Progress	7 - Info & Ed	8 - Elim Haz Area Dev	9 - Cultural & Hist Res	10 - Agency Coord	11 - NHMP/Comp Plan	# Goals	Coastal Hazards	Drought	Dust Storms	Earthquakes	Floods	Landslides	Tsunamis	Volcanic Hazards	Wildfires	Windstorms	Winter Storms	# Hazards	Funding Source(s)	**REASON** for Removal and Comments
MP-21	Develop a post-disaster tsunami scientific data recovery plan	After a damaging tsunami, response and short-term recovery efforts may destroy any scientific evidence of the tsunami, such as surge heights and inundation distances. These data are critical in understanding the tsunami and helping to better prepare for future ones. Once lost it can never be retrieved. Therefore, it is imperative that data gathering be a part of the overall response and recovery plan. This effort should be coordinated with the scientific and technical clearinghouse discussed in the earthquake chapter (short-term #3) and emergency management response and recovery efforts.	X	X	X									X							X					1	N/A	**COVERED** by #71 (Priority).
MP-22	Reconvene the committee that oversees the Mount Hood Coordination Plan.	The committee, including the Oregon Office of Emergency Management, USDA Forest Service, U.S. Geological Survey, Oregon Department of Geology and Mineral Industries, Clackamas County, Multnomah County, Hood River County, Wasco County, the Confederated Tribes of the Warm Springs, Clark County, Skamania County, Washington Emergency Management Division, and the Federal Emergency Management Agency (Region X), should reconvene and incorporate new data from the recent DOGAMI Multi-Hazard and Risk Study for the Mount Hood Region (Burns et al., 2011b).							X					X								X				1	State-OEM	**DONE.**
MP-24 (REVISED)	Perform multi-hazard risk analysis at all potentially active volcanoes in Oregon	Multi-hazard risk analysis should be performed at all potentially active volcanoes in Oregon. For an example see the DOGAMI Multi-Hazard and Risk Study for the Mount Hood Region (Burns et al., 2011b).	X	X			X		X				X	5								X				1	N/A	**COVERED** by #80 (Ongoing).
MP-25 (REVISED)	Install a multi-function lahar warning system in areas of high vulnerability	A warning system should be developed for volcano and weather-induced hazards like flood, channel migration, and landslides.	X	X			X		X			X		5								X				1	N/A	**NOT BEING PURSUED.**
MP-26	Develop coordination plans for other volcanoes in Oregon	This action has been completed for Mount Hood. Some similar documents have been completed for other volcanoes in Oregon.							X					1								X				1	N/A	**DONE.**
MP-27	Evaluation of Landslide Risk	DOGAMI will complete this evaluation in cooperation with local municipalities. Specific methods and priority locations are still to be determined.							X					1						X						1	N/A	**COVERED** by #8 and 49 (Priority).

Table 3-4. Crosswalk—2012 to 2015 Mitigation Actions

2012 to 2015 Mitigation Action Crosswalk						
2012 Action #	**2012 Action Statement**	**2012 Action Description**	**2015 Action #**	**2015 Action Statement**	**2015 Action Description**	**Revised or New? Which 2015 Table?**
LEGISLATIVE/POLICY						
LP-1*	Review and re-establish State IHMT membership and member responsibilities	When first established, the State IHMT membership consisted largely of agency directors or other high level agency staff. Over time, agency interaction with and oversight of State IHMT activities has been delegated. In some instances, this has resulted in better connection with the individuals that are actually responsible for mitigation activities in the respective agencies. In other cases, such delegation has resulted in the loss of an overall understanding of mitigation activities occurring throughout individual agencies. Given the lack of dedicated resources at the agency level for participation in the State IHMT, a review and re-establishment of the State IHMT membership and member responsibilities based on current resource constraints is needed.	**43**	Review and adjust State IHMT membership.	As state and agency priorities and personnel change, agency membership should be reviewed and adjusted, and member agencies should be encouraged to budget for participation in State IHMT activities. In late 2014, Emergency Support Functions were reassigned, and the new structure should be considered when reviewing State IHMT membership. When membership is aligned with its goals and mitigation actions, the State IHMT will provide better oversight and leadership of the state's mitigation strategy and programs.	Revised. Priority.
LP-2*	Complete a hazard mitigation policy legislative needs assessment	The Oregon NHMP contains a number of specific policy recommendations. In addition, the state of Oregon maintains a number of policies related to natural hazards and the mitigation thereof. It is unclear at this time what legislative action may be needed in order to fully implement existing and proposed mitigation actions. The State IHMT has identified greater interaction with the legislature as a top priority in the coming years. As a first step, the State IHMT recommends completing an assessment of the potential legislation needed to implement hazard mitigation policies. The assessment shall review existing and proposed policies and develop a list of potential legislative priorities.	**4**	Complete a hazard mitigation policy legislative needs assessment	The Oregon NHMP contains a number of specific policy recommendations. In addition, the state of Oregon maintains a number of policies related to natural hazards and the mitigation thereof. It is unclear at this time what legislative action may be needed in order to fully implement existing and proposed mitigation actions. The State IHMT recommends completing an assessment of the potential legislation needed to implement hazard mitigation policies.	Revised. Priority.
LP-3*	Establish statutory authority for the State IHMT	Since its formation, the State IHMT has continued to play major roles in hazard mitigation activities, including the development of this hazard mitigation plan. There is strong agreement that the State IHMT is important, should be continued, and ought to be made permanent because it is the only state body focused on coordination of natural hazard mitigation. It is recommended that the State IHMT be formally established in Oregon statute.	**44**	Establish formal and official authority for the State IHMT	Since its formation, the State IHMT has continued to play a major role in hazard mitigation activities, including the development of this hazard mitigation plan. There is strong agreement that the State IHMT is important, should be continued, and ought to be made permanent because it is the only state body focused on coordination of natural hazard mitigation. It is recommended that the State IHMT be formally and officially established.	Revised. Priority.
LP-4*	Promote a state disaster and hazard mitigation fund to assist local governments' mitigation and response efforts	The availability of funding to meet immediate emergency needs, including hazard mitigation activities, is a major concern. Federal assistance programs require various matching fund contributions from state and local applicants and are not guaranteed to exist in the future. Legislation has been considered to create such a fund, common to many states, so that financial commitments can be made quickly to support hazard mitigation. The federal Disaster Mitigation Act of 2000 (DMA2K) addresses hazard mitigation planning and projects. This legislation reinforces the importance of mitigation planning, and emphasizes implementing local actions to reduce risk before disasters occur. DMA2K established a federal Pre-Disaster Mitigation (PDM) Program and new requirements for the post-disaster Hazard Mitigation Grant Program (HMGP). Section 322 of DMA2K specifically addresses hazard mitigation planning at the state and local government levels. It identifies new requirements that allow HMGP funds to be used for planning activities, and increases the amount of HMGP funds available to states that have developed a comprehensive, "enhanced" mitigation plan prior to a disaster. States and local governments must have approved hazard mitigation plans in place in order to qualify to receive post-disaster HMGP funds. Mitigation plans must demonstrate that their proposed mitigation measures are based on a sound planning process that accounts for risk and capabilities. Establishing a state fund to assist local governments with hazard mitigation and response efforts would go a long way toward securing and leveraging federal funds.	**LP-4***	Promote a state disaster and hazard mitigation fund to assist local governments' mitigation and response efforts	The availability of funding to meet immediate emergency needs, including hazard mitigation activities, is a major concern. Federal assistance programs require various matching fund contributions from state and local applicants and are not guaranteed to exist in the future. Legislation has been considered to create such a fund, common to many states, so that financial commitments can be made quickly to support hazard mitigation. The federal Disaster Mitigation Act of 2000 (DMA2K) addresses hazard mitigation planning and projects. This legislation reinforces the importance of mitigation planning, and emphasizes implementing local actions to reduce risk before disasters occur. DMA2K established a federal Pre-Disaster Mitigation (PDM) Program and new requirements for the post-disaster Hazard Mitigation Grant Program (HMGP). Section 322 of DMA2K specifically addresses hazard mitigation planning at the state and local government levels. It identifies new requirements that allow HMGP funds to be used for planning activities, and increases the amount of HMGP funds available to states that have developed a comprehensive, "enhanced" mitigation plan prior to a disaster. States and local governments must have approved hazard mitigation plans in place in order to qualify to receive post-disaster HMGP funds. Mitigation plans must demonstrate that their proposed mitigation measures are based on a sound planning process that accounts for risk and capabilities. Establishing a state fund to assist local governments with hazard mitigation and response efforts would go a long way toward securing and leveraging federal funds.	Removed.

2012 to 2015 Mitigation Action Crosswalk

2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
LP-5*	Establish a system of special zones, procedures, restrictions, and conditions to limit development in tsunami inundation zones	Decisions on land use planning, siting of improvements, or capital expenditure for public and private infrastructure, critical lifeline facilities and residential, commercial, industrial and other development do not explicitly factor in potential tsunami-related hazards. Some method for factoring in tsunami hazard information is desirable. One possibility among many is implementation of a system of special zones, etc. that would include the means to determine the appropriate level of allowable activities. A thorough discussion of the policy implications of any proposed land use restrictions would need to precede any decisions. Such discussions would need to factor in the probabilities and areas potentially exposed to distant versus local tsunamis, economic and social coasts of any restrictions, and the potential benefits in terms of life and property saved. Any land use restrictions would need to be based on relatively sophisticated information and mapping that would include a determination of hazardous areas for both distant and local tsunami sources, an evaluation of the hazard, an evaluation of the severity, and the level of allowable risk. Detailed mapping for local Cascadia Subduction Zone tsunamis has been completed for six areas (Warrenton/Astoria, Seaside/Gearhart, Lincoln City, Newport, Coos Bay, and Gold Beach). Mapping for a worst case distant tsunami has been completed for Seaside/Gearhart. The adoption might involve amendment of DLCD's Goal 7.	**LP-5***	Establish a system of special zones, procedures, restrictions, and conditions to limit development in tsunami inundation zones	Decisions on land use planning, siting of improvements, or capital expenditure for public and private infrastructure, critical lifeline facilities and residential, commercial, industrial and other development do not explicitly factor in potential tsunami-related hazards. Some method for factoring in tsunami hazard information is desirable. One possibility among many is implementation of a system of special zones, etc. that would include the means to determine the appropriate level of allowable activities. A thorough discussion of the policy implications of any proposed land use restrictions would need to precede any decisions. Such discussions would need to factor in the probabilities and areas potentially exposed to distant versus local tsunamis, economic and social coasts of any restrictions, and the potential benefits in terms of life and property saved. Any land use restrictions would need to be based on relatively sophisticated information and mapping that would include a determination of hazardous areas for both distant and local tsunami sources, an evaluation of the hazard, an evaluation of the severity, and the level of allowable risk. Detailed mapping for local Cascadia Subduction Zone tsunamis has been completed for six areas (Warrenton/Astoria, Seaside/Gearhart, Lincoln City, Newport, Coos Bay, and Gold Beach). Mapping for a worst case distant tsunami has been completed for Seaside/Gearhart. The adoption might involve amendment of DLCD's Goal 7.	Removed.
			A	Develop tsunami land use guidance for local governments for reducing risk within tsunami inundation zones. The guidance would include model comprehensive plan and code amendments (policies, procedures, incentives, best practices, restrictions, conditions, and a tsunami overlay zone).	The risk of tsunami hazard for Oregon's coastal communities is well-documented with the completion of comprehensive tsunami inundation maps developed by DOGAMI. The State of Oregon can assist affected communities by developing land use guidance for tsunami risk reduction.	New. Removed.
			B	Provide the tsunami land use guidance to local governments.	The risk of tsunami hazard for Oregon's coastal communities is well-documented with the completion of comprehensive tsunami inundation maps developed by DOGAMI. The State of Oregon can assist affected communities by providing them with land use guidance for tsunami risk reduction.	New. Removed.
			125	Assist local governments in implementing the tsunami land use guidance.	The risk of tsunami hazard for Oregon's coastal communities is well-documented with the completion of comprehensive tsunami inundation maps developed by DOGAMI. The State of Oregon can assist affected communities with its implementation, leading to better protection of life and property from tsunamis.	New. Ongoing.
			126	Monitor implementation of the tsunami land use guidance by tracking the number of jurisdictions that have used it.	The risk of tsunami hazard for Oregon's coastal communities is well-documented with the completion of comprehensive tsunami inundation maps developed by DOGAMI. Monitoring success of the guidance will allow the State to adjust its approach and update the guidance as necessary, leading to better protection of life and property.	New. Ongoing.
LP-6*	Integrate hazard data into planning and regulations	Integrate new high-resolution hazard data into local planning and regulations. Special regulations should be established for proposed new critical facilities and/or infrastructure.	**LP-6***	Integrate hazard data into planning and regulations	Integrate new high-resolution hazard data into local planning and regulations. Special regulations should be established for proposed new critical facilities and/or infrastructure.	Removed.
LP-7	Improve ocean shore and related permit process	Enhance where possible the involvement of key state agencies in the ocean shore permit and related permit processes (local government, U.S. Army Corps of Engineers, etc.).	**LP-7**	Improve ocean shore and related permit process	Enhance where possible the involvement of key state agencies in the ocean shore permit and related permit processes (local government, U.S. Army Corps of Engineers, etc.).	Removed.

2012 to 2015 Mitigation Action Crosswalk

2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
LP-8	Consider developing procedures for escorting vehicular traffic through dust storms	ODOT and OSP both have procedures for escorting traffic under various circumstances. ODOT especially has much experience escorting traffic. It may be possible to develop and implement procedures for escorting traffic through dangerous dust storm conditions.	**LP-8**	Develop procedures for escorting vehicular traffic through dust storms	ODOT and OSP both have procedures for escorting traffic under various circumstances. ODOT especially has much experience escorting traffic. It may be possible to develop and implement procedures for escorting traffic through dangerous dust storm conditions.	Revised. Removed.
LP-9	Obtain a secure source of funding for wildfire related use of the Emergency Conflagration Act	Currently, when the Conflagration Act is used to respond to wildfire related events, the funds expended by the Office of State Marshal must either be subsequently appropriated by the Oregon Legislature or be taken from an account available to the Office of State Fire Marshal. In the latter case, the result is that monies are used for a purpose for which it was not intended and other valuable programs and projects are negatively impacted. Under this action item, the Office of State Fire Marshal will work with the Oregon Legislature to identify and fund a secure source of funding that will pay the expenses incurred in the use of the Emergency Conflagration Act. Currently, within the budget process, the OSFM has identified the need to have funds held aside for responses.	**LP-9**	Obtain a secure source of funding for wildfire related use of the Emergency Conflagration Act	Currently, when the Conflagration Act is used to respond to wildfire related events, the funds expended by the Office of State Marshal must either be subsequently appropriated by the Oregon Legislature or be taken from an account available to the Office of State Fire Marshal. In the latter case, the result is that monies are used for a purpose for which it was not intended and other valuable programs and projects are negatively impacted. Under this action item, the Office of State Fire Marshal will work with the Oregon Legislature to identify and fund a secure source of funding that will pay the expenses incurred in the use of the Emergency Conflagration Act. Currently, within the budget process, the OSFM has identified the need to have funds held aside for responses.	Removed.
LP-10	Continue seeking effective hazard mitigation opportunities compatible with habitat and fisheries protection via multi-objective mitigation efforts	Government and private nonprofit agencies in Oregon must address complex issues associated with flood hazard mitigation in the context of clean drinking water, riparian habitat, watershed health, fisheries, wetlands protection, and overall environmental quality. An important plan related to this effort is the Oregon Plan for Salmon and Watersheds. Solutions require multi-agency and intergovernmental efforts. While the decisions and projects will vary with each disaster, the state will continue its efforts to develop appropriate policies and criteria to ensure that these are considered along with hazard mitigation needs. This includes guidance on large wood placement, restoration after flood events, and habitat-friendly methods to accomplish pre- and post-disaster hazard mitigation. Watershed assessments being completed around the state by local watershed councils will be used in the evaluation of flood hazards and floodplain processes.	**26**	Incorporate text addressing hazard mitigation into natural resource agencies' guidance and process documents focusing on environmental quality to ensure that natural resources are protected in the design and construction of hazard mitigation projects.	Government and private nonprofit agencies in Oregon must address complex issues associated with flood hazard mitigation in the context of clean drinking water, riparian habitat, watershed health, fisheries, wetlands protection, and overall environmental quality. An important plan related to this effort is the *Oregon Plan for Salmon and Watersheds.* Solutions require multi-agency and intergovernmental efforts. While the decisions and projects will vary with each disaster, the state will continue its efforts to develop appropriate policies and criteria to ensure that these are considered along with hazard mitigation needs. This includes guidance on large wood placement, restoration after flood events, and habitat-friendly methods to accomplish pre- and post-disaster hazard mitigation. Watershed assessments being completed around the state by local watershed councils will be used in the evaluation of flood hazards and floodplain processes.	Revised. Priority.
LP-11	Work toward the floodplain management goals outlined in the Willamette River Legacy Program	The Governor's office has established a Willamette River initiative that lays out various goals for repairing water quality, restoring habitats, and supporting recreational opportunities. Several proposed actions would support sound floodplain management in the river basin. This includes a proposed action to protect existing functioning floodplains and reconnect historic floodplains, with a target of reconnecting 200 acres per year, 1,000 acres by 2010 focusing on tributary confluence areas between Eugene and Salem. Projected benefits of this action include reduced stream temperature, less severe flooding downstream, improved water quality, improved habitat, and increased natural storage of water. The Governor's office has identified potential funding sources as OWEB grants, CREP enrollments, 319 Grants (watershed restoration), Restoration and Enhancement Grants, Wetlands Reserve Program (WRP) and WREP, TNC utility customer salmon habitat grants, and BPA habitat compensation funds.	**LP-11**	Work toward the floodplain management goals outlined in the Willamette River Legacy Program	The Governor's office has established a Willamette River initiative that lays out various goals for repairing water quality, restoring habitats, and supporting recreational opportunities. Several proposed actions would support sound floodplain management in the river basin. This includes a proposed action to protect existing functioning floodplains and reconnect historic floodplains, with a target of reconnecting 200 acres per year, 1,000 acres by 2010 focusing on tributary confluence areas between Eugene and Salem. Projected benefits of this action include reduced stream temperature, less severe flooding downstream, improved water quality, improved habitat, and increased natural storage of water. The Governor's office has identified potential funding sources as OWEB grants, CREP enrollments, 319 Grants (watershed restoration), Restoration and Enhancement Grants, Wetlands Reserve Program (WRP) and WREP, TNC utility customer salmon habitat grants, and BPA habitat compensation funds.	Removed.
LP-12	Address problem of structures requiring replacement but ineligible under SRGP	Revise SRGP legislation or develop an alternate funding mechanism to help replace schools and emergency facilities that are too structurally deficient for cost-effective retrofit and need to be replaced instead. This would also include structures in the "local" tsunami inundation zone that should not be retrofit in-place but, rather, rebuilt on natural high ground.	**19**	Work with Business Oregon to introduce in 2015 legislation allowing reconstruction of structures that cannot feasibly be retrofitted.	Revise SRGP legislation or develop an alternate funding mechanism to help replace schools and emergency facilities that are too structurally deficient for cost-effective retrofit and need to be replaced instead. This would also include structures in the "local" tsunami inundation zone that should not be retrofit in-place but, rather, rebuilt on natural high ground.	Revised. Priority.

2012 to 2015 Mitigation Action Crosswalk

2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
LP-13	Seek funding for the installation and operation of additional stream gauges	The availability of timely and accurate telemetered data from stream gauges is essential for flood forecasting, for prediction of imminent flood hazards, and for response to flood emergencies. Stream gauging data also provide basic hydrologic information for floodplain mapping and watershed management by communities throughout the state. Numerous agencies of the federal government need data from stream gauges for effective management of projects and resources; therefore the installation and maintenance of stream gauges has traditionally been a responsibility of the federal government. State agencies plan to work with their federal counterparts to ensure adequate funding and support for existing gauges and for the installation of new gauging sites where required. It is recommended that state agencies endeavor to leverage federal funding with state resources and local matching commitments to achieve a reliable network of stream gauges around the state.	**LP-13**	Seek funding for the installation and operation of additional stream gages	The availability of timely and accurate telemetered data from stream gauges is essential for flood forecasting, for prediction of imminent flood hazards, and for response to flood emergencies. Stream gauging data also provide basic hydrologic information for floodplain mapping and watershed management by communities throughout the state. Numerous agencies of the federal government need data from stream gauges for effective management of projects and resources; therefore the installation and maintenance of stream gauges has traditionally been a responsibility of the federal government. State agencies plan to work with their federal counterparts to ensure adequate funding and support for existing gauges and for the installation of new gauging sites where required. It is recommended that state agencies endeavor to leverage federal funding with state resources and local matching commitments to achieve a reliable network of stream gauges around the state.	Removed.
			97	Expand the state's stream gaging network. Seek stable funding for the operation, and maintenance of stream gages.	The availability of timely and accurate telemetered data from stream gages is essential for flood forecasting, for prediction of imminent flood hazards, and for response to flood emergencies. Streamflow data also provides basic hydrologic information for floodplain mapping and watershed management by communities throughout the state, and is critical for understanding and forecasting drought conditions. Numerous local, state and federal water management agencies rely on data from stream gages for effective management of projects and resources; the installation and maintenance of stream gages has traditionally been a responsibility of state and federal agencies... State agencies plan to work with their partners to ensure adequate funding and support for existing gages and for the installation of new gaging sites where needed. It is recommended that state agencies endeavor to leverage federal funding with state resources and local matching commitments to achieve a reliable network of stream gages around the state. The data from these gages is used to support the RAFT and Raptor tools highlighted in Action "NEW MP-15A"	New. Ongoing.
LP-14	Seek funding to enhance capacity of state floodplain management program to better support implementation of the NFIP and higher regulatory standards	DLCD and OEM provide various services to FEMA Region 10, local governments, other governmental agencies, and the general public in support of implementation of the NFIP in Oregon. While coordination and cooperation and pursuit of various federal funding opportunities have allowed the state to temporarily enhance the services provided in some areas, neither DLCD nor OEM have been able to secure funding to permanently enhance the work capacity of the two agencies. FEMA funding is supporting a limited duration position focused on Risk MAP. The agencies could more fully serve the needs of local floodplain management programs and the citizens of Oregon if additional resources could be secured.	**LP-14**	Seek funding to enhance capacity of state floodplain management program to better support implementation of the NFIP and higher regulatory standards.	DLCD and OEM provide various services to FEMA Region 10, local governments, other governmental agencies, and the general public in support of implementation of the NFIP in Oregon. While coordination and cooperation and pursuit of various federal funding opportunities have allowed the state to temporarily enhance the services provided in some areas, neither DLCD nor OEM have been able to secure funding to permanently enhance the work capacity of the two agencies. FEMA funding is supporting a permanent position focused on Risk MAP. The agencies could more fully serve the needs of local floodplain management programs and the citizens of Oregon if additional resources could be secured.	Removed.
LP-15	Develop incentive/subsidy program for retrofit of one and two family residences	Design a system of grants or tax credits to encourage homeowners to retrofit residences to minimize displaced post-earthquake shelter demand and reduce population loss during recovery.	**41**	Develop an incentive or subsidy program for retrofit of one and two family residences	Design a system of grants or tax credits to encourage homeowners to retrofit residences to minimize displaced post-earthquake shelter demand and reduce population loss during recovery. At the same time, take advantage of weatherization measures such as energy audits, cash rebates, and tax credits to help keep the cold out during winter.	Priority.
LP-16	Develop incentives to increase the rate of replacement of 6 times seismically deficient buildings	Develop tax incentives, permitting facilitation, other means to increase the natural rate of building turnover.	**62**	Develop incentives to increase the rate of replacement of 6 times seismically deficient buildings	Develop tax incentives, permit facilitation, and other means to increase the natural rate of building turnover.	Priority.

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2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
LP-17	Encourage the U.S. Forest Service to allow the owners of long-term dwelling leases to apply mitigation standards adjacent to their dwellings	In Oregon, several thousand seasonal homes, which are located in high-risk wildland-urban interface areas, are on lands owned by the U.S. Forest Service. Because these structures are located on ground owned by the federal government, they are not subject to the Oregon Forestland-Urban Interface Fire Protection Act. In many locations, even when the owners of these homes desire to complete wildfire mitigation practices, federal lease requirements totally or substantially prevent them from doing so. Under this action item, a survey will be made of all lease locations in Oregon and the federal mitigation limitation and prohibitions will be identified. This information will then be used to approach the appropriate federal officials with a request to change their policies or regulations, to allow for the application of mitigation practices on leased property.	**144**	Collaborate through work groups within the Pacific Northwest Coordination Group to encourage the U.S. Forest Service to allow the owners of long-term dwelling leases to apply mitigation standards adjacent to their dwellings.	In Oregon, several thousand seasonal homes, which are located in high-risk wildland-urban interface areas, are on lands owned by the U.S. Forest Service. Because these structures are located on ground owned by the federal government, they are not subject to the *Oregon Forestland-Urban Interface Fire Protection Act*. In many locations, even when the owners of these homes desire to complete wildfire mitigation practices, federal lease requirements totally or substantially prevent them from doing so. Under this action item, a survey will be made of all lease locations in Oregon and the federal mitigation limitation and prohibitions will be identified. This information will then be used to approach the appropriate federal officials with a request to change their policies or regulations, to allow for the application of mitigation practices on leased property.	Revised. Ongoing.
LP-18	Establish a method for verifying the adequacy of geotechnical site reports on an as-needed basis	Independent peer review by qualified and registered geotechnical professionals is one of the best methods of ensuring that site reports done for local governments, property owners, developers, and others are of an acceptable quality and adequately address landslide issues. It is recommended that peer review processes throughout the state be strengthened so landslide hazards are minimized.	**LP-18**	Establish a method for verifying the adequacy of geotechnical site reports on an as-needed basis	Independent peer review by qualified and registered geotechnical professionals is one of the best methods of ensuring that site reports done for local governments, property owners, developers, and others are of an acceptable quality and adequately address landslide issues. It is recommended that peer review processes throughout the state be strengthened so landslide hazards are minimized.	Removed.
LP-19	Develop and implement flood protection standards for state-owned buildings	According to the Senate Bill 814 Task Force (Oregon Legislature, 1997 Session), there is a need to develop and effectively implement a strict standard governing the siting, construction, and leasing of buildings occupied by state agencies in flood-prone areas. There is a corresponding need to inventory existing state buildings located in flood-prone areas.	**22**	Develop flood protection standards for state-owned/leased buildings.	According to the SB 814 Task Force (Oregon Legislature, 1997 Session), there is a need to develop and effectively implement a strict standard governing the siting, construction, and leasing of buildings occupied by state agencies in flood-prone areas.	Revised. Priority.
			87	Continue to improve inventory of state-owned/leased buildings in all hazard areas.	Using DAS's data, DOGAMI developed an inventory of state-owned/leased buildings and identified those in hazard areas for the 2012 Plan and updated the inventory for the 2015 Plan. The data should be continuously updated by DAS-CFO to facilitate DOGAMI's inventory updates in future plan cycles.	Revised. Ongoing
			123	Implement flood protection standards for state-owned/leased buildings.	According to the Senate Bill 814 Task Force (Oregon Legislature, 1997 Session), there is a need to develop and effectively implement a strict standard governing the siting, construction, and leasing of buildings occupied by state agencies in flood-prone areas.	Revised. Ongoing.
			39	Install real-time monitoring capabilities on the remaining 51 state-operated stream gages, with the goal of making the network 100% real-time by the year 2020.	The availability of timely and accurate data from stream gages is essential for flood forecasting, for prediction of imminent flood hazards, and for response to flood emergencies. Today, 178 of the state's 229 stream gages provide real-time data. Upgrade the state's existing stream gaging network, with the goal of installing real-time capability on all remaining gages.	New. Priority.
			23	Update the state's Peak Discharge Estimation Program.	Peak discharge estimation tools can help determine the magnitude and frequency of floods. The state's program provides engineers and land managers with the information needed to make informed decisions about development in or near watercourses. The Peak Discharge Estimation Program is based on a modified version of the U.S. Geological Survey's "Bulletin 17b." The U.S. Geological Survey is in the process of updating this bulletin. OWRD's methodology will need to be brought up to date to reflect these recent findings.	New. Priority.
			42	Request the Oregon Legislature to fund the "State Disaster Loan and Grant Account" immediately following a presidentially declared disaster or other disaster.	The State Disaster Loan and Grant Account includes an account that can be used to fund local government and school district mitigation projects after a Presidentially declared disaster. The Oregon Legislature may authorize deposits to the account when requested.	New. Priority.

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2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
			17	Request LCDC to include Local Natural Hazards Mitigation Planning as a priority for DLCD Technical Assistance Grant awards to use as match for federal funds when available.	The Land Conservation and Development Commission (LCDC) awards Technical Assistance Grants to local governments to support local planning efforts in certain priority land use topic areas which at this time do not include natural hazard mitigation. If LCDC were to include natural hazards mitigation planning as a priority topic area, local governments would have the opportunity to compete for funding and the state would be better able to provide technical assistance for natural hazards mitigation planning.	New. Priority.
EDUCATION/OUTREACH						
EO-1*	Continue promoting the CRS program throughout the state	The CRS, part of the NFIP, is a program that rewards communities for going above and beyond the minimum requirements of the NFIP in minimizing potential losses due to flooding (See previous CRS summary under Section 2 of Hazard Mitigation Successes). The state will continue its efforts to implement CRS in local communities. See the CRS Information Center at: http://training.fema.gov/EMIWeb/CRS/ for more information. Each year DLCD conducts community assistance visits in an average of five NFIP communities. During this process, qualified jurisdictions will be encouraged to participate in CRS and/or strengthen CRS ratings. DLCD will also create a "pathway to CRS" schedule for each jurisdiction for which it conducts a community assistance visit	**20**	Add at least five jurisdictions, with emphasis on coastal jurisdictions, to the Community Rating System (CRS) program during the life of each Oregon NHMP.	The CRS, part of the NFIP, is a program that rewards communities for going above and beyond the minimum requirements of the NFIP in minimizing potential losses due to flooding. Participating in the CRS benefits the jurisdiction with extra flood protection and benefits property owners by lowering flood insurance rates. See the CRS Information Center at: http://training.fema.gov/EMIWeb/CRS/ for more information. Each year DLCD conducts community assistance visits in an average of five NFIP communities. During this process, qualified jurisdictions will be encouraged to participate in CRS or strengthen CRS ratings. DLCD will also create a "pathway to CRS" schedule for each jurisdiction for which it conducts a community assistance visit. The state has also started CRS Users' Groups (NEW EO-1C and EO-1D) to encourage greater participation in the CRS program.	Revised. Priority.
			29	Strengthen the existing Community Rating System (CRS) rating of at least five jurisdictions, with emphasis on coastal jurisdictions, during the life of each Oregon NHMP.	The CRS, part of the NFIP, is a program that rewards communities for going above and beyond the minimum requirements of the NFIP in minimizing potential losses due to flooding. There are a number of measures a community can implement to obtain a CRS rating, and most communities do not implement them all. As a community implements more CRS flood protection measures, its CRS rating is strengthened, and the community is rewarded with better flood protection and lower flood insurance rates.	New. Priority.
			C	Initiate a Community Rating System (CRS) Users' Group Program for Oregon.	Communities in Oregon that participate in the NFIP's CRS Program lack a way to network with and learn from other CRS communities in the state. Users' groups would provide such a forum. The groups would be open to communities already participating in the CRS Program and to others interested in floodplain best management practices. The state anticipates that the CRS Users' Groups will facilitate and strengthen participation in the CRS Program, resulting in greater protection from flood damage at lower cost to property owners.	New. Removed.
			112	Continue implementing the Oregon CRS Users Group Program.	DLCD will continue to coordinate Oregon's two NFIP CRS Users' Groups. Each group will meet a minimum of three times per year to share floodplain best management practices and to receive technical support from the State, FEMA's Insurance Support Organization, and others as needed. The State anticipates that the support provided through the CRS Users' Groups will encourage more communities to participate in the CRS program and participating communities to strengthen their CRS ratings, resulting in greater protection from flood damage at lower cost to property owners.	New. Ongoing.

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2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
EO-2*	Develop a statewide strategy to encourage the purchase of flood insurance	Despite the statewide availability of flood insurance, coverage in place in most communities in Oregon varies from 10% to 20% of the homes and businesses located in the Special Flood Hazard Area (100-year floodplain). Not only does flood insurance reduce the financial vulnerability of individuals, families, businesses, government agencies, other organizations, and the community to the costs posed by flooding, but through the "increased cost of compliance" provision of flood insurance, it also provides funding for the elevation, floodproofing, demolition, or relocation of homes and businesses when required due to "substantial damage" to the structure. State agencies, local governments, and private sector insurance companies need to promote the purchase of flood insurance. Efforts could be linked with NFIP efforts such as the floodsmart.gov website and associated advertising campaigns.	**27**	Develop a statewide strategy to encourage the purchase of flood insurance.	It's well-known that well-insured communities recover faster. A strategy will help the state direct information to under-insured areas thereby reducing vulnerability, facilitating recovery, and increasing access to "increased cost of compliance" funding.	Revised. Priority.
EO-3*	Assist communities to adopt risk reduction techniques and ordinances	Techniques can involve requiring geological or geotechnical studies for new development, stormwater control for neighborhoods on hillslopes, strict land use ordinances for active landslides, working with infrastructure operators to increase reliability of services after storms, and more.	**EO-3***	Assist communities to adopt risk reduction techniques and ordinances	Techniques can involve requiring geological or geotechnical studies for new development, stormwater control for neighborhoods on slopes, strict land use ordinances for active landslides, working with infrastructure operators to increase reliability of services after storms, and more.	Removed.
EO-4*	Encourage Oregon coastal communities to enroll in the NFIP's Community Rating System (CRS) which includes tsunami standards.	The CRS, included in the National Flood Insurance Program, is a FEMA program that provides incentives to communities to mitigate flood disasters. By enrolling in the CRS, communities, through specific actions, receive points that go toward a reduction in insurance rates. Tsunami actions are included in the CRS and have recently been revised by FEMA in conjunction with the Insurance Services Office (ISO). Contact DLCD, OEM, or FEMA for information about the CRS tsunami program.	**EO-4***	Encourage Oregon coastal communities to enroll in the NFIP's Community Rating System (CRS) which includes tsunami standards.	The CRS, included in the National Flood Insurance Program, is a FEMA program that provides incentives to communities to mitigate flood disasters. By enrolling in the CRS, communities, through specific actions, receive points that go toward a reduction in insurance rates. Tsunami actions are included in the CRS and have recently been revised by FEMA in conjunction with the Insurance Services Office (ISO). Contact DLCD, OEM, or FEMA for information about the CRS tsunami program.	Removed.
EO-5	Improve hazard mitigation technical assistance for local governments and infrastructure operators	A DLCD-led review of the implementation of statewide planning Goal 7 resulted in the identification of several needs to strengthen local hazard mitigation efforts. These included providing current hazard information and technical assistance to local governments, improving communications between local governments and state agencies with respect to natural hazards, and providing hazard mitigation training. An ongoing need to provide technical assistance to local governments exists, and the State IHMT continues to look for ways to bridge the gaps between local planning, building, and emergency management programs, and between the local and state levels. Despite this recognition, implementation of such activities is difficult to fund and institutionalize. Through the Oregon Partnership for Disaster Resilience (OPDR) these issues have been addressed since 1999. OPDR has offered measurable outcomes on how increased communication, coordination, and collaboration between diverse partners (public and private) can assist the state and communities in reducing their risk and exposure to natural hazards. Various State IHMT partners will continue to look for opportunities to provide technical assistance in a manner that encourages coordination among various local programs and informs communities of assistance available. The State IHMT also continues to seek stable non-federal funding for OPDR. The State IHMT will endeavor to ensure that technical assistance materials provided by DLCD, OEM, DOGAMI, BCD, OPDR, PUC and other agencies support local officials' and infrastructure operator's understanding and use of hazard and risk information.	**EO-5**	Improve hazard mitigation technical assistance for local governments and infrastructure operators	A DLCD-led review of the implementation of statewide planning Goal 7 resulted in the identification of several needs to strengthen local hazard mitigation efforts. These included providing current hazard information and technical assistance to local governments, improving communications between local governments and state agencies with respect to natural hazards, and providing hazard mitigation training.An ongoing need to provide technical assistance to local governments exists, and the State IHMT continues to look for ways to bridge the gaps between local planning, building, and emergency management programs, and between the local and state levels.Despite this recognition, implementation of such activities is difficult to fund and institutionalize. Through the Oregon Partnership for Disaster Resilience (OPDR) these issues have been addressed since 1999. OPDR has offered measurable outcomes on how increased communication, coordination, and collaboration between diverse partners (public and private) can assist the state and communities in reducing their risk and exposure to natural hazards.Various State IHMT partners will continue to look for opportunities to provide technical assistance in a manner that encourages coordination among various local programs and informs communities of assistance available. The State IHMT also continues to seek stable non-federal funding for OPDR.The State IHMT will endeavor to ensure that technical assistance materials provided by DLCD, OEM, DOGAMI, BCD, OPDR, PUC and other agencies support local officials' and infrastructure operator's understanding and use of hazard and risk information.	Removed.
EO-6	Develop and distribute local hazard mitigation planning guidance; provide plan development support	The Oregon Partnership for Disaster Resilience (OPDR) assists communities in developing and implementing local risk reduction plans and projects. Funding for planning-related activities comes from the Pre-Disaster Mitigation Grant	**EO-6**	Develop and distribute local hazard mitigation planning guidance; provide plan	The Oregon Partnership for Disaster Resilience (OPDR) assists communities in developing and implementing local risk reduction plans and projects. Funding for planning-related activities comes from the Pre-Disaster Mitigation Grant	Removed.

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2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
		Program, and 2012 marks the ninth year of regional planning efforts aimed at developing multi-jurisdictional natural hazards mitigation plans. As a direct result of OPDR activities, the majority of Oregon's counties maintain FEMA-approved natural hazards mitigation plans. On October 1, 2012, new FEMA local plan review procedures will be fully phased-in, and this will require outreach and training on a state-wide basis. In conjunction with PDM plan development assistance, OPDR develops and implements training programs that benefit communities, agencies, and partners in natural hazards risk reduction. For communities developing hazard mitigation plans, OPDR develops and facilitates a series of quarterly plan development workshops. The series includes workshops on developing planning processes; involving stakeholders and conducting public outreach; mapping community assets and assessing local risks and vulnerabilities; developing goals and action items; and developing strategies for plan implementation and maintenance. OPDR also hosts a two-part plan update training series and business continuity trainings. In addition to the trainings, OPDR provides communities with support, tools, and resources necessary to develop and/or update their natural hazards mitigation plans. Communities developing natural hazards mitigation plans receive a Pre-Disaster Mitigation Community Training Manual. The Training Manual offers technical information and resources to assist communities in the development of local mitigation plans, and is used in conjunction with OPDR's four-part work session series. Both the work sessions and manual synthesize the approaches developed by OPDR for Disaster Resilience, state and federal agencies, and other organizations to assist communities in developing natural hazards mitigation plans. OPDR has also created an addendum to the Training Manual to assist communities in the plan update process. OPDR plays an instrumental role in the packaging and distribution of scientific and technical knowledge. Based on information provided by State IHMT and OPDR members/agencies, OPDR develops and distributes regional profiles and risk assessments to local communities. The regional reports are part of the State's Enhanced Natural Hazards Mitigation Plan, and they also serve as regional resources for local planning initiatives. The regional profiles and risk assessments are maintained and updated in accordance with the State's Plan implementation and maintenance schedule. As such, the reports include and disseminate the most recent scientific and technical knowledge available at the time. Likewise, communities are encouraged to update the regional profiles and risk assessments with local data, as available. Additionally, OPDR's website hosts a number of useful resources for communities developing and/or updating natural hazards mitigation plans, including the searchable natural hazard mitigation action item database. The database includes action items from plans developed as part of the Pre-Disaster Mitigation Planning Grants covering the Mid/Southern Willamette Valley, Mid-Columbia, Southeast Oregon, Northeast Oregon, and Oregon Coast regional planning initiatives. Eventually, this database will host the action items from all local plans. Additional online resources include the state's enhanced natural hazards mitigation plan, links to regional planning initiatives, technical memos, links to state agencies' websites, and hazard-specific resources.		development support	Program, and 2012 marks the ninth year of regional planning efforts aimed at developing multi-jurisdictional natural hazards mitigation plans. As a direct result of OPDR activities, the majority of Oregon's counties maintain FEMA-approved natural hazards mitigation plans. On October 1, 2012, new FEMA local plan review procedures will be fully phased-in, and this will require outreach and training on a state-wide basis. In conjunction with PDM plan development assistance, OPDR develops and implements training programs that benefit communities, agencies, and partners in natural hazards risk reduction. For communities developing hazard mitigation plans, OPDR develops and facilitates a series of quarterly plan development workshops. The series includes workshops on developing planning processes; involving stakeholders and conducting public outreach; mapping community assets and assessing local risks and vulnerabilities; developing goals and action items; and developing strategies for plan implementation and maintenance. OPDR also hosts a two-part plan update training series and business continuity trainings. In addition to the trainings, OPDR provides communities with support, tools, and resources necessary to develop and/or update their natural hazards mitigation plans. Communities developing natural hazards mitigation plans receive a Pre-Disaster Mitigation Community Training Manual. The Training Manual offers technical information and resources to assist communities in the development of local mitigation plans, and is used in conjunction with OPDR's four-part work session series. Both the work sessions and manual synthesize the approaches developed by OPDR for Disaster Resilience, state and federal agencies, and other organizations to assist communities in developing natural hazards mitigation plans. OPDR has also created an addendum to the Training Manual to assist communities in the plan update process. OPDR plays an instrumental role in the packaging and distribution of scientific and technical knowledge. Based on information provided by State IHMT and OPDR members/agencies, OPDR develops and distributes regional profiles and risk assessments to local communities. The regional reports are part of the State's Enhanced Natural Hazards Mitigation Plan, and they also serve as regional resources for local planning initiatives. The regional profiles and risk assessments are maintained and updated in accordance with the State's Plan implementation and maintenance schedule. As such, the reports include and disseminate the most recent scientific and technical knowledge available at the time. Likewise, communities are encouraged to update the regional profiles and risk assessments with local data, as available. Additionally, OPDR's website hosts a number of useful resources for communities developing and/or updating natural hazards mitigation plans, including the searchable natural hazard mitigation action item database. The database includes action items from plans developed as part of the Pre-Disaster Mitigation Planning Grants covering the Mid/Southern Willamette Valley, Mid-Columbia, Southeast Oregon, Northeast Oregon, and Oregon Coast regional planning initiatives. Eventually, this database will host the action items from all local plans. Additional online resources include the state's enhanced natural hazards mitigation plan, links to regional planning initiatives, technical memos, links to state agencies' websites, and hazard-specific resources.	
			50	Update *Planning for Natural Hazards: Oregon Technical Resource Guide.*	*Planning for Natural Hazards: Oregon Technical Resource Guide* was published in 2000 and needs to be updated.	Revised. Priority.

2012 to 2015 Mitigation Action Crosswalk

2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
			46	Provide the updated *Planning for Natural Hazards: Oregon Technical Resource Guide* to local governments.	To encourage communities to use *Planning for Natural Hazards: Oregon Technical Resource Guide* it must be provided to them.	New. Priority.
			83	Assist local governments in using the updated *Planning for Natural Hazards: Oregon Technical Resource Guide* to update their comprehensive plans and development regulations.	The original purpose of *Planning for Natural Hazards: Oregon Technical Resource Guide* was to assist communities in amending their comprehensive plans and development regulations to reduce risk from natural hazards, implementing Statewide Goal 7. The updated document will also be helpful in developing local hazard mitigation plans and integrating them with local comprehensive plans and development regulations.	New. Ongoing.
			84	Monitor the implementation of the updated *Planning for Natural Hazards: Oregon Technical Resource Guide* provided to local governments by tracking the number of jurisdictions that have used it.	Monitoring success of *Planning for Natural Hazards: Oregon Technical Resource Guide* will allow the State to adjust its approach and update the guidance as necessary, leading to better protection of life and property.	New. Ongoing.
			85	Provide support for development and update of local and state hazard mitigation plans.	The State provides support for development of local NHMPs and the state NHMP by managing federal grant funding in ways that assist the state and local governments with NHMP development and update tasks and processes.	New. Ongoing.
EO-7	Improve and sustain public information and education programs aimed at mitigating the damage caused by natural hazards	While ongoing efforts are being made in this area, a strong message conveyed by several State IHMT Reports notes the need to strengthen and sustain public information, education, and training efforts by providing additional resources. Although commonly recognized that interest in reducing losses increase during and after events, there is an ongoing need to provide residents and key stakeholder groups (such as infrastructure operators) with hazard mitigation information. These reports cite the need to have timely seasonal information available, better methods to inform residents of sources of hazard mitigation information, use improved electronic methods (e.g., web sites), and materials oriented toward the intended users. This helps keep awareness levels higher, will stimulate actions by some, and reminds users to consider and include hazard mitigation measures in the contexts of regular activities, such as building a new home, relocating an office, or repairing a business.	**86**	Improve and sustain public information and education programs aimed at mitigating the damage caused by natural hazards	While ongoing efforts are being made in this area, a strong message conveyed by several State IHMT Reports notes the need to strengthen and sustain public information, education, and training efforts by providing additional resources. Although commonly recognized that interest in reducing losses increase during and after events, there is an ongoing need to provide residents and key stakeholder groups (such as infrastructure operators) with hazard mitigation information. These reports cite the need to have timely seasonal information available, better methods to inform residents of sources of hazard mitigation information, use improved electronic methods (e.g., web sites), and materials oriented toward the intended users. This helps keep awareness levels higher, will stimulate actions by some, and reminds users to consider and include hazard mitigation measures in the contexts of regular activities, such as building a new home, relocating an office, or repairing a business.	Ongoing.
EO-8	Develop tsunami hazard and evacuation maps	Tsunami runup areas and evacuation maps continue to be developed in conjunction with local governments. Tsunamis can dramatically affect coastal erosion and must be taken into account in planning activities.	**EO-8**	Develop tsunami hazard and evacuation maps	Tsunami runup areas and evacuation maps continue to be developed in conjunction with local governments. Tsunamis can dramatically affect coastal erosion and must be taken into account in planning activities.	Removed.
EO-9	Assist local governments	Continue — and enhance where possible — state technical and planning grant assistance to coastal cities and counties for addressing issues associated with coastal erosion and related hazards.	**1**	Develop and fund a legislative package for general funds or lottery funds to match federal funding for local hazard mitigation planning, including additional funds for DLCD Technical Assistance Grants.	Continue — and enhance where possible — state technical and planning grant assistance to cities and counties for addressing issues associated with local hazards.	Revised. Priority.
EO-10	Expand Coastal Atlas GIS resources	Expand the Coastal Atlas geographic information system (GIS) in terms of data content and tools available for use. Continue to promote the use of the Coastal Atlas by local and state land use planners, permit reviewers and other practitioners	**101**	Continue to facilitate accessibility and use of the *Coastal Atlas* GIS resources.	Make the *Coastal Atlas* geographic information system (GIS) more useful for a wider audience, from local and state staff to interested citizens, by continuing to improve its data and tools, and providing training on how to access and use them.	Revised. Ongoing.

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2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
EO-11	Produce Coastal Development Handbook	Produce a Coastal Development Handbook that addresses coastal process and hazards, beach and shoreland public policy, buying oceanfront property [what to look for, what questions to ask], building on oceanfront property, choosing appropriate hazard mitigation techniques, and choosing and using geotechnical consultants and engineers.	**47**	Produce Coastal Development Handbook	Produce a *Coastal Development Handbook* that addresses coastal process and hazards, beach and shoreland public policy, buying oceanfront property [what to look for, what questions to ask], building on oceanfront property, choosing appropriate hazard mitigation techniques, and choosing and using geotechnical consultants and engineers.	Priority.
EO-12	Better coordinate, fund, and publicize programs to reduce the abundance of juniper trees in arid landscapes across Oregon	Juniper trees are not native to Oregon. They develop extensive root systems that draw critically needed water from arid soils, transpiring water vapor into the atmosphere. There are programs in Oregon to reduce juniper trees from areas where their competition for groundwater resources is harmful, but these programs need to be better coordinated, funded, and publicized.	**98**	Better coordinate, fund, and publicize programs to reduce the abundance of juniper trees in arid landscapes across Oregon	Juniper trees develop extensive root systems that draw critically needed water from arid soils, transpiring water vapor into the atmosphere, intensifying drought and increasing the risk of wildfire. There are programs in Oregon to reduce juniper trees from areas where their competition for groundwater resources is harmful, but these programs need to be better coordinated, funded, and publicized.	Ongoing.
EO-13	Determine the effectiveness of EAS in dust prone areas at providing timeline information to the traveling public about dangerous blowing dust conditions and make improvements if needed.	One of several ideas proposed following the Sept. 1999 accidents on I-84 near Echo was to “put word out quickly” utilizing the Emergency Alert System (EAS) via area radio stations about dust storm potential, and especially about actual conditions that are interfering with visibility. This idea was in addition to ODOT’s Highway Advisory Radio and related resources noted as success stories on pages DS-5 to DS-7. With regard to the Mid-Columbia Region, it was noted that Tri-Cities radio stations need to be included because many people driving through that area are listening to stations based in Washington State. ODOT and OSP have primary responsibility for activating the traffic advisory components of the dust storm response plan for the Mid-Columbia Region. The National Weather Service can also activate EAS from their forecast offices in Pendleton, Boise, Medford, and Portland. Many local emergency program managers can also activate the system.	**52**	Determine the effectiveness of and the feasibility of using the Emergency Alert System (EAS) in dust prone areas to provide timely information to the traveling public about dangerous blowing dust conditions and make improvements if needed.	ODOT and OSP have primary responsibility for activating the traffic advisory components of the dust storm response plan for the Mid-Columbia Region. The National Weather Service can also activate EAS from their forecast offices in Pendleton, Boise, Medford, and Portland. Many local emergency program managers can also activate the system. Providing this information can save lives in the event of a dust storm.	Revised. Priority.
EO-14	Explore ways of improving communication of hazardous blowing dust conditions between public safety answering points, ODOT, OSP, and local law enforcement agencies	Community Solutions Team (CST) meetings in the Mid-Columbia Region of Oregon during the spring of 2000 identified that better communication between public safety answering points (PSAPs) about the existence and likely direction of travel of dust storms might have provided additional warning time for ODOT, OSP, and local law enforcement to stop travel on downwind highways likely to be affected. Protocols and training should be considered that would result in PSAPs relaying information, as appropriate, to ODOT, OSP, local law enforcement, and the downwind neighboring PSAP regarding reports of dust storms headed in a particular direction. This may provide additional time for ODOT and law enforcement agencies to briefly close stretches of highways in the path of the storm and/or for reader boards and other advisory systems to be activated with information. There are a number of issues and factors that would need to be addressed in determining the feasibility of developing protocols and training on them: • Staffing/Costs — Some PSAPs do not have more than one or two people per shift on duty; when events such as dust storms happen, personnel sometimes find it difficult to keep-up with existing, ongoing protocols. • Feasibility — If the only information PSAPs have is based on what they are told by callers or mobile police/fire units via radio, will they know enough about the direction of travel of the dust storm to issue reliable information? • Technology — Is new technology needed to accomplish the task contemplated? Liability — Would adding such protocols unnecessarily contribute to potential liability for PSAPs? • Work with APCO/NENA — and especially local PSAPs in dust storm prone areas — to explore the possibility of developing and training on communication protocols for dust storms.	**EO-14**	Develop protocols for improving communication of hazardous blowing dust conditions between public safety answering points, ODOT, OSP, and local law enforcement agencies.	Community Solutions Team (CST) meetings in the Mid-Columbia Region of Oregon during the spring of 2000 identified that better communication between public safety answering points (PSAPs) about the existence and likely direction of travel of dust storms might have provided additional warning time for ODOT, OSP, and local law enforcement to stop travel on downwind highways likely to be affected. Protocols should be developed and training provided should be considered that would result in PSAPs relaying information, as appropriate, to ODOT, OSP, local law enforcement, and the downwind neighboring PSAP regarding reports of dust storms headed in a particular direction. This may provide additional time for ODOT and law enforcement agencies to briefly close stretches of highways in the path of the storm and/or for reader boards and other advisory systems to be activated with information. There are a number of issues and factors that would need to be addressed in determining the feasibility of developing protocols and training on them: • Staffing/Costs — Some PSAPs do not have more than one or two people per shift on duty; when events such as dust storms happen, personnel sometimes find it difficult to keep-up with existing, ongoing protocols. • Feasibility — If the only information PSAPs have is based on what they are told by callers or mobile police/fire units via radio, will they know enough about the direction of travel of the dust storm to issue reliable information? • Technology — Is new technology needed to accomplish the task contemplated? • Liability — Would adding such protocols unnecessarily contribute to potential liability for PSAPs? • Work with APCO/NENA — and especially local PSAPs in dust storm prone areas—to develop and train on communication protocols for dust storms.	Revised. Removed.

2012 to 2015 Mitigation Action Crosswalk

2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
EO-15	Coordinate development of a post disaster scientific and technical clearinghouse with other state and federal agencies, higher education, and associations	When an earthquake strikes the state, there will be an influx of scientists and engineers from inside and outside the state to study the event and offer help. There needs to be a coordination of their efforts to put them to use in the most efficient and effective way possible. This clearinghouse will work with the emergency coordination center established immediately after the earthquake, including working with the state agencies implementing State Support Function #3, Public Works and Engineering.	**71**	Coordinate development of a post-disaster scientific and technical clearinghouse with other state and federal agencies, higher education, and associations.	When an earthquake, flood, tsunami, or other disaster strikes the state, there will be an influx of scientists and engineers from inside and outside the state to study the event and offer help. There needs to be a coordination of their efforts to put them to use in the most efficient and effective way possible. This clearinghouse will work with the emergency coordination center established immediately after the earthquake, flood, tsunami, or other disaster.	Priority.
EO-16	Provide additional information to the traveling public about dust storm driving safety	Among the ideas generated by the Community Solutions Team meetings in the spring of 2000 was to provide additional public education outreach in dust storm prone areas of the state, especially Morrow and Umatilla Counties. Among the ideas were the following: (a) Provide dust storm driving information in safety rest area kiosks. (b) Develop, print, and distribute "table cards" to area restaurants and truck stops, providing information on driving when visibility is reduced (dust storms, fog, smoke, etc.), perhaps making similar information available at DMV offices. (c) Develop and distribute PSAs on the topic of driving in dust storm conditions to radio stations; stations would be encouraged to run these during peak periods when there is a strong possibility of high winds and blowing dust (Tri-Cities radio stations should be included). Determine the merit of these ideas and implement those that are likely to result in a better-informed traveling public, thereby increasing safety on Oregon's highways.	**EO-16**	Provide additional information to the traveling public about dust storm driving safety	Among the ideas generated by the Community Solutions Team meetings in the spring of 2000 was to provide additional public education outreach in dust storm prone areas of the state, especially Morrow and Umatilla Counties. Among the ideas were the following: (a) Provide dust storm driving information in safety rest area kiosks. (b) Develop, print, and distribute "table cards" to area restaurants and truck stops, providing information on driving when visibility is reduced (dust storms, fog, smoke, etc.), perhaps making similar information available at DMV offices. (c) Develop and distribute PSAs on the topic of driving in dust storm conditions to radio stations; stations would be encouraged to run these during peak periods when there is a strong possibility of high winds and blowing dust (Tri-Cities radio stations should be included). Determine the merit of these ideas and implement those that are likely to result in a better-informed traveling public, thereby increasing safety on Oregon's highways.	Removed.
EO-17	Publicize and facilitate the implementation of both structural and non-structural seismic mitigation measures for home owners, business owners, renters, and contractors, including methods of reducing hazards	Models to display chimney reinforcing techniques, attaching homes to foundations and non-structural measures for building contents have been developed by FEMA following the Nisqually earthquake disaster. Oregon will request models from FEMA Region 10 and/or other sources; develop and deploy a training program for seismic retrofits to be conducted regionally throughout the state. Work with various "Showcase State" partners, as well as the Construction Contractors Board, public and private sector lenders, private sector construction material suppliers and nonprofit organizations to develop programs to assist home and business owners and renters to implement structural and non-structural seismic mitigation measures.	**106**	Publicize and facilitate the implementation of both structural and non-structural seismic mitigation measures for home owners, business owners, renters, and contractors, including methods of reducing hazards	Working with federal partners, such as FEMA, and non-profit industry groups, such as AIA, Oregon will enhance education on structural and non-structural seismic mitigation measures by adopting the following actions: • Increase the number of educational opportunities by working with FEMA to offer courses from the National Earthquake Technical Assistance Program. • Work with the Construction Contractors Board, public and private sector lenders, private sector construction material suppliers, and nonprofit organizations to develop programs to assist home and business owners and renters to implement innovative structural and non-structural seismic mitigation measures.	Revised. Ongoing.

2012 to 2015 Mitigation Action Crosswalk

2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
EO-18	Promote agricultural practices that are known to reduce erosion of soil by wind, thereby reducing the frequency and magnitude of dust storms	It is clear that certain agricultural practices reduce the frequency and amount of blowing dust, as well as reduce wind-caused soil erosion. Oregon Department of Agriculture should continue to work with farmers, agricultural associations, and soil and water conservation districts to further promote and implement (a) residue management, including no-till or direct seed farming; (b) cover crops and other BMPs (see below); (c) field strip cropping systems; and (d) landscape buffers/windbreaks. The most commonly used practice for both wind and water erosion control is residue management. This involves leaving some or all of the residue from the previous crop on the soil surface to provide cover and surface roughness to provide protection against erosion. Residue management involves tillage practices that do not turn the soil over thus burying the residue. Reduced tillage, minimum tillage, no-till, mulch till, and conservation tillage are all terms used to describe the various methods used to accomplish residue management. Other "best management practices" (BMPs) used in wind erosion prone areas include cover crops, annual or continuous cropping, and crop rotations. On irrigated land, a common practice is to irrigate soon after tillage to form a crust on the soil that reduces the potential for wind erosion. Field strip cropping systems can reduce exposed surface area by up to 50% on each field. Landscape buffers/windbreaks are likely the most expensive alternative because a series of properly spaced tree and shrub windbreaks requires the purchase of trees/shrubs and, because trees/scrubs would likely need irrigation, some infrastructure development and maintenance costs. Additionally, to be effective, it needs to be done as a system, involving multiple ownerships. The Coordinated Resource Management System approach might be used to obtain cooperation and achieve coordinated implementation. The Columbia Plateau Wind Erosion/Air Quality Project, also known as the Columbia Plateau PM_{10} Project, has conducted years of research and has produced many fine publications. The latest report, Farming with the Wind II (Special Report XB1042) was released in Feb. 2004. For more information, see: http://pnw-winderosion.wsu.edu	**EO-18**	Promote agricultural practices that are known to reduce erosion of soil by wind, thereby reducing the frequency and magnitude of dust storms	It is clear that certain agricultural practices reduce the frequency and amount of blowing dust, as well as reduce wind-caused soil erosion. Oregon Department of Agriculture should continue to work with farmers, agricultural associations, and soil and water conservation districts to further promote and implement (a) residue management, including no-till or direct seed farming; (b) cover crops and other BMPs (see below); (c) field strip cropping systems; (d) landscape buffers/windbreaks. The most commonly used practice for both wind and water erosion control is residue management. This involves leaving some or all of the residue from the previous crop on the soil surface to provide cover and surface roughness to provide protection against erosion. Residue management involves tillage practices that do not turn the soil over thus burying the residue. Reduced tillage, minimum tillage, no-till, mulch till, and conservation tillage are all terms used to describe the various methods used to accomplish residue management. Other "best management practices" (BMPs) used in wind erosion prone areas include cover crops, annual or continuous cropping, and crop rotations. On irrigated land, a common practice is to irrigate soon after tillage to form a crust on the soil that reduces the potential for wind erosion. Field strip cropping systems can reduce exposed surface area by up to 50% on each field. Landscape buffers/windbreaks are likely the most expensive alternative because a series of properly spaced windbreaks requires the purchase of trees/shrubs and, because the trees and scrubs would likely need irrigation, some infrastructure development and maintenance costs. Additionally, to be effective, it needs to be done as a system, involving multiple ownerships. The Coordinated Resource Management System approach might be used to obtain cooperation and achieve coordinated implementation. The Columbia Plateau Wind Erosion/Air Quality Project, also known as the Columbia Plateau PM_{10} Project, has conducted years of research and has produced many fine publications. The latest report, *Farming with the Wind II* (Special Report XB1042) was released in Feb. 2004. For more information, see: http://pnw-winderosion.wsu.edu	Removed.
EO-19	Encourage local jurisdictions to hold biennial volcano preparedness forums	Preparedness forums should include talks from USGS, DOGAMI, and local emergency management specialists. Preparedness and response education materials should be distributed	**136**	Each year, ask the Governor to designate May to be Volcano Awareness Month by proclamation.	Working with federal partners, such as the USGS Cascades Volcano Observatory, the state of Oregon will increase the ability for citizens to respond to volcanic eruptions by increasing the level of awareness and preparedness in the public and governmental agencies.	Revised. Ongoing.
			36	Host at least one workshop or other educational opportunity on a biennial basis in communities where a Volcano Coordination Plan has been adopted.	The State of Oregon will actively work to increase the public's knowledge of the volcano hazard in Oregon.	New. Priority.
EO-20	Continue mandatory earthquake drills for state agencies, private employers with more than 250 employees.	"Drop, cover, and hold" or other protective action is critical in reducing injury and loss of life in the workplace and home during an earthquake. The more people practice the drill, the better they will respond to a real event. State agencies are setting an example by conducting a drill annually. OAR 104, Division 20 defines the responsibilities of state and local agencies, and private sector employers with 250 or more employees to hold annual drills instructing employees on earthquake emergency procedures.	**108**	Each year, ask the Governor to designate the third Thursday of the month of October as the Great Oregon ShakeOut Day by proclamation.	Practicing to "drop, cover, and hold" is critical in reducing injury and loss of life in the workplace and home during an earthquake. The more people practice the drill, the better they will respond to a real event. A gubernatorial declaration will promote increased participation in the Great Oregon ShakeOut, or other annual earthquake Drop, Cover, and Hold On drill.	Revised. Ongoing.
			37	Achieve 100% state agency participation in the Great Oregon ShakeOut	Practicing to "drop, cover, and hold" is critical in reducing injury and loss of life in the workplace and home during an earthquake. The more people practice the drill, the better they will respond to a real event. State agencies are setting an example by conducting a drill annually. The State of Oregon will have 100% State agency participation in the Great Oregon ShakeOut and will encourage schools and universities to participate.	New. Priority.

2012 to 2015 Mitigation Action Crosswalk

2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
EO-21	Provide information to local governments regarding adoption of programs and model ordinances for mitigation of existing, hazardous, unsecured buildings elements, such as parapets	Some common building features subject to earthquake damage and corresponding safety hazards include parapets, awnings, signs, decorative features, and masonry moldings. BCD has adopted the International Building Code (IEBC) as an alternate method, which was amended to support Portland's local ordinances on seismic design requirements for existing buildings. Local governments that wish to adopt hazard mitigation standards for existing buildings as permitted by ORS 455.020(4) should follow the City of Portland's local ordinance (Chapter 24.85 Seismic Design Requirements for Existing Buildings).	**EO-21**	Provide information to local governments regarding adoption of programs and model ordinances for mitigation of existing, hazardous, unsecured buildings elements, such as parapets	Some common building features subject to earthquake damage and corresponding safety hazards include parapets, awnings, signs, decorative features, and masonry moldings. BCD has adopted the International Building Code (IEBC) as an alternate method, which was amended to support Portland's local ordinances on seismic design requirements for existing buildings. Local governments that wish to adopt hazard mitigation standards for existing buildings as permitted by ORS 455.020(4) should follow the City of Portland's local ordinance (Chapter 24.85 Seismic Design Requirements for Existing Buildings).	Removed.
EO-22	Encourage the purchase of earthquake insurance	Unlike flood insurance, which is underwritten by the U.S. Government (through the National Flood Insurance Program), earthquake insurance is offered by private sector agents and generally "packaged" as a rider to a standard homeowner or business property insurance policy. For some people, the question should not be whether or not to purchase earthquake insurance, but rather, how much to buy. For others, the decision requires a risk assessment: how likely is an earthquake?; how much damage would it inflict on one's property?; and how much can one afford to lose? Earthquake insurance rates are determined differently by each insurance company and can vary widely depending on several rating factors. Generally, older homes cost more to insure than new homes. Wood homes get better rates than brick ones because they tend to withstand earthquake stresses better. Because earthquake insurance is a type of catastrophic coverage, most policies carry a high deductible; usually anywhere from 5% to 15% of the value of a house. It is recommended that state agencies, local governments, and private sector insurance companies do a better job of promoting the purchase of earthquake insurance.	**109**	Include information about the benefits of purchasing earthquake insurance in public outreach materials and disseminate those materials through appropriate public outreach programs and venues.	Unlike flood insurance, which is underwritten by the U.S. Government (through the National Flood Insurance Program), earthquake insurance is offered by private sector agents, generally as a rider to a standard homeowner or business property insurance policy. Because earthquake insurance is a type of catastrophic coverage, most policies carry a high deductible, Oregon's Department of Consumer and Business Services Insurance Division offers information about earthquake insurance on its website and provides personal assistance through its insurance hotline. In addition, the Division is active in outreach activities, partnering with other agencies and organizations to bring insurance information to the public.	Revised. Ongoing.
EO-23	Identify an Oregon institution to host the Advanced National Seismic System (ANSS) Interpretive Center in Oregon	The August 2001 implementation plan for the ANSS Pacific Northwest Region identifies a need for an institution in Oregon to interpret ANSS Oregon earthquake data and information products for users ranging from emergency managers and news media to research scientists. This project is, in part, a USGS effort mandated by Congress, which involves the purchase, installation, monitoring, and maintenance of strong motion seismographs.	**EO-23**	Identify an Oregon institution to host the Advanced National Seismic System (ANSS) Interpretive Center in Oregon	The August 2001 implementation plan for the ANSS Pacific Northwest Region identifies a need for an institution in Oregon to interpret ANSS Oregon earthquake data and information products for users ranging from emergency managers and news media to research scientists. This project is, in part, a USGS effort mandated by Congress, which involves the purchase, installation, monitoring, and maintenance of strong motion seismographs.	Removed.
EO-24	Continue to improve the communication of historical information on stream flows during past El Niño and La Niña years to water managers throughout Oregon; historical data provides the earliest clue on where flooding may occur or where there could be water shortages.	Stream flow data from past El Niño and La Niña years can provide clues as to where the state is more likely than during an "average" year to experience water shortages or flooding. This information should be better communicated to water managers, floodplain managers, emergency managers, and others with an interest in stream flows. The apparent association of ENSO signals and streamflows shows up only in some basins and some years and thus cannot be relied on with certainty… A forecast based only on ENSO signals may be overly simplified, or in some cases, misleading. (For example) the SOI variable is significant in both the Wilson and Trask rivers but the La Niña variable is not significant in these two basins. Neither variable is significant in the Siletz (which has 60-plus years of record). Although (there is) a potential role for ENSO signals in flood planning, relevance will depend in part on the physical characteristics of individual watersheds and on the particular flow metrics of interest to floodplain managers. An apparently strong ENSO signal in a particular region may be of little use for some individual catchments in the region other factors can play major roles in whether a high flow results in a flood event. Along Oregon's coast, for example, floods in some smaller rivers that empty into bays often are caused by storm surges and high tides in concert with heavy precipitation. These surges and tides pile-up bay water and decrease the rate at which streamflows can be discharged to the open sea.	**EO-24**	Continue to improve the communication of historical information on stream flows during past El Niño and La Niña years to water managers throughout Oregon; historical data provides the earliest clue on where flooding may occur or where there could be water shortages.	Stream flow data from past El Niño and La Niña years can provide clues as to where the state is more likely than during an "average" year to experience water shortages or flooding. This information should be better communicated to water managers, floodplain managers, emergency managers, and others with an interest in stream flows. The apparent association of ENSO signals and stream flows shows up only in some basins and some years and thus cannot be relied on with certainty. A forecast based only on ENSO signals may be overly simplified, or in some cases, misleading. (For example) the SOI variable is significant in both the Wilson and Trask rivers but the La Niña variable is not significant in these two basins. Neither variable is significant in the Siletz (which has 60-plus years of record). Although (there is) a potential role for ENSO signals in flood planning, relevance will depend in part on the physical characteristics of individual watersheds and on the particular flow metrics of interest to floodplain managers. An apparently strong ENSO signal in a particular region may be of little use for some individual catchments in the region other factors can play major roles in whether a high flow results in a flood event. Along Oregon's coast, for example, floods in some smaller rivers that empty into bays often are caused by storm surges and high tides in concert with heavy precipitation. These surges and tides pile-up bay water and decrease the rate at which stream flows can be discharged to the open sea.	Removed.

2012 to 2015 Mitigation Action Crosswalk

2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
EO-25	Facilitate additional training on seismic design of structures and requirements of the State Building Code relating to hazard mitigation	Facilitate the development of training courses for individuals involved in earthquake hazard mitigation and building design, construction, and inspection. Focus on audiences that include architects, engineers, contractors and code enforcement personnel. The workshops will also provide a forum for instruction on construction and retrofitting techniques to increase the seismic resistance of existing buildings.	**EO-25**	Facilitate additional training on seismic design of structures and requirements of the State Building Code relating to hazard mitigation.	Facilitate the development of training courses for individuals involved in earthquake hazard mitigation and building design, construction, and inspection. Focus on audiences that include architects, engineers, contractors and code enforcement personnel. The workshops will also provide a forum for instruction on construction and retrofitting techniques to increase the seismic resistance of existing buildings.	Removed.
EO-26	Draft model intergovernmental agreements to establish clear definitions of assistance and authority across jurisdictional lines or when state or federal resources are needed.	Create a model mutual aid agreement to be used by state and local governments when providing assistance across jurisdiction lines. Establish additional clear guidelines when local jurisdictions need additional state, federal, or special resources.	**EO-26**	Draft model intergovernmental agreements to establish clear definitions of assistance and authority across jurisdictional lines or when state or federal resources are needed.	Create a model mutual aid agreement to be used by state and local governments when providing assistance across jurisdiction lines. Establish additional clear guidelines when local jurisdictions need additional state, federal, or special resources.	Removed.
EO-27	Support development, enhancement and implementation of local education programs designed to mitigate the wildfire hazard and to reduce wildfire losses	As part of its statewide fire prevention program, the Oregon Department of Forestry actively encourages and promotes local education and awareness programs that are designed to mitigate, or reduce the impacts of wildfires. This action reflects ODF's ongoing intentions to (a) collaborate with agencies and organizations to promote consistency in the development and application of fire prevention standards,(b) work to make individuals aware of their personal accountability and responsibility for wildfire safety, (c) determine local resources and capacity, and (d) define needs and solutions required to increase capacity. Please see Section 3 of the SNHMP for descriptions of current statewide educational programs.	**137**	Support development, enhancement, and implementation of local education programs designed to mitigate the wildfire hazard and to reduce wildfire losses, such as the Firewise Communities/NFPA Program and the annual Wildfire Awareness Week Campaign.	As part of its statewide fire prevention program, the Oregon Department of Forestry actively encourages and promotes local education and awareness programs that are designed to mitigate, or reduce the impacts of wildfires. This action reflects ODF's ongoing intentions to (a) collaborate with agencies and organizations to promote consistency in the development and application of fire prevention standards, (b) work to make individuals aware of their personal accountability and responsibility for wildfire safety, (c) determine local resources and capacity, and (d) define needs and solutions required to increase capacity.	Revised. Ongoing.
EO-28	Increase the number of local governments using the Wildfire Hazard Zone process to mitigate wildfire risk and losses	The Wildfire Hazard Zone (WHZ) process allows local governments to require the use of fire resistant roofing materials in jurisdictions assessed to be at a high risk of wildland fire. Currently, only a few eligible entities have used the WHZ process. To promote additional use, an assessment will be made of the portions of the state where it appears the WHZ process will have the greatest benefit. Following this assessment, local governments in the areas identified will be educated on the desirability of implementing the process. Those governments that express an interest in applying the process will be assisted in completing the required analysis work.	**138**	Continue to increase the number of local governments using the Wildfire Hazard Zone process to mitigate wildfire risk and losses	The Wildfire Hazard Zone (WHZ) process allows local governments to require the use of fire resistant roofing materials in jurisdictions assessed to be at a high risk of wildland fire. Currently, only a few eligible entities have used the WHZ process. To promote additional use, an assessment will be made of the portions of the state where it appears the WHZ process will have the greatest benefit. Following this assessment, local governments in the areas identified will be educated on the desirability of implementing the process. Those governments that express an interest in applying the process will be assisted in completing the required analysis work.	Revised. Ongoing.
EO-29	Increase the number of counties and communities that have current Community Wildfire Protection Plans.	The federal Healthy Forests Restoration Act (HFRA) includes statutory incentives for federal agencies to give consideration to the priorities of local communities as they develop and implement wildfire hazard mitigation projects. To become eligible for priority consideration under HFRA, a community must first prepare a Community Wildfire Protection Plan (CWPP). Most Oregon counties and many Oregon communities have completed CWPPs. To encourage the completion of additional CWPPs, as well as future updates of CWPP's counties and communities will be informed of the benefits to be gained from maintaining a CWPP and assistance will be offered to help facilitate the development and/or update of the plans.	**139**	Continue to develop and increase the number of updated Community Wildfire Protection Plans (CWPPs) with the goal of aligning CWPP updates with 5-year NHMP updates, where possible.	The federal Healthy Forests Restoration Act (HFRA) includes statutory incentives for federal agencies to give consideration to the priorities of local communities as they develop and implement wildfire hazard mitigation projects. To become eligible for priority consideration under HFRA, a community must first prepare a *Community Wildfire Protection Plan* (CWPP). Most Oregon counties and many Oregon communities have completed CWPPs. To encourage the completion of additional CWPPs, as well as future updates of CWPP's counties and communities will be informed of the benefits to be gained from maintaining a CWPP and assistance will be offered to help facilitate the development and/or update of the plans. Since the majority of Counties refer to CWPP's as their Wildfire Chapters, aligning CWPP updates with NHMP updates will ensure consistency and promote efficiencies in planning processes.	Revised. Ongoing.
EO-30	Expand the Firewise Communities/NFPA program in Oregon	The national Firewise Communities/USA recognition program promotes a self-help approach by which local communities can improve their level of protection from wildfires. Within a community, the program is started when a fire service professional provides information about how the community can successfully coexist with wildfires, explains basic fire mitigation measures, and helps to complete a community assessment of their situation. The community then uses this information to develop and carry out a mitigation plan which is tailored to its unique location and situation. Currently, several of Oregon's communities have participated in the program. More will be encouraged to do so.	**EO-30**	Expand the Firewise Communities/NFPA program in Oregon	The national Firewise Communities/USA recognition program promotes a self-help approach by which local communities can improve their level of protection from wildfires. Within a community, the program is started when a fire service professional provides information about how the community can successfully coexist with wildfires, explains basic fire mitigation measures, and helps to complete a community assessment of their situation. The community then uses this information to develop and carry out a mitigation plan which is tailored to its unique location and situation. Currently, several of Oregon's communities have participated in the program. More will be encouraged to do so.	Removed.

2012 to 2015 Mitigation Action Crosswalk

2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
EO-31	Encourage increased commercial utilization of biomass materials from wildland-urban interface areas	For a variety of reasons, vegetative fuels in and adjacent to wildland-urban interface (WUI) areas are accumulating at historically high rates. The ability to properly, cost effectively, or ecologically dispose of such fuels, as a part of a comprehensive mitigation strategy, is often limited and may even be nonexistent in some locales. One way to address this problem is to encourage increased commercial utilization of biomass materials which are created by mitigation activities in WUI areas, such as by burning to create steam and electricity (co-generation). The development of the infrastructure to support such utilization requires significant marketing and investment. Under this action item, the desirability of entering such markets will be promoted to potential developers and investors.	**EO-31**	Encourage increased commercial utilization of biomass materials from wildland-urban interface areas	For a variety of reasons, vegetative fuels in and adjacent to wildland-urban interface (WUI) areas are accumulating at historically high rates. The ability to properly, cost effectively, or ecologically dispose of such fuels, as a part of a comprehensive mitigation strategy, is often limited and may even be nonexistent in some locales. One way to address this problem is to encourage increased commercial utilization of biomass materials which are created by mitigation activities in WUI areas, such as by burning to create steam and electricity (co-generation). The development of the infrastructure to support such utilization requires significant marketing and investment. Under this action item, the desirability of entering such markets will be promoted to potential developers and investors.	Removed.
EO-32	Expand Oregon's annual Wildfire Awareness Week campaign	Creating public awareness of the need to consider and to apply wildfire mitigation actions, such as hazardous fuels removal, on privately owned lands is one of the keys to the successful implementation of a comprehensive wildfire awareness program. In recent years, the states of Oregon and Washington have jointly conducted an annual wildfire awareness campaign, early in the spring. To date, these campaigns have been relatively low-key and have had only moderate success in improving the public's awareness. Under this action item, Oregon will devote more time, energy, and money to designing and conducting an annual wildfire awareness week campaign. The goal will be to make residents more aware of the wildfire risks they face and how they can help reduce that risk.	**EO-32**	Continue Oregon's annual Wildfire Awareness Week campaign	Creating public awareness of the need to consider and to apply wildfire mitigation actions, such as hazardous fuels removal, on privately owned lands is one of the keys to the successful implementation of a comprehensive wildfire awareness program. In recent years, the states of Oregon and Washington have jointly conducted an annual wildfire awareness campaign, early in the spring. Under this action item, Oregon will devote more time, energy, and money to designing and conducting an annual wildfire awareness week campaign. The goal will be to make residents more aware of the wildfire risks they face and how they can help reduce that risk.	Revised. Removed.
EO-33	Promote the use of monies for fire prevention and wildfire mitigation projects by counties received pursuant to Title III, Section 302(5) of Public Law 106-393, or other similar federal legislation	Under the federal Secure Rural Schools and Community Self-Determination Act of 2000, counties have the ability to receive and spend federal funds for projects that educate homeowners about wildfire mitigation efforts they can apply on their property and for planning projects that increase the protection of people and property from wildfires. Under this action item, counties will be encouraged to apply for these monies and guidance will be offered on how the monies can best be applied.	**140**	Continue to provide technical assistance in accessing funding for fire prevention or wildfire mitigation projects through Title III, the National Fire Plan, or other funding mechanisms.	Under the federal *Secure Rural Schools and Community Self-Determination Act of 2000* (Title III, Section 301(5) of PL 106-393, commonly known as *Title III*), counties have the ability to receive and spend federal funds for projects that educate homeowners about wildfire mitigation efforts they can apply on their property and for planning projects that increase the protection of people and property from wildfires. National Fire Plan and other funding mechanisms may also be available for assisting communities in preventing wildfires and implementing wildfire mitigation projects.	Revised. Ongoing.
EO-34	Promote "flood fight" plans and protocols	Several State IHMT Reports call for the development of flood fight plans and protocols in advance of flood emergencies. In addition to the state agencies potentially involved in flood fighting such as OEM, WRD, and the National Guard, environmental protection and habitat conservation agencies such as DEQ and ODFW should be involved in flood fight planning. At the federal level, the U.S. Army Corps of Engineers is a key partner. These plans and protocols might include improving emergency warnings, strengthening communications systems, stockpiling needed materials, preparing procedures for emergency vehicle access to flooded areas, and other related subjects, including ongoing public education efforts.	**116**	Provide information and potentially resources to local governments for developing "flood fight" plans and protocols.	Several post-disaster mitigation strategy reports call for the development of flood fight plans and protocols in advance of flood emergencies. In addition to the state agencies potentially involved in flood fighting such as OEM and OWRD, environmental protection and habitat conservation agencies such as DEQ and ODFW should be involved in flood fight planning. At the federal level, the U.S. Army Corps of Engineers is a key partner. These plans and protocols might include improving emergency warnings, strengthening communications systems, stockpiling needed materials, preparing procedures for emergency vehicle access to flooded areas, and other related subjects, including ongoing public education efforts.	Revised. Ongoing.

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2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
EO-35	Floodplain Management Outreach	DLCD has an active floodplain and natural hazards outreach program. The department publishes and distributes newsletters and other outreach information to local governments and other interested parties. DLCD also maintains a website which includes a link to this NHMP. The natural hazards website (http://www.oregon.gov/LCD/HAZ/index.shtml) contains information and links to floodplain management information including many of the documents and booklets prepared by FEMA. DLCD uses an email distribution service for its Natural Hazard Newsletter and other correspondence. The email distribution service affords interested subscribers a greater opportunity to obtain flood management and natural hazards information from DLCD in a timely manner and for DLCD to more readily share information from a variety of sources. DLCD and other State IHMT participants also conduct or sponsor training sessions and meetings throughout the year focused on up-to-date floodplain management practices and projects. DLCD will continue to deliver focused training to surveyors, building officials, real estate agents and planners as well as local floodplain managers. The interdependent relationships among these key players in providing comprehensive floodplain management will also be highlighted during trainings. In addition to the on-going activities mentioned, DLCD will add the following to its outreach program. DLCD will prepare text for local broadcast two Public Service Announcements (PSAs) each year on a seasonal topic. DLCD will also complete and disseminate the Floodplain Management Administrative Procedures Guidebook to all 270 OR communities participating in the NFIP. This guidebook clarifies roles, responsibilities and actions to be taken by local communities. It will also be used during NFIP trainings given to local officials.	**EO-35**	Floodplain Management Outreach	DLCD has an active floodplain and natural hazards outreach program. The department publishes and distributes newsletters and other outreach information to local governments and other interested parties. DLCD also maintains a website which includes a link to this NHMP. The natural hazards website (http://www.oregon.gov/LCD/HAZ/index.shtml) contains information and links to floodplain management information including many of the documents and booklets prepared by FEMA. DLCD uses an email distribution service for its Natural Hazard Newsletter and other correspondence. The email distribution service affords interested subscribers a greater opportunity to obtain flood management and natural hazards information from DLCD in a timely manner and for DLCD to more readily share information from a variety of sources. DLCD and other State IHMT participants also conduct or sponsor training sessions and meetings throughout the year focused on up-to-date floodplain management practices and projects. DLCD will continue to deliver focused training to surveyors, building officials, real estate agents and planners as well as local floodplain managers. The interdependent relationships among these key players in providing comprehensive floodplain management will also be highlighted during trainings. In addition to the on-going activities mentioned, DLCD will add the following to its outreach program. DLCD will prepare text for local broadcast two Public Service Announcements (PSAs) each year on a seasonal topic.DLCD will also complete and disseminate the Floodplain Management Administrative Procedures Guidebook to all 270 Oregon communities participating in the NFIP. This guidebook clarifies roles, responsibilities and actions to be taken by local communities. It will also be used during NFIP trainings given to local officials.	Removed.
			117	Continue the State's active Floodplain Management Outreach Program	DLCD has an active floodplain and natural hazards outreach program. The department publishes and distributes newsletters and other outreach information to local governments and other interested parties. DLCD also maintains a website which includes a link to this NHMP. The natural hazards website (http://www.oregon.gov/LCD/HAZ/index.shtml) contains information and links to floodplain management information including many of the documents and booklets prepared by FEMA. DLCD uses an email distribution service for its Natural Hazard Newsletter and other correspondence. The email distribution service affords interested subscribers a greater opportunity to obtain flood management and natural hazards information from DLCD in a timely manner and for DLCD to more readily share information from a variety of sources.	Revised. Ongoing.
			118	Continue the State's active Floodplain Management Training Program	DLCD and other State IHMT participants conduct or sponsor training sessions and meetings throughout the year focused on up-to-date floodplain management practices and projects. DLCD will continue to deliver focused training to surveyors, building officials, real estate agents and planners as well as local floodplain managers. The interdependent relationships among these key players in providing comprehensive floodplain management will also be highlighted during trainings.	Revised. Ongoing.
			119	Prepare text for local broadcast of one Public Service Announcement (PSA) each year on a seasonal topic.	PSAs are an effective method for disseminating pertinent seasonal information about hazard preparedness and mitigation.	Revised. Ongoing.

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			D	DLCD will also disseminate the Floodplain Management Administrative Procedures Guidebook to all 270 OR communities participating in the NFIP.	This guidebook clarifies roles, responsibilities and actions to be taken by local communities. It will also be used during NFIP trainings given to local officials.	Revised. Removed.
EO-36	Develop effective means and information to minimize erosion of soils and stream banks during flood events of varying magnitude	Several State IHMT Reports call attention to the need to systematically develop means and information to help minimize the effects of erosion from farmlands, stream embankments, slide areas, farm roads, and other locales. There is a need to promote effective erosion control techniques, including bioengineering of stream banks and planting of riparian vegetation, to help preserve soils, riparian zones, and habitats. Evaluate and use post-disaster funding opportunities (such as the Hazard Mitigation Grant Program) to study the efficacy of natural, bioengineering stream bank protection strategies. Potential projects could be the outcome of these studies and proposed treatments that demonstrate cost-effective solutions. DSL is the state agency responsible for issuing the required permits for instream work, and those required to build or repair a levee. DEQ is also involved in the permitting process with help from ODFW, USACE, and the NRCS. DEQ often requires bioengineering in conjunction with the issuance of a permit. DEQ is also responsible for setting water quality standards. ODFW is involved with riparian planting and restoration projects. Various state agencies have opportunities to participate in riparian protection or erosion prevention programs, and those efforts, when taken collectively, should help the state make progress with this action.	**EO-36**	Develop effective means and information to minimize erosion of soils and stream banks during flood events of varying magnitude	Several State IHMT Reports call attention to the need to systematically develop means and information to help minimize the effects of erosion from farmlands, stream embankments, slide areas, farm roads, and other locales. There is a need to promote effective erosion control techniques, including bioengineering of stream banks and planting of riparian vegetation, to help preserve soils, riparian zones, and habitats. Evaluate and use post-disaster funding opportunities (such as the Hazard Mitigation Grant Program) to study the efficacy of natural, bioengineering stream bank protection strategies. Potential projects could be the outcome of these studies and proposed treatments that demonstrate cost-effective solutions. DSL is the state agency responsible for issuing the required permits for instream work, and those required to build or repair a levee. DEQ is also involved in the permitting process with help from ODFW, USACE, and the NRCS. DEQ often requires bioengineering in conjunction with the issuance of a permit. DEQ is also responsible for setting water quality standards. ODFW is involved with riparian planting and restoration projects. Various state agencies have opportunities to participate in riparian protection or erosion prevention programs, and those efforts, when taken collectively, should help the state make progress with this action.	Removed.
EO-37	Creation of New Lidar-Based Landslide Inventory and Susceptibility Maps, especially near population centers	DOGAMI will create these maps in cooperation with local municipalities. Specific methods and priority locations are still to be determined.	**49**	Create new lidar-based Landslide Inventory and Susceptibility Maps, especially near population centers.	DOGAMI will create these maps in cooperation with local jurisdictions. Specific methods and priority locations are still to be determined. The locations will be determined by the Oregon Landslide Workgroup (New EO-73). These new maps will enable communities to introduce development restrictions or recommend mitigation strategies in areas highly susceptible to landslides.	Revised. Priority.
			8	Create a new lidar-based statewide landslide susceptibility map.	DOGAMI will develop a statewide landslide susceptibility map of Oregon as part of the Oregon Geographic Information Council (OGIC) Framework Data Development Program. This map will be used by the Oregon Landslide Workgroup (New EO-73) to prioritize locations for more detailed Landslide Inventory and Susceptibility Maps.	New. Priority.
			13	Produce new lidar-based flood hazard maps	Lidar-based flood hazard maps are produced for counties or watershed as funding is provided. These maps have newly delineated flood zones based on new detailed studies, new coastal analysis, and/or delineation of existing zones based on new topography data (lidar). Lidar-based flood hazard maps are being produced or are anticipated to be produced for: Silvies Watershed Lower Columbia River/Sandy River Watershed Clatsop County Tillamook County Lincoln County Curry County Lane County Douglas County	New. Priority.

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2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
EO-38	Complete an evacuation mapping GIS database	With funding from the National Tsunami Hazard Mitigation Program all existing evacuation maps are being entered into a GIS database. Data collected for future maps will also be entered into the database. This will provide not only a centralized location for all the evacuation maps but the ability to make maps and permanent signs with a similar format for all coastal areas. The long-term objective is to empower users to make their own evacuation maps through an interactive web site that allows placement of the evacuation zone on a variety of base maps at any scale desired.	**EO-38**	Complete an evacuation mapping GIS database	With funding from the National Tsunami Hazard Mitigation Program all existing evacuation maps are being entered into a GIS database. Data collected for future maps will also be entered into the database. This will provide not only a centralized location for all the evacuation maps but the ability to make maps and permanent signs with a similar format for all coastal areas. The long-term objective is to empower users to make their own evacuation maps through an interactive web site that allows placement of the evacuation zone on a variety of base maps at any scale desired.	Removed.
EO-39	Encourage coastal communities to enroll in the Tsunami Ready Program.	The Tsunami Ready Program is a program sponsored by the National Weather Service that is designed to provide communities with incentives to reduce their tsunami risk. Cannon Beach was the first community for Oregon. There are currently six communities and three counties on the coast that are Tsunami Ready. Under a proposed plan through the NTHMP, three communities per year will be added to the roles of the program. This program is currently evolving through a review process being carried out by the NTHMP national Coordinating Committee. OEM is the primary point of contact for more information about the Tsunami Ready Program.	**3**	Enroll 3 coastal communities in the Tsunami Ready Program each year.	The Tsunami Ready Program is a program sponsored by the National Weather Service that is designed to provide communities with incentives to reduce their tsunami risk. Cannon Beach was the first community for Oregon. Under a proposed plan through the National Tsunami Hazard Mitigation Program (NTHMP), three communities per year will be added to the rolls of the program. This program is currently evolving through a review process being carried out by the NTHMP National Coordinating Committee. OEM is the primary point of contact for more information about the Tsunami Ready Program.	Revised. Priority.
			127	Continue to renew coastal communities' enrollments in the Tsunami Ready Program.	The Tsunami Ready Program is a program sponsored by the National Weather Service that is designed to provide communities with incentives to reduce their tsunami risk. Cannon Beach was the first community for Oregon. Under a proposed plan through the NTHMP, additional communities will be added until there is full participation. This program is currently evolving through a review process being carried out by the NTHMP National Coordinating Committee. OEM is the primary point of contact for more information about the Tsunami Ready Program.	New. Ongoing.
EO-40	Public information and education about tsunami preparedness and mitigation	Each year more people visit or move to the coast. There is thus a constant need for public education: what are the tsunami hazards, what to do in the event of a tsunami, and how to mitigate tsunami hazards. This is especially important in light of the problems some coastal counties had during the Nisqually Earthquake in Washington that was felt on the Oregon Coast and the Peru earthquake and tsunami where the Oregon Coast was twice in a tsunami watch. A systematic study of what educational strategies work the best was accomplished in a NTHMP-supported pilot study of Seaside, Oregon (see DOGAMI Open File Report O-05-10). According to polls conducted for this study, door-to-door outreach and evacuation drills were the most effective techniques. As demonstrated in the Seaside study, tsunami evacuation drills help people respond quickly and efficiently to a tsunami warning and generate local media attention to the issue. This is particularly important if a major earthquake is expected to trigger a near-source-generated tsunami. Tsunami surges may arrive within just a few minutes, so it is imperative for people to instinctively know where to evacuate to immediately after the shaking stops. Community Emergency Response Teams (CERT) are an effective means of doing door-to-door outreach and organizing evacuation drills. The long-term objective is to implement CERT in every coastal community. The Seaside format was used in Lincoln City to great success, showing the usefulness of the methods. Leveraging the various volunteers, such as CERT and Neighborhood Watch, is one of the most effective uses of scarce resources. As a result of post-disaster mitigation funding (HMGP) from DR-1964, there will be potential project opportunities to evaluate and demonstrate effective mitigation techniques that identify natural, high ground locations outside of the tsunami inundation zone as safe havens for evacuation.	**EO-40**	Public information and education about tsunami preparedness and mitigation	Each year more people visit or move to the coast. There is thus a constant need for public education: what are the tsunami hazards, what to do in the event of a tsunami, and how to mitigate tsunami hazards. This is especially important in light of the problems some coastal counties had during the Nisqually Earthquake in Washington that was felt on the Oregon Coast and the Peru earthquake and tsunami where the Oregon Coast was twice in a tsunami watch.A systematic study of what educational strategies work the best was accomplished in a NTHMP-supported pilot study of Seaside, Oregon (see DOGAMI Open File Report O-05-10). According to polls conducted for this study, door-to-door outreach and evacuation drills were the most effective techniques. As demonstrated in the Seaside study, tsunami evacuation drills help people respond quickly and efficiently to a tsunami warning and generate local media attention to the issue. This is particularly important if a major earthquake is expected to trigger a near-source-generated tsunami. Tsunami surges may arrive within just a few minutes, so it is imperative for people to instinctively know where to evacuate to immediately after the shaking stops. Community Emergency Response Teams (CERT) are an effective means of doing door-to-door outreach and organizing evacuation drills. The long-term objective is to implement CERT in every coastal community.The Seaside format was used in Lincoln City to great success, showing the usefulness of the methods. Leveraging the various volunteers, such as CERT and Neighborhood Watch, is one of the most effective uses of scarce resources.As a result of post-disaster mitigation funding (HMGP) from DR-1964, there will be potential project opportunities to evaluate and demonstrate effective mitigation techniques that identify natural, high ground locations outside of the tsunami inundation zone as safe havens for evacuation.	Removed.

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			128	Continue supporting school participation in annual tsunami evacuation drills.	Increase the ability of Oregonians to prepare for and recover from earthquakes and tsunamis on the Oregon Coast.	New. Ongoing.
			129	Continue supporting local agencies and local non-profits, such as CERT, in participating in educational efforts such as door-to-door campaigns to educate those living or working in the inundation zone on how to respond to an earthquake and tsunami.	Increase the ability of Oregonians to prepare for and recover from earthquakes and tsunamis on the Oregon Coast.	New. Ongoing.
			130	Continue innovative outreach activities, such as tsunami evacuation route fun runs.	Increase the ability of Oregonians to prepare for and recover from earthquakes and tsunamis on the Oregon Coast.	New. Ongoing.
EO-41	Coordinate an Oregon-specific distant tsunami warning workshop	The Oregon Distant Tsunami Working Group (ODTWG) is a partnership between Federal, State and Local agency representatives; local business partners and community members designed to reduce the impact of distant tsunamis on coastal Oregon communities. Led by the Oregon Office of Emergency Management (OEM), the ODTWG is Oregon's community-focused program to improve tsunami mitigation and preparedness of at-risk areas within Oregon. One goal of the Working Group will be to look at how response to a distant tsunami could be applied in the case of a local tsunami. The ODTWG includes Counties, Cities, the Oregon Office of Emergency Management, the National Weather Service, the Federal Management Agency, the Oregon Department of Geology and Mineral Industries, Media representatives and community members. This strong and active partnership enables all levels of government to work toward the common goal of saving lives of all people at risk for a tsunami at our state's coastline, and reducing damage to property and the economy.	**EO-41**	Coordinate an Oregon-specific distant tsunami warning workshop	The Oregon Distant Tsunami Working Group (ODTWG) is a partnership between Federal, State and Local agency representatives; local business partners and community members designed to reduce the impact of distant tsunamis on coastal Oregon communities. Led by the Oregon Office of Emergency Management (OEM), the ODTWG is Oregon's community-focused program to improve tsunami mitigation and preparedness of at-risk areas within Oregon. One goal of the Working Group will be to look at how response to a distant tsunami could be applied in the case of a local tsunami. The ODTWG includes Counties, Cities, the Oregon Office of Emergency Management, the National Weather Service, the Federal Management Agency, the Oregon Department of Geology and Mineral Industries, Media representatives and community members. This strong and active partnership enables all levels of government to work toward the common goal of saving lives of all people at risk for a tsunami at our state's coastline, and reducing damage to property and the economy.	Removed.
EO-42	Develop evacuation maps for all affected communities with established assembly areas	The key to effective tsunami mitigation is to insure that people know what to do and where to go in the event of a tsunami. Evacuation maps that are consistent and easy to read and that identify the safe areas, best evacuation routes and destination sites are critical. With the development of the GIS database the maps can be easily disseminated	**EO-42**	Develop tsunami evacuation maps for all affected communities with established assembly areas	The key to effective tsunami mitigation is to insure that people know what to do and where to go in the event of a tsunami. Evacuation maps that are consistent and easy to read and that identify the safe areas, best evacuation routes and destination sites are critical. With the development of the GIS database the maps can be easily disseminated.	Removed.
EO-43	Encourage local jurisdictions to disseminate volcano preparedness educational materials	Preparedness materials should include what to do in the event of an eruption, evacuation maps, and volcano specific items to include in first aid kits (e.g., breathing masks and goggles). The USGS and FEMA have existing educational materials.	**67**	Initiate an outreach strategy to encourage local jurisdictions to disseminate volcano preparedness educational materials.	Increase the ability of Oregonians to prepare for and recover from volcanic hazards.	Revised. Priority.
EO-44	Install tsunami signs in all affected coastal communities	Signs reinforce the evacuation maps and tsunami educational materials and are a very visible reminder of the tsunami hazard, where the hazard zone is and where the best evacuation routes are. A few communities have already installed hazard zone and evacuation route signs. Many counties have signs, but are waiting either for the time and/or money or development of evacuation maps before installing them. Robust signage that delineates evacuation routes leading to natural, high ground outside of the tsunami inundation zone is a low-cost, top mitigation priority.	**EO-44**	Install tsunami signs in all affected coastal communities	Signs reinforce the evacuation maps and tsunami educational materials and are a very visible reminder of the tsunami hazard, where the hazard zone is and where the best evacuation routes are. A few communities have already installed hazard zone and evacuation route signs. Many counties have signs, but are waiting either for the time and/or money or development of evacuation maps before installing them. Robust signage that delineates evacuation routes leading to natural, high ground outside of the tsunami inundation zone is a low-cost, top mitigation priority.	Revised. Removed.

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EO-45	Encourage local emergency managers with potential volcanic hazards to include volcanoes in their response and natural hazards mitigation plans	State and local emergency managers plan responses for a variety of hazards, including volcanoes. Clackamas County, which includes the southwest portion of Mount Hood, was the first jurisdiction in the nation to complete a FEMA-approved natural hazards mitigation plan, which includes short and long-term proposed actions to mitigate the effects of volcanic eruptions. Local response plan chapters (annexes) developed for volcanic hazards should include pre-eruption through post-eruption sections.	**EO-45**	Encourage local emergency managers with potential volcanic hazards to include volcanoes in their response and natural hazards mitigation plans	State and local emergency managers plan responses for a variety of hazards, including volcanoes. Clackamas County, which includes the southwest portion of Mount Hood, was the first jurisdiction in the nation to complete a FEMA-approved natural hazards mitigation plan, which includes short and long-term proposed actions to mitigate the effects of volcanic eruptions. Local response plan chapters (annexes) developed for volcanic hazards should include pre-eruption through post-eruption sections.	Removed.
EO-46	Encourage development of volcanic hazard evacuation maps	Volcanic eruptions often produce lahars that travel down river valleys. Evacuation maps should include the hazard area as well as preferred evacuation routes and evacuation sites. USGS staff should support local and state agencies in this effort.	**135**	Develop volcanic hazard evacuation maps	Volcanic eruptions often produce lahars that travel down river valleys. Evacuation maps should include the hazard area as well as preferred evacuation routes and evacuation sites. USGS staff should support local and state agencies in this effort.	Revised. Ongoing.
EO-47	Encourage communities to include volcano hazards, if appropriate, in their multi-hazard mitigation planning process	How a community might respond to volcano hazards depends on a number of things including proximity of the community to the volcano, the nature of the volcano hazards, local volcano history, what is at risk/vulnerable to volcano hazards, and the probability of when or if an event might occur. The difficulty in predicting how catastrophic volcano-associated hazards might be and how often they might occur creates a problem for land use planning solutions. Except for a few Oregon communities on or very near a volcano (e.g., Government Camp on Mount Hood), stringent standards solely based on the prospect of volcanic activity are not realistic. The best approach may be multi-hazards instead of treating volcano-associated hazards separately. A multi-hazard approach would take all natural hazards into consideration during a community's planning process. For example, prohibiting development in the 100-year (1%) floodplain ensures some degree of safety from flood, lahars, earthquake damage (e.g., liquefiable soils), and so on, while preserving the floodplain for natural and beneficial uses. In addition, siting standards for infrastructure and/or critical facilities would include volcano-associated hazards among other hazards to be avoided. DOGAMI published two special papers to help communities look at multi-hazard mitigation: Special Paper 31, *Mitigating Geologic Hazards in Oregon: a Technical Reference Manual* (Beaulieu and Olmstead, 1999a) and Special Paper 32, *Geologic Hazards: Reducing Oregon's Losses* (Beaulieu and Olmstead, 1999b). These publications have been widely distributed to local governments. Secondary effects also need to be incorporated into the multi-hazard framework. These effects include degradation or loss of habitat for endangered species (or species that may become endangered after a major eruption), the economic loss if timber resources are destroyed or made inaccessible, and the loss of surface water as a source of drinking water, irrigation, or for industrial needs. Each of these can have a long-lasting economic effect on Oregonians as well as create physical changes in the landscape made by an eruption.	**EO-47**	Encourage communities to include volcano hazards, if appropriate, in their multi-hazard mitigation planning process	How a community might respond to volcano hazards depends on a number of things including proximity of the community to the volcano, the nature of the volcano hazards, local volcano history, what is at risk/vulnerable to volcano hazards, and the probability of when or if an event might occur.The difficulty in predicting how catastrophic volcano-associated hazards might be and how often they might occur creates a problem for land use planning solutions. Except for a few Oregon communities on or very near a volcano (e.g., Government Camp on Mount Hood), stringent standards solely based on the prospect of volcanic activity are not realistic. The best approach may be multi-hazards instead of treating volcano-associated hazards separately. A multi-hazard approach would take all natural hazards into consideration during a community's planning process. For example, prohibiting development in the 100-year (1%) floodplain ensures some degree of safety from flood, lahars, earthquake damage (e.g., liquefiable soils), and so on, while preserving the floodplain for natural and beneficial uses. In addition, siting standards for infrastructure and/or critical facilities would include volcano-associated hazards among other hazards to be avoided. DOGAMI published two special papers to help communities look at multi-hazard mitigation: Special Paper 31, *Mitigating Geologic Hazards in Oregon: a Technical Reference Manual* (Beaulieu and Olmstead, 1999a) and Special Paper 32, *Geologic Hazards: Reducing Oregon's Losses* (Beaulieu and Olmstead, 1999b). These publications have been widely distributed to local governments. Secondary effects also need to be incorporated into the multi-hazard framework. These effects include degradation or loss of habitat for endangered species (or species that may become endangered after a major eruption), the economic loss if timber resources are destroyed or made inaccessible, and the loss of surface water as a source of drinking water, irrigation, or for industrial needs. Each of these can have a long-lasting economic effect on Oregonians as well as create physical changes in the landscape made by an eruption.	Removed.

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2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
EO-48	Educate communities, workers, and the public about the role of proper tree pruning and care in preventing damage during windstorms	Arboricultural groups, public agencies, and utilities should cooperate in promoting proper tree pruning and care practices that can reduce the risk of tree failure and property damage. Common messages refined by state level entities such as the Oregon Department of Forestry (ODF) and OSU Extension can help provide continuity and efficiency across the state. While implementation of this action largely takes place at the local government level, the state has a role in encouraging and providing incentives for best management practices. ODF maintains and implements a communication plan that includes educational initiatives aimed at improving tree health in cities. This includes a variety of products, including a bimonthly newsletter, a website, and brochures that help convey these messages. State and local cooperators should: • Provide training to crews working on power lines in worker safety and the identification of trees to prune or remove; • Review regulations and standards for easement and right of way maintenance, and provide training to foresters and logging crews; and • Instruct homeowners in pruning of vegetation, tree care safety, and proper tree care for trees bordering utility corridors and public rights of way.	**146**	Continue to educate communities, workers, and the public about the role of proper tree pruning and care in preventing damage during windstorms.	Arboricultural groups, public agencies, and utilities should cooperate in promoting proper tree pruning and care practices that can reduce the risk of tree failure and property damage. Common messages refined by state level entities such as the Oregon Department of Forestry (ODF) and OSU Extension can help provide continuity and efficiency across the state. While implementation of this action largely takes place at the local government level, the state has a role in encouraging and providing incentives for best management practices. ODF maintains and implements a communication plan that includes educational initiatives aimed at improving tree health in cities. This includes a variety of products, including a bimonthly newsletter, a website, and brochures that help convey these messages. OSHA requires utilities to: • Provide training to crews working on power lines in worker safety and the identification of trees to prune or remove; and • Review regulations and standards for easement and right of way maintenance, and provide training to foresters and logging crews. Utilities should instruct homeowners in pruning of vegetation, tree care safety, and proper tree care for trees bordering utility corridors and public rights of way.	Revised. Ongoing.
EO-49	Educate motorists on safe winter driving	Actions such as sanding, applying de-icing chemicals, and snowplowing do not make the road safe. Motorists must drive at speeds appropriate for the weather and road conditions.	**149**	Continue educating motorists on safe winter driving, including how to be prepared for traveling over snowy and icy mountain passes.	Actions such as sanding, applying de-icing chemicals, and snowplowing do not make the road safe. Motorists must drive at speeds appropriate for the weather and road conditions, and be prepared to handle adverse conditions. Many drivers do not carry chains and do not know how or simply do not install them when conditions warrant. Also, many drivers are not prepared for a long wait in their car. Education programs would help save lives on snowy and icy roads.	Revised. Ongoing.
EO-50	Encourage citizens to prepare and maintain 72-hour kits	State agencies should work with the American Red Cross and local emergency managers to encourage citizens to be prepared to survive on their own for 72 hours.	**88**	Encourage citizens to prepare and maintain at least two weeks' worth of emergency supplies.	State agencies should work with the American Red Cross and local emergency managers to encourage citizens to be prepared to survive on their own for at least two weeks.	Revised. Ongoing.
EO-51	Educate citizens about the different National Weather Service announcements	State agencies should work with the National Weather Service and local governments to educate the public about the meaning of the different National Weather Service announcements: winter storm watch, winter storm warning, ice storm warning, heavy snow warning, blizzard warning, severe blizzard warning, and high wind warning.	**95**	Educate citizens about the different National Weather Service announcements.	State agencies should work with the National Weather Service and local governments to educate the public about the meaning of the different National Weather Service announcements: winter storm watch, winter storm warning, ice storm warning, heavy snow warning, blizzard warning, severe blizzard warning, dust storm and high wind warning.	Ongoing.
EO-52	Educate citizens about safe emergency heating equipment	Improper use of alternate heat sources during winter storms can cause fires. Ongoing efforts of the Office of State Fire Marshal and it's work with local fire departments through the Life Safety Team (http://www.oregon.gov/OSP/SFM/CommEd_OLST.shtml) In addition, people can be killed by carbon monoxide emitted by fuels such as charcoal briquettes when used for heating homes. To reduce the threat of carbon monoxide poisoning, known as the silent killer, the 2009 Legislature passed HB3450A requiring landlords to install carbon monoxide alarms in rentals with a carbon monoxide source and homeowners must ensure they are installed in homes at the time of sale, if the home has a source. Sources include gas heating or fireplaces, wood-burning fireplaces or stoves, and attached garages. Partnerships for consistent public education messages and outreach are underway, and will include information on the dangers of introducing a carbon monoxide risk.	**148**	Educate citizens about safe emergency heating equipment.	Improper use of alternate heat sources during winter storms can cause fires. Ongoing efforts of the Office of State Fire Marshal and it's work with local fire departments through the Life Safety Team (http://www.oregon.gov/OSP/SFM/Pages/CommEd_OLST.aspx). In addition, people can be killed by carbon monoxide emitted by fuels such as charcoal briquettes when used for heating homes. To reduce the threat of carbon monoxide poisoning, known as the silent killer, the 2009 Legislature passed HB 3450A requiring landlords to install carbon monoxide alarms in rentals with a carbon monoxide source and homeowners must ensure they are installed in homes at the time of sale, if the home has a source. Sources include gas heating or fireplaces, wood-burning fireplaces or stoves and attached garages. Partnerships for consistent public education messages and outreach are underway, and will include information on the dangers of introducing a carbon monoxide risk.	Ongoing.
EO-53	Educate citizens about ways to weatherize their homes	Weatherization measures can help keep the cold out during winter. Energy audits, cash rebates, and tax credits are available to help homeowners.	**EO-53**	Educate citizens about ways to weatherize their homes.	Weatherization measures can help keep the cold out during winter. Energy audits, cash rebates, and tax credits are available to help homeowners. Energy audits, cash rebates, and education are also provided by the Energy Trust of Oregon to customers of the regulated energy utilities with oversight by the OPUC.	Revised. Removed.

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2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
EO-54	Educate citizens about the dangers of hypothermia, other winter health conditions	State agencies should work with the American Red Cross and local health authorities to educate citizens about the dangers of winter health conditions, including hypothermia, exhaustion, and heart attacks caused by overexertion.	**EO-54**	Educate citizens about the dangers of hypothermia and other winter health conditions.	State agencies should work with the American Red Cross and local health authorities to educate citizens about the dangers of winter health conditions, including hypothermia, exhaustion, and heart attacks caused by overexertion.	Removed.
EO-55	Educate homeowners about choosing ice and windstorm-resistant trees and landscaping practices to reduce tree-related hazards in future ice storms	Trees that don't stand up well to ice and wind, especially when planted near power lines, can cause power outages and other damage. Certain species of trees hold up better to winter's fury than others. Other factors, such as where a tree is planted and use of proper pruning techniques, can also help trees be more resistant to ice storm damage.	**99**	Educate homeowners about choosing ice and windstorm-resistant trees and landscaping practices to reduce tree-related hazards in future ice storms	Trees that don't stand up well to ice and wind, especially when planted near power lines, can cause power outages and other damage. Certain species of trees hold up better to winter's fury than others. Other factors, such as where a tree is planted and use of proper pruning techniques, can also help trees be more resistant to ice storm damage.	Ongoing.
EO-56	Educate motorists who plan to travel over mountain passes in winter about the need to be prepared	During the December 2003 closure of the Siskiyou Pass on I-5, ODOT and Oregon State Police freed many drivers only to have them spin out and get stuck again. If drivers would have had tire chains, and installed them when conditions warranted, clearing the pass would have been completed hours earlier. Many drivers were not prepared for a long wait in their car. Each year ODOT finds stranded motorists who either do not have or do not know how to install chains.	**EO-56**	Educate motorists who plan to travel over mountain passes in winter about the need to be prepared	During the December 2003 closure of the Siskiyou Pass on I-5, ODOT and Oregon State Police freed many drivers only to have them spin out and get stuck again. If drivers would have had tire chains, and installed them when conditions warranted, clearing the pass would have been completed hours earlier. Many drivers were not prepared for a long wait in their car. Each year ODOT finds stranded motorists who either do not have or do not know how to install chains.	Removed.
EO-57	Improve geotechnical report standards	Numerous local jurisdictions have upgraded the geotechnical report standards for assessing the risk and mitigation measures for development proposed in hazardous areas, and continue to encourage local governments to improve these standards.	**EO-57**	Improve geotechnical report standards for the coast.	Numerous local jurisdictions have upgraded the geotechnical report standards for assessing the risk and mitigation measures for development proposed in coastal hazard area.	Revised. Removed.
EO-58	Maintain an inventory of shoreline protection structures	Maintain an inventory of existing and new coastal engineering (shore protection) structures on the Oregon Coast.	**104**	Maintain the updated inventory of shoreline protection structures.	Maintain the inventory of existing and new coastal engineering (shore protection) structures on the Oregon Coast in order to provide local governments and applicable agencies an important coastal management tool to address anticipated increasing coastal erosion. It is anticipated that this inventory and information will assist in potential future policy changes to address a changing climate and associated coastal erosion impacts.	Revised. Ongoing.
EO-59	Improve coastal erosion hazard mapping and inventories	Coastal hazard mapping is a long-term program for four reasons. One is budgetary. It is expensive to research and map information for such a dynamic system. Another reason is the dynamic nature of the Oregon coast. Beaches, dunes, and headlands change over relatively short (and longer) time spans. As headlands recede, for example, new maps with new shorelines and erosion rates need to be developed. New technology is the third reason. For example, the tsunami maps issued by DOGAMI are created with the help of sophisticated computer models and high resolution digital elevation models that were not available until a few years ago. Finally, different uses require maps of different scales. Mapping is one element needed in an inventory. Progress is being made by DOGAMI and DLCD to increase assistance to local governments in developing inventories based on sound technological research (Figure CE-6). While this process takes significant time to complete, there are a variety of strategies local governments and state agencies can use: • Inventory and catalog existing coastal natural hazards, studies, maps, digital data, and other information available from city, county, state, federal, university, private, and other resources. • Establish criteria and standards for collecting, reporting, and mapping information about chronic and catastrophic coastal natural hazards. • Develop standardized, detailed coastal hazard maps for priority areas along the Oregon Coast.	**EO-59**	Improve coastal erosion hazard mapping and inventories	Coastal hazard mapping is a long-term program for four reasons. One is budgetary. It is expensive to research and map information for such a dynamic system. Another reason is the dynamic nature of the Oregon coast. Beaches, dunes, and headlands change over relatively short (and longer) time spans. As headlands recede, for example, new maps with new shorelines and erosion rates need to be developed. New technology is the third reason. For example, the tsunami maps issued by DOGAMI are created with the help of sophisticated computer models and high resolution digital elevation models that were not available until a few years ago. Finally, different uses require maps of different scales. Mapping is one element needed in an inventory. Progress is being made by DOGAMI and DLCD to increase assistance to local governments in developing inventories based on sound technological research (Figure CE-6). While this process takes significant time to complete, there are a variety of strategies local governments and state agencies can use: • Inventory and catalog existing coastal natural hazards, studies, maps, digital data, and other information available from city, county, state, federal, university, private, and other resources. • Establish criteria and standards for collecting, reporting, and mapping information about chronic and catastrophic coastal natural hazards. • Develop standardized, detailed coastal hazard maps for priority areas along the Oregon Coast.	Removed.

2012 to 2015 Mitigation Action Crosswalk

2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
EO-60	Better understand beach processes	As recent research has shown, ocean water levels and wave dynamics along the Oregon coast are changing. These will, in turn, affect beach sand budgets and rates of erosion. More research must be done on alternative shore protection methods, effects of hard shore protection structures, near-shore circulation processes and sediment budgets, sea cliff erosion processes, and other hazard processes. In addition to the state agencies below, NOAA and USACE will play a role in advancing this action.	**EO-60**	Better understand beach processes by developing a coastal geomorphic database.	Develop a coastal geomorphic database that describes the various morphological parameters of beaches, dunes, and bluffs present along the central to northern Oregon coast, specifically in Clatsop and Tillamook Counties.	Revised. Removed.
			102	Research the effects of changing ocean water levels and wave dynamics along the central and southern Oregon coast, and use that data to augment the coastal geomorphic database.	As recent research has shown, ocean water levels and wave dynamics along the Oregon coast are changing. These will, in turn, affect beach sand budgets and rates of erosion. More research must be done on alternative shore protection methods, effects of hard shore protection structures, near-shore circulation processes and sediment budgets, sea cliff erosion processes, and other hazard processes	Revised. Ongoing.
EO-61	Mandate review for site-specific seismic hazard reports	Independent peer review by qualified and registered geotechnical and engineering geologic professionals is one of the best methods of ensuring that site reports done for local governments, property owners, developers, and others are of an acceptable quality and adequately address site issues associated with earthquake faults and earthquake-caused ground failures. A mandatory review requirement and funding/cost recovery mechanism are needed.	**EO-61**	Mandate review for site-specific seismic hazard reports	Independent peer review by qualified and registered geotechnical and engineering geologic professionals is one of the best methods of ensuring that site reports done for local governments, property owners, developers, and others are of an acceptable quality and adequately address site issues associated with earthquake faults and earthquake-caused ground failures. A mandatory review requirement and funding/cost recovery mechanism are needed.	Removed.
EO-62	Install new Entering and Leaving Tsunami Hazard Zone signs in selected areas in the inundation zone along US-101.	Existing tsunami hazard zones signs are considered inadequate for placement along stretches of US-101, or on any roads, that are within the tsunami hazard zone. A single tsunami hazard zone sign will not indicate the boundaries of the inundation zone. US-101 often stays within the inundation zone for miles. Therefore ODOT, in collaboration with OEM, DOGAMI, and the coastal county emergency managers, designed the template for Entering and Leaving Tsunami Hazard Zone signs and placed the signs to identify the hazard zones. Resources for this project were limited, so signs are not present in every hazardous part of the coast highway system. A long-term goal is to complete this project and to reposition signs where new inundation mapping indicates a need. There is need for increased public education program to let the public, including motorists who are not local residents, know what the signs mean and what actions they should take. Additional/improved signage is proposed to reflect changes in maps by 2015.	**EO-62**	Install new Entering and Leaving Tsunami Hazard Zone signs in selected areas in the inundation zone along US-101.	Existing tsunami hazard zones signs are considered inadequate for placement along stretches of US-101, or on any roads, that are within the tsunami hazard zone. A single tsunami hazard zone sign will not indicate the boundaries of the inundation zone. US-101 often stays within the inundation zone for miles. Therefore ODOT, in collaboration with OEM, DOGAMI, and the coastal county emergency managers, designed the template for Entering and Leaving Tsunami Hazard Zone signs and placed the signs to identify the hazard zones. Resources for this project were limited, so signs are not present in every hazardous part of the coast highway system. A long-term goal is to complete this project and to reposition signs where new inundation mapping indicates a need. There is need for increased public education program to let the public, including motorists who are not local residents, know what the signs mean and what actions they should take. Additional/improved signage is proposed to reflect changes in maps by 2015.	Removed.
			132	Work with ODOT to replace or move existing Entering/Leaving Tsunami Hazard Zone signs to correspond with the XXL inundation line developed by DOGAMI.	Existing tsunami hazard zones signs are considered inadequate for placement along stretches of US-101, or on any roads, that are within the tsunami hazard zone. A single tsunami hazard zone sign will not indicate the boundaries of the inundation zone. Tsunami Hazard Zone signs should be located to correspond with the XXL inundation line developed by DOGAMI.	Revised. Ongoing.
			133	Work with ODOT to develop additional signage as needed to increase awareness of the tsunami hazard.	Existing tsunami hazard zones signs are considered inadequate for placement along stretches of US-101, or on any roads, that are within the tsunami hazard zone. A single tsunami hazard zone sign will not indicate the boundaries of the inundation zone. There is need for increased public education program to let the public, including motorists who are not local residents, know what the signs mean and what actions they should take.	New. Ongoing.
			134	Work with Oregon Parks & Recreation Department and Oregon Travel Experience to increase the number of interpretive educational installations along US-101.	Existing tsunami hazard zones signs are considered inadequate for placement along stretches of US-101, or on any roads, that are within the tsunami hazard zone. There is need for increased public education program to let the public, including motorists who are not local residents, know what the signs mean and what actions they should take.	New. Ongoing.

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2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
			113	Monitor the effectiveness of the statewide strategy to encourage the purchase of flood insurance by demonstrating that the number of flood insurance policies held throughout the state continues to increase.	Despite the statewide availability of flood insurance, coverage in place in most communities in Oregon varies from 10% to 20% of the homes and businesses located in the Special Flood Hazard Area (100-year floodplain). Not only does flood insurance reduce the financial vulnerability of individuals, families, businesses, government agencies, other organizations, and the community to the costs posed by flooding, but through the "increased cost of compliance" provision of flood insurance, it also provides funding for the elevation, flood-proofing, demolition, or relocation of homes and businesses when required due to "substantial damage" to the structure.	New. Ongoing.
			69	Update the 2000 Guidelines for conducting site-specific geohazard investigations.	The state has guidelines for conducting site-specific seismic investigations. The guidelines date from 2000 and need to be updated. The update should expand the scope of the guidelines to cover site-specific investigations for all geohazards. This will improve local government implementation of development regulations in areas subject to geohazards.	New. Priority.
			21	Update the inventory of shoreline protective structures.	Update the inventory of existing and new coastal engineering (shore protection) structures on the Oregon Coast in order to provide local governments and applicable agencies an important coastal management tool to address anticipated increasing coastal erosion.	New. Priority.
			E	Refine coastal erosion risk mapping for Tillamook County and its cities to use a fully probabilistic approach.	Revise coastal erosion risk mapping and analysis for Tillamook County, and cities within the County, to use a fully probabilistic approach. Probabilistic modeling approaches will be used to better address uncertainty and allow local and state hazard managers to use the information to better manage uses based on relative risks. This will allow DLCD and DOGAMI to increase assistance to local governments in developing inventories based on sound technological research and in incorporating this information into their coastal management programs.	New. Removed.
			F	Establish Base Flood Elevation Determination Service	Establish state-approved service to provide Base Flood Elevations to surveyors for the purpose of completing Letters of Map Amendment under the National Flood Insurance Program. Base Flood Elevations are determined by DOGAMI by producing hydraulic models based on lidar topographic data. This is useful in areas where Base Flood Elevations have not been determined by FEMA, though Special Flood Hazard Areas have been mapped.	New. Removed.
			14	Create an informational website for the new Base Flood Elevation Determination Service.	Create website that describes the state's base Flood Elevation Determination Service. Website will include brochure, pricing, map of completed determinations, and data clearinghouse for completed determinations.	New. Priority.
			28	Establish a web page where building owners can register their interest in participating in acquisition programs for flood-damaged buildings.	FEMA funds can be used to buyout repetitive loss and severe repetitive loss properties in the floodplain. The paperwork and process to achieve a buyout are lengthy and complex. First and foremost, a property owner must be willing to sell. Buyout funds could be more efficiently and effectively spent if willing sellers were identified and paperwork prepared before funds became available. This registry would augment the state's current outreach efforts, making it easy for willing sellers to identify themselves and for the state to prepare for and execute buyouts.	New. Priority.
			57	Prepare model coordination protocols for local Floodplain Managers and Building Officials.	Local government Floodplain Managers and Building Officials are often unaware of the other's role in floodplain management and how they could work together to better manage floodplain development and mitigate flood hazards. Providing model protocols for the two positions to coordinate would increase each one's awareness of the other's role, ultimately enhancing local flood hazard mitigation.	New. Priority.

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2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
			51	Facilitate self-sustaining outreach programs staffed by Community Emergency Response Teams (CERT) in each coastal population center aimed at creating a culture of preparedness and response for both local Cascadia and distant tsunami events.	Establish Community Emergency Response Teams (CERT). These teams will work to save lives and restore communities following a major disaster. Encourage CERT to use outreach techniques tested in a 2005 pilot study of Seaside (#1 priority = door-to-door education; #2 priority = community evacuation drill; #3 = K-12 education supplemented by workshops targeted at specific user groups such as the lodging industry). Create measures of sustainability and success.	New. Priority.
			6	Form an Oregon Landslide Workgroup.	An Oregon Landslide Workgroup will be created to prioritize areas for new mapping projects, to promote landslide hazard awareness through education & outreach, to develop and influence policy at the federal state, and local levels, and to assist in response & recovery efforts during disasters.	New. Priority.
			9	Upgrade the Oregon Landslide Warning System.	The current warning system needs updating to include rainfall thresholds from local rainfall gauges. A permanent real-time website will be constructed to show the areas under a landslide warning that will include guidance on what people should do to help protect their life and property from a landslide.	New. Priority.
			100	Each year, ask the Governor to designate October to be Earthquake and Tsunami Awareness Month.	Practicing to "Drop, cover, and hold" is critical in reducing injury and loss of life in the workplace and home during an earthquake. The more people practice the drill, the better they will respond to a real event. A gubernatorial declaration will promote increased participation in the Great Oregon ShakeOut, or other annual earthquake Drop, Cover, and Hold On drill.	New. Ongoing.

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2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
CRITICAL INFRASTRUCTURE / ESSENTIAL PUBLIC FACILITIES						
CI-1*	Complete a statewide evaluation of the condition of levees, dikes, and dams built for flood control purposes	Several reports indicate a broad need to assess the capabilities, conditions, and maintenance of levees statewide to assess performance under flood conditions. As part of the FIRM modernization program, FEMA identified 12 levees in Oregon that are mapped as providing protection against flood waters, but may in fact be deficient. FEMA asked affected communities to complete an accreditation process to prove the levees are capable of controlling the 1% annual flood before they can be shown as providing protection against the 1% annual flood on the FIRM. Five communities managed to complete the accreditation The levees identified by FEMA by no means reflect the full inventory of levees in the state that provide flood protection, but which may be insufficiently or improperly maintained. Many of these levees are privately owned. One of the challenges identified during FEMA accreditation process was confusion over what kind of vegetation is appropriate to allow on levees and how it should be maintained. This is not a new concern. DEQ, ODFW, USACE, and other agencies have been discussing development of a guidance document on preferred levee types and appropriate use of vegetation. At a minimum, the federal agencies NRCS and USACE should be involved with the state agencies noted below in implementing this action item. Dams present another challenge. Regardless of whether a particular dam was designed and built for flood control, the presence of any large dam will serve to reduce the peak flow in the downstream river channel to some degree. Typically, the larger the structure, the greater the corresponding effects of reservoir flood routing and the greater the perceived reduction in short-term or periodic flooding. In Oregon, there are many examples of areas below such dams where development has encroached upon riparian areas that formerly were subject to periodic flooding. However, it is important to realize that long-term reduction in downstream flooding does not exist below most such dams. Runoff from large storms may need to be passed downstream to avoid the potential for dam failure. This sudden release of water may prove very damaging to downstream life and property. All dams and reservoirs which would likely result in direct loss of life in the event of failure and the associated sudden release of water are defined as "high hazard" structures. Maps illustrating the zone of downstream inundation area are required to be produced for these structures. The inundation zone shows the physical boundaries, water depths, and arrival times associated with the projected flood wave. Existing "high hazard" dams that have inundation maps will be inventoried and copies of these maps provided to local emergency managers for incorporation into local mitigation plans. High priority must be given to inundation mapping for existing "high hazard" dams that do not currently have inundation maps.	**CI-1***	Complete a statewide evaluation of the condition of levees, dikes, and dams built for flood control purposes	Several reports indicate a broad need to assess the capabilities, conditions, and maintenance of levees statewide to assess performance under flood conditions. As part of the FIRM modernization program, FEMA identified 12 levees in Oregon that are mapped as providing protection against flood waters, but may in fact be deficient. FEMA asked affected communities to complete an accreditation process to prove the levees are capable of controlling the 1% annual flood before they can be shown as providing protection against the 1% annual flood on the FIRM. Five communities managed to complete the accreditation The levees identified by FEMA by no means reflect the full inventory of levees in the state that provide flood protection, but which may be insufficiently or improperly maintained. Many of these levees are privately owned. One of the challenges identified during FEMA accreditation process was confusion over what kind of vegetation is appropriate to allow on levees and how it should be maintained. This is not a new concern. DEQ, ODFW, USACE, and other agencies have been discussing development of a guidance document on preferred levee types and appropriate use of vegetation. At a minimum, the federal agencies NRCS and USACE should be involved with the state agencies noted below in implementing this action item. Dams present another challenge. Regardless of whether a particular dam was designed and built for flood control, the presence of any large dam will serve to reduce the peak flow in the downstream river channel to some degree. Typically, the larger the structure, the greater the corresponding effects of reservoir flood routing and the greater the perceived reduction in short-term or periodic flooding. In Oregon, there are many examples of areas below such dams where development has encroached upon riparian areas that formerly were subject to periodic flooding. However, it is important to realize that long-term reduction in downstream flooding does not exist below most such dams. Runoff from large storms may need to be passed downstream to avoid the potential for dam failure. This sudden release of water may prove very damaging to downstream life and property. All dams and reservoirs which would likely result in direct loss of life in the event of failure and the associated sudden release of water are defined as "high hazard" structures. Maps illustrating the zone of downstream inundation area are required to be produced for these structures. The inundation zone shows the physical boundaries, water depths, and arrival times associated with the projected flood wave. Existing "high hazard" dams that have inundation maps will be inventoried and copies of these maps provided to local emergency managers for incorporation into local mitigation plans. High priority must be given to inundation mapping for existing "high hazard" dams that do not currently have inundation maps.	Removed.
			79	Continue to refine statewide natural hazard identification and characterization.	The Oregon NHMP identifies the types of natural hazards affecting Oregon, their geographic extent, history and probability of occurrence, and as they may be affected by climate change. Throughout the life of the Plan, new and continuing research studies and projects provide new data and analysis, improving our ability to identify and understand Oregon's natural hazards and their probability of occurrence. To advance hazard mitigation in Oregon, it is important for the State to plan, budget, and take advantage of opportunities that arise for continued research and new studies to enhance our knowledge of Oregon's natural hazards.	Revised. Ongoing.

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2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
			CI-1B	Complete statewide tsunami hazard identification.	Identify local and distant tsunami inundation zones.	Revised. Removed.
			80	Continue to refine the State's risk assessment methodology and statewide assessments of natural hazard exposure, vulnerability, and potential losses.	At the core of the Oregon NHMP is a statewide risk assessment of exposure and vulnerability, and an estimate of potential dollar losses to state-owned/leased buildings, infrastructure, and critical or essential facilities from natural hazard events. Schools, emergency facilities, water and waste water, dams and levees, transportation, telecommunications, and energy facilities are examples of structures, infrastructure, and facilities that could be exposed and vulnerable to natural hazards. Other examples include populations, businesses, and industries. At this time, the state does not have a standardized risk assessment methodology across all hazards at the state and local levels. To advance hazard mitigation in Oregon, it is important for the State to plan, budget, and take advantage of opportunities that arise for continued enhancement of the risk assessment, better enabling limited mitigation resources to be directed to the areas that most need them.	Revised. Ongoing.
			81	Continue to refine statewide identification and prioritization of the greatest risks from and communities most vulnerable to Oregon's natural hazards.	Identifying and prioritizing the greatest risks from and communities most vulnerable to natural hazard events will enable the state to leverage its limited mitigation resources in ways that efficiently protect life, property, and the environment from natural hazard events and facilitate recovery.	Revised. Ongoing.
			82	Continue to develop and implement resilience initiatives statewide.	Natural hazard mitigation is a fundamental element of resilience. It is important for the state to plan, budget, and partner with other public and private entities to alleviate potential damage from natural hazard events before they occur by (a) improving the reliability of critical/essential facilities, services, and infrastructure during and after a natural hazard event; (b) developing evacuation routes and facilities; (c) informing the public; (d) planning for long-term recovery; and (e) taking other necessary actions.	Revised. Ongoing.
CI-2*	Continue to conduct and improve risk assessments for state-owned properties	FEMA requires the state's plan to (a) describe the types of state-owned or -operated critical facilities located in the identified hazard areas and (b) present an estimate of the potential dollar losses to state-owned or -operated buildings, infrastructure, and critical facilities in the identified hazard areas. In addition, FEMA also requires that the state develop a comprehensive multi-year plan to mitigate the risks posed to existing buildings that have been identified as necessary for post-disaster response and recovery. Part of this risk assessment for state-owned property should be to identify (a) which facilities would be necessary for response and recovery efforts and (b) mitigation strategies for those priority facilities. Currently, the State Plan's assessment of state-owned properties consists of a "low," "moderate," or "high" vulnerability ranking. Rankings are derived from county-wide hazard analysis scores that do not account for local variations in vulnerability. Likewise, the structural integrity and physical condition of the critical facilities are not yet considered. As such, the State IHMT will encourage the state to invest resources in performing more detailed vulnerability assessments for state-owned properties. The assessments may result in mitigation opportunities that reduce the state's vulnerability to natural hazards.	**CI-2***	Continue to conduct and improve risk assessments for state-owned properties	FEMA requires the state's plan to (a) describe the types of state-owned or =operated critical facilities located in the identified hazard areas, and (b) present an estimate of the potential dollar losses to state-owned or -operated buildings, infrastructure, and critical facilities in the identified hazard areas. In addition, FEMA also requires that the state develop a comprehensive multi-year plan to mitigate the risks posed to existing buildings that have been identified as necessary for post-disaster response and recovery. Part of this risk assessment for state-owned property should be to identify (a) which facilities would be necessary for response and recovery efforts and (b) mitigation strategies for those priority facilities. Currently, the State Plan's assessment of state-owned properties consists of a 'low,' 'moderate,' or 'high' vulnerability ranking. Rankings are derived from county-wide hazard analysis scores that do not account for local variations in vulnerability. Likewise, the structural integrity and physical condition of the critical facilities are not yet considered. As such, the State IHMT will encourage the state to invest resources in performing more detailed vulnerability assessments for state-owned properties. The assessments may result in mitigation opportunities that reduce the state's vulnerability to natural hazards.	Revised. Removed.
CI-3*	Promote the reduction of non-structural hazards in K-12 schools	Provide training to school officials and teachers in reducing non-structural hazards in schools such as unsecured bookcases, filing cabinets, and light fixtures, which can cause injuries and block exits. The program should include a procedure for periodic life safety inspections of non-structural seismic hazards in schools that can be implemented by local fire department inspectors. BCD will have an important role in providing technical assistance in the development of educational materials	**107**	Provide information and technical assistance to implement mitigation of non-structural hazards in K-12 schools.	Provide training to school officials and teachers in reducing non-structural hazards in schools such as unsecured bookcases, filing cabinets, and light fixtures, which can cause injuries and block exits. The program should include a procedure for periodic life safety inspections of non-structural seismic hazards in schools that can be implemented by local fire department inspectors. BCD will have an important role in providing technical assistance in the development of educational materials.	Revised. Ongoing.

2012 to 2015 Mitigation Action Crosswalk

2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
CI-4*	Inventory and evaluate state-owned and -occupied buildings for seismic risk	Determine earthquake damage and losses expected to occur to the state-owned building inventory including higher education buildings. Produce information to enable development of statewide priorities and strategies to guide mitigation of earthquake risk, to protect lives during an earthquake, and to preserve ongoing operations after an earthquake. Use accepted methods to determine building type, construction and occupancy, to estimate damage and losses due to various earthquake scenarios and probabilities relating to building codes. Prioritized results shall be factored into effective, routine decision processes for building occupancy, maintenance, use and potential mitigation treatments. Properly used, this information over time can provide for strategic and responsible voluntary seismic upgrade in areas of greatest need for reasonable cost as a part of broader facilities management.	**32**	Request and compile seismic and flood information for personnel-occupied buildings from other agencies.	Determine flood and earthquake damage and losses expected to occur to the state-owned building inventory including higher education buildings. Produce information to enable development of statewide priorities and strategies to guide mitigation of earthquake risk, to protect lives during an earthquake, and to preserve ongoing operations after an earthquake. Use accepted methods to determine building type, construction and occupancy, to estimate damage and losses due to various earthquake scenarios and probabilities relating to building codes.	Revised. Priority.
			33	Request seismic and flood information from landlords as part of analyzing potential leased spaces going forward in new leases and potential renewals.	Determine flood and earthquake damage and losses expected to occur to the state-owned building inventory including higher education buildings. Produce information to enable development of statewide priorities and strategies to guide mitigation of earthquake risk, to protect lives during an earthquake, and to preserve ongoing operations after an earthquake. Use accepted methods to determine building type, construction and occupancy, to estimate damage and losses due to various earthquake scenarios and probabilities relating to building codes.	Revised. Priority.
			35	Investigate/inventory DAS-owned buildings for seismic risk.	Determine earthquake damage and losses expected to occur to the state-owned building inventory including higher education buildings. Produce information to enable development of statewide priorities and strategies to guide mitigation of earthquake risk, to protect lives during an earthquake, and to preserve ongoing operations after an earthquake. Use accepted methods to determine building type, construction and occupancy, to estimate damage and losses due to various earthquake scenarios and probabilities relating to building codes.	Revised. Priority.
			55	Use DAS-CFO data and investigation/inventory of seismic and flood risk to DAS-owned/leased buildings in an effective, routine decision-making process for building occupancy, maintenance, use and potential mitigation treatments.	This information over time can provide for strategic and responsible voluntary flood and seismic upgrades in areas of greatest need for reasonable cost as a part of broader facilities management.	Revised. Priority.

2012 to 2015 Mitigation Action Crosswalk

2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
CI-5*	Strongly encourage voluntary relocation of essential facilities, hazardous facilities, and special occupancy structures that are in the tsunami inundation zone	A large tsunami (preceded by a locally devastating earthquake) would likely destroy many buildings in coastal communities that are located in the tsunami inundation zone. The damage would be from the combined effects of the forces from the tsunami surges, currents and debris as well as the earthquake hazards. Essential facilities and special occupancy structures, such as fire stations/hospitals and schools, and hazardous facilities are often located in the tsunami inundation zone. Because of the critical need of essential facilities during a disaster, the added danger from hazardous materials, and the importance of protecting children, these facilities and structures need to be relocated out of the inundation zone through some type of incentive program. A voluntary program can be implemented without statutory change; however, a mandatory program would require legislative support. After a tsunami disaster, the top priority would be to reconstruct essential facilities, special occupancy structures, and hazardous facilities out of the tsunami inundation zone as defined in the maps produced for ORS 455.466 and 455.467. Finally, when these facilities come up for replacement, they should be encouraged to build out of the tsunami inundation zone.	**CI-5***	Strongly encourage voluntary relocation of existing essential facilities, hazardous facilities, and special occupancy structures that are in the tsunami inundation zone.	A large tsunami (preceded by a locally devastating earthquake) would likely destroy many buildings in coastal communities that are located in the tsunami inundation zone. The damage would be from the combined effects of the forces from the tsunami surges, currents and debris as well as the earthquake hazards. Essential facilities and special occupancy structures, such as fire stations/hospitals and schools, and hazardous facilities are often located in the tsunami inundation zone. Because of the critical need of essential facilities during a disaster, the added danger from hazardous materials, and the importance of protecting children, these facilities and structures need to be relocated out of the inundation zone through some type of incentive program. A voluntary program can be implemented without statutory change; however, a mandatory program would require legislative support. After a tsunami disaster, the top priority would be to reconstruct essential facilities, special occupancy structures, and hazardous facilities out of the tsunami inundation zone as defined in the maps produced for ORS 455.466 and 455.467. Finally, when these facilities come up for replacement, they should be encouraged to build out of the tsunami inundation zone.	Revised. Removed.
CI-6	Continue seismic rehabilitation of hospital, fire, and police facilities under the Seismic Rehabilitation Grant Program administered by OEM	Continue to rehabilitate to operational readiness in the event of an earthquake essential hospital buildings, fire, and police stations that pose a threat to occupant safety. Senate Bill 15 of the 2001 Legislative Session requires that rehabilitation or other actions to be completed by January 1, 2022. SJR 21 and 22 are bond measures (November 2002 election) which would provide funding to implement this proposed action. Senate Bills 2 to 5 (2005) provided the mechanism to accomplish some of these legislatively mandated tasks. Under SB 2, Oregon Department of Geology and Mineral Industries developed a seismic needs assessment database of emergency response facilities buildings. These data are being used the SRGP to administer a grant program which provides for seismic rehabilitation of eligible buildings (SB 3). Senate Bill 5 allows the State Treasury to sell Government Obligation Bonds to fund the program.	**110**	Continue seismic rehabilitation of hospital, fire, and police facilities under the Seismic Rehabilitation Grant Program administered by Business Oregon's Infrastructure Finance Division.	Continue to rehabilitate to operational readiness in the event of an earthquake essential hospital buildings, fire, and police stations that pose a threat to occupant safety. Senate Bill 15 of the 2001 Legislative Session requires that rehabilitation or other actions to be completed by January 1, 2022. Senate Bills 2 to 5 (2005) provided the mechanism to accomplish some of these legislatively mandated tasks. Under SB 2, Oregon Department of Geology and Mineral Industries developed a seismic needs assessment database of emergency response facilities buildings. These data are being used by the Seismic Rehabilitation Grant Program to provide funding for seismic rehabilitation of eligible buildings (SB 3). Senate Bill 5 allows the State Treasury to sell Government Obligation Bonds to fund the program.	Revised. Ongoing.
CI-7	Geo-survey the state's rights of way (ROW) to determine where seismic, landslide, and flood prone areas exist.	With this information, the state can develop a statewide right-of-way tenant plan that requires the construction of suitable utility supporting structures. This will improve utilities' resilience in seismic, flood, and landslide events. Cost subsidy for the studies could be an integral element in the utility permit fees, annual franchise fees or an additional tax levied against the utility's continuing property record.	**34**	Lidar survey the State's ROW (rights of way), west of the Cascade Range, to determine where landslide potential exists.	The acquired information can improve critical infrastructure resilience in the face of landslide events, by providing useful information to planners, design professionals and decision makers prior to delivery system construction.	Revised. Priority.
			74	Lidar survey the State's ROW (rights of way), west of the Cascade Range, to determine where seismic fault potential exists.	The acquired information can improve critical infrastructure resilience in the face of seismic events, by providing useful information to planners, design professionals and decision makers prior to delivery system construction.	Revised. Priority.
CI-8	Promote improved reliability and resiliency of critical infrastructure to operators.	Lifeline services, such as electricity, gas, telecommunications, water, and transportation, can be critical to a community's wellbeing. However, much of Oregon's infrastructure has not been designed to tolerate extreme conditions, such as severe storms, major earthquakes, or large landslides. Certain lifeline services should have reliable performance to ensure that the region can withstand future damage without crippling consequences. These items of critical infrastructure require vulnerability studies in order to understand potential damages and consequences.	**92**	Improve reliability and resiliency of critical infrastructure statewide by adopting industry-specific best practices, guidelines, and standards.	Lifeline Service Delivery Systems (critical infrastructure), including electric supply, natural gas, telecommunications, water/wastewater, hydraulic structures (e.g., dikes, levees, dams), transportation corridors, pipelines and petroleum fuels storage facilities, are all vital resources for a community's life-safety and economic viability. However, much of Oregon's existing critical infrastructure has not been designed or constructed to withstand the impact of severe natural disasters such as extreme wind & winter storms, major earthquakes, or large landslides. Lifeline Service Delivery Systems (critical infrastructure) should be evaluated statewide, and reliable and measurable performance objectives which insure the region's critical infrastructure can withstand future damage without crippling consequences should be instituted.	Revised. Ongoing.

2012 to 2015 Mitigation Action Crosswalk

2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
CI-9	Continue seismic rehabilitation of public schools buildings under the Seismic Rehabilitation Grant Program administered by OEM.	Continue to rehabilitate to occupant life safety standards certain public school and community college buildings. Senate Bill 14 from the 2001 Session of the Oregon Legislature requires that the State Board of Education examine buildings used for both instructional and non-instructional activities, including libraries, auditoriums, and dining facilities in order to determine which buildings are in most need of additional analysis. Following the identification of high-risk buildings and additional analysis, high-risk buildings must be rehabilitated by January 1, 2032, subject to available funding. SJR 21 and 22 are bond measures (November 2002 election) which would provide funding to implement this proposed action. SB 2 to 5 (2005) provided the mechanism to accomplish some of these legislatively mandated tasks. Under SB 2, Oregon Department of Geology and Mineral Industries developed a seismic needs assessment database of K-12 and Community College public school buildings. These data are being used the SRGP to administer a grant program for seismic rehabilitation of eligible buildings (SB 3). SB 4 allows the State Treasury to sell Government Obligation Bonds to fund the program.	**111**	Continue seismic rehabilitation of public schools buildings under the Seismic Rehabilitation Grant Program administered by Business Oregon's Infrastructure Finance Division.	Continue to rehabilitate to occupant life safety standards certain public school and community college buildings. Senate Bill 14 from the 2001 Session of the Oregon Legislature requires that the State Board of Education examine buildings used for both instructional and non-instructional activities, including libraries, auditoriums, and dining facilities in order to determine which buildings are in most need of additional analysis. Following the identification of high-risk buildings and additional analysis, high-risk buildings must be rehabilitated by January 1, 2032, subject to available funding. SJR 21 and 22 are bond measures (November 2002 election) which would provide funding to implement this proposed action. SB 2 to 5 (2005) provided the mechanism to accomplish some of these legislatively mandated tasks. Under SB 2, Oregon Department of Geology and Mineral Industries developed a seismic needs assessment database of K-12 and Community College public school buildings. These data are being used the SRGP to administer a grant program for seismic rehabilitation of eligible buildings (SB 3). SB 4 allows the State Treasury to sell Government Obligation Bonds to fund the program.	Revised. Ongoing.
CI-10	Promote vulnerability studies of critical infrastructure	Promote vulnerability studies of critical infrastructure (lifelines) to operators. Lifeline services, such as electricity, gas, and telecommunications, can be critical to a community's well-being. However, much of Oregon's infrastructure has not been designed to tolerate extreme conditions, such as severe storms, major earthquakes, or large landslides. Certain lifeline services should have reliable performance to ensure that the region can withstand future damage without crippling consequences. Critical infrastructure including energy and telecom utilities infrastructure require vulnerability studies in order to understand potential damages and consequences. Transportation, water, wastewater and other important services are also important.	**CI-10**	Promote vulnerability studies of critical infrastructure	Promote vulnerability studies of critical infrastructure (lifelines) to operators. Lifeline services, such as electricity, gas, and telecommunications, can be critical to a community's wellbeing. However, much of Oregon's infrastructure has not been designed to tolerate extreme conditions, such as severe storms, major earthquakes, or large landslides. Certain lifeline services should have reliable performance to ensure that the region can withstand future damage without crippling consequences. Critical infrastructure including energy and telecom utilities infrastructure require vulnerability studies in order to understand potential damages and consequences. Transportation, water, wastewater and other important services are also important.	Revised. Removed.
CI-11	Determine where additional aquifer studies might lead to greater water supplies and how to fund these studies	There are many areas in the state where the dynamics of the aquifers are not well understood. Studying these aquifers may reveal under-used water resources and other information useful to water managers. Determine which aquifers would benefit by detailed studies and how these studies can be funded.	**CI-11**	Determine where additional aquifer studies might lead to greater water supplies and how to fund these studies	There are many areas in the state where the dynamics of the aquifers are not well understood. Studying these aquifers may reveal under-used water resources and other information useful to water managers. Determine which aquifers would benefit by detailed studies and how these studies can be funded.	Removed.

2012 to 2015 Mitigation Action Crosswalk

2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
CI-12	Increase storage of water, especially off stream storage	The need to store water is very apparent to irrigators in Eastern Oregon who find creeks going dry during summer and early autumn. One way to avoid that common occurrence is by encouraging storage facilities where they are needed and where they are feasible to construct. In an initial study of potential reservoir locations, storage sites were identified that are very high in drainage basins so that the impact to anadromous fish would be minimal. High elevation, small stream type structures may be considered environmentally acceptable. ODA has also looked at diverting water away from streams through pipelines or canals into off-channel basins. These types of structures are more costly but don't have the impact on fish passage that are often associated with instream structures. Other ideas include development of aquifer storage and recovery projects. Surface water from streams is diverted during times of abundance and injected into underground aquifers for storage. WRD has developed an inventory of above-ground and below-ground storage opportunities: http://apps2.wrd.state.or.us/apps/planning/owsci/sw_project_search.aspx http://apps2.wrd.state.or.us/apps/planning/owsci/gw_project_search.aspx . These are also available from the following link, which includes introductory information: http://www.wrd.state.or.us/OWRD/LAW/owsci_info.shtml#Potential_Water_Storage_Sites . Land management practices that slow down or prevent runoff are also being employed by landowners such as creation of wetlands, catchment depressions, diversion dikes, or terraces. The idea is to simply retain water in the watershed. For additional information, see the following Oregon Department of Agriculture web site and the WRD web site: http://www.oregon.gov/ODA/NRD/water_quality_front.shtml www.oregon.gov/WRD ODA should work with private landowners and special districts to implement projects such as those described above.	**CI-12**	Increase storage of water, especially off stream storage	The need to store water is very apparent to irrigators in Eastern Oregon who find creeks going dry during summer and early autumn. One way to avoid that common occurrence is by encouraging storage facilities where they are needed and where they are feasible to construct. In an initial study of potential reservoir locations, storage sites were identified that are very high in drainage basins so that the impact to anadromous fish would be minimal. High elevation, small stream type structures may be considered environmentally acceptable. ODA has also looked at diverting water away from streams through pipelines or canals into off-channel basins. These types of structures are more costly but don't have the impacts on fish passage that are often associated with instream structures. Other ideas include development of aquifer storage and recovery projects. Surface water from streams is diverted during times of abundance and injected into underground aquifers for storage. OWRD has developed an inventory of above-ground and below-ground storage opportunities: http://apps2.wrd.state.or.us/apps/planning/owsci/sw_project_search.aspx http://apps2.wrd.state.or.us/apps/planning/owsci/gw_project_search.aspx. These are also available from the following link, which includes introductory information: http://www.wrd.state.or.us/OWRD/LAW/owsci_info.shtml#Potential_Water_Storage_Sites. Land management practices that slow down or prevent runoff are also being employed by landowners such as creation of wetlands, catchment depressions, diversion dikes, or terraces. The idea is to simply retain water in the watershed. For additional information, see the following Oregon Department of Agriculture web site and the OWRD web site: http://www.oregon.gov/ODA/NRD/water_quality_front.shtml www.oregon.gov/OWRD ODA should work with private landowners and special districts to implement projects such as those described above.	Removed.
CI-13	Encourage local governments to inter-tie water systems	The capital expense associated with this action needs to be carried mostly by local governments, perhaps with some grant or low-interest loan funding provided by the state or federal governments. The role of the state in this action is to encourage local governments located proximate to one another, yet with separate water systems, to develop the physical capability to send water from one system to the other. Often during drought situations, one local government will have a bit of water to spare while a nearby government is struggling to meet its needs. Transferring water by truck is expensive and inefficient when compared to transferring water via pipeline. Water inter-ties are also effective mitigation for the flood and earthquake hazards where one system can serve as backup for another.	**94**	Provide technical assistance and funding to local governments to evaluate the need and opportunities for inter-tie projects in Local Natural Hazards Mitigation Plans.	The capital expense associated with this action needs to be carried mostly by local governments, perhaps with some grant or low-interest loan funding provided by the state or federal governments. The role of the state in this action is to encourage local governments located proximate to one another, yet with separate water systems, to develop the physical capability to send water from one system to the other. Often during drought situations, one local government will have a bit of water to spare while a nearby government is struggling to meet its needs. Transferring water by truck is expensive and inefficient when compared to transferring water via pipeline. Water inter-ties are also effective mitigation for the flood and earthquake hazards where one system can serve as backup for another.	Revised. Ongoing.
CI-14	Maintain a roster of qualified post-earthquake, flood, and wind inspectors. Solicit those with ATC-45 flood & wind inspection training. Develop plans for rapid mobilization of inspectors for post disaster facility inspection	Continue to compile and maintain a list of individuals trained and certified for post-disaster inspection. Support the recruitment and training of qualified ATC-20 post earthquake inspectors and inspection teams. Create rapid communication networks to effectively alert necessary inspectors when disasters occur. Work with OEM, local government building officials, and emergency planners to establish an effective process for assigning inspection teams to needed areas and educating local governments regarding the circumstances and process for initiating BCD and state involvement	**96**	Continue to maintain the existing roster of qualified post-earthquake, flood, and wind inspectors with ATC-20 earthquake and ATC-45 flood & wind inspection training.	Continue to compile and maintain a list of individuals trained and certified for post-disaster inspection. Support the recruitment and training of qualified ATC-20 post earthquake inspectors and inspection teams.	Revised. Ongoing.

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2012 Action #	**2012 Action Statement**	**2012 Action Description**	**2015 Action #**	**2015 Action Statement**	**2015 Action Description**	**Revised or New? Which 2015 Table?**
			76	Establish process for assigning inspection teams to needed areas for post-disaster facility inspection.	Work with OEM, local government building officials, and emergency planners to establish an effective process for assigning inspection teams to needed areas and educating local governments regarding the circumstances and process for initiating BCD and state involvement.	Revised. Priority.
CI-15	Require fish passage at all new and replaced structures	ODFW statutes require fish passage at all artificial barriers to fish migration. New structures, such as dams and culverts, are currently required to provide fish passage. Old structures that are replaced need to provide fish passage as well. DLCD, ODFW and OEM will continue to integrate FEMA's 1999 "Policy on Fish Enhancement Structures in the Floodway" policy memorandum into fish passage projects and design guidelines. ODFW will continue to ensure that projects meet fish-passage standards and are also designed with consideration of the need to pass wood and sediment. Standards that provide for fish passage should also provide better passage for floodwaters and organic materials. Efforts to replace structures proactively to ensure passage of fish and floodwaters/debris will be supported as feasible.	**CI-15**	Require fish passage at all new and replaced structures	ODFW statutes require fish passage at all artificial barriers to fish migration. New structures, such as dams and culverts, are currently required to provide fish passage. Old structures that are replaced need to provide fish passage as well. DLCD, ODFW and OEM will continue to integrate FEMA's 1999 "Policy on Fish Enhancement Structures in the Floodway" policy memorandum into fish passage projects and design guidelines. ODFW will continue to ensure that projects meet fish-passage standards and are also designed with consideration of the need to pass wood and sediment. Standards that provide for fish passage should also provide better passage for floodwaters and organic materials. Efforts to replace structures proactively to ensure passage of fish and floodwaters/debris will be supported as feasible.	Removed.
CI-16	Evaluate expected earthquake damage and system interruptions to existing lifelines and hydraulic structures, including dams	Lifelines include all essential transportation facilities and the associated bridges, tunnels, locks, and ferries, including airports and railways, petroleum and natural gas pipelines, electric transmission lines, water and sewage systems, "emergency operations and telecommunications infrastructure. The evaluation proposed would study the vulnerability of existing lifeline systems and hydraulic structures to a major seismic event, and estimate the expected damage and losses. Estimating the expected losses will include determining those systems that likely would experience a total loss of operation immediately following a major event, although the actual physical damage to the system may not be total or extensive. In order to implement this action, the State of Oregon will need to work with several federal agencies which are involved in ownership, authority, or responsibility for some of the structures and facilities cited. Detailed benefit-cost analyses (to include hazard damages to facilities, downstream impacts and economic loss of service) can be used to identify and prioritize potential mitigation projects (retrofits, intake relocations, or even new construction).	**CI-16**	Evaluate expected earthquake damage and system interruptions to existing lifelines and hydraulic structures, including dams	Lifelines include all essential transportation facilities and the associated bridges, tunnels, locks, and ferries, including airports and railways, petroleum and natural gas pipelines, electric transmission lines, water and sewage systems, "emergency operations and telecommunications infrastructure. The evaluation proposed would study the vulnerability of existing lifeline systems and hydraulic structures to a major seismic event, and estimate the expected damage and losses. Estimating the expected losses will include determining those systems that likely would experience a total loss of operation immediately following a major event, although the actual physical damage to the system may not be total or extensive. In order to implement this action, the State of Oregon will need to work with several federal agencies which are involved in ownership, authority, or responsibility for some of the structures and facilities cited. Detailed benefit-cost analyses (to include hazard damages to facilities, downstream impacts and economic loss of service) can be used to identify and prioritize potential mitigation projects (retrofits, intake relocations, or even new construction).	Removed.
CI-17	Encourage/require public entities adopt and follow ANSI National Tree Care Standards	This action requires additional scoping to determine how best to encourage and require state and local agencies to adopt and routinely implement ANSI A300, Tree Care Operations Standards. These national standards were developed by a diverse committee of tree care professionals from the private and public sectors and cover proper tree pruning, fertilization, and tree support systems. These standards set forth the requirements and recommendations for satisfactory tree care maintenance. Public entities and tree care companies who perform work according to ANSI A300 standards are following accepted industry practices for proper tree care maintenance operations, resulting in healthier trees with reduced tree hazards. For more information, see: http://www.ansi.org/news_publications/media_tips/tree_care.aspx?menuid=7 This action may result in a legislative concept for a future session of the Oregon Legislature, and may include an incentive such as limited liability when the standards are implemented. Currently, the state has not adopted the ANSI A300 standards, though several state agencies follow them voluntarily. As a first step, the lead and support agencies noted below will better publicize the standards and persuade additional agencies to voluntarily adopt them.	**CI-17**	Encourage/require public entities adopt and follow ANSI National Tree Care Standards	This action requires additional scoping to determine how best to encourage and require state and local agencies to adopt and routinely implement ANSI A300, Tree Care Operations Standards. These national standards were developed by a diverse committee of tree care professionals from the private and public sectors and cover proper tree pruning, fertilization, and tree support systems. These standards set forth the requirements and recommendations for satisfactory tree care maintenance. Public entities and tree care companies who perform work according to ANSI A300 standards are following accepted industry practices for proper tree care maintenance operations, resulting in healthier trees with reduced tree hazards. For more information, see: http://www.ansi.org/news_publications/media_tips/tree_care.aspx?menuid=7 This action may result in a legislative concept for a future session of the Oregon Legislature, and may include an incentive such as limited liability when the standards are implemented. Currently, the state has not adopted the ANSI A300 standards, though several state agencies follow them voluntarily. As a first step, the lead and support agencies noted below will better publicize the standards and persuade additional agencies to voluntarily adopt them.	Removed.

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2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
CI-18	Work to improve policies, procedures relevant to the construction and maintenance of overhead lines.	Experience with previous incidents and events has demonstrated that overhead utility systems are vulnerable to severe storms. The systems impacted by such an event create safety issues and outages that can cause serious problems for customers, communities, and the public in general as a result of the increasing dependency upon those systems and networks. As such, individuals, local government, communities and commercial enterprises should be encouraged to engage in preparedness efforts in support of service outage mitigation, including the installation of emergency electrical energy generation units. This effort is especially warranted at other critical infrastructure lifeline facilities, where additional health and environmental impacts are witnessed by the loss of commercial power (water and waste water treatment facilities). The PUC, in collaboration with industry stakeholders, strives to improve the safety and reliability of overhead lines (ORS:758-210-270) through improved design, construction, maintenance and rights-of-way management. Additional consideration can be given to initial constructs, utilizing underground or buried techniques, as opposed to conversion of overhead lines. The latter, when unassociated to HMGP funding, has an extensive list of considerations, over and above the recurring and initial costs to the utility and the service delivery end-user, respectively. Including, but not limited to: maintenance, fault isolation and repair, capacity augmentation, facility rehabilitation and replacement. The latter activities entail expenses associated with excavation or trenching, select backfill, compaction, property restoration, all of these items are inclusive with the prudent decision to pursue deployments in the underground or buried configurations. This action item involves ongoing development of relevant and concise policies and procedures relative to overhead line maintenance, inspection, engineering, and joint-use cooperation to ensure and improve the long-term safety and reliability of overhead line systems.	**CI-18**	Introduce legislation in 2015 requiring all overhead facility operators to mitigate service outages due to natural hazards by installing emergency electrical energy generation units; using underground or buried facilities for initial construction in areas where other hazards (e.g., landslide, earthquake, flood) are unlikely cause damage to them; and instituting other mitigation and preparedness measures.	Previous incidents and events demonstrate that overhead facilities are vulnerable to severe storms. The impact of such an event creates safety issues and system outages which can cause serious concerns to customers, communities, and the public in general as a result of the increasing dependency upon service delivery systems and networks. As such, individuals, local government, communities and commercial enterprises should be encouraged to engage in preparedness efforts in support of service outage mitigation, including the installation of emergency electrical energy generation units. This effort is especially warranted at other critical infrastructure lifeline facilities, where additional health and environmental impacts are witnessed by the loss of commercial power (i.e., medical facilities and water-waste water treatment facilities). The PUC, in collaboration with industry stakeholders, strives to improve the safety and reliability of overhead lines (ORS 758-010-035) through improved design, construction, maintenance, and rights-of-way management. Additional consideration should be given to initial constructs, utilizing underground or buried techniques, as opposed to conversion of overhead lines as a reactionary solution, keeping in mind that underground and buried constructs are vulnerable to geologic and flooding events that may cause the same result, and impact that the conversion of the same facilities was intended to resolve.	Revised. Removed.
CI-19	Develop evacuation plans for ports and harbors	Ports and harbors are the haven for commercial and recreational fishing and recreational boating industries. They are often the major centers of economic activity in coastal communities that have bays. To protect the vessels from tsunami damage requires a unique evacuation plan for both distant and local tsunamis. The plans should be integrated with community evacuation plans. The Oregon State University Extension Sea Grant Program has identified this as a major issue in their pilot project in Yaquina Bay. Their project is titled Reducing Earthquake and Tsunami Hazards in the Pacific Northwest Ports and Harbors. For distant tsunami events and storm surge events that can occur during any winter, evaluate potential port and harbor mitigation retrofit projects that protect and strengthen floating and anchored infrastructure such as piers, bulkheads and landings.	**24**	Develop evacuation plans for ports and harbors at the rate of one per year.	Ports and harbors are the haven for commercial and recreational fishing and recreational boating industries. They are often the major centers of economic activity in coastal communities that have bays. To protect the vessels from tsunami damage requires a unique evacuation plan for both distant and local tsunamis. The plans should be integrated with community evacuation plans. The Oregon State University Extension Sea Grant Program has identified this as a major issue in their pilot project in Yaquina Bay. Their project is titled *Reducing Earthquake and Tsunami Hazards in the Pacific Northwest Ports and Harbors.* For distant tsunami events and storm surge events that can occur during any winter, evaluate potential port and harbor mitigation retrofit projects that protect and strengthen floating and anchored infrastructure such as piers, bulkheads and landings.	Priority.
CI-20	Encourage windstorm mitigation techniques that reduce losses to electric utilities through existing state programs	Implement outreach efforts through existing safety-related programs managed by the PUC in coordination with private and public utilities	**147**	Use industry best practices to minimize impact and outages to service delivery system of overhead line operators, during windstorm events.	Implement outreach efforts through existing safety-related programs managed by the PUC in coordination with private and public utilities. Compliance with PUC administrative rules includes safety codes and vegetation management. The PUC provides administrative to support to the Oregon Utility Safety Committee where all utility operators (electric, natural gas, telecommunication & water) discuss safety issues and best practices.	Revised. Ongoing.

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CI-21	Identify and implement tsunami mitigation projects to improve life safety by creating hardened and improved evacuation routes.	After a Cascadia Subduction Zone earthquake, a tsunami could arrive within minutes. It is essential that residents and visitors be able to quickly move to high ground on foot. This requires clearly marked and safe routes that pedestrians are able to navigate even in dark and stormy weather. Projects should be identified that will enable Oregon to establish new standards and guidelines for methods to harden and mark way-finding of tsunami evacuation routes to natural high ground. Where natural high ground is not within the expected evacuation time, evaluate the retrofit of existing facilities and/or construction of new facilities that rise above the level of tsunami inundation and can serve as safe haven refuges.	**40**	Implement better way-finding solutions for tsunami evacuation. Create hardened and improved evacuation routes to include elevated safe areas above the level of modeled inundation.	After a Cascadia Subduction Zone earthquake, a tsunami could arrive within minutes. It is essential that residents and visitors be able to quickly move to high ground on foot. This requires clearly marked and safe routes that pedestrians are able to navigate even in dark and stormy weather. Where high ground is available, projects should be identified that will enable Oregon to establish new standards and guidelines for methods to harden and mark way-finding of tsunami evacuation routes to natural high ground. Where natural high ground is not within the expected evacuation time, evaluate the retrofit of existing facilities and/or construction of new facilities that rise above the level of tsunami inundation and can serve as safe haven refuges.	Revised. Priority.
			38	Fund and provide technical assistance for local governments to engage in evacuation route planning and project implementation.	After a Cascadia Subduction Zone earthquake, a tsunami could arrive within minutes. It is essential that residents and visitors be able to quickly move to high ground. Some evacuation planning is already underway. Local governments need funding and technical assistance to begin or continue to engage in evacuation planning.	New. Priority.
			56	Identify, prioritize, and map areas susceptible to rapid channel migration	Identify areas susceptible to rapid channel migration. Prioritize those areas' susceptibility and rank their risk from a rapid channel migration event. Create channel migration zone and risk maps for the areas determined to have the highest risk for rapid channel migration.	New. Priority.
			60	Identify funding to support various public transportation providers and local jurisdictions to conduct comprehensive vulnerability assessments of their transportation facilities and services.	OSSPAC, in the Oregon Resilience Plan has identified an immediate near-term need to inventory and assess vulnerability and mitigation opportunities for local street networks, transit assets, ports, airports, and railroads. The Oregon Resilience Task Force in its October 2014 report to the Oregon Legislature suggested ongoing funding inventory, assessment, and mitigation. These activities would serve to reduce vulnerability to a Cascadia Subduction Zone event.	New. Priority.
			65	Prioritize mitigation and retrofit projects on seismic lifelines.	ODOT Seismic Lifelines Evaluation, Vulnerability Synthesis and Identification Report provides recommended priority corridors but does not provide sufficient detail to actually prioritize retrofit investment packages. Engineering evaluations and cost estimation are ongoing on a funding-available basis and will inform that prioritization process.	New. Priority.
			91	Continue to act upon opportunities to advance the State's lifeline mitigation investment practice.	Expand upon the State's mitigation investment practice by (a) supporting efforts by jurisdictions and transportation districts to develop mitigation policy and retrofit plans for lifeline assets and service facilities; (b) continuing to advance design and maintenance standards and requirements for bridges and unstable slopes, transit, rail, ports, and priority lifeline airfields; (c) developing a temporary bridge installation policy and standards; and (d) supporting research on retrofit methods and strategies for Cascadia subduction zone earthquake loads and tsunamis.	New. Ongoing.
			16	Complete a Climate Change Vulnerability Assessment and Adaptation Pilot for north coast highways.	The goal of ODOT's pilot is to conduct a regional vulnerability assessment and prepare options for adaptation actions and priorities. In coordination with ODOT Maintenance, the project will collect and map vulnerability and risk data based on climate science, asset conditions, and known and anticipated natural hazards. Hazard sites will be selected within a study corridor for more detailed analysis. Based on engineering and technical reviews, adaptation measures will be developed for vulnerable infrastructure and assembled into a coastal adaptation implementation plan. ODOT received a Federal Highway Administration grant to conduct the project, scheduled for completion in fall 2014.	New. Priority.

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			58	Develop a database of non-state-owned critical/essential facilities and their property values.	FEMA requires the state's plan to (a) identify critical facilities located in the identified hazard areas and (b) estimate the potential dollar losses to those structures. Data for non-state-owned critical facilities is incomplete and lacks standardization, therefore creating a wide margin of error. Identifying local non-state-owned critical facilities and gathering descriptive data for these structures will help increase the quality of the data, resulting in a more precise understanding of state and regional vulnerabilities and mitigation priorities.	New. Priority.
			31	Improve state agency procedures for tracking data on state-owned/leased buildings and critical or essential facilities.	Create a policy standard for facilities data collection required from state agencies on an annual basis. Develop a facilities data framework standard that best enables hazard mitigation analysis; incorporate data into DAS-CFO DataMart and make available to partner agencies at will.	New. Priority.
			77	Develop an improved methodology for gathering data and identifying the communities most vulnerable to drought and related impacts.	Although we know that areas in Oregon have suffered from drought, there has not been a coordinated effort to systematically characterize how frequently droughts have occurred, or the impact on Oregonians and ecosystems. Communities are beginning to plan for worst case drought scenarios and need better information about the frequency, duration, and intensity of previous droughts in order to assess the appropriate response. Comprehensive information is not currently available by region, or statewide.	New. Priority.
			105	Implement the improved methodology for gathering data and identifying the communities most vulnerable to drought and related impacts.	Although we know that areas in Oregon have suffered from drought, there has not been a coordinated effort to systematically characterize how frequently droughts have occurred, or the impact on Oregonians and ecosystems. Communities are beginning to plan for worst case drought scenarios and need better information about the frequency, duration, and intensity of previous droughts in order to assess the appropriate response. Comprehensive information is not currently available by region, or statewide.	New. Ongoing.
			78	Establish a program for studying winter storms and their impacts statewide. As a part of that program, develop a system for gathering snowfall data statewide.	Establish a network of snow accumulation tracking stations at strategic locations throughout the state to provide data tracking of snowfall accumulation over the short term and long term in order to develop statistics for studying snow level trends across the state.	New. Priority.
LAND USE/DEVELOPMENT						
LU-1*	Develop model risk reduction techniques and ordinances for landslide-prone communities	Techniques can involve requiring geological or geotechnical studies for new development, stormwater control for neighborhoods on hillslopes, strict land use ordinances for active landslides, working with infrastructure operators to increase reliability of services after storms, and more.	**5**	Develop model risk reduction techniques and ordinances for landslide-prone communities	Techniques can involve requiring geological or geotechnical studies for new development, stormwater control for neighborhoods on hillsides, strict land use ordinances for active landslides, working with infrastructure operators to increase reliability of services after storms, and more.	Priority.
LU-2*	Develop a process for implementing revised elements of Goal 7	Goal 7 currently includes a process for notification to local governments of new hazard information. It also requires that local governments review any new hazard information brought to their attention and determine if a local land use response is needed. (LCDC adopted the revised goal in 2001. The revised Goal 7 became effective in June 2002.) Since the Goal's revision, several studies and reports on natural hazards have been published and disseminated. The process for determining which information should trigger local land use evaluations, however, remains untested. The State IHMT currently serves as an informal review board to examine new information on natural hazards and evaluate if or how to address this information via the Goal 7 planning process. DLCD, with the assistance of DOGAMI, and OEM, will determine the process by which 'new hazard information' designations will occur. This action is necessary to ensure that local governments evaluate and respond to information regarding natural hazards within their communities.	**18**	Develop a process for implementing Goal 7.	Under Goal 7, DLCD is responsible for notifying local governments if new hazard information requires a local response. The process for determining which information should trigger local land use evaluations and notifying local governments, however, remains untested. DLCD will implement the process, review the results, and determine whether any changes are necessary. This action is necessary to ensure that local governments evaluate new hazard information and take necessary action to protect life and property.	Revised. Priority.

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LU-3*	Enhance coordination of hazard mitigation planning with local comprehensive planning	Explore how to better connect hazard mitigation plans with local comprehensive/land use plans. Should hazard mitigation plans be incorporated into comprehensive/land use plans? How can comprehensive and land use plans become better vehicles for implementing hazard mitigation? Are changes needed in statute, rule, or goal to better incorporate hazard mitigation plans into comprehensive/land use plans?	**30**	Provide technical assistance to local governments to help integrate hazard mitigation plans with local comprehensive plans.	Local NHMPs are often adopted as an appendix to the comprehensive plan or separately and are therefore in practice not used to their full potential. By assisting local governments in integrating the two plans, hazard mitigation will be more easily and meaningfully implemented in local land use planning practice.	Revised. Priority.
LU-4*	Complete a model “Substantial Improvement/Substantial Damage” program to support local government regulation of floodplain development	DLCD and OEM are in the process of creating a Substantial Improvement/Substantial Damage (SI/SD) manual. The SI/SD Manual will include local ordinance language and companion guidance on administrative processes that can be used by local jurisdictions for cumulative tracking of substantial improvements. It will also address common implementation difficulties encountered at the local level, and suggest approaches that could be used by local governments to overcome those difficulties. The SI/SD Manual will be completed and integrated into Model Code and ongoing NFIP training. (See FL-22 for definitions of substantial improvement and substantial damage.)	**LU-4***	Complete a model “Substantial Improvement/Substantial Damage” program to support local government regulation of floodplain development	DLCD and OEM are in the process of creating a Substantial Improvement/Substantial Damage (SI/SD) manual. The SI/SD Manual will include local ordinance language and companion guidance on administrative processes that can be used by local jurisdictions for cumulative tracking of substantial improvements. It will also address common implementation difficulties encountered at the local level, and suggest approaches that could be used by local governments to overcome those difficulties. The SI/SD Manual will be completed and integrated into Model Code and ongoing NFIP training.	Removed.
LU-5	Develop guidance on determination of mudslides/mudflow triggers and relation to rain/flood events	Work with FEMA Region 10, DOGAMI, and other interested parties to develop scientifically and legally-based guidance on when mudflows/mudslides are to be considered part of a rain/flood event pursuant to the NFIP. Address the definition of mudflow/mudslide, regulatory factors, scientific understanding of mudslides, and implications for flood insurance.	**68**	Develop guidance on determination of mudslides triggers and relation to rain or flood events	Work with FEMA Region 10, DOGAMI, and other interested parties to develop scientifically and legally-based guidance on when mudflows are to be considered part of a rain or flood event pursuant to the NFIP. Address the definition of mudflow, regulatory factors, scientific understanding of mudslides, and implications for flood insurance.	Priority.
LU-6	Implement the Oregon Forestland-Urban Interface Fire Protection Act (“Senate Bill 360”) in all Oregon counties	The Oregon Forestland-Urban Interface Fire Protection Act, more commonly known as “Senate Bill 360,” was enacted by the Oregon Legislature in response to the growing incidence of wildfire destroying homes and communities in Oregon’s wildland-urban interface. The Act recognizes that individual property owners are in the best position to take mitigation actions which will have the most direct impact to whether or not a structure will survive a wildfire. Under this action item, the Act will be implemented county by county in those portions of the state, based on weather, fire incidence, fuels, or on the number of structures at risk. It has been Legislature’s stated preference that implementation be accomplished with federal grant funds.	**141**	Implement the Oregon Forestland-Urban Interface Fire Protection Act (“Senate Bill 360”) in all Oregon counties that meet criteria under the law.	The *Oregon Forestland-Urban Interface Fire Protection Act*, more commonly known as “Senate Bill 360,” was enacted by the Oregon Legislature in response to the growing incidence of wildfire destroying homes and communities in Oregon’s wildland-urban interface. The Act recognizes that individual property owners are in the best position to take mitigation actions which will have the most direct impact to whether or not a structure will survive a wildfire. Under this action item, the Act will be implemented county by county in those portions of the state, based on weather, fire incidence, fuels, or on the number of structures at risk. It has been Legislature’s stated preference that implementation be accomplished with federal grant funds.	Revised. Ongoing.
LU-7	Update the Model Ordinance for Flood Damage Prevention	FEMA Region 10 has approved for use in Oregon a model ordinance for flood damage prevention. This model ordinance incorporates the NFIP minimum standards plus some elements of Oregon’s state building codes. DLCD reviewed and updated the model ordinance in 2006 and again in 2008. DLCD views the model ordinance as a living document and will continue to work with Region 10 and other interested parties to develop model ordinance provisions that address issues such as “fish-friendly” floodplain management, reducing flood insurance costs, etc. Model code language was developed in 2008 to guide habitat restoration projects in the floodway. Model code is based on FEMA Region X, “Policy on Fish Enhancement Structures in the Floodway” dated June 1999, and Portland District of the Army Corps of Engineers and the Oregon Department of State Lands jointly developed Regional General Permit (RGP) for Stream Habitat Restoration (ref NWP-2007-1023). The model code language was reviewed by FEMA and incorporated into Oregon Flood Hazard Reduction model ordinance. In 2010 the model ordinance was rewritten to incorporate Oregon Building Codes by reference and to include suggested administrative and permitting procedures. The model code language was reviewed by FEMA and published in 2011. DLCD will continue to modify the model ordinance in response to changing FEMA guidance, building code revisions and sound floodplain management experience.	**114**	Update the Model Ordinance for Flood Damage Prevention	FEMA Region 10 has approved for use in Oregon a model ordinance for flood damage prevention. DLCD views the model ordinance as a living document and will continue to work with Region 10 and other interested parties to develop model ordinance provisions that address issues such as “fish-friendly” floodplain management, reducing flood insurance costs, etc.	Revised. Ongoing.

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LU-8	Identify buildings and cultural resources that would benefit from hazard mitigation by supporting buildable lands inventories that identify constrained lands	Identify funding in order to make grants to local governments for inventories of buildable lands, where lands impacted by hazards would be identified as non-buildable or at least highly constrained. Through this process, also work with local governments to identify buildings and other cultural resources that would benefit from flood proofing or other hazard mitigation activities. These inventories should include an identification of land uses, lifelines, critical/essential facilities, cleanup sites in the floodway or floodplain, hazardous and solid waste generators, etc. DEQ and EPA may be able to assist in providing some of this data. Individual flood disasters have revealed the need for a comprehensive inventory of at-risk structures in all flood prone areas that could be subject to damage. These data could be the foundation for improved hazard mitigation programs that are based on priorities rather than addressing damaged properties after specific events.	**11**	Develop guidance for local governments on how to use Goal 7 together with other pertinent Statewide Land Use Planning Goals to classify lands subject to natural hazards in the buildable lands inventory and adjust urban growth boundaries in a manner that minimizes or eliminates potential damage to life, property, and the environment while continuing to provide for efficient development patterns.	Goal 7 discourages new development in areas subject to natural hazards. Goal 14 and other Statewide Land Use Planning Goals encourage development within urban growth boundaries. Local governments need guidance on how to classify lands subject to natural hazards in their buildable lands inventories and adjust urban growth boundaries to protect life, property, and the environment from natural hazards while providing for efficient development patterns within urban growth boundaries. This guidance will assist local governments in integrating local natural hazards mitigation plans with comprehensive plans.	Revised. Priority.
			66	Provide funding and technical assistance to local governments to use the new guidance on classifying lands subject to natural hazards in their buildable lands inventories and adjusting urban growth boundaries.	Local governments need funding and technical assistance to be able to use the new guidance on how to classify lands subject to natural hazards and adjust urban growth boundaries to protect life, property, and the environment from natural hazards while providing for efficient development patterns within urban growth boundaries. Comprehensive Plan amendments are likely to result. This funding and technical assistance will promote integration of local natural hazards mitigation plans with comprehensive plans.	Revised. Priority.
LU-9	Change state land use laws to better connect use of land with water supply	Occasionally land is developed in Oregon utilizing well water without regard to other nearby existing uses. Land developments can reduce recharging of the aquifer that is under them due to sending runoff largely away from the development. Farmers have lost well water or been forced to develop deeper wells due to loss of aquifer water to the newly developed land in the vicinity. Oregon land use law needs to require that new developments not create water hardships on existing land uses and other beneficial uses of water.	**LU-9**	Change state land use laws to better connect use of land with water supply	Occasionally land is developed in Oregon utilizing well water without regard to other nearby existing uses. Land developments can reduce recharging of the aquifer that is under them due to sending runoff largely away from the development. Farmers have lost well water or been forced to develop deeper wells due to loss of aquifer water to the newly developed land in the vicinity. Oregon land use law needs to require that new developments not create water hardships on existing land uses and other beneficial uses of water.	Revised. Removed.
LU-10	Work with the insurance industry to develop and apply a common standard of interface mitigation measures adjacent to dwellings	The Oregon Forestland-Urban Interface Fire Protection Act recognizes that individual property owners are in the best position to take mitigation actions which will have a direct relationship to whether or not their structures survive a wildfire. To that end, the Act required the development of standards that owners are to apply on their property. At the same time, some insurance companies have developed or adopted different standards which their customers must apply on their property in order to obtain or retain insurance coverage. Such a situation of "competing" standards is confusing to property owners and can hamper the application of effective mitigation measures. Under this action item, insurance companies will be encouraged to adopt the Act's standards or, rather than apply a different set of standards, that they will encourage their customers to comply with the Act.	**LU-10**	Work with the insurance industry to develop and apply a common standard of interface mitigation measures adjacent to dwellings	The *Oregon Forestland-Urban Interface Fire Protection Act* recognizes that individual property owners are in the best position to take mitigation actions which will have a direct relationship to whether or not their structures survive a wildfire. To that end, the Act required the development of standards that owners are to apply on their property. At the same time, some insurance companies have developed or adopted different standards which their customers must apply on their property in order to obtain or retain insurance coverage. Such a situation of "competing" standards is confusing to property owners and can hamper the application of effective mitigation measures. Under this action item, insurance companies will be encouraged to adopt the Act's standards or, rather than apply a different set of standards, that they will encourage their customers to comply with the Act.	Removed.

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LU-11	Strongly encourage the adoption of State Building Code standards (or other incentives) for retrofitting, upgrading, protecting, essential facilities, hazardous facilities, and special occupancy structures in coastal communities that are vulnerable to tsunamis	A large tsunami (and associated earthquake) would likely destroy many buildings in coastal communities that are located in the tsunami inundation zone. The damage would be from the combined effects of the forces from the tsunami surges, currents and debris, as well as the earthquake hazards. The State of Hawaii has adopted construction standards for buildings in tsunami zones. The National Tsunami Hazard Mitigation Program recently completed the document Designing for Tsunamis that outlines some of these issues. These documents could be evaluated and used as a starting point in developing standards. Although not under the jurisdiction of Building Code Standards, port and harbor facilities can benefit from lessons learned from DR-1964 and damages (distant generated tsunami impacts) at facilities in Brookings-Harbor, Depoe Bay, and Bandon. Such mitigation measure include strengthen pilings for floating docks, improved dock supports that facilitate unrestricted up-down movement during wave surges, and strengthened bulkhead walls that reduce scour from wave surges.	**LU-11**	Strongly encourage the adoption of State Building Code standards (or other incentives) for retrofitting, upgrading, protecting, essential facilities, hazardous facilities, and special occupancy structures in coastal communities that are vulnerable to tsunamis.	A large tsunami (and associated earthquake) would likely destroy many buildings in coastal communities that are located in the tsunami inundation zone. The damage would be from the combined effects of the forces from the tsunami surges, currents and debris, as well as the earthquake hazards. The State of Hawaii has adopted construction standards for buildings in tsunami zones. The National Tsunami Hazard Mitigation Program recently completed the document Designing for Tsunamis that outlines some of these issues. These documents could be evaluated and used as a starting point in developing standards. Although not under the jurisdiction of Building Code Standards, port and harbor facilities can benefit from lessons learned from DR-1964 and damages (distant generated tsunami impacts) at facilities in Brookings-Harbor, Depoe Bay, and Bandon. Such mitigation measure include strengthen pilings for floating docks, improved dock supports that facilitate unrestricted up-down movement during wave surges, and strengthened bulkhead walls that reduce scour from wave surges.	Removed.
LU-12	Establish and maintain a priority ranking system for properties for flood mitigation	The State's strategy for selecting properties for flood hazard mitigation projects is four-fold. It prioritizes projects that (a) are geographically balanced, (b) are in communities with a FEMA-approved local hazard mitigation plan, (c) address properties with sustained substantial damages or repetitive losses, and (d) provide communities with information and/or tools to evaluate properties suitable for mitigation, and to develop mitigation projects. Repetitive flood loss properties (those which have experienced multiple flood insurance claims) have been identified as high priority hazard mitigation projects by the NFIP. Nationwide, 40% of all flood insurance claims are paid on just 2% of insured properties. In Oregon, repetitive loss (RL) properties represent about 1% of all insured properties, and account for about 14% of all claims paid (19% of the dollar amount paid). Most (80%) of Oregon's repetitive loss properties pre-date the FIRMs. These properties are referred to as "pre-FIRM"; they were built in floodplains before FEMA FIRMs became available. Because of this, the property owners do not pay the true, actuarial cost of flood insurance. The RL lists provided by FEMA can have value for hazard mitigation planning because their locations may be indicative of persistent flood or drainage problems that may or may not be reflected on a FIRM. The state, working with local jurisdictions, will verify the FEMA-provided repetitive flood loss information at least once during this Plan's term and establish a priority ranking for properties that would benefit most from hazard mitigation by means of acquisition, relocation, elevation, or demolition. The state will maintain and review this list annually as a basis for selecting and funding hazard mitigation projects that directly benefit homeowners and businesses. The review of the repetitive lost list is tied to the FMA Program guidance that is updated annually with the state grant allocations. Following a major disaster declaration, these properties could be pre-approved by FEMA for hazard mitigation to include post-disaster mitigation funding from the Hazard Mitigation Grant Program that can often be expedited. Once the repetitive loss list is verified, DLCD and OEM will analyze and summarize the information in a geographic information system to discover spatial patterns associated with repetitive losses. Results will be shared with jurisdictions in which repetitive loss structures are located, with the recommendation that the loss areas be addressed in local hazard mitigation plans as potential mitigation action items (in concept but not by specific property address). DLCD will provide NFIP communities with RL properties the information necessary for them to identify and pre-qualify potential mitigation project opportunities that are cost-effective, environmentally sound and	**LU-12**	Establish and maintain a priority ranking system for properties for flood mitigation	The State's strategy for selecting properties for flood hazard mitigation projects is four-fold. It prioritizes projects that (a) are geographically balanced, (b) are in communities with a FEMA-approved local hazard mitigation plan, (c) address properties with sustained substantial damages or repetitive losses, and (d) provide communities with information and/or tools to evaluate properties suitable for mitigation, and to develop mitigation projects. Repetitive flood loss properties (those which have experienced multiple flood insurance claims) have been identified as high priority hazard mitigation projects by the NFIP. The state, working with local jurisdictions, will verify the FEMA-provided repetitive flood loss information at least once during this Plan's term and establish a priority ranking for properties that would benefit most from hazard mitigation by means of acquisition, relocation, elevation, or demolition. The state will maintain and review this list annually as a basis for selecting and funding hazard mitigation projects that directly benefit homeowners and businesses. The review of the repetitive lost list is tied to the FMA Program guidance that is updated annually with the state grant allocations. Following a major disaster declaration, these properties could be pre-approved by FEMA for hazard mitigation to include post-disaster mitigation funding from the Hazard Mitigation Grant Program that can often be expedited. Once the repetitive loss list is verified, DLCD and OEM will analyze and summarize the information in a geographic information system to discover spatial patterns associated with repetitive losses. Results will be shared with jurisdictions in which repetitive loss structures are located, with the recommendation that the loss areas be addressed in local hazard mitigation plans as potential mitigation action items (in concept but not by specific property address). DLCD will provide NFIP communities with RL properties the information necessary for them to identify and pre-qualify potential mitigation project opportunities that are cost-effective, environmentally sound and technically feasible. OEM will work with these communities in turning qualified potential projects into sub-grant applications. The Severe Repetitive Loss (SRL) grant program was authorized by the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004 to provide funding to reduce or eliminate the long-term risk of flood damage to severe repetitive loss (SRL) structures insured under the National Flood Insurance Program (NFIP). As of May 2011, there are nine identified SRL properties in Oregon, eight of which are insured with the NFIP. The State has been working closely with the property owner of the property with the highest number of losses (7) to mitigate against	Revised. Removed.

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		technically feasible. OEM will work with these communities in turning qualified potential projects into sub-grant applications. The Severe Repetitive Loss (SRL) grant program was authorized by the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004 to provide funding to reduce or eliminate the long-term risk of flood damage to severe repetitive loss (SRL) structures insured under the National Flood Insurance Program (NFIP). As of May 2011, there are nine identified SRL properties in Oregon, eight of which are insured with the NFIP. The State has been working closely with the property owner of the property with the highest number of losses (7) to mitigate against future loss. This mitigation project is projected to come to completion in 2011 using SRL grant funds (pending FEMA approval). DLCD and OEM will develop a plan for addressing the remaining SRL properties based upon experience with the 2011 mitigation project. Cost-effectiveness of mitigation must be proven for SRL properties and unfortunately the dollar losses suffered by the remaining SRL properties in Oregon may not allow mitigation to be funded using the SRL grant program (or Federal mitigation grant programs). FEMA's Greatest-Savings-to-the-Fund (GSTF) calculation does not provide sufficient benefits to mitigate any of Oregon's SRL properties. Mitigation costs will likely exceed the GSTF calculation in all cases. Consequently, DLCD and OEM will evaluate the remaining SRL properties, including conducting screening benefit-cost analysis, to determine whether the remaining SRL properties qualify for priority ranking for mitigation action. Results will be shared with FEMA and local jurisdictions. Any decision to move forward will be made in consultation with local jurisdictions and property owners.			future loss. This mitigation project is projected to come to completion in 2011 using SRL grant funds (pending FEMA approval). DLCD and OEM will develop a plan for addressing the remaining SRL properties based upon experience with the 2011 mitigation project. Cost-effectiveness of mitigation must be proven for SRL properties and unfortunately the dollar losses suffered by the remaining SRL properties in Oregon may not allow mitigation to be funded using the SRL grant program (or Federal mitigation grant programs). FEMA's Greatest-Savings-to-the-Fund (GSTF) calculation does not provide sufficient benefits to mitigate any of Oregon's SRL properties. Mitigation costs will likely exceed the GSTF calculation in all cases. Consequently, DLCD and OEM will evaluate the remaining SRL properties, including conducting screening benefit-cost analysis, to determine whether the remaining SRL properties qualify for priority ranking for mitigation action. Results will be shared with FEMA and local jurisdictions. Any decision to move forward will be made in consultation with local jurisdictions and property owners.	
LU-13	Maintain the Riparian Lands Tax Incentive Program	This program is administered by the ODFW. This program involves the preparation of a plan and agreement between the landowner and the ODFW. The plan details measures the landowner will implement to preserve, enhance, or restore the riparian areas. Landowners receive a complete property tax exemption for the riparian property (up to 100 feet from the top of stream bank or the edge of non-aquatic vegetation). This program helps reduce sediment and protect stream banks which helps reduce the filling of river and stream channels.	**115**	Maintain the Riparian Lands Tax Incentive Program	This program is administered by the ODFW. This program involves the preparation of a plan and agreement between the landowner and the ODFW. The plan details measures the landowner will implement to preserve, enhance, or restore the riparian areas. Landowners receive a complete property tax exemption for the riparian property (up to 100 feet from the top of stream bank or the edge of non-aquatic vegetation). This program helps reduce sediment and protect stream banks which helps reduce the filling of river and stream channels.	Ongoing.
LU-14	Develop additional littoral cell plans	The state intends to pursue development of plans for additional sections of coastline, based on need and the level of risk to development.	**LU-14**	Develop additional littoral cell plans	The state intends to pursue development of plans for additional sections of coastline, based on need and the level of risk to development.	Removed.
LU-15	Acquire existing homes and businesses seriously threatened by landslide hazards	When opportunities and funding become available (pre- and/or post-disaster) explore options for the acquisition of developed property, particularly homes, in areas of repetitive or ongoing landslide hazards. Acquired properties will be maintained as open space in perpetuity and may also provide a buffer for landslide movements and debris that could otherwise impact improvements such as transportation routes.	**124**	Acquire existing homes and businesses seriously threatened or damaged by landslide hazards	When opportunities and funding become available (pre- and/or post-disaster) explore options for the acquisition of developed property, particularly homes, in areas of repetitive or ongoing landslide hazards. Acquired properties will be maintained as open space in perpetuity and may also provide a buffer for landslide movements and debris that could otherwise impact improvements such as transportation routes.	Revised. Ongoing.
LU-16	Develop training and information packets and articles for local building officials informing them of their responsibilities and authority under ORS 455.446 and 455.447 and the State Building Code.	Statutes and the State Building Code limit construction of new essential facilities and special occupancy structures in the mapped tsunami inundation zone. Definitions of essential and special occupancy structures are in the Oregon State Structural Specialty Code. Training has not been provided to local building officials since the original adoption of SB 379 (1995 Oregon Legislative Session), codified as ORS 455.446 - .447. As personnel change and time passes, additional training and information for officials will be provided.	**131**	Continue to develop training and information packets and articles for local building officials informing them of their responsibilities and authority under ORS 455.446 and 455.447 and the State Building Code.	Statutes and the State Building Code limit construction of new essential facilities and special occupancy structures in the mapped tsunami inundation zone. Definitions of essential and special occupancy structures are in the Oregon State Structural Specialty Code. As personnel change and time passes, additional training and information for officials will be provided.	Revised. Ongoing.

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2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
LU-17	Organize a GIS tsunami database workshop	A GIS database of tsunami safe zones, evacuation routes, and evacuation sites is presently under construction (see short-term action item #1). Once completed, it is important to integrate the data into county databases. The workshop would not only assist counties with how to integrate the data, but also how the data can be used for tsunami evacuation planning.	**LU-17**	Organize a GIS tsunami database workshop	A GIS database of tsunami safe zones, evacuation routes, and evacuation sites is presently under construction. Once completed, it is important to integrate the data into county databases. The workshop would not only assist counties with how to integrate the data, but also how the data can be used for tsunami evacuation planning.	Removed.
			25	Integrate the GIS database of tsunami safe zones and assembly areas into local government databases.	Assist counties not only with how to integrate the data, but also how the data can be used for tsunami evacuation planning.	Revised. Priority.
LU-18	Assist local communities in securing funding to implement measures to mitigate damage to buildings exposed to or having experienced repetitive flood losses	The state maintains an inventory of high priority repetitively damaged buildings located in floodplains (also see short-term action #7). As funding opportunities arise, continue to acquire, elevate, or otherwise mitigate damage to buildings exposed to or having experienced unacceptable flood damages. The flood event of December 2007 heavily impacted the City of Vernonia and the unincorporated Nehalem Valley. As a result of this flood, significant changes were made to flood hazard maps in the area, causing scores of buildings to be placed in the regulated flood hazard zone. DLCD and OEM have worked closely with these communities to secure funding to mitigate buildings now located in the flood hazard zone and to buyout properties now located in the floodway and will continue to provide such expertise statewide where needed.	**120**	Assist local communities in securing funding to mitigate damage to repetitive flood loss properties or those substantially damaged by flooding.	The state maintains an inventory of high priority repetitively damaged buildings located in floodplains. DLCD and OEM have worked closely with communities to secure funding to mitigate buildings located in the flood hazard zone and to buyout properties located in the floodway. These agencies will continue to provide such expertise statewide where needed.	Revised. Ongoing.
			45	Develop a system for prioritizing and ranking state-owned facilities, including critical facilities, for mitigation.	Create an evaluation framework for determining a comprehensive list of critical state-owned facilities in terms of local and regional service needs in the event of a natural disaster; prioritize these critical facilities based on mitigation needs by disaster type; and evaluate each critical facility on the basis of investment cost and potential relocation/decommission in locations with increased hazard risk.	New. Priority.
			G	Provide guidance to the maritime community for evacuation response for local Cascadia and distant tsunami events.	Tsunami model data including minimum flow depths and maximum flow velocities will be analyzed to determine port-specific maritime guidance.	New. Removed.
MAINTENANCE/PLANNING						
MP-1*	State IHMT Agency Action Item Progress Reports	Prior to the April State IHMT meetings of each year, State IHMT priority functional category leads will submit progress briefs on all mitigation activities to OEM for review. Briefs will include a progress update on primary action item responsibilities, identification of agency success stories, suggestions for potential new action items and identification of any new or updated information that will be germane to the update of the state NHMP chapters or appendices. Leads will complete success stories for any completed actions at that time. Priority functional categories for the 2012–2015 planning period include: • Legislative/Policy • Education/Outreach and • Critical Infrastructure / Essential Public Facilities	**MP-1***	State IHMT Agency Action Item Progress Reports	Prior to the April State IHMT meetings of each year, State IHMT priority functional category leads will submit progress briefs on all mitigation activities to OEM for review. Briefs will include a progress update on primary action item responsibilities, identification of agency success stories, suggestions for potential new action items and identification of any new or updated information that will be germane to the update of the state NHMP chapters or appendices. Leads will complete success stories for any completed actions at that time. Priority functional categories for the 2012–2015 planning period include: • Legislative/Policy • Education/Outreach and • Critical Infrastructure / Essential Public Facilities	Removed.

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2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
MP-2*	Develop post-disaster strategic reconstruction plans based on damage projections from a Cascadia Subduction Zone earthquake and tsunami.	A large Cascadia Subduction Zone earthquake/tsunami may destroy a significant percentage of the buildings in coastal communities, as well as much of the public and private infrastructure that ties them together. Reconstruction of buildings and associated infrastructure will be a massive, long-term undertaking, requiring a great deal of financial aid, planning, technical assistance and cooperation among agencies and the public. Although tragic, such a disaster will also present communities with an opportunity to physically redesign and reshape themselves, creating safer places for people to live and work. A state post disaster planning and recovery task force would be established to plan for reconstruction and to oversee post disaster reconstruction. The Cascadia Region Earthquake Workgroup has recently developed a detailed damage scenario for a CSZ event using Hazus (Hazards U.S. loss estimation software program) and other information to supplement the Hazus data. For example, Hazus does not take into account tsunami damage. This scenario could be used as the basis for developing reconstruction plans.	**MP-2***	Develop post-disaster strategic reconstruction plans based on damage projections from a Cascadia Subduction Zone earthquake and tsunami.	A large Cascadia Subduction Zone (CSZ) earthquake/tsunami may destroy a significant percentage of the buildings in coastal communities, as well as much of the public and private infrastructure that ties them together. Reconstruction of buildings and associated infrastructure will be a massive, long-term undertaking, requiring a great deal of financial aid, planning, technical assistance and cooperation among agencies and the public. Although tragic, such a disaster will also present communities with an opportunity to physically redesign and reshape themselves, creating safer places for people to live and work.A state post disaster planning and recovery task force would be established to plan for reconstruction and to oversee post disaster reconstruction. The Cascadia Region Earthquake Workgroup has recently developed a detailed damage scenario for a CSZ event using Hazus (Hazards U.S. loss estimation software program) and other information to supplement the Hazus data. For example, Hazus does not take into account tsunami damage. This scenario could be used as the basis for developing reconstruction plans.	Removed.
MP-3*	Monitor hazard mitigation implementation	It is recommended that OEM establish and maintain a formal process to ensure that actions in this Plan are being properly implemented. By monitoring implementation of successful mitigation projects, important data can be obtained to support loss avoidance studies that quantify the benefits of mitigation. Monitoring of floodplain and landslide property acquisitions (funded by FEMA mitigation grants) is required and must be reported to FEMA every 3 years. Although not a federal requirement, monitoring of floodplain property elevations will ensure compliance with meeting NFIP flood insurance requirements. Hazard mitigation implementation may also be reviewed and this Plan revised following any Presidential emergency or major disaster declaration. At one time this was a requirement of federal law, but it now is simply a good idea, especially if interest in the event has provided both resources and opportunity for mitigation.	**MP-3***	Monitor hazard mitigation implementation	It is recommended that OEM establish and maintain a formal process to ensure that actions in this Plan are being properly implemented. By monitoring implementation of successful mitigation projects, important data can be obtained to support loss avoidance studies that quantify the benefits of mitigation. Monitoring of floodplain and landslide property acquisitions (funded by FEMA mitigation grants) is required and must be reported to FEMA every 3 years. Although not a federal requirement, monitoring of floodplain property elevations will ensure compliance with meeting NFIP flood insurance requirements. Hazard mitigation implementation may also be reviewed and this Plan revised following any Presidential emergency or major disaster declaration. At one time this was a requirement of federal law, but it now is simply a good idea, especially if interest in the event has provided both resources and opportunity for mitigation.	Removed.
MP-4	Maintain a statewide action item database	OPDR hosts a searchable action item database on its website that identifies the actions from existing local natural hazards mitigation plans. During the 2009 Oregon NHMP update, revisions were made to the action item database to allow for local actions to be categorized underneath the state plan goals. This will allow the state or FEMA to quickly sort local actions by the various state plan goals. This function will allow for easier reporting on the State of Oregon's progress toward reducing risk and can be organized under the six Oregon NHMP goals. OPDR is working to add the state plan goal references to actions that are currently listed and is also working to add the actions of new plans as they are developed. Maintaining this database is time and resource intensive; therefore, all local actions may not be categorized during this Plan update. This will be an ongoing task for OPDR and OEM staff. Action Item Database: http://csc.uoregon.edu/opdr/actionitems/	**MP-4**	Maintain a statewide action item database	OPDR hosts a searchable action item database on its website that identifies the actions from existing local natural hazards mitigation plans. During the 2009 Oregon NHMP update, revisions were made to the action item database to allow for local actions to be categorized underneath the state plan goals. This will allow the state or FEMA to quickly sort local actions by the various state plan goals. This function will allow for easier reporting on the State of Oregon's progress toward reducing risk and can be organized under the six Oregon NHMP goals. OPDR is working to add the state plan goal references to actions that are currently listed and is also working to add the actions of new plans as they are developed. Maintaining this database is time and resource intensive; therefore, all local actions may not be categorized during this Plan update. This will be an ongoing task for OPDR and OEM staff. Action Item Database: http://csc.uoregon.edu/opdr/actionitems/	Removed.
MP-5	Assure full implementation of NFIP map modernization program in Oregon	Work cooperatively with FEMA to ensure that the NFIP map modernization program is fully implemented in Oregon, giving high priority to remapping of coastal areas due to age of existing FIRM maps and potential severity of flooding and related erosion hazards.	**MP-5**	Complete implementation of NFIP Map Modernization program in Oregon.	Work cooperatively with FEMA to ensure that the NFIP map modernization program is fully implemented in Oregon, giving high priority to remapping of coastal areas due to age of existing FIRM maps and potential severity of flooding and related erosion hazards.	Revised. Removed.
			121	Continue implementation of FEMA's Risk MAP program in Oregon, including building effective community strategies for reducing risk.	Measurably increase the public's awareness of flood and other natural hazards through a combination of regulatory and non-regulatory products, tools, community outreach. Address gaps in flood hazard data, identifying areas of dated and/or inconsistent mapping and updating high-priority areas with new mapping and innovative natural hazard mapping techniques that lead to actions that reduce risk to life and property. Provide support to help manage the FEMA Map Modernization projects that remain to be completed.	New. Ongoing.

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2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
			7	Through FEMA's Risk MAP program, update 1,000 miles of streams with lidar-based flood mapping.	FEMA's Risk MAP program funds revisions of Flood Insurance Studies and Flood Insurance Rate Maps. The State should focus on updating these products so they are based on high quality topographic data (e.g., lidar). Lidar-derived streams are a by-product of high quality topographic data. These more accurately located streams will assist in the improvement of a community's flood maps to more accurately show flood risk to life and property. The State should continue to pursue Risk MAP funds for this purpose.	New. Priority.
MP-6	Establish a Silver Jackets Program	The State IHMT should consider establishing a joint state-federal flood mitigation subcommittee, which is tied to a national USACE initiative called "Silver Jackets" (Oregon is not required to adopt this name for the subcommittee). It would provide a forum where DLCD, DOGAMI, OEM, USACE, FEMA, USGS, and additional federal, state and sometimes local and Tribal agencies can come together to collaboratively plan and implement flood mitigation, optimizing multi-agency utilization of federal assistance by leveraging state/local/Tribal resources, including data/information, talent and funding, and preventing duplication among agencies. Objectives of this subcommittee might include: • Facilitate strategic life-cycle flood risk reduction, • Create or supplement a continuous mechanism to collaboratively solve state-prioritized issues and implement or recommend those solutions, • Improve processes, identifying and resolving gaps and counteractive programs, • Leverage and optimize resources, • Improve and increase flood risk communication and present a unified interagency message, and • Establish close relationships to facilitate integrated post-disaster recovery solutions. The State of Oregon will establish a "Silver Jackets", as a subcommittee to the IHMT, with the primary intents of strengthening interagency relationships and cooperation, optimizing resources, and improving risk communication and messaging.	MP-6	Establish a Silver Jackets Program	The State IHMT should consider establishing a joint state-federal flood mitigation subcommittee, which is tied to a national USACE initiative called "Silver Jackets" (Oregon is not required to adopt this name for the subcommittee). It would provide a forum where DLCD, DOGAMI, OEM, USACE, FEMA, USGS, and additional federal, state and sometimes local and Tribal agencies can come together to collaboratively plan and implement flood mitigation, optimizing multi-agency utilization of federal assistance by leveraging state/local/Tribal resources, including data/information, talent and funding, and preventing duplication among agencies. Objectives of this subcommittee might include: • Facilitate strategic life-cycle flood risk reduction, • Create or supplement a continuous mechanism to collaboratively solve state-prioritized issues and implement or recommend those solutions, • Improve processes, identifying and resolving gaps and counteractive programs, • Leverage and optimize resources, • Improve and increase flood risk communication and present a unified interagency message, and • Establish close relationships to facilitate integrated post-disaster recovery solutions. The State of Oregon will establish a "Silver Jackets", as a subcommittee to the State IHMT, with the primary intents of strengthening interagency relationships and cooperation, optimizing resources, and improving risk communication and messaging.	Removed.
MP-7	Revise OEM Hazard Analysis Methodology	Each county in Oregon is required to conduct a hazard analysis within their communities. As part of the hazard analysis, each county develops risk scores for the natural hazards that affect their communities. These scores range from 24 (low) to 240 (high), and reflect the county's perceived risk for each particular hazard. The hazard analysis methodology was first developed by the Federal Emergency Management Agency (FEMA) circa 1983, and gradually refined by the Oregon Office of Emergency Management (OEM) over the years. The current methodology could be improved upon to allow for the integration of more detailed risk assessment information. Currently, communities are tasked with determining whether hazards have a 'high,' 'moderate,' or 'low' probability of occurrence; likewise, communities are asked to determine whether their community has a 'high,' 'moderate,' or 'low' vulnerability to each hazard. When better probability or vulnerability data is available, communities should be able to reflect these data in their hazard analyses. Additionally, OEM will work with OPDR to integrate the hazard analysis methodology with the three-phase risk assessment used and taught by OPDR with respect to the development of local natural hazards mitigation plans. In the development of local mitigation plans, the county's hazard analysis scores are typically referenced. If, however, the planning steering committee believes the scores should be different, the scores are simply changed, and the perceived validity of the OEM hazard analysis methodology is weakened. The integration of the analysis with the three-phase risk assessment should therefore be refined.	MP-7	Revise OEM Hazard Analysis Methodology	Each county in Oregon is required to conduct a hazard analysis within their communities. As part of the hazard analysis, each county develops risk scores for the natural hazards that affect their communities. These scores range from 24 (low) to 240 (high), and reflect the county's perceived risk for each particular hazard. The hazard analysis methodology was first developed by the Federal Emergency Management Agency (FEMA) circa 1983, and gradually refined by the Oregon Office of Emergency Management (OEM) over the years. The current methodology could be improved upon to allow for the integration of more detailed risk assessment information. Currently, communities are tasked with determining whether hazards have a 'high,' 'moderate,' or 'low' probability of occurrence; likewise, communities are asked to determine whether their community has a 'high,' 'moderate,' or 'low' vulnerability to each hazard. When better probability or vulnerability data is available, communities should be able to reflect these data in their hazard analyses. Additionally, OEM will work with OPDR to integrate the hazard analysis methodology with the three-phase risk assessment used and taught by OPDR with respect to the development of local natural hazards mitigation plans. In the development of local mitigation plans, the county's hazard analysis scores are typically referenced. If, however, the planning steering committee believes the scores should be different, the scores are simply changed, and the perceived validity of the OEM hazard analysis methodology is weakened. The integration of the analysis with the three-phase risk assessment should therefore be refined.	Removed.

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2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
MP-8	Track key performance measures toward a disaster resistant state.	State "benchmarks" for mitigation have been superseded by Key Performance Measures (KPMs), and are comprised of the following: DLCD KPM #9, "Percent of urban areas that have updated buildable land inventories to account for natural resource and hazard areas"; DOGAMI KPM #1, "Percent of communities and other stakeholders with hazard maps and risk studies for earthquake and landslide hazards"; DOGAMI KPM #2, "Percent target communities with official, reviewed evacuation map brochures"; DOGAMI KPM #3, "Percent target communities with standardized, 4-risk zone erosion hazard maps"; DOGAMI KPM #4, "Public awareness of geologic hazards and mitigation efforts"; DOGAMI KPM #9, "Percent of coastal communities provided with detailed tsunami inundation maps for local emergency planning"; OMD-OEM KPM #10, "Percent of Oregon coastal counties with complete evacuation plans"; and OMD-OEM KPM #12, "Percent of jurisdictions with approved hazard mitigation plans." In combination, these KPMs are moving Oregon toward the goal of developing a disaster resistant state, which institutionalizes hazard mitigation, including: the characterization of natural hazards; the presence of ordinances or standards at the local government level to mitigate natural hazards; and ongoing education on natural hazard mitigation.	**MP-8**	Track key performance measures toward a disaster resistant state.	State "benchmarks" for mitigation have been superseded by Key Performance Measures (KPMs), and are comprised of the following: DLCD KPM #9, "Percent of urban areas that have updated buildable land inventories to account for natural resource and hazard areas"; DOGAMI KPM #1, "Percent of communities and other stakeholders with hazard maps and risk studies for earthquake and landslide hazards"; DOGAMI KPM #2, "Percent target communities with official, reviewed evacuation map brochures"; DOGAMI KPM #3, "Percent target communities with standardized, 4-risk zone erosion hazard maps"; DOGAMI KPM #4, "Public awareness of geologic hazards and mitigation efforts"; DOGAMI KPM #9, "Percent of coastal communities provided with detailed tsunami inundation maps for local emergency planning"; OMD-OEM KPM #10, "Percent of Oregon coastal counties with complete evacuation plans"; and OMD-OEM KPM #12, "Percent of jurisdictions with approved hazard mitigation plans." In combination, these KPMs are moving Oregon toward the goal of developing a disaster resistant state, which institutionalizes hazard mitigation, including: the characterization of natural hazards; the presence of ordinances or standards at the local government level to mitigate natural hazards; and ongoing education on natural hazard mitigation.	Revised. Removed.
MP-9	Encourage GIS capability development	Assist local governments with GIS program development, including system planning, hardware/software costs, training, and data development in relation to all hazards mapping and regulation of coastal development.	**89**	Continue to assist local governments with GIS capability development	Assist local governments with GIS program development, including system planning, hardware/software costs, training, and data development in relation to all hazards mapping and regulation of coastal development.	Revised. Ongoing.
MP-10	Improve statewide earthquake hazard datasets, develop more accurate and detailed risk datasets, make hazard and risk information widely and easily available	In order to assess the likely impact of future earthquakes, improved shaking models are needed, along with more accurate and detailed mapping of the distribution of soils that might amplify shaking or liquefy, and mapping of areas susceptible to coseismic landslides. These data should be combined with improved asset information to do risk studies using Hazus and exploring the use of GIS-based exposure analysis. Detailed hazard and risk mapping and modeling provides local and state governments with essential planning tools. Hazard and risk information should be made widely and easily available to planners, decision makers, and most importantly the general public. Easy to use interactive web tools with comprehensive earthquake and multi-hazard information should be deployed statewide .	**MP-10**	Improve statewide earthquake hazard datasets, develop more accurate and detailed risk datasets, make hazard and risk information widely and easily available	In order to assess the likely impact of future earthquakes, improved shaking models are needed, along with more accurate and detailed mapping of the distribution of soils that might amplify shaking or liquefy, and mapping of areas susceptible to coseismic landslides. These data should be combined with improved asset information to do risk studies using Hazus and exploring the use of GIS-based exposure analysis. Detailed hazard and risk mapping and modeling provides local and state governments with essential planning tools. Hazard and risk information should be made widely and easily available to planners, decision makers, and most importantly the general public. Easy to use interactive web tools with comprehensive earthquake and multi-hazard information should be deployed statewide.	Removed.
			2	Create a "Clearinghouse" for natural hazards data.	Emergency responders and community planners alike need access to the best and most current natural hazards data that is available. This project would be a cooperative effort between authoritative data sources — DLCD, DOGAMI, OEM, OWRD, and federal partners (FEMA, USACE, NWS, USGS) — and would include: Establishing a single point of online access to reliable data, maps, and information about natural hazards; Developing, in conjunction with DAS-GEO, a "portal" to distribute this data; Developing a multi-agency State of Oregon flood hazard website; Providing an ongoing inventory and assessment of existing natural hazards data; and Creating a central library for natural hazard risk assessments.	New. Priority.
MP-11	Survey coastline to monitor erosion	Continue to periodically measure and monitor the Oregon coastline in order to document the response of Oregon's beach and bluffs to changes in ocean water levels (sea level rise and storm surges), storms (frequency and intensity), precipitation patterns that may threaten lives and property. Maintain a long-term, permanent Oregon Beach and Shoreline Mapping and Analysis Program (OBSMAP). The program will be a partnership with local, state, and federal agencies that have responsibility over coastal and ocean activities.	**103**	Survey coastline to monitor erosion	Continue to periodically measure and monitor the Oregon coastline in order to document the response of Oregon's beach and bluffs to changes in ocean water levels (sea level rise and storm surges), storms (frequency and intensity), precipitation patterns that may threaten lives and property. Maintain a long-term, permanent Oregon Beach and Shoreline Mapping and Analysis Program (OBSMAP). The program will be a partnership with local, state, and federal agencies that have responsibility over coastal and ocean activities.	Ongoing.

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MP-12	Analyze wildfire ignition probability statistics to better target prevention efforts at the leading causes of fires	There is currently no single database or common method of collecting fire cause information for wildfires occurring in Oregon. This results in different entities focusing their prevention and mitigation efforts on those causes which may not be the state's leading causes of fires. This likelihood can be lessened by developing a process to compare fire cause data collected by the Oregon Department of Forestry, the Office of State Marshal, and federal wildfire agencies. It is also important to understand the ignition probability from homes within and adjacent to the wildland interface because of the ignition risk to nearby wildlands. Under this action item, until a common database is developed, a process will be developed to identify the most common wildfire ignition causes, compile and analyze a list of those causes and trends, and distribute this information to agencies and organizations that can help prevent such wildfires. Having data on the leading causes of ignitions, organized by county, will help establish a course of action for prevention programs.	**142**	Analyze wildfire ignition probability statistics to better target prevention efforts at the leading causes of fires.	There is currently no single database or common method of collecting fire cause information for wildfires occurring in Oregon. This results in different entities focusing their prevention and mitigation efforts on those causes which may not be the state's leading causes of fires. This likelihood can be lessened by developing a process to compare fire cause data collected by the Oregon Department of Forestry, the Office of the State Fire Marshal, and federal wildfire agencies. It is also important to understand the ignition probability from homes within and adjacent to the wildland interface because of the ignition risk to nearby wildlands. While there is no centralized database, wildland and structural fire agencies will continue to work collaboratively to determine leading fire causes and focus efforts statewide and locally to prevent future ignitions.	Revised. Ongoing.
MP-13	Develop a single, comprehensive statewide method or process to collect and analyze wildfire occurrence data in a timely manner	Currently, data concerning the causes of wildfire incidents is collected and analyzed by at least two state agencies, five federal agencies, and numerous local fire departments. These agencies have no database standardization or common reporting requirements. This results in great difficulty, when attempting to determine the number of wildfires that occur in Oregon, when identifying fire cause trends, and generally in obtaining information concerning wildfire trends in a timely manner. Under this action item, all agencies responsible for suppressing wildfires will be requested to report incident occurrence information to a central data repository, in a standard format, and within prescribed reporting time limits. Such a system would allow for the rapid identification of fire ignition trends and would permit the timely design and delivery of targeted prevention programs and activities. The State Fire Marshal's Oregon All Incident Reporting System (OAIRS) may be a key component in the solution.	**145**	Develop a single, comprehensive statewide method or process to collect and analyze wildfire occurrence data in a timely manner	Currently, data concerning the causes of wildfire incidents is collected and analyzed by at least two state agencies, five federal agencies, and numerous local fire departments. These agencies have no database standardization or common reporting requirements. This results in great difficulty, when attempting to determine the number of wildfires that occur in Oregon, when identifying fire cause trends, and generally in obtaining information concerning wildfire trends in a timely manner. Under this action item, all agencies responsible for suppressing wildfires will be requested to report incident occurrence information to a central data repository, in a standard format, and within prescribed reporting time limits. Such a system would allow for the rapid identification of fire ignition trends and would permit the timely design and delivery of targeted prevention programs and activities. The State Fire Marshal's Oregon All Incident Reporting System (OAIRS) may be a key component in the solution.	Ongoing.
			143	Collaborate through work groups within the Pacific Northwest Coordination Group (PNWCG) to continue collecting and analyzing wildfire occurrence data using the standardized statewide method and report to the state legislature as required.	Previously, data concerning the causes of wildfire incidents was collected and analyzed by at least two state agencies, five federal agencies, and numerous local fire departments. These agencies had no database standardization or common reporting requirements. A standardized data collection system has been developed and data collection and reporting continues collaboratively through work groups within the Pacific Northwest Coordination Group (PNWCG). The new system allows rapid identification of fire ignition trends and permits timely design and delivery of targeted prevention programs and activities.	New. Ongoing.
MP-14	Develop probabilistic risk maps for the Oregon Coast	Consider and examine combinations and permutations of multi-hazard risk exposure and maps for the entire Oregon Coast.	**73**	Develop probabilistic multi-hazard risk maps for the Oregon Coast	Consider and examine combinations and permutations of multi-hazard risk exposure and maps for the entire Oregon Coast.	Revised. Priority.
MP-15	Work to improve forecasting for warning and hazard mitigation	State agencies plan to continue to work with the State Climatologist and the National Weather Service to better understand the nature and frequency of windstorms, and to improve communication of long and short range forecasts in order to allow for improved warnings and lead time for local governments to take effective hazard mitigation actions.	**MP-15**	Work to improve forecasting for warning and hazard mitigation	State agencies plan to continue to work with the State Climatologist and the National Weather Service to better understand the nature and frequency of windstorms, and to improve communication of long and short range forecasts in order to allow for improved warnings and lead time for local governments to take effective hazard mitigation actions.	Removed.

2012 to 2015 Mitigation Action Crosswalk

2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
			10	Implement the Rapid Assessment of Flooding Tool (RAFT)	The RAFT has been funded and developed by the U.S. Army Corps of Engineers (USACE) through FY 14 for $115,000. The goal of the RAFT is to take real time flood forecasts and relate them to flood frequency curves from FEMA, USGS, and OWRD. This will help decision makers prioritize real-time flood fighting assistance. The tool will also incorporate other important decision-influencing factors, possibly including structures in danger of flooding, population affected, and likelihood of levee failure. The RAFT is intended to work in concert with and feed data to other emergency management tools, such as OEM's RAPTOR. The RAFT is in very early development, and the scope and schedule are under development. Once RAFT is completed, OEM will have operational oversight when the ECC is activated.	New. Priority.
			53	Add at least three new flood inundation forecast points to the National Weather Service's Flood Inundation Mapping website and the USGS's Flood Inundation Mapper before 2018.	The National Weather Service (NWS) Advanced Hydrologic Prediction Service (AHPS) has developed inundation mapping sites for various stream gage locations nationwide. Currently there are none in Oregon. This is a useful tool for understanding potential inundation areas based on NWS forecasts. NWS: http://water.weather.gov/ahps/inundation.php; USGS: http://wim.usgs.gov/fimi/)	New. Priority.

2012 to 2015 Mitigation Action Crosswalk

2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
MP-16	Seek funding for the installation and operation of additional precipitation gauges	The state continues to participate in FEMA's national effort to update flood hazard maps, and through the 2004-2009 Map Modernization Program (Map Mod) the majority of flood maps for Oregon have now been issued in a new digital, countywide format. The state will continue to provide support to help manage the Map Mod projects that remain to be completed (Coos, Lane, Tillamook, and Washington Counties), and DLCD will continue to implement the map modernization management support strategy and activities by: 1. Establishing and maintaining a premier data collection and delivery system, 2. Achieving effective long-term management of flood hazard maps, 3. Building and maintaining mutually beneficial partnerships to accomplish mapping work, and 4. Expanding and better informing the flood map user community. Risk MAP (Mapping, Assessment, and Planning) is FEMA's new multi-year mapping program. The program builds on flood hazard data and maps produced through Map Mod while including the vision of building effective community strategies for reducing risk. In partnership with DOGAMI, FEMA contractors, and other state and local agencies, the objectives in Oregon's Risk MAP business plan include: 1. Addressing gaps in flood hazard data, identifying areas of dated and/or inconsistent mapping and updating high-priority areas with new mapping (Coos (remap), Curry, Lincoln, Tillamook, Clatsop, and Klamath Counties, as well as the Silvies Watershed and the Lower Columbia-Sandy Watershed—most projects contracted with DOGAMI); 2. Acquire new lidar topographic data for precise flood hazard mapping; 3. Measurably increase the public's awareness of flood and other natural hazards through a combination of regulatory and non-regulatory products, tools, community outreach, and innovative natural hazard mapping techniques (such as those developed by DOGAMI) that lead to actions that reduce risk to life and property; 4. Lead effective engagement in flood mitigation planning through partnerships and shared datasets; 5. Provide a coordinated multi-agency digital platform that includes data, links to data, applications, strategies, a digital library of flood hazard maps, and a web map depicting the most recent statewide Special Flood Hazard Area layer; 6. Coordinate events, project status, and actions; and 7. Align risk analysis programs and develop synergies.	**MP-16**	Seek funding for the installation and operation of additional precipitation gauges	The availability of timely and accurate telemetered data from rain (precipitation) gauges is essential for flash flood and debris flow forecasting. State agencies plan to work with their federal counterparts to ensure adequate funding and support for existing gauges and for the installation of new gauging sites where required. It is recommended that state agencies leverage federal funding with state resources and local matching commitments to achieve a reliable network of rain gauges in those areas that are susceptible to flash flooding and rapidly moving landslides (debris flows).	Revised. Removed.
MP-17	Develop statewide resiliency plan consistent with intent of HR 3	The availability of timely and accurate telemetered data from rain (precipitation) gauges is essential for flash flood and debris flow forecasting. State agencies plan to work with their federal counterparts to ensure adequate funding and support for existing gauges and for the installation of new gauging sites where required. It is recommended that state agencies leverage federal funding with state resources and local matching commitments to achieve a reliable network of rain gauges in those areas that are susceptible to flash flooding and rapidly moving landslides (debris flows).	**MP-17**	Develop statewide resiliency plan consistent with intent of HR 3	Set realistic and achievable, graduated resiliency goals. Evaluate existing weaknesses in structures, infrastructure, systems and institutions to identify critical vulnerabilities that will severely hinder response and recovery from a future megathrust earthquake. Develop prioritized and graduated levels of mitigation activity with estimates of costs and benefits. Identify needed mandates, regulations, codes, incentives and educational and cultural changes needed to reach resiliency goals. Prepare written plan and report for 2013-2015 legislatures.	Removed.

2012 to 2015 Mitigation Action Crosswalk

2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
MP-18	Support the completion of updated, digital floodplain mapping projects initiated through the FEMA Map Modernization Program (previously short-term action #1) and transition to FEMA's current Risk MAP program.	Set realistic and achievable, graduated resiliency goals. Evaluate existing weaknesses in structures, infrastructure, systems and institutions to identify critical vulnerabilities that will severely hinder response and recovery from a future megathrust earthquake. Develop prioritized and graduated levels of mitigation activity with estimates of costs and benefits. Identify needed mandates, regulations, codes, incentives and educational and cultural changes needed to reach resiliency goals. Prepare written plan and report for 2013-2015 legislature.	**MP-18**	Support the completion of updated, digital floodplain mapping projects initiated through the FEMA Map Modernization Program (previously short-term action #1) and transition to FEMA's current Risk MAP program.	The state continues to participate in FEMA's national effort to update flood hazard maps, and through the 2004-2009 Map Modernization Program (Map Mod) the majority of flood maps for Oregon have now been issued in a new digital, countywide format. The state will continue to provide support to help manage the Map Mod projects that remain to be completed (Coos, Lane, Tillamook, and Washington Counties), and DLCD will continue to implement the map modernization management support strategy and activities by: 1. Establishing and maintaining a premier data collection and delivery system, 2. Achieving effective long-term management of flood hazard maps, 3. Building and maintaining mutually beneficial partnerships to accomplish mapping work, and 4. Expanding and better informing the flood map user community. Risk MAP (Mapping, Assessment, and Planning) is FEMA's new multi-year mapping program. The program builds on flood hazard data and maps produced through Map Mod while including the vision of building effective community strategies for reducing risk. In partnership with DOGAMI, FEMA contractors, and other state and local agencies, the objectives in Oregon's Risk MAP business plan include: 1. Addressing gaps in flood hazard data, identifying areas of dated and/or inconsistent mapping and updating high-priority areas with new mapping (Coos (remap), Curry, Lincoln, Tillamook, Clatsop, and Klamath Counties, as well as the Silvies Watershed and the Lower Columbia-Sandy Watershed—most projects contracted with DOGAMI); 2. Acquire new lidar topographic data for precise flood hazard mapping; 3. Measurably increase the public's awareness of flood and other natural hazards through a combination of regulatory and non-regulatory products, tools, community outreach, and innovative natural hazard mapping techniques (such as those developed by DOGAMI) that lead to actions that reduce risk to life and property; 4. Lead effective engagement in flood mitigation planning through partnerships and shared datasets; 5. Provide a coordinated multi-agency digital platform that includes data, links to data, applications, strategies, a digital library of flood hazard maps, and a web map depicting the most recent statewide Special Flood Hazard Area layer; 6. Coordinate events, project status, and actions; and 7. Align risk analysis programs and develop synergies.	Revised. Removed.
MP-19	New maps of precipitation intensity	If not yet available, high-resolution lidar topographic data should be collected on all potentially active volcanoes in Oregon and all the way down the major drainages of each volcano. Lidar data should be used to improve volcano, landslide, flood, and earthquake hazard data. For an example, see the DOGAMI Multi-Hazard and Risk Study for the Mount Hood Region (Burns et al., 2011b).	**MP-19**	New maps of precipitation intensity	A basic study of precipitation intensity will be done, including 24-hour isopluvials (2-, 5-, 10-, 50-, and 100-year maps), as well as development of probable maximum precipitation coverages for Oregon.	Removed.

2012 to 2015 Mitigation Action Crosswalk

2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
MP-20	Acquire high-resolution lidar data and map hazards	After a damaging tsunami, response and short-term recovery efforts may destroy any scientific evidence of the tsunami, such as surge heights and inundation distances. These data are critical in understanding the tsunami and helping to better prepare for future ones. Once lost it can never be retrieved. Therefore, it is imperative that data gathering be a part of the overall response and recovery plan. This effort should be coordinated with the scientific and technical clearinghouse discussed in the earthquake chapter (short-term #3) and emergency management response and recovery efforts.	**93**	Acquire statewide lidar coverage for the purpose of improving natural hazard mapping and infrastructure inventories.	Lidar is currently the best source of regional topographic data and allows for highly precise and accurate natural hazard mapping (landslide, flooding, volcanic hazards, channel migration zones, tsunami, geologic faults, etc.) and infrastructure inventories (buildings, utilities, lifelines, etc.). The state should continue to invest in lidar acquisition for the purpose of understanding risk to natural hazards at a local scale.	Revised. Ongoing.
MP-21	Develop a post-disaster tsunami scientific data recovery plan	A basic study of precipitation intensity will be done, including 24-hour isopluvials (2-, 5-, 10-, 50-, and 100-year maps), as well as development of probable maximum precipitation coverages for Oregon.	**MP-21**	Develop a post-disaster tsunami scientific data recovery plan	After a damaging tsunami, response and short-term recovery efforts may destroy any scientific evidence of the tsunami, such as surge heights and inundation distances. These data are critical in understanding the tsunami and helping to better prepare for future ones. Once lost it can never be retrieved. Therefore, it is imperative that data gathering be a part of the overall response and recovery plan. This effort should be coordinated with the scientific and technical clearinghouse discussed in the earthquake chapter (short-term #3) and emergency management response and recovery efforts.	Removed.
MP-22	Reconvene the committee that oversees the Mount Hood Coordination Plan	The committee, including the Oregon Office of Emergency Management, USDA Forest Service, U.S. Geological Survey, Oregon Department of Geology and Mineral Industries, Clackamas County, Multnomah County, Hood River County, Wasco County, the Confederated Tribes of the Warm Springs, Clark County, Skamania County, Washington Emergency Management Division, and the Federal Emergency Management Agency (Region X), should reconvene and incorporate new data from the recent DOGAMI Multi-Hazard and Risk Study for the Mount Hood Region (Burns and others, 2011).	**MP-22**	Reconvene the committee that oversees the Mount Hood Coordination Plan.	The committee, including Oregon Office of Emergency Management, USDA Forest Service, U.S. Geological Survey, Oregon Department of Geology and Mineral Industries, Clackamas County, Multnomah County, Hood River County, Wasco County, the Confederated Tribes of the Warm Springs, Clark County, Skamania County, Washington Emergency Management Division, and the Federal Emergency Management Agency (Region X), should reconvene and incorporate new data from the recent DOGAMI Multi-Hazard and Risk Study for the Mount Hood Region (Burns and others, 2011).	Removed.
MP-23	Assess hazards associated with active crustal faults newly discovered by statewide lidar program.	Multi-hazard and risk analysis should be performed at all potentially active volcanoes in Oregon. For an example see the DOGAMI Multi-Hazard and Risk Study for the Mount Hood Region (Burns et al., 2011b).	**75**	Assess hazards associated with active crustal faults newly discovered by statewide lidar program.	Particularly in central and eastern Oregon, the major earthquake hazards result from poorly known crustal faults. Lidar has greatly expanded the ability to find these faults, which should be systematically evaluated for their potential to generate damaging earthquakes using trenching, geophysical and field studies. This action would help communities prepare and mitigate for newly defined hazard areas in central and eastern Oregon.	Priority.
MP-24	Perform multi-hazard risk analysis at all potentially active volcanoes in Oregon	A warning system should be developed for volcano and weather-induced hazards like flood, channel migration, and landslides.	**MP-24**	Perform multi-hazard risk analysis at all potentially active volcanoes in Oregon	Multi-hazard risk analysis should be performed at all potentially active volcanoes in Oregon. For an example see the DOGAMI Multi-Hazard and Risk Study for the Mount Hood Region (Burns et al., 2011b).	Revised. Removed.
MP-25	Warning system	This action has been completed for Mount Hood. Some similar documents have been completed for other volcanoes in Oregon.	**MP-25**	Install a multi-function lahar warning system in areas of high vulnerability	A warning system should be developed for volcano and weather-induced hazards like flood, channel migration, and landslides.	Revised. Removed.
MP-26	Develop coordination plans for other volcanoes in Oregon	Particularly in central and eastern Oregon, the major earthquake hazards result from poorly known crustal faults. Lidar has greatly expanded the ability to find these faults, which should be systematically evaluated for their potential to generate damaging earthquakes using trenching, geophysical and field studies	**MP-26**	Develop coordination plans for other volcanoes in Oregon	This action has been completed for Mount Hood. Some similar documents have been completed for other volcanoes in Oregon.	Removed.
MP-27	Evaluation of Landslide Risk	DOGAMI will complete this evaluation in cooperation with local municipalities. Specific methods and priority locations are still to be determined.	**MP-27**	Evaluation of Landslide Risk	DOGAMI will complete this evaluation in cooperation with local municipalities. Specific methods and priority locations are still to be determined.	Removed.
MP-28	Update Special Paper 29 (Wang and Clark, 1999)	Update Special Paper 29, Earthquake Damage In Oregon: Preliminary Estimates of Future Earthquake Losses, a statewide damage and loss estimation study (Wang and Clark, 1999). This update should include preparing tsunami damage and loss estimates, and possibly better accounting for unreinforced masonry construction.	**72**	Update Special Paper 29 (Wang and Clark, 1999)	Update 1999 Special Paper 29, Earthquake Damage In Oregon: Preliminary Estimates of Future Earthquake Losses (Wang and Clark, 1999), a statewide damage and loss estimation study. This update, at a minimum, should incorporate damage and loss estimates for a magnitude 9 Cascadia earthquake, an exposure analysis of tsunami hazards, and probabilistic hazards including updated probabilistic earthquake ground motions and flooding zones. School and emergency facilities from the 2007 DOGAMI database should be incorporated.	Revised. Priority.

2012 to 2015 Mitigation Action Crosswalk

2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
			90	Use lidar for statewide analysis of all natural hazards	Lidar is currently the best source of regional topographic data and allows for highly precise and accurate natural hazard mapping (landslide, flooding, volcanic hazards, channel migration zones, tsunami, geologic faults, etc.) and infrastructure inventories (buildings, utilities, lifelines, etc.). Many Oregon state agencies currently use lidar for natural hazard analyses and will continue to do so where lidar is available.	New. Ongoing.
			122	Continue developing Emergency Action Plans for all remaining high hazard dams in Oregon.	In Oregon, money from FEMA grants and state funds is used to help dam owners create Emergency Action Plans (EAP). An EAP helps identify situations where a dam failure might occur, actions to take that could save the dam, if possible, and evacuation routes for a dam failure situation. There is an Oregon-specific EAP template available, designed for owners of remote dams that have limited personnel. Approximately 75% of state-regulated high hazard dams have, or are currently developing EAPs. There are 67 state regulated high hazard dams, and another 65 federal high hazard dams in which OWRD plays a coordinating role.	New. Ongoing.
			54	Support and implement the actions in the February 2013 Oregon Resilience Plan and recommended in the Oregon Resilience Plan Task Force's October 2014 report.	The Oregon Resilience Task Force was established by Senate Bill 33. It was tasked to facilitate a comprehensive and robust plan to implement the strategic vision and roadmap of the Oregon Resilience Plan for responding to the consequences of naturally occurring seismic events associated with geologic shift along the Cascadia subduction zone. The Task Force's report was delivered to the legislature on October 1, 2014.	New. Priority.
			70	Conduct a pilot project on two coastal estuaries to develop a framework for modeling sea level rise and to assess the overall impact of sea level rise on the estuaries.	Implement sea level rise modeling for the pilot study areas. Study results will be used to guide a future, more comprehensive and coast-wide assessment of sea level rise impacts. Once completed, the results can be used minimize future damage or loss of property and the environment.	New. Priority.
			63	Identify areas on the coast that will be "islands", or cut off, from other cities or critical recovery resources following a Cascadia Subduction Zone earthquake & tsunami.	Produce GIS database of resources in each "island" expected to be isolated after a Cascadia Subduction Zone (CSZ) earthquake and resulting tsunami in order to preplan for response. Shape files are to be imported into RAPTOR, Oregon Explorer, and other GIS tools. This action item supports the local community's ability to prepare for and sustain or recover function following a CSZ earthquake and tsunami.	New. Priority.
			12	Assist one coastal community per year in considering vertical evacuation structures and improved evacuation routes due to evacuation constraints.	Use the anisotropic path modeling to measure the time needed to evacuate all parts of the maximum-considered Cascadia tsunami inundation zone in order to evaluate the need for vertical evacuation structures and improvements in evacuation routes. These actions will provide guidance to communities on the best locations to build vertical evacuation structures that will save lives in a catastrophic tsunami event. The results will also inform communities of priority evacuation routes needing additional signage or way-finding markers. The planned communities are: 2014 = Seaside 2015 = Warrenton 2016 = Rockaway Beach 2017 = Siletz Bay area 2018 = Pacific City	New. Priority.
			48	Evaluate the impact of climate change on landslides.	The precipitation-triggered landslides will increase or decrease with changes in climate. Evaluation of this change will be important for the future of Oregon.	New. Priority.
			64	Evaluate sediment impacts to Oregon's water resources.	Oregon has unique water resources, some of which are for drinking water. Landslides can have a great impact on this resource by input of large amounts of sediment. Evaluation of erosion potential by watershed would help the regulators and providers identify areas for mitigation.	New. Priority.

2012 to 2015 Mitigation Action Crosswalk

2012 Action #	2012 Action Statement	2012 Action Description	2015 Action #	2015 Action Statement	2015 Action Description	Revised or New? Which 2015 Table?
			15	Develop new standardized risk assessment methodology across all hazards, at the state and local levels.	Oregon does not have a clear and common methodology to identify the most vulnerable populations across all hazards at the state and local levels. In 2013, the State IHMT Risk Assessment Subcommittee in partnership with the OPDR and the U of O InfoGraphics Lab developed a model concept, work plan and budget. Pending funding, this model could be fully developed between 2014 and 2019 and then be used to inform the 2020 Oregon NHMP. Upon full development, the model will allow state and local governments to strategically target mitigation resources.	New. Priority.
			61	Install High Water Mark (HWM) signs after flood events and co-locate stage crest gages on select HWM signs.	HWM signs installed in high visibility areas increase the general public's awareness of flood risk and drive flood mitigation actions in communities. They spark conversations about past floods and are a good entry point for discussions promoting mitigation actions such as elevating buildings, purchasing flood insurance, and participating in FEMA's Community Rating System Program. Stage crest gages co-located with select HWM signs will capture new high-water data when floods occur.	New. Priority.
			59	Schedule three opportunities over the life of this Plan for state-local dialogue on vulnerability assessments to improve consistency and mutual understanding.	Traditionally, local jurisdictions have used the OEM Hazard Analysis Methodology to update LNHMP vulnerability assessments. State agencies with hazard oversight use a wide range of methods to conduct statewide vulnerability assessments for the Oregon NHMP. The results are varying degrees of similarities and differences among local and state vulnerability scores. This dialogue is intended for the state and local governments to educate each other on the rationale behind the differing scores and to identify ways to better align local and state vulnerability assessments.	New. Priority.

3.3.5 Mitigation Successes

Oregon maintains documentation of "mitigation success stories." These are completed mitigation actions that have shown to be successful by either (a) avoiding potential losses or (b) demonstrating cost-effectiveness through benefit-cost analysis, qualitative assessment, or both. Likewise, actions that support mitigation efforts, like risk or vulnerability assessment studies, are included. Mitigation success stories are completed by or with input from the action's coordinating agency.

3.3.5.1 Mitigation Success — State of Oregon, 2014

Best Practices Federal Emergency Management Agency / Region 10 2014

FEMA

Best practices

Disaster Mitigation Working in Oregon

Mitigation Brings Enhanced Safety and Reduced Losses

Oregon individuals, businesses and government agencies work together to promote safety and to invest in hazard mitigation actions that save lives and reduce or eliminate damage. As a result, a severe winter storm may become an emergency, but not necessarily a disaster.

Oregon — A severe winter storm may bring extreme cold, wind, snow, ice, falling trees, or all of these and more. The result, at the very least, is major inconvenience. Emergency managers and others work throughout the year to limit the impacts of these storms.

During the hazardous event, transportation woes can be kept to a minimum when public warning systems and years of outreach education convince most people to stay off the roads. Schools may be closed and other activities canceled or postponed. With reduced traffic, emergency services crews are better able to respond quickly and efficiently.

There may or may not be electrical power outages associated with a storm. Electric utility officials work throughout the year to improve the reliability of their power distribution systems. They make ongoing investments in tree pruning, pole replacement and maintenance of equipment, as well as investing in strong, flexible and more durable insulators and other components. The experts must analyze and prioritize the investments to address the most trouble-prone sections of the distribution systems. In some instances these may be rerouted to safer areas or placed underground in buried conduit and waterproof vaults.

Additionally, electric utilities undertake projects that provide redundant power sources to critical facilities such as emergency services buildings, medical centers, communications towers, sewage treatment plants, water systems and so on. The investments often include automated power transfer switches, sensors, monitors and other sophisticated equipment.

The wide variety of mitigation investments that promote safety and prevent damage are funded, in part, through state and federal grant programs. Others are paid for by local governments, utilities, businesses and individuals.

The work and expense pay big dividends when a storm arrives and departs without generating a disaster. No news can really be very good news!

Hazard mitigation is about taking action before the next disaster to reduce human and financial consequences later.

This publication was produced by FEMA Region 10 Mitigation Division and the Oregon Office of Emergency Management

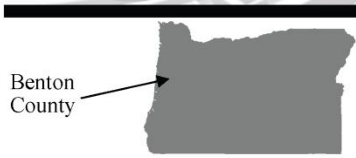
3.3.5.2 Mitigation Success — Benton County, 2014

Best Practices **Federal Emergency Management Agency / Region 10** **2014**

FEMA

Best practices

Disaster Mitigation Working in Oregon



Mitigation Investments Bring Safety and Reliable Power

Effective mitigation can break the cycle of disaster damage, reconstruction and repeated damage. It lessens the financial impact on individuals, communities and society as a whole.

A recent study by the Multi-hazard Mitigation Council shows that each dollar spent on mitigation saves society an average of four dollars.

Benton County, Oregon—
Electrical power outages are a familiar experience when winter storms bring high wind, heavy snow, ice and falling trees. All of these can cause severe damage to transmission lines, poles and transformers.

Consumers Power Inc. (CPI) is a consumer-owned electric power cooperative that serves parts of Benton and five other Oregon counties. Director of Operations & Engineering Greg Pierce said he knows that prevention of storm damage and resulting service disruption requires continuous maintenance and investment in upgrades to the utility's electrical distribution system.

Wind, snow, and ice cause damage to power systems

Pruning and removing "hazard trees" is part of the solution. Permanent system improvements can also be cost effective.

"These can sometimes include adding more poles to reduce spans and reduce stress on poles and arms," said Pierce. "Using new technology such as more flexible and durable insulators and fiberglass cross arms is another way to reduce storm damage."

Relocating the power lines to underground conduit, while expensive, can also sometimes be an excellent alternative. This approach has helped CPI to improve the reliability of power from its Corvallis substation to a major hospital and surrounding campus of 13 other buildings on Medical Hill just north of the city. The mitigation project was developed in partnership with Good Samaritan Hospital, Corvallis Clinic, and the Benton County Emergency Management Council.

As a consumer-owned utility, CPI was eligible to apply for financial assistance from the Federal Emergency Management Agency (FEMA) Hazard Mitigation Grant Program (HMGP) to replace a troublesome section of its

continued on page 2…

This publication was produced by FEMA Region 10 Mitigation Division and the Oregon Office of Emergency Management

Best Practices **Disaster Mitigation Working in Oregon**

Good Samaritan Hospital

12,470-volt feeder line that serves the health care complex. The project was approved and completed in 2003. Moving the wires underground has significantly reduced power outages caused by winter storms.

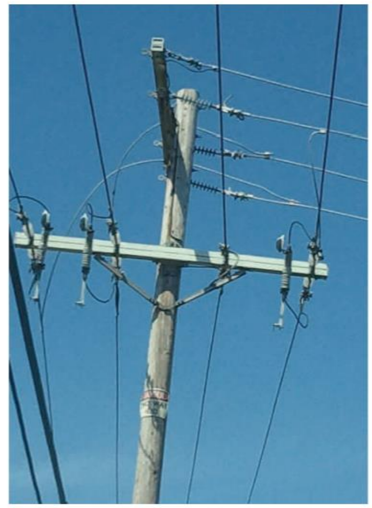
HMGP funding is administered by the Oregon Office of Emergency Management FEMA. FEMA provides 75 percent of the eligible costs of approved projects.

CPI is now in the pre-application process for HMGP funding to begin a similar project to further improve the reliability of electrical service to the hospital campus and surrounding area. A nearby section of the main overhead feeder line passes through a 4,330-foot right-of-way corridor that has no road access. Part of the densely wooded area is very wet and muddy, making it difficult during most of the year to make repairs, replace poles or prune trees. The CPI proposal is to move the transmission lines underground by digging a trench in part of the problem area, and to use horizontal boring equipment to install the line beneath the ground. This type of work requires "best management practices" to minimize disturbance of wildlife and other natural resources.

Approval of grant-funded hazard mitigation projects requires proof of a clear benefit to the community. An obvious fact is that critical medical facilities depend on reliable sources of electricity.

The grant application will include a benefit-versus-cost analysis that includes the history of power outages from this section of line along with associated repair expenses. Approximate costs to utility customers who lose power will also be considered. The proposal must also describe and analyze alternative solutions. An example would be rerouting the power around the entire problem area by using an existing road right of way. Detailed cost estimates of the proposed new work are another critical part of a successful grant application.

The safety of utility workers is another important factor to be considered. Emergency repair work during bad weather is dangerous!



New insulator technology

"The cost of power failures and emergency repairs is just too much for our customers and our utility" said Pierce. "We've found that continuous improvements can bring safety, reliability and savings year after year."

Underground power conduit

Project site visit

Build Stronger, Safer, Smarter 2

3.3.5.3 Mitigation Success — Lane County, 2014

Best Practices **Federal Emergency Management Agency / Region 10** **2014**

FEMA

Best practices

Disaster Mitigation Working in Oregon

Protecting Critical Power and Communications Facilities

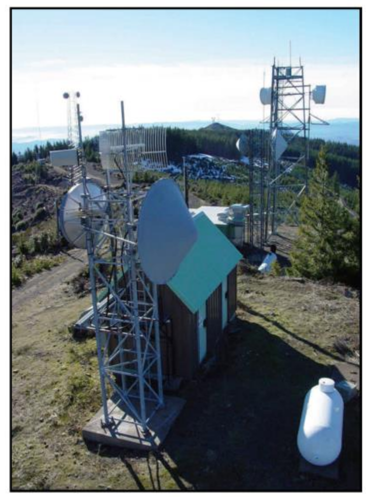
Hazard mitigation benefits society by:

- **Creatinig safer communities by reducing loss of life and property;**
- **Enabling individuals to recover more rapidly from floods and other disasters, and;**
- **Lessening the financial impact on the Federal Treasury, States, Tribes and communities.**

Lane County, Oregon — The Emerald People's Utility District (EPUD) provides electrical power to a remote mountaintop communications site on Badger Mountain, west of Veneta, Oregon. Over the years, the 12,000-volt overhead power line has been consistently subjected to prolonged outages during storm seasons while serving AT&T Cellular, Verizon, Nextel, Blachly Lane Electric Cooperative, and the Bonneville Power Administration communication tower. All are critical links to the cellular phone service and power transmission in the Lane County area.

Buried power line vault

EPUD is in the preliminary stages of requesting Federal Emergency Management Agency (FEMA) Hazard Mitigation Grant Program (HMGP) cost-share-funding to replace the 2.3 mile overhead line with an underground power line along existing roads. This is expected to eliminate the outages caused by falling limbs, trees and lightning. It will also reduce fire danger by eliminating risk of dry weather tree contact with energized power lines.



Previous and highly successful Harness Mountain project

The consumer-owned utility district made a similar investment in 2002 that was also partially funded with HMGP funds. A 5.5-mile overhead line to Harness Mountain communications facilities was plagued with repetitive outages. Repair work sometimes took many hours- and even days- to restore because of deep snow, impassible roads and fallen trees. EPUD leaders have stated the project is a huge success.

This publication was produced by FEMA Region 10 Mitigation Division and the Oregon Office of Emergency Management

3.3.5.4 Mitigation Success — City of Springfield, 2014

Best Practices   Federal Emergency Management Agency / Region 10   2014

FEMA

Best practices

Disaster Mitigation Working in Oregon

Electric Power Loss Mitigation: Invest in the Weak Links

Hazard mitigation is about taking action before the next disaster to reduce human and financial consequences later.

Overhead to underground power transmission project

Springfield, Oregon - The Emerald Circuit is a vital part of an electrical power transmission system that connects three Springfield-area substations to hundreds of homes, businesses, a shopping center, schools, a fire station, traffic signals and two water reservoirs.

Sections of the overhead line run through an area with numerous trees, making damage to the system almost inevitable when severe storms bring high wind, wet snow or freezing rain. A mitigation measure for one segment of circuit was implemented in 2002, when a particularly damage-prone 2,700-foot section of the overhead system was removed and replaced with wires installed in underground conduit and waterproof vaults.

The Springfield Utility Board worked closely with the Oregon Office of Emergency Management and the Federal Emergency Management Agency (FEMA) to secure Hazard Mitigation Grant Program (HMGP) funding to enable the $163,642 investment in greater system reliability.

The HMGP funding required that costs, benefits and alternatives were carefully analyzed to ensure the project was cost-effective and appropriate. The area's rugged and steeply sloping landscape meant that the estimated cost of replacing damaged poles and lines for the section was to be $144,000 to $180,000. Access issues added additional expenses and delay when past repairs were needed. Potential threats to public health and safety from a power outage, along with extremely high costs to utility customers, were also significant factors in the calculation of project benefits and losses that could be avoided.

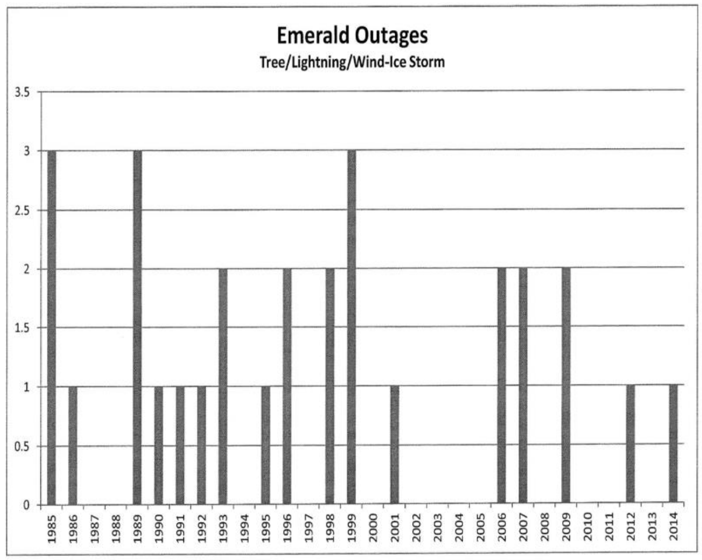
continued on page 2

This publication was produced by FEMA Region 10 Mitigation Division and the Oregon Office of Emergency Management

Best Practices **Disaster Mitigation Working in Oregon**

The 12 years since project completion have brought significant reduction of documented damage to the Emerald Circuit *(see chart on right)*. During this period, the Springfield Utility Board made various investments in equipment upgrades as well as two additional "undergrounding" projects.

Severe winter storms still cause occasional power outages along another section of the Emerald line. This residual "weak link" in the system is a vulnerable 1,450-foot stretch of overhead transmission line adjacent to the earlier project and similarly accessible only on foot or with track equipment. A pre-application for HMGP funding to help pay for the undergrounding of this troublesome section is currently under review.



Power transmission easement bordered by 40-to 80-foot trees

The Federal Emergency Management Agency (FEMA), along with its state partners, administers the Hazard Mitigation Grant Program (HMGP) to assist states and local communities in implementing long-term hazard mitigation measures following a major disaster declaration.

Following 2012's Hurricane Sandy, the *Sandy Recovery Improvement Act* helped bring about a more streamlined HMGP process with an emphasis on more timely selection and implementation of projects.

State and local Hazard Mitigation Plans that are up to date and approved are critical to establishing eligibility and priorities in the selection of projects.

Build Stronger, Safer, Smarter **2**

3.3.5.5 Mitigation Success — City of Vernonia, 2014

Best Practices Federal Emergency Management Agency / Region 10 2014

FEMA

Best practices

Disaster Mitigation Working in Oregon

Vernonia

Vernonia's Whole Community Working for a Resilient Future

New school and community center facilities

Vernonia, Oregon — This remote community of about 2,150 people is celebrating the relocation and replacement of its three school facilities. The success of the enormous project came after years of struggling to recover from the 2007 "flood of record," the worst of 27 flood events that are part of the town's history.

Among the many challenges that followed the flood was the need to replace the heart of their community, the elementary, middle and high schools that served more than 700 students. After an impressive investment of resources, and intense effort by the local communities, Vernonia now has a far brighter outlook. Its beautiful new school buildings are finally relocated out of the flood-plain and in full use.

A history of disaster damage: The city of Vernonia has been plagued with severe, repetitive, highly damaging floods, typically from rain falling on snow in the Nehalem River and Rock Creek watersheds. A major event in 1996 was about three feet higher than the 1972 and 1974 floods. Residents and business owners cleaned up and made major efforts to rebuild stronger and safer, elevating many buildings above the floodplain. But disaster struck again in December of 2007, with an even more catastrophic "flood of record."

This time, infrastructure and property, including electrical substations, health care buildings, the senior center and many other critical facilities, were severely damaged or destroyed. More than 1,000 homes sustained damage and at least 100 were found to be beyond repair.

A final blow came when the wastewater treatment facility was inundated and five feet of sewage-contaminated water poured into the elementary, middle and high school buildings.

Oregonians and the nation provided emergency assistance, including more than 1 million hours of volunteer aid, but the nearly complete loss of Vernonia's school system cast an enormous shadow over the future of the community.

continued on page 2

This publication was produced by FEMA Region 10 Mitigation Division and the Oregon Office of Emergency Management

Best Practices **Disaster Mitigation Working in Oregon**

2007 "flood of record" — hours before sewage-contaminated water rose two additional feet

The "Best Practices" story:
The story of recovery and triumph over this disaster involves intense determination and cooperative effort that began in the local community. The challenges were taken up by virtually all of the local leaders, local and regional business owners and countless volunteers.

Oregon's governor appointed an **Oregon Solutions Task Force** of 36 agencies and organizations, and more than 50 individuals, to identify funding sources for a renewed school system and to develop a plan. **Their charge was to involve the community through a fair, open and participatory process that would earn the support of the whole community.**

After researching a variety of alternatives, the community agreed to build an entirely new K-12 campus and community center. The discussions led to the decision to locate the new facilities on higher ground that was partly occupied by Spencer Park. After demolition of the old school buildings, the plan specified that the park would be re-established at the flood-prone school property.

A daunting challenge was the need to raise an estimated $40 million to accomplish the ambitious goals. The search for financial resources would include potential State of Oregon contributions. One of the many successes was an eventual $3.8 million Oregon Department of Transportation grant.

The largest sources of funding for the school project, and for many other elements of Vernonia's overall disaster recovery, were made possible by the coordination and collaboration of the Oregon Office of Emergency Management and the Federal Emergency Management Agency (FEMA). These agencies were able to provide approximately $20 million in FEMA Flood Mitigation Assistance and Hazard Mitigation Grant Program funds, along with many additional millions through the Public Assistance infrastructure repair funding, and Individual Assistance programs.

Other federal agencies, including the Department of Energy, also helped make it possible to invest in Leadership in Energy and Environmental Design Platinum-rated "state of the art" buildings. The energy-efficient, durable and sustainable new facilities are now compatible with the ambitious educational program goals of the Vernonia school district.

A major foundation challenge grant was matched by corporate, small business, foundation and individual contributions from all over the state.

In a critical 2009 vote, despite severe blows to the local economy from the flood and a more general recession, voters in Columbia County and Washington County who live within the Vernonia School District voted to approve a $13 million school construction bond measure. In addition, the school district secured a $5.6 million long-term, low-interest loan.

At a recent celebration of the completed school replacement project, donors and supporters who were responsible for achieving the ambitious goals were honored for their dedication. The superintendent of Vernonia schools summarized the spirit and motivation that brought success: **"We came together for a common purpose: Not just to build a school, but to strengthen the community."**

Vernonia is an example of a <u>resilient community</u>, where people work together to anticipate and address future conditions and challenges. Investing in hazard mitigation can break the cycle of disaster damage, reconstruction and repeated damage.

Build Stronger, Safer, Smarter 2

3.3.5.6 Mitigation Success — City of Brookings Wastewater Treatment Plant, 2014

The Brookings Wastewater Treatment Plant (WWTP) serves a population of 10,380 people and is the sole treatment facility for the city of Brookings and the Brookings Harbor unincorporated area east of the city limits. The WWTP is located on a bluff adjacent to the Pacific Ocean where grade elevations at the plant range from about 85 to 90 feet; thus, the plant is above the tsunami hazard area.

The WWTP faced a severe, imminent risk from slope failure; the active slope-failure slip plane had been mapped by a site-specific geotechnical evaluation. Mapped tension cracks from downslope slip extend inland to the western wall of plant's tanks and piping infrastructure. This most likely landslide failure mode would destroy significant components of the WWTP rendering the plant non-operational.

The approved mitigation project is to stabilize the slope at the location of most acute slope failure risk — the area adjacent to the northwest side of the facility. By installing a system of "tied-back" solider piles, this mitigation project will significantly reduce the risk of slope failure which would otherwise be a catastrophic point of failure for the function of the WWTP. A lower-bound benefit-cost ratio greater than one demonstrates this mitigation project is a long-term, cost-effective solution to the slope failure risk. The mitigation project was completed in October 2014 prior to the onset of the winter rainy season.

3.3.5.7 Mitigation Success — City of Salem, Lower Cinnamon Lake Dam Rehabilitation, 2014

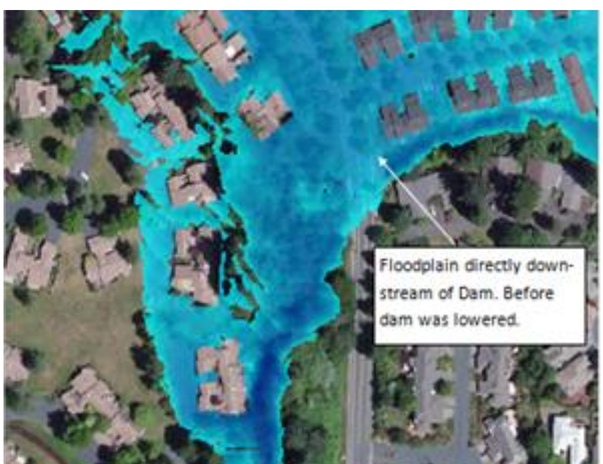
Lower Cinnamon Lake is the last in a string of small lakes located in a residential neighborhood in Salem (Marion County, Oregon). The lake is permitted under the statutory size requirement. In other words, it does not fall under the oversight of the state's Dam Safety Program. Because of its smaller size, there was limited awareness of any potential hazard. A bathymetric survey and volume estimate provided by the Oregon Water Resources Department revealed the lake to be larger than previously thought, requiring it to come into alignment with the state's dam safety requirements. Due to its unsatisfactory condition, the dam posed a high hazard to downstream life and property.


Dam flunks state inspection, threatens 40 Salem homes

A state inspection has concluded that the Lower Cinnamon Lakes Dam, a little-known earthen dam in South Salem, is in "unsatisfactory condition" and presents a risk to approximately 40 homes.

The Statesman Journal, a local newspaper, ran several articles covering Cinnamon Lakes Dam

The Department worked with the dam owner and others to quantify the risk of a potential failure, soliciting the expertise of Boatwright Engineering to assess needs and alternatives, and regularly engaging with the media and community members. Design drawings for the dam were not available and the date the lake was initially filled was unknown, therefore standard engineering practices could not be assumed. Reliable inundation maps were produced. In May 2014, the Department held an informational public meeting for the community at risk to address concerns and answer questions.



Dam Breach Floodplain Map

The solution was to reduce the pool elevation by 3 feet, which reduced the lake's capacity and alleviated the risk. At this reduced level, flood depths in the event of a dam failure are not considered harmful. This also successfully brought the dam and its storage capacity into compliance with the authorized water right. Inundation maps were produced at the lower elevation, and a sensitivity analysis was completed to verify downstream safety. Upon lowering the reservoir, significant damage was observed where beavers had burrowed into the dam upstream — another reason these small dams were edging closer to a catastrophe.

The Department's Dam Safety staff conducted the bathymetric analysis and dam breach model. The City of Salem, Boatwright Engineering, and the Water Resources Department worked collectively and quickly to restore this lake to continue providing aesthetic benefits to the community.

3.3.5.8 Mitigation Success — Oregon Coast, Tsunami Evacuation Wayfinding, 2014

Context: The people of the Oregon coast critically need accurate educational materials and effective mitigation tools to prepare for both distant tsunamis and the next great Cascadia earthquake and tsunami.

Problem: In the critical few moments between a Cascadia Subduction Zone earthquake and the arrival of the tsunami, residents and visitors to the coast need to have a clear, easily identifiable pathway to safety. Currently, tsunami evacuation routes are poorly marked.

Solution: This research study was the first step in re-evaluating how we do tsunami evacuation wayfinding. The University of Oregon's Portland Urban Architecture Laboratory (PUARL) was engaged to complete this stage of the project. The researchers brought a unique viewpoint and methodology to the problem. PUARL made several field trips to the coast to meet with local stakeholders and conduct preliminary work. On August 29-30, a charrette was held in Astoria, Oregon to work through common evacuation problems and formulate a menu of innovative solutions.

Charrette participants provide feedback on tsunami evacuation route wayfinding. (A. Rizzo)

Creative ideas are displayed. (A. Rizzo)

Pedestrian time and speed maps developed by DOGAMI were key products that aided visualization of evacuation problems. Charrette participants — mainly local government representatives from several coastal communities — developed creative solutions to common problems. All of the data collected by PUARL is being shared through the final report that is available through the Oregon Tsunami Clearinghouse

The study used the development of a pattern language to solve problems and offer community-driven solutions. One of the most important recommendations was implementation of lighted evacuation routes utilizing solar technologies that will survive a local earthquake. Implementation of this technology will solve the problem of night time evacuation and greatly enhance the likelihood of successful daytime evacuation as well.

Benefits: This project, when completed will help save lives after a Cascadia subduction zone earthquake and tsunami.

3.3.5.9 Mitigation Success — City of Portland, Johnson Creek Floodplain Acquisition and Restoration, 2013

Almost every year, whenever a large rainstorm event would pass through Portland, Johnson Creek would flood the flat, residential and commercial areas along Foster Road and SE 100th, 106th, and 108th Avenues if waters rose over 11 feet. Given the repeated flooding, the city of Portland invested $20 million to purchase homes and restore 70 acres of the Johnson Creek watershed.

A major storm in January 2013 tested the restoration efforts. Johnson Creek rose to 13 feet, and while it was close, homes and businesses were spared flooding. Water instead filled the restored floodplain that diverted floodways away from the roadway into 120 feet of new flood storage. The 60-acre site, called the “Foster Floodplain Natural Area,” will be transferred to Portland Parks and Recreation to be managed as a natural area. According to Maggie Skenderian, Johnson Creek Watershed Manager for Portland Environmental Services, the city successfully addressed flood damage and made wildlife habitat improvements. “In the 1930’s, they thought if they moved water downstream it would alleviate flooding — it didn’t work,” she said.

Project funding for the property acquisitions was initially provided by the Hazard Mitigation Grant Program from DR-1099, February 1996 Oregon Flood Disaster. A project to restore floodplain function and reduce the extent of flooding was funded by a Pre-Disaster Mitigation grant in 2005. Along with substantial city funding this project leveraged opportunities to reduce flood impacts in the community and eliminate future losses to the National Flood Insurance Program within the project area and reduce losses north of Foster Road. A project celebration ceremony was held in April 2013 to recognize property acquisition, restoration of the floodplain function, and losses avoided during the winter of 2012-13.

Source: “East Lents Floodplain Project wraps up, creates 70-acre natural area in East Portland,” by Sara Hottman, The Oregonian, December 27, 2012. Accessed online at: http://www.oregonlive.com/gresham/index.ssf/2012/12/east_lents_floodplain_project.html on June 9, 2014

Source: Communications with Maggie Skenderian via email on July 9, 2014.

3.3.5.10 Mitigation Success — State of Oregon Base Flood Elevation Determination Service, 2013

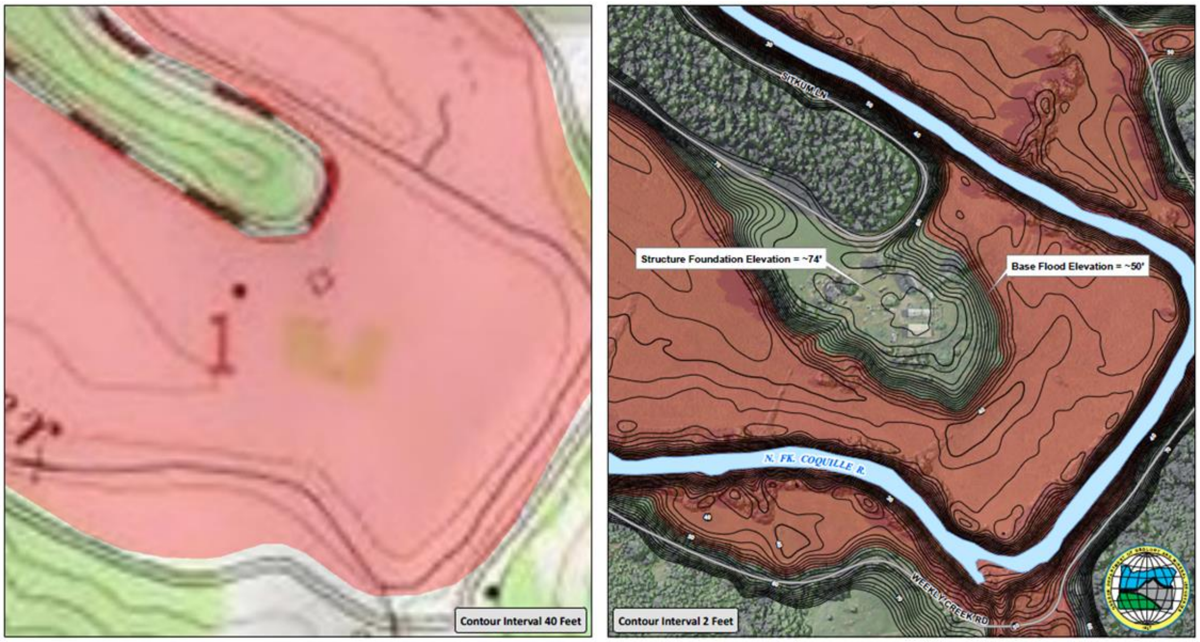
Context: Flood Insurance Rate Maps (FIRMs) published by the Federal Emergency Management Agency (FEMA) depict special flood hazard areas (SFHAs) where flood insurance is typically required for structures with federally-backed mortgages. The SFHA represents inundation from a given flooding source (e.g. rivers, ocean, lakes) during a 1% annual probability (100 year) flood event. The SFHA can be mapped by either detailed or approximate methods. While Base Flood Elevations (BFEs) are published for detailed SFHAs (i.e. zones AE, VE, AH, A1-30, and V1-30), they are not published for approximate SFHAs (i.e. zones A, V).

Problem: The SFHA is mapped using the best information and technology available at the time, but unfortunately many FIRMs in Oregon have not been revised since the 1970's and 1980's. FIRMs created several decades ago can be very inaccurate by today's standards and may incorrectly show homes or other insurable structures in the SFHA. In these cases it may be appropriate to submit a Letter of Map Amendment (LOMA) to FEMA that documents the structure is above the nearest BFE. While a professional surveyor can be hired to measure the structure's elevation, if the SFHA is a Zone A or V, a BFE is not available for comparison.

Solution: DOGAMI is recognized by FEMA as an authoritative source of BFE determinations. In 2013 DOGAMI established the BFE Determination Service which can assist surveyors, local officials, or professional engineers in determining the BFE for a specific location in areas where lidar data are available. DOGAMI provides a study map, summary report, BFE determination letter(s), and a data analysis package in GIS format to the requester.

Benefits:

- The general public now has a prompt and affordable option to receive a BFE determination from a government agency.
- LOMAs are processed quickly because DOGAMI is recognized by FEMA as an authoritative source of BFE information, saving FEMA and the homeowner time.
- Each BFE determination is made for a minimum of two river miles and made publicly available so developers or nearby homeowners can use the information freely.
- All BFE determinations are made using highly accurate lidar topography so floodplain mapping can be performed with a high degree of certainty.



A new lidar-based BFE determination along the North Fork Coquille River in Coos County shows a house is actually 24 feet above the BFE (right). The house was previously mapped in the SFHA on a FIRM from the 1980s (left).

3.3.5.11 Mitigation Success — Lincoln County, Silver Sands Road District Downstream Culvert Upsizing, 2013

In unincorporated Lincoln County, Buckley Creek runs northward through a residential neighborhood and two culverts before draining into the Pacific Ocean. During Disaster DR-4055, the upstream culvert was washed out by heavy stream flow that continued downstream and flooded three residential properties. The damaged upstream culvert was replaced with a larger one as a 406 mitigation measure by the Public Assistance (PA) program. Unfortunately, the downstream culvert (which was undamaged) became a flow constraint in the conveyance and would likely be the cause for continued residential flooding. In fact, the PA Project Worksheet noted that the deficient downstream culvert should be upgraded in tandem with the upstream culvert, but that part of the project was not eligible under the Public Assistance program. An HMGP project was developed to replace the downstream culvert with a larger one matching the conveyance of the upstream culvert so water would pass unrestricted. The downstream culvert replacement project was completed in October 2013 and is an example of two FEMA mitigation programs working in partnership.

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3.3.5.12 Mitigation Success — Oregon Coast, Tsunami Hazard Identification, Mapping, and Evacuation, 2013

Background: One of the most important tasks for DOGAMI is helping coastal communities understand and mitigate the risk of possible tsunamis. Communities located in exposed, low-lying areas along the Oregon coast face risk of inundation by tsunamis produced by earthquakes around the Pacific Rim far from Oregon, as well as local earthquakes on the Cascadia subduction zone (CSZ). In the wake of the 2004 Indian Ocean tsunami, the state of Oregon advanced a new effort to reassess tsunami hazards for the entire length of the state's Pacific coastline. Reports of tsunami runup as high as 30-35m near the epicenter of the great Sumatra-Andaman Islands earthquake of 2004 raised the question: Could the Cascadia subduction zone produce a wave as large as the devastating Indian Ocean tsunami? The urgency for this reassessment was underscored by a study of Oregon's tsunami vulnerability (Wood, 2007) which indicated that, on average, the Oregon tsunami inundation zone every day contains approximately 22,201 residents, 14,857 employees, and 53,714 Oregon State Parks visitors. DOGAMI then completed a tsunami hazard assessment at Cannon Beach, Oregon (Priest et al., 2009) that highlighted the potential severity of a future Cascadia event and showed that new maps were critically needed to reduce the loss of life and property threatened by tsunamis.

Problem: The state of Oregon has a beautiful coastline on the Pacific Ocean where thousands of people visit, live, work, and play each year. Prior to 2009, advanced hydrodynamic tsunami modeling had not been done and therefore the tsunami hazard area was very poorly defined. Without better definition, it was very difficult to create a culture of awareness and preparedness that would reduce the loss of life and property.

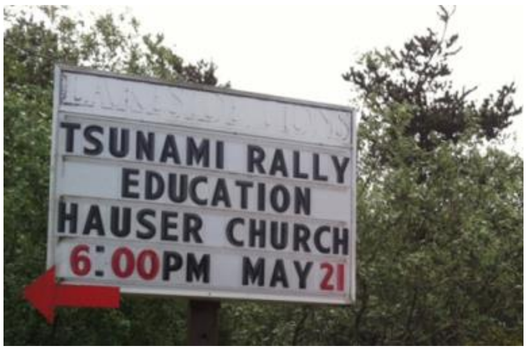
Solution: In 2009, DOGAMI was awarded a grant from NOAA to complete tsunami inundation modeling and mapping along the state's entire Pacific coastline, provide mitigation products that promote preparedness, and implement a sustainable, volunteer-driven education and outreach program. This five year project resulted in tsunami inundation data and maps for the entire Oregon coastline showing distant and local tsunami scenarios, evacuation brochures for populated areas along the coast, and an outreach and education program (Tsunami Outreach Oregon) that facilitated evacuation drills, training for local preparedness volunteers, the distribution of materials, and signs for evacuation routes and assembly areas.

Benefits:

- Hazard identification for the entire coastline has been completed. This is a monumental step toward effective planning and the creation of mitigation actions to reduce the loss of life and property.
- The GIS data of the tsunami scenarios and assembly areas are publicly available for anyone to use.
- Tsunami inundation maps for the entire coastline have been created. Evacuation brochures for 42 communities along the coast have been created and are publicly available from the Oregon Tsunami Clearinghouse web page. http://www.oregontsunami.org
- DOGAMI staff worked hand-in-hand with each community to create the evacuation brochures. Most communities did not have areas identified outside of the inundation zones where people

could temporarily assemble following a CSZ event. Establishing assembly areas for communities can be an intensive process depending on factors like the availability of high ground options, determining the landowner of a location, and acquiring permission from private property owners. All 42 evacuation brochures created during this project have assembly areas established and shown on the maps. The outreach program also funded the purchase of 24”x36” assembly area signs that have been erected at these locations so that evacuees know when they’ve reached the designated locations.

- The evacuation brochures also highlight the best evacuation routes to take in order to reach high ground or an assembly area.



Tsunami readiness rallies were held along the Oregon coast to educate the public on the earthquake and tsunami hazard, unveil the new inundation maps for the area, distribute new evacuation brochures to residents, and generate interest in the area’s evacuation drill.

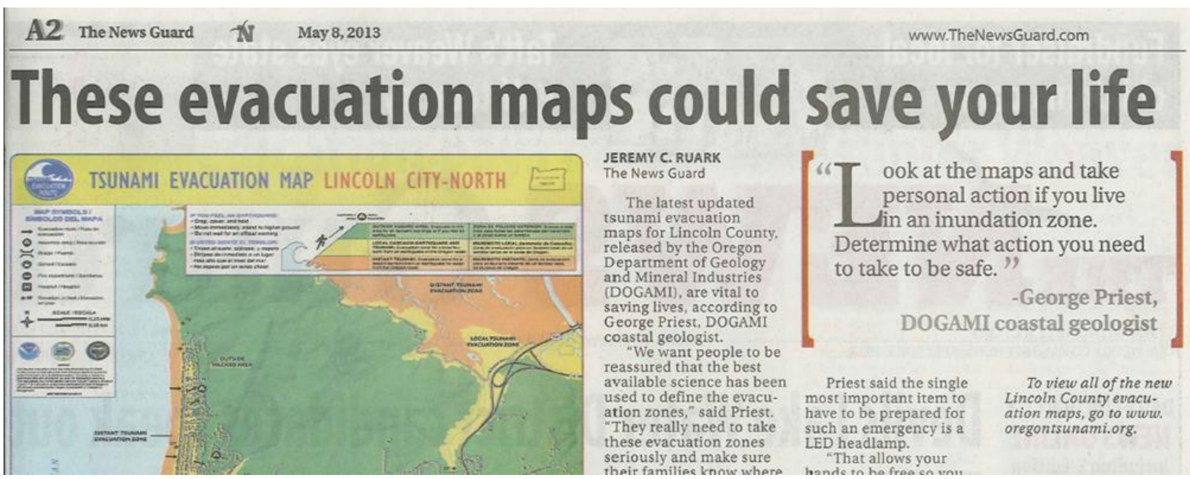
DOGAMI staff meet with local emergency responders and planners to establish new assembly areas and review draft evacuation brochures.

In Gleneden Beach, a "Tsunami Stroll" attracted 97 participants, including many seniors who previously didn't think they could reach high ground on foot:

Mr. Lee Hood won the “Best Decorated Go Bag” prize.

Ms. Nellie Jaujou celebrates her arrival at an assembly area.

Residents in Lincoln City examine tsunami inundation maps, the basis of the evacuation brochures distributed for free in coastal communities and available online at www.oregontsunami.org.



A2 The News Guard May 8, 2013 www.TheNewsGuard.com

These evacuation maps could save your life

TSUNAMI EVACUATION MAP LINCOLN CITY-NORTH

JEREMY C. RUARK
The News Guard

The latest updated tsunami evacuation maps for Lincoln County, released by the Oregon Department of Geology and Mineral Industries (DOGAMI), are vital to saving lives, according to George Priest, DOGAMI coastal geologist.

"We want people to be reassured that the best available science has been used to define the evacuation zones," said Priest. "They really need to take these evacuation zones seriously and make sure their families know where

"Look at the maps and take personal action if you live in an inundation zone. Determine what action you need to take to be safe."
-George Priest,
DOGAMI coastal geologist

Priest said the single most important item to have to be prepared for such an emergency is a LED headlamp.

"That allows your hands to be free so you

To view all of the new Lincoln County evacuation maps, go to www.oregontsunami.org.

The News Guard newspaper was one of many media outlets that helped disseminate the important messaging of the outreach program and provided a reprint of the evacuation brochures.

3.3.5.13 Mitigation Success — Tillamook Bay Repetitive Flood Loss Properties, 2012

As staff and funding resources allow, OEM conducts loss avoidance studies that quantitatively assess the effectiveness of hazard mitigation projects. The most recent loss avoidance study (Appendix 9.3.2) was completed in September 2009 and supported by FEMA's Hazard Mitigation Technical Assistance Program (HMTAP) under the auspices of DR-1824. The loss avoidance study was developed to evaluate the success of flood mitigation projects in Tillamook County which has experienced significant, repetitive flood losses beginning with Stafford Act assistance provided under DR-853 (January 1990) through DR-1824 (a total of four major declarations and at least another four significant flood events that were not declared). Flood Mitigation Assistance (FMA) program funding was also used to acquire and elevate flood-prone properties.

Low-lying areas between the Coast Range and the Pacific Ocean are particularly vulnerable to severe flooding. The City of Tillamook, which is located in this region, has repeatedly experienced severe floods, most recently on January 8, 2009 (post DR-1824). In response to these repetitive events, the City and County of Tillamook implemented a number of non-structural flood mitigation projects to reduce damages from future flooding. The projects consisted of the acquisition, elevation, and relocation of flood-prone buildings. The local governments completed the projects with assistance from FEMA, the State of Oregon, other public agencies, and private entities.

Multiple floods have occurred since completion of the mitigation projects and could have damaged the buildings had the projects not been completed. To evaluate losses avoided by the projects, FEMA offered HMTAP assistance to Oregon to support a study to evaluate losses avoided by nine of the projects: elevation of three commercial buildings and acquisition and demolition of six commercial buildings along US-101 in the City of Tillamook.

FEMA calculated the value of the losses avoided and compared the value to the cost of mitigation. The aggregate losses avoided were valued at $3.1 million, and the aggregate project cost was valued at approximately $4.7 million (both values in 2009 dollars), resulting in a return on investment of 66%. FEMA estimates that elevation projects are estimated to have an average useful life of 30 years, and that acquisition projects have a useful life of 100 years. The majority of the projects studied were implemented after 2003, which is only some 10 years into the useful life. It is anticipated that the value of the losses avoided, and therefore the return on investment will increase in the future as other flood events occur.

In late 2012, the acquisition of the former Safeway store was finalized (funded by a DR-1733 HMGP sub-grant) and the property restored to provide open space and flood storage capacity.

3.4 Capability Assessment

Requirement 44 CFR §201.4(c), To be effective the plan must include the following elements:

(3) A Mitigation Strategy that provides the State's blueprint for reducing the losses identified in the risk assessment. This section shall include:

(ii) A discussion of the State's pre- and post-disaster hazard management policies, programs, and capabilities to mitigate the hazards in the area, including: an evaluation of State laws, regulations, policies, and programs related to hazard mitigation as well as to development in hazard-prone areas; a discussion of State funding capabilities for hazard mitigation projects; and a general description and analysis of the effectiveness of local mitigation policies, programs, and capabilities.

3.4.1 State Capability Assessment

3.4.1.1 State Capability Changes Since Approval of the 2012 Oregon NHMP

After approval of the 2012 Oregon NHMP, DLCD accepted responsibility for the Oregon NHMP and in 2013 hired two full-time staff focused exclusively on natural hazard mitigation, with implementation of Goal 7 as one of their core activities. They also support the State Floodplain Coordinator and the State Risk MAP Coordinator. With this increased capacity, DLCD's Natural Hazards Program is initiating enhanced coordination among internal and external partners, and reaching out to local governments and other interested parties through web-based information sharing, seminars, and other means.

In May 2012, the Oregon Department of Transportation completed the *Oregon Seismic Lifeline Routes (OSLR) Identification* project. The OSLR project study recommends a specific list of highways and bridges that comprise the seismic lifeline network; and establishes a three-tiered system of seismic lifelines to help prioritize investment in seismic retrofits on state-owned highways and bridges.

Mitigation for the earthquake hazard specifically has continued to be a top legislative priority for Oregon. In February 2013, the Oregon Seismic Safety Policy Advisory Commission (OSSPAC) published the *Oregon Resilience Plan* (**Oregon Resilience Plan**) highlighting the state's vulnerabilities in the event of a Cascadia earthquake and tsunami and identifying mitigation actions. Following publication, the Oregon legislature demonstrated its continuing strong policy focus on earthquake and tsunami mitigation by appointing a Resilience Task Force to suggest which mitigation actions should be undertaken first. The Task Force reported to the legislature on October 1, 2014.

Oregon has begun actively encouraging local governments to consider natural hazards in their land use planning processes. In January 2014, DLCD issued *Preparing for a Cascadia Subduction Zone Tsunami: A Land Use Guide for Oregon Coastal Communities* (http://www.oregon.gov/lcd/ocmp/docs/publications/tsunamiguide20140108.pdf), which provides information on planning techniques to mitigate loss from a Cascadia earthquake and tsunami event.

DLCD is also encouraging local governments to integrate NHMPs with comprehensive plans. In the first half of 2014, with leadership from OPDR and DLCD acting in an advisory capacity, the City of Madras undertook a pilot project to update the Goal 7 section of its comprehensive plan and integrate it with its recently updated NHMP. The project was completed successfully. Clatsop County is updating its NHMP and integrating it with its comprehensive plan on its own. With new landslide susceptibility maps issued by DOGAMI in 2013 and 2014, Clackamas County and most of its cities, Coos and Curry Counties are positioned to do the same. DLCD's new natural hazards planners will be providing these communities with technical assistance, including a model code for mitigating landslide hazards, through the Goal 7 implementation process.

In the latter half of 2014, DLCD also applied for FEMA funding to assist Tillamook County and its cities, Albany, Beaverton, and Medford with NHMP updates, and will assist as well with integrating the updated NHMPs with comprehensive plans either during or after the NHMP updates.

Staff in ODF are also working toward integrating Community Wildfire Protection Plans with local NHMPs and comprehensive plans.

The North Coast Resilience Project, a cooperative endeavor of DLCD, OPDR, and Oregon Sea Grant is engaging north coast communities in hazard mitigation and resilience planning.

The Regional Framework for Climate Adaptation is taking place at the same time in Clatsop and Tillamook Counties. It is designed to align agency climate adaptation priorities and to build capacity at the state and local levels to plan for climate variability and change. This effort is being conducted as a proof of concept to develop a low-overhead, comprehensive, risk- and landscape-based approach to climate adaptation planning.

The Oregon Climate Change Research Institute and Oregon Climate Service joined the State IHMT and lent expertise to the 2015 Oregon NHMP in the areas of climate change, drought, and windstorms. This is a very important and exciting enhancement of the State's natural hazard mitigation capability.

New staff in DAS's Chief Financial Office are working to improve data on state-owned/leased buildings and critical/essential facilities that we anticipate will improve the next Oregon NHMP's risk assessment.

In the latter half of 2014, DLCD initiated and continues to support two Community Rating System Users Groups (northern and southern Oregon) to encourage current participants to maintain their participation and increase their ratings, and to encourage non-participating communities to join the CRS Program. An online forum encourages communication and mutual support, as do regular meetings three times each year.

Oregon is actively pursuing opportunities to expand funding for local mitigation planning and projects. In 2013, the State augmented its capability by hiring two full-time staff in DLCD. In 2014, several state agencies are working on significantly increasing current funding levels and establishing stable funding for hazard mitigation beginning with the 2015–2017 budget cycle. These efforts include:

- Requests for additional staff;
- State funds to provide local governments with at least a portion of the non-federal cost-share required to obtain and use federal hazard mitigation grants through DLCD's Technical Assistance Grant Program; and
- Funding for hazard identification studies, improvements to the current risk assessment methodologies, and enhanced risk communication technology.

As with federal funding, appropriation of funds depends on budget priorities and politics, so the level of funding to support local hazard mitigation planning and projects will always fluctuate. With attention to hazards intensifying, state funding for natural hazard mitigation may begin to grow.

3.4.1.2 Policies, Programs, and Capabilities

Pre-Disaster Hazard Mitigation Policy Framework

Oregon maintains a robust pre-disaster natural hazard mitigation policy framework. The foundation of this framework is rooted in the Oregon statewide land use planning requirements passed in 1973. Goal 7, the natural hazard planning component of a community's comprehensive land use plan, provided an incentive for all of Oregon's flood-prone communities to participate in the National Flood Insurance Program. A number of Oregon communities have chosen to participate in the Community Rating System Program as well. Oregon updated Goal 7 in 2002, largely driven by the flooding and landslides of the February 1996 major disaster declaration (DR-1099). In its current form, Goal 7 directs communities to regulate development in hazard-prone areas through local comprehensive plans and implementing ordinances. At minimum, local comprehensive plans in Oregon must address floods (coastal and riverine), landslides, earthquakes and related hazards, tsunamis, coastal erosion, and wildfires where applicable. Accordingly, all of Oregon's cities and counties are required to plan for Oregon's major natural hazard events and to mitigate impacts through regulatory controls.

Table 3-5 provides an overview of the various policies and federal programs related to specific natural hazards in Oregon.

Table 3-5. Policies and Federal Programs Related to Specific Natural Hazards in Oregon

Hazard	Oregon Statewide Planning Goals & Policies	Federal Programs & National Resources
Multi-Hazard	Local Comprehensive Plans	Pre-disaster mitigation planning grants (FEMA)
	Goal 2: Land Use Planning	
	Goal 7 Natural Hazards	American Planning Association (Resources on landslides, flooding, and post-disaster recovery)
	Oregon Building Codes	
Coastal Hazards	Goal 17: Coastal Shorelands	National Flood Insurance Program (NFIP)
	Goal 18: Beaches and Dunes	NFIP V-Zone Construction
	Ocean Shore Regulation	Army Corps of Engineers Permit Program
	Tsunamis — ORS 336.071, ORS 455.446, and ORS 455.448	
Flood	Goal 5: Natural Resources, Scenic and Historic Areas, and Open Spaces	National Flood Insurance Program (NFIP)
	Division of State Lands (DSL) Fill and Removal Permit Program	NFIP Community Rating System Flood Mitigation Assistance Programs (includes Severe Repetitive Loss and Repetitive Flood Claims Programs as of 2013)
	The Oregon Plan for Salmon and Watersheds	FEMA Region X's Policy on Fish Enhancement Structures in the Floodway
	Oregon's Wetlands Protection Program	Army Corps of Engineers Permit Program
Landslide	Goal 17: Coastal Shorelands	American Planning Association: Landslide Hazards and Planning
	The Oregon Plan for Salmon and Watersheds	
	1997 Senate Bill 12: Rapidly Moving Landslides	
Seismic	2005 Senate Bill 2: Statewide seismic needs assessment for schools and emergency facilities	USGS Earthquake Hazards Program
	2005 Senate Bill 3: Seismic earthquake rehabilitation grant program	
	2005 Senate Bill 4 and 5: State bond authorization	
	2001 Senate Bill 13: Seismic Event Preparation	
	2001 Senate Bill 14: Seismic Surveys for School Buildings	
	2001 Senate Bill 15: Seismic Surveys for Hospital Buildings	
	1991 Senate Bill 96: Seismic Hazard Investigation	
	Tsunamis — ORS 336.071, ORS 455.446, and ORS 455.448	
Fire–WUI	1997 Senate Bill 360: Wildland-Urban Interface	National Fire Protection Agency Firewise Program
	Additional Criteria for Forestland Dwellings — ORS 215.730	
	Urban Interface Fire Protection — ORS 477.015-061	

Source: OPDR

State Pre-Disaster Hazard Management Policies

Multi-Hazards

Statewide Land Use Planning Goals Related to Natural Hazards

In Oregon, every city and county has a comprehensive plan that includes inventories, policies, and implementation measures (e.g., laws and ordinances) to guide community land use decisions. Comprehensive plans are required to address local concerns and issues raised by each of the state's 19 land use planning goals.

GOAL 2: LAND USE PLANNING

Statewide Land Use Planning Goal 2 establishes a planning process and policy framework as a basis for decisions and actions related to use of land. It also assures that an adequate factual base exists for such decisions and actions.

GOAL 5: NATURAL RESOURCES, SCENIC AND HISTORIC AREAS, AND OPEN SPACES

Statewide Land Use Planning Goal 5 requires local governments to adopt programs that will protect natural resources and conserve scenic, historic, and open space resources for present and future generations. Conservation of resources promotes a healthy environment and natural landscape that contributes to Oregon's livability.

GOAL 7: AREAS SUBJECT TO NATURAL HAZARDS

Statewide Land Use Planning Goal 7 aims to protect people and property from natural hazards. Local governments are required to adopt comprehensive plans (inventories, policies and implementing measures) to reduce risk to people and property from natural hazards. Natural hazards for the purpose of this goal are: floods (coastal and riverine), landslides (including "rapidly moving landslides" regulated by ORS 195.250-275, 1999 edition), earthquakes and related hazards, tsunamis, coastal erosion, and wildfires. Local governments may also identify and plan for other natural hazards.

GOAL 15: WILLAMETTE RIVER GREENWAY

The purpose of Goal 15 is to protect, conserve, enhance, and maintain the natural, scenic, historical, agricultural, economic and recreational qualities of lands along the Willamette River as the Willamette River Greenway.

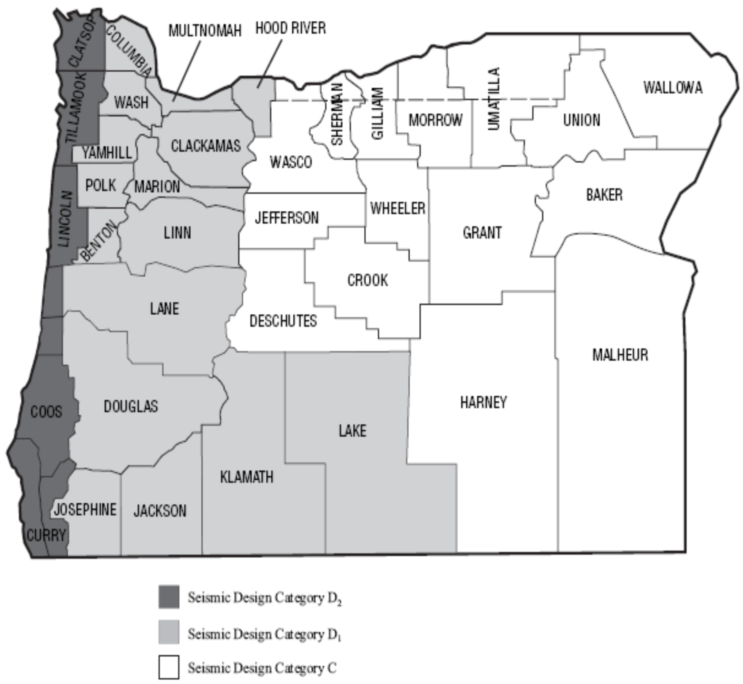
Oregon Building Codes

Coastal and Flood Hazards. The 2014 Oregon Structural Residential Specialty Codes contain requirements for all new construction of buildings, structures, and portions of buildings and structures within flood hazard areas, including substantial improvement and restoration of substantial damage to buildings and structures. For example, the lowest floors of buildings and structures must be elevated at least one foot above the design flood elevation. Flood hazard areas are determined by flood hazard maps that include, at minimum, areas of special flood hazard as identified by the Federal Emergency Management Agency.

Coastal areas that are subject to wave heights in excess of three feet or subject to high-velocity wave action or wave-induced erosion are designated as high-hazard areas. Buildings and structures constructed in whole or in part in coastal high-hazard areas must be designated and constructed in accordance with building code requirements.

Seismic Hazards. The 2014 Oregon Residential Specialty Code addresses seismic concerns by breaking the state up into the following zones. The code contains specific regulations for development within each zone.

Figure 3-1. Oregon's Seismic Design Regions



Unlike the Oregon Residential Specialty Code which assigns seismic categories, the Structural Specialty Code relies on a "seismic design load." The seismic design load is determined in accordance with an engineering calculation factoring peak ground acceleration of the site, use of the building, and soil conditions.

Landslide Hazards. The 2010 Oregon Structural Specialty Code and the 2011 Oregon Residential 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 compaction and lateral loads from soil and groundwater on sloped lots.

Wildfire Hazards. The 2011 Oregon Residential Specialty Code provides minimum standards for dwellings and their accessory structures located in or adjacent to vegetated areas subject to wildfires, to reduce or eliminate hazards presented by wildfires. Wildfire zones are determined using criteria established by the Oregon Department of Forestry.

Windstorm Hazards. The 2011 Oregon Residential Specialty Code and the 2010 Oregon Structural Specialty Code provide design criteria for buildings and construction within "exposure classification" areas of the state. Within Oregon, there are three exposure categories. All areas with full exposure to ocean winds, for example, must be designed to accommodate 110 mph winds. Design criteria include requirements related to protection of openings, and building height, and wind load.

Oregon's Wetlands Protection Program

Oregon's Wetlands Program was created in 1989 to integrate federal and state rules concerning wetlands protection with the Oregon Land Use Planning Program. The Wetlands Program has a mandate to work closely with local governments and the Division of State Lands (DSL) to improve land use planning approaches to wetlands conservation. A Local Wetlands Inventory (LWI) is one component of that program. DSL also develops technical manuals, conducts wetlands workshops for planners, provides grant funds for wetlands planning, and works directly with local governments on wetlands planning tasks.

The Oregon Plan for Salmon and Watersheds

"The Oregon Plan" is the state's program to restore native salmon and trout populations and to improve water quality. The overall goal of the Oregon Plan is to restore fish populations to productive and sustainable levels that will provide substantial environmental, cultural, and economic benefits.

Division of State Lands Fill and Removal Permit Program (ORS 196.800-990)

The Division of State Lands (DSL) Fill and Removal Permit Program (ORS 196.800-990) requires individuals who remove or fill 50 cubic yards or more in "waters of the state" to obtain a permit from the DSL. In State Scenic Waterways or areas designated by DSL as essential indigenous anadromous salmonid habitat, most removal-fill activities require a permit, regardless of the number of cubic yards affected. In addition, the Oregon Department of Environmental Quality is responsible for water quality certification under section 401(a) of the Clear Water Act. This certification is required as part of the DSL permitting process.

In addition, the Removal/Fill Law and implementing regulations contain specific standards and requirements for riprap and other bank and shore stabilization projects in areas that extend from the Pacific Ocean shore to the line of established upland vegetation or the highest measured tide, whichever is greater. The Oregon Parks and Recreation Department (OPRD) administers the removal/fill regulations jointly with the Ocean Shore Permit Authority. Activities permitted under these regulations are required to comply with the Statewide Planning Goals and be compatible with corresponding provisions of local comprehensive plans. Permits for shoreline protective structures may be issued only when development existed prior to January 1, 1977, as required under Goal 18. Foredune management plans, often implemented as hazard mitigation strategies, require a permit from OPRD because these strategies affect the structure of the shoreline. Other hazard mitigation strategies that require OPRD approval include: natural product (dirt) removal, re-sloping of a vertical bank below the statutory line of vegetation, and mitigating for erosion by altering the course of a stream that flows into the ocean.

Coastal Hazards

Statewide Land Use Planning Goals Related to Natural Hazards

GOAL 16: ESTUARINE RESOURCES

The purpose of Goal 16 is twofold: to recognize and protect the unique environmental, economic, and social values of each estuary and associated wetlands; and to protect, maintain, where appropriate develop, and where appropriate restore the long-term environmental, economic, and social values, diversity, and benefits of Oregon's estuaries. Comprehensive management programs to achieve these objectives are to be developed by appropriate local, state, and federal agencies for all estuaries.

GOAL 17: COASTAL SHORELANDS

Statewide Land Use Planning Goal 17 is concerned with conservation and protection, as well as appropriate development of Oregon's coastal shorelands. It aims to reduce the hazard to human life and property, and the adverse effects upon water quality and fish and wildlife habitat resulting from the use and enjoyment of Oregon's coastal shorelands.

GOAL 18: BEACHES AND DUNES

The purpose of Statewide Land Use Planning Goal 18 is to conserve, protect, and where appropriate, to either develop on or restore resources and benefits of coastal beach and dune areas. It is also concerned with reducing the hazard to human life and property from natural or human-induced actions associated with these areas.

Ocean Shore Regulation

The Oregon Parks and Recreation Department (OPRD) is responsible for protecting the scenic, recreational, and natural resource values of the Oregon coast. OPRD accomplishes this through an extensive permitting program for shoreline protection under the authority of The Ocean Shore Law (ORS 390.605-390.770), also known as the "Beach Bill." While not responsible for activities above the statutory vegetation line, the survey line, or the line of established vegetation, OPRD is the permitting authority for actions affecting the ocean shorelands. This distinction can be seen visually at the line of established vegetation that backs the shoreline.

The Division of State Lands (DSL) has co-authority with the OPRD over rocky intertidal areas. The DSL manages the state-owned seabed within three nautical miles of low tide at the ocean shore. Specifically, the DSL regulates removal and filling of seabed and estuaries, including any dredged materials or seabed minerals. DSL may also issue leases for the harvest of Bull Kelp, a large seaweed in rocky areas of Oregon's coast. The Beach Bill requires that a permit be obtained from OPRD for all "beach improvements" west of a surveyed beach zone line. Communities can check their comprehensive plan or contact OPRD to obtain the location of this surveyed line.

Earthquakes/Tsunamis

Tsunamis — ORS 336.071, ORS 455.446, and ORS 455.448

Fourteen earthquake-related bills were introduced during the 1995 session. Several passed, including a new requirement for earthquake education and tsunami drills to be conducted in public schools (ORS 336.071), a requirement for essential and special-occupancy structures to be built outside of tsunami inundation zones (ORS 455.446), provisions for the inspection and entrance of buildings damaged by earthquakes (ORS 455.448) and specific provisions for the abatement of buildings damaged by earthquakes. Senate Bill 1057 created a task force to evaluate the risks impacting existing buildings and make recommendations to the 1997 legislature.

Senate Bill 96 (1991): Seismic Hazard Investigation

The legislature passed Senate Bill 96 in 1991. This law requires site-specific seismic hazard investigations before the construction of essential facilities, hazardous facilities, major structures, and special-occupancy structures (e.g., hospitals, schools, utilities and public works, police and fire stations). These requirements were adopted into the State Building Code. The law also provides for the installation of strong-motion sensors in selected major buildings and mandates that school officials in all public schools lead students and staff in earthquake drills.

Senate Bill 13 (2001): Seismic Event Preparation

Senate Bill 13, signed by the Governor on June 14, 2001, requires each state and local agency and persons employing 250 or more full-time employees to develop seismic preparation procedures and inform their employees about the procedures. Further, the bill requires agencies to conduct drills in accordance with Oregon Office of Emergency Management guidelines. These drills must include "familiarization with routes and methods of exiting the building and methods of duck, cover and hold during an earthquake."

Senate Bill 14 (2001): Seismic Surveys for School Buildings

The Governor signed Senate Bill 14 on July 19, 2001. The bill required the State Board of Higher Education to conduct seismic safety surveys of buildings that have a capacity of 250 or more persons and are routinely used for student activities by public institutions or departments under the control of the board. A seismic safety survey was not required for buildings that had previously undergone seismic safety surveys, or that had been constructed to meet state building code standards. For buildings that were found to pose an undue risk to life and safety during a seismic event, the bill required the State Board of Higher Education to develop plans for seismic rehabilitation or seismic risk reduction. Subject to available funding, all seismic rehabilitation or risk reduction activities must be completed before January 1, 2032.

Senate Bill 15 (2001): Seismic Surveys for Hospital Buildings

The Governor signed Senate Bill 15 on July 19, 2001. The bill required the Health Division to conduct seismic safety surveys of hospital buildings that contain acute inpatient care facilities. Subject to available funding, seismic surveys must also be conducted on fire stations, police stations, sheriffs' offices, and similar facilities. The surveys were completed in January, 2007.

A seismic survey was not required for buildings that had previously undergone seismic safety surveys, or that had been constructed to meet state building code standards. For buildings that were found to pose an undue risk to life and safety during a seismic event, the bill required building occupants to develop plans for seismic rehabilitation or seismic risk reduction. Subject to available funding, all seismic rehabilitation or risk reduction activities must be completed before January 1, 2022.

Oregon Seismic Safety Policy Advisory Commission (OSSPAC) — ORS 401.337 to 401.353

The Oregon Seismic Safety Policy Advisory Commission (OSSPAC), otherwise known as the Earthquake Commission, is a state advisory commission that was created in February 1990 through an executive order from Governor Neil Goldschmidt. The group is composed of 18 individuals who represent a variety of interests concerned with the formulation of public policy regarding earthquakes. It has six representatives of government, six representatives of the public interest, and six representatives of industries and stakeholders. This variety of interests helps direct the goals of the Commission for the benefit of all Oregon citizens.

The Earthquake Commission has the unique task of promoting earthquake awareness and preparedness through education, research, and legislation. OSSPAC seeks to positively influence decisions and policies regarding pre-disaster mitigation of earthquake and tsunami hazards, and to increase public understanding of hazards, risk, exposure, and vulnerability. In order to fulfill the goals of the commission, OSSPAC members have developed five primary objectives. These objectives are to increase or improve:

- Earthquake awareness, education, and preparedness;
- Earthquake risk information;
- The earthquake safety of buildings and lifelines;
- Geoscience and technical information; and
- Emergency pre-disaster planning, response and recovery efforts.

For information on OSSPAC, contact the Oregon Office of Emergency Management.

Senate Bill 2 (2005): Statewide Seismic Needs Assessment Using Rapid Visual Screening

Oregon Senate Bill 2 directed DOGAMI, in consultation with project partners, to develop a statewide seismic needs assessment that includes seismic safety surveys of K-12 public school buildings and community college buildings that have a capacity of 250 or more persons, hospital buildings with acute inpatient care facilities, fire stations, police stations, sheriffs' offices and other law enforcement agency buildings.

The statewide needs assessment consisted of rapid visual screenings (RVS) of these buildings, information gathering to supplement RVS, and ranking of RVS results into risk categories. The results are posted on DOGAMI's website.

Senate Bill 2 (2005) provided the first step in a pre-disaster mitigation strategy that is further defined in Senate Bills 3-5 (2005).

Wildfires and Wildland-Urban Interface

Oregon Forestland-Urban Interface Fire Protection Act (SB 360)

The Oregon Forestland-Urban Interface Fire Protection Act, often referred to as Senate Bill 360, enlists the aid of property owners toward the goal of turning fire-vulnerable urban and suburban properties into less-volatile zones where firefighters may more safely and effectively defend homes from wildfires. Senate Bill 360 established Oregon's first comprehensive statewide policy regarding mitigation in wildland-urban interface areas. It broadly defined the WUI and set in place a process to identify and classify these areas. The legislation also required the development of standards, which WUI owners are to apply in order to manage and minimize wildfire hazards on their property. When work to implement Senate Bill 360 begins in a county, a committee of local representatives formally identifies and classifies WUI areas. Individual property owners in these areas are then contacted and informed of the standards they are required to meet. They have up to 2 years to bring their property into compliance with the standards and then to certify that they have done so. Owners who fail to certify become subject to a potential liability of up to $100,000 for certain costs of suppressing fires which start on their property.

The Oregon Forestland-Urban Interface Fire Protection Act is fully described in Oregon Revised Statutes 477.015 through 477.061, and Oregon Administrative Rules 629-044-1000 through 629-044-1110.

Oregon Revised Statute 215.730: Additional Criteria for Forestland Dwellings

ORS 215.730 (County Planning; Zoning, Housing Codes) provides additional criteria for approving dwellings located on lands zoned for forest and mixed agriculture and forest use. Under its provisions, county governments must require, as a condition of approval, that single-family dwellings on lands zoned as forestland meet the following requirements:

1. Dwelling has a fire retardant roof;
2. Dwelling will not be sited on a slope of greater than 40%;
3. Evidence is provided that the domestic water supply is from a source authorized by the Water Resources Department and not from a Class II stream as designated by the State Board of Forestry;
4. Dwelling is located upon a parcel within a fire protection district or is provided with residential fire protection by contract;
5. If dwelling is not within a fire protection district, the applicant provides evidence that the applicant has asked to be included in the nearest such district;
6. If dwelling has a chimney or chimneys, each chimney has a spark arrester; and
7. Dwelling owner provides and maintains a primary fuel-free break and secondary break areas on land surrounding the dwelling that is owned or controlled by the owner. If a governing body determines that meeting the fourth requirement is impractical, local officials can approve an alternative means for protecting the dwelling from fire hazards.

This can include a fire sprinkling system, on-site equipment and water storage, or other methods that are reasonable, given the site conditions. If a water supply is required under this subsection, it must be a swimming pool, pond, lake or similar body of water that at all times contains at least 4,000 gallons or a stream that has a minimum flow of at least one cubic foot per second. Road access must be provided to within 15 feet of the water's edge for fire-fighting pumping units, and the road access must accommodate a turnaround for fire-fighting equipment.

Oregon Revised Statute 477.015-061 Urban Interface Fire Protection

These provisions were established through efforts of the Oregon Department of Forestry, the Office of the State Fire Marshal, fire service agencies from across the state, and the Commissioners of Deschutes, Jefferson, and Jackson Counties. It is innovative legislation designed to address the expanding interface wildfire problem within Oregon Department of Forestry Fire Protection Districts. Full implementation of the statute will occur on or after January 1, 2002. The statute does the following:

1. Directs the State Forester to establish a system of classifying forestland-urban interface areas;
2. Defines forestland-urban interface areas;
3. Provides education to property owners about fire hazards in forestland-urban interface areas;
4. Allows for a forestland-urban interface county committee to establish classification standards;
5. Requires maps identifying classified areas to be made public;
6. Requires public hearings and mailings to affected property owners on proposed classifications;

7. Allows property owners appeal rights;
8. Directs the Board of Forestry to promulgate rules that set minimum acceptable standards to minimize and mitigate fire hazards within forestland-urban interface areas;
9. Creates a certification system for property owners meeting acceptable standards; and
10. Establishes a $100,000 liability limit for cost of suppressing fires, if certification requirements are not met.

Oregon Revised Statute Chapter 478: Rural Fire Protection Districts

ORS 478, Rural Fire Protection Districts, includes the following provisions, among others, related to wildfire hazard mitigation:

478.120 Inclusion of forestland in district. The authority to include forestland within a rural fire protection district pursuant to ORS 478.010 (2)(c) applies to forestland within the exterior boundaries of an existing district and to forestland on which structures subject to damage by fire have been added after July 20, 1973.

478.140 Procedure for adding land to district by consent of owner. Any owner consenting to add the forestland of the owner to the district under ORS 478.010 (2)(c) shall do so on forms supplied by the Department of Revenue. The owner shall file the original with the district. The district shall forward a copy to the assessor of each county in which the land is located, within 20 days of receipt.

478.910 Adoption of fire prevention code. A district board may, in accordance with ORS 198.510 to 198.600, adopt a fire prevention code.

478.920 Scope of fire prevention code. The fire prevention code may provide reasonable regulations relating to:

1. Prevention and suppression of fires.
2. Mobile fire apparatus means of approach to buildings and structures.
3. Providing fire-fighting water supplies and fire detection and suppression apparatus adequate for the protection of buildings and structures.
4. Storage and use of combustibles and explosives.
5. Construction, maintenance, and regulation of fire escapes.
6. Means and adequacy of exit in case of fires and the regulation and maintenance of fire and life safety features in factories, asylums, hospitals, churches, schools, halls, theaters, amphitheaters, all buildings, except private residences, which are occupied for sleeping purposes, and all other places where large numbers of persons work, live, or congregate from time to time for any purpose.
7. Requiring the issuance of permits by the fire chief of the district before burning trash or waste materials.
8. Providing for the inspection of premises by officers designated by the board of directors, and requiring the removal of fire hazards found on premises at such inspections.

478.927 Building permit review for fire prevention code. A district adopting a fire prevention code shall provide plan review at the agency of the city or county responsible for the issuance of building permits for the orderly administration of that portion of the fire prevention code that requires approval prior to the issuance of building permits.

Landslides

Senate Bill 12: Rapidly Moving Landslides

Following the flood and landslide events of 1996, legislation was drafted to reduce risk from future landslide hazards. The legislature passed Senate Bill 1211 in 1997, which dealt with rapidly moving landslide issues around steep forestlands, and not in typical urban or community settings. Senate Bill 1211 granted authority to the State Forester to prohibit forest operations in certain landslide-prone locations, and created the Interim Task Force on Landslides and Public Safety. SB 1211 charged the Interim Task Force with developing a comprehensive, practicable, and equitable solution to the problem of risks associated with landslides.

The Interim Task Force developed the legislative concept that resulted in Senate Bill 12 in the 1999 session (ORS 195.250 et seq.). Senate Bill 12 directs state and local governments to protect people from rapidly moving landslides. The bill has three major components affecting local governments: detailed mapping of areas potentially prone to debris flows (i.e., "further review area maps"), local government regulating authority, and funding for a model ordinance. The legislature allocated funding to the Department of Geology and Mineral Industries (DOGAMI) to prepare the "further review area maps," and provided $50,000 for a grant to a local government to develop a model program to address rapidly moving landslides. Senate Bill 12 applies only to rapidly moving landslides, which are uncommon in many communities, but are very dangerous in areas where they do occur.

Post-Disaster Hazard Mitigation Policy Framework

Following the Presidential Disaster Declaration for the December 2007 winter storm event (DR-1683), Governor Kulongoski signed Executive Order 08-20 establishing the Governor's Emergency Recovery Framework. The Order established a Recovery Planning Cell (RPC) comprised of emergency recovery advisors, state agency leadership, and others as the situation requires. The RPC directs emergency recovery in Oregon, providing leadership and coordinating private and government sector recovery efforts. It is charged with the development and initial execution of a "day after" plan for recovery efforts. The Order also established the Governor's Recovery Cabinet to coordinate ongoing recovery efforts following the initial emergency response.

State Post-Disaster Hazard Management Policies

Earthquakes/Tsunamis

More recently, the legislature passed House Resolution 3 following the 2011 Great Tohoku Earthquake in Japan and the resulting tsunami that impacted the Oregon coast (DR-1964). HR 3 recognizes risks and susceptibility of Oregon to catastrophic damage and loss of life resulting from megathrust earthquakes and tsunamis associated with Cascadia fault. Furthermore, it directed the creation and legislative consideration of an "Oregon Resilience Plan." The Oregon Seismic Safety Policy Advisory Committee published that Plan in February 2013. The plan identifies the state's vulnerabilities in the event of a Cascadia earthquake and tsunami, and contains mitigation actions. Following publication, the legislature appointed the Resilience Task

Force to recommend which mitigation actions to take first. The Resilience Task Force's report (**Appendix** 9.2.6) is due to the legislature on October 1, 2014.

Floods

Substantial Damage Policy

Under the NFIP, a building is considered to be substantially damaged when the total cost of repair equals or exceeds 50% of the pre-damage market value of the structure. A substantial damage determination provides opportunities for mitigation through acquisition, relocation, demolition, and elevation. For NFIP-insured properties, timely determinations of substantial damage are critical for meeting the application period for an **Increased Cost of Compliance (ICC)** mitigation claim. If approved for ICC, the ICC payment of up to $30,000 may be used as the property owner's non-federal cost share. Timely substantial damage determination is a standard protocol for all flood disaster declarations in Oregon.

Repetitive Loss (RL) and Severe Repetitive Loss (SRL) Policy

Repetitive Losses and **Severe Repetitive Losses** properties are defined in the State Risk Assessment.

RL and SRL properties are a top priority for mitigation in Oregon. However, several criteria must generally align for their mitigation to be executable. In addition to meeting the federal statutory criteria for mitigation projects — technically feasible, cost-effective, and environmentally sound — the state will vigorously pursue mitigation of RL and SRL properties if:

- The structure is substantially damaged and eligible for funding under the NFIP's Increased Cost of Compliance provision;
- The structure is located in a community with a FEMA-approved local NHMP;
- The structure is located in a community with ability to handle federal grant funds;
- The structure is located in a declared county (post-disaster) and post-disaster mitigation funding is available; and
- The owners of the structure are interested in mitigation through elevation, flood-proofing, relocation, or demolition.

In addition, geographic distribution of properties may play a role. It is the state's policy to distribute mitigation assistance and funding to impacted communities in different areas of the state whenever practicable.

Pre- and Post-Disaster Hazard Mitigation Programs and Capabilities Framework

Oregon Lidar Consortium

Formed by the Department of Geology and Mineral Industries, the Oregon Lidar Consortium (OLC) develops cooperative agreements for the collection of high-quality lidar that benefits the public at large, the business community, and agencies at all levels of government. The goal of the OLC is to provide high-quality lidar coverage for the entire state. The collection of lidar data can assist governments in better identifying hazardous areas.

Oregon Seismic Safety Policy Advisory Committee

OSSPAC is a state advisory commission created in February 1990 through an executive order from Governor Neil Goldschmidt and established in statute by the 1991 Oregon Legislature (ORS 401.337). The purpose of the 18-member group is to reduce exposure to Oregon's earthquake hazards.

Hazard Mitigation Grant Review Board

The Hazard Mitigation Grant Review Board is an intergovernmental body which, when convened, reviews, discusses, ranks, and recommends projects for funding under Section 404 of the Stafford Act (also known as Hazard Mitigation Grant Program or HMGP).

Drought Council

The Drought Council is responsible for assessing the impact of drought conditions and making recommendations to the Governor's senior advisors.

Numerous additional agency-specific hazard mitigation programs and capabilities also exist or are under development. For example, OPDR is a coalition of public, private, and professional organizations working collectively toward the mission of creating a disaster resilient and sustainable state. Developed and coordinated by the Community Service Center at the University of Oregon, OPDR employs a service learning model to increase community capacity and enhance disaster safety and resilience statewide. Similarly, DLCD is currently working to incorporate the principles of FEMA's Risk Map program into an Oregon-specific initiative called Risk Plan. The Risk Plan program is conceptual at this point, but when implemented will offer an integrated state-wide framework for delivering information, guidance, technical assistance and other resources to local governments.

Agencies/Organizations

State Interagency Hazard Mitigation Team

First convened by Governor Kitzhaber in 1996, the State Interagency Hazard Mitigation Team (IHMT) meets quarterly, and provides leadership in addressing natural hazards mitigation in Oregon. The State IHMT is an important state mechanism for interagency coordination. The team's focus is to understand losses arising from natural hazards, including secondary losses that occur when natural hazard events impact technological systems and critical infrastructure, and to coordinate recommended strategies to mitigate loss of life, property, economic and natural resources by maintaining the FEMA-approved and Governor-adopted *Oregon Natural Hazards Mitigation Plan*.

The State IHMT's goals are:

1. Coordinate hazard mitigation programs and activities at all levels in the state of Oregon.
2. Describe and evaluate the natural hazards to which the state of Oregon is vulnerable.
3. Describe and evaluate state, local government, and private sector hazard mitigation policies, programs, and capabilities, consistent with federal codes and regulations.
4. Identify sources of hazard mitigation funding and the procedures that must be followed to obtain such funding; make this information widely available.

5. Identify and evaluate proposed hazard mitigation strategies, projects, and legislation to ensure consistency and to proactively integrate natural resource goals into mitigation activities.
6. Continue to develop, implement, monitor, evaluate, and update the Oregon Natural Hazards Mitigation Plan.
7. Provide education and information about natural hazards and steps which can be taken to mitigate against their effects.
8. Facilitate integration of hazard mitigation into the activities and programs of state and local government agencies, and to the extent practical, into the activities of private sector organizations.
9. Strive to integrate into natural hazard mitigation: natural resource protection and restoration, stormwater management, ecosystem concerns, floodplain management, and protection of water quality for public use.
10. Promote and facilitate the concept of a disaster resistant economy in Oregon.

OEM houses the State Hazard Mitigation Officer, who also serves as Chair of the IHMT. In addition, OEM provides overall staff support through routine communication with the membership, agenda development, and meeting logistics. Members of the State IHMT are called upon to assist with various mitigation activities outside of the scheduled State IHMT meetings to include such things as updating the Oregon NHMP and identifying and reviewing projects, particularly following major disaster declarations.

State IHMT meetings are open to the public. Liaison representatives from non-state IHMT agencies and organizations can be added as needed. Descriptions of the State IHMT agencies' hazard mitigation roles, responsibilities, and authorities are provided in **Table 3-6**.

Table 3-6. IHMT Agencies' Hazard Mitigation Roles, Responsibilities and Authorities

State IHMT Agency	Hazard Mitigation Roles and Responsibilities	Natural Hazards Mitigation Legal Authority
Department of Administrative Services (DAS), Chief Financial Office	Works to prepare state government offices for emergency evacuation planning using the State of Oregon's *Sound the Alarm RisKey* guide. DAS works to improve safety among the workplace by identifying risks and developing tools to manage risks. DAS also works to protect state-owned property and buildings, and sets standards for leasing and constructing state buildings.	No legal authority for natural hazards mitigation, except that which may arise from a claim under self-insurance property coverage.
Oregon Department of Agriculture (ODA)	Works to exclude or eradicate certain insect pests from becoming established in the state. Using the Insect Pest Prevention and Management program (IPPM), the ODA works to protect Oregon's agriculture, horticulture and timber resources from damaging insect pests, thus preventing the defoliation of vast acreage of trees and reducing fire and erosion hazards; works with soil and water conservation districts to help landowners implement best management practices to reduce erosion, thereby preventing slides, floods, and erosion-related problems; actively involved in watershed health and maintaining natural resources through education, technical assistance, and regulatory programs for landowners.	ORS, Chapter 568 provides authority for water quality and soil conservation measures, and Chapter 570 provides authority for pest and disease control programs.
Department of Consumer and Business Services (DCBS), Building Codes Division (BCD)	Works to implement statewide building codes through a permitting program. . BCD has adopted construction standards that help create disaster resistant buildings. BCD administers the post-earthquake inspection program for damaged buildings and provides technical assistance and training for building inspectors, plans examiners, designers, and contractors. A post-earthquake inspector carries out post-earthquake habitability assessments for all structures affected by an earthquake. BCD has compiled an active list of certified post-earthquake inspectors. BCD generally adopts nationally recognized model codes that include various standards to ensure building safety. Technical assistance is provided to designers, contractors, building officials, and the public through its code specialists, its web page, regular mailings to interested parties and local building officials, and its quarterly publication *Codelink*.	ORS, Chapter 455 provides legal authority for the Building Codes Division's (BCD) natural hazard mitigation activities including 455.020 (code adoption), .725 (training), .440 (site soil analysis), .446 (construction in tsunami zones), .447 (seismic site hazard analysis), and .448-.449 (entry and inspection of earthquake damaged buildings).
DCBS - Insurance Division (DCBS-ID)	Works to perform a major balancing role, protecting the public's interests through ensuring the financial soundness of insurers, the availability and affordability of insurance, and the fair treatment of policyholders and claimants while maintaining a positive business climate. The DCBS Insurance Division helps home and business owners prepare for natural hazards through the provision of insurance-related educational material. The DCBS Insurance Division also works to help ensure insurance compensation to insurance holders in the wake of a natural disaster.	ORS Chapter 731 provides authority to DCBS insurance division. House Bill 3605 allows the director of the Department of Consumer and Business Services (DCBS) to modify insurance policy terms in times of emergency.

State IHMT Agency	Hazard Mitigation Roles and Responsibilities	Natural Hazards Mitigation Legal Authority
Business Oregon, Infrastructure Finance Authority (BusOR-IFA)	Works with the Governor and all state agencies to prioritize programs and modify services that help those affected by natural disasters. Works with current loan customers to address needs during recovery from a natural disaster. Works with communities to prioritize infrastructure needs resulting from a natural disaster, which is used to develop state and federal funding solutions for Oregon communities. Offers Emergency Response Funding Programs. Also supports hazard mitigation by promoting development of new facilities and infrastructure in appropriate locations. As of January 1, 2014, administers the Seismic Rehabilitation Grant Program.	ORS Chapter 285A-C provides authority to Oregon Business, including 285B.020 (infrastructure).
Oregon Climate Change Research Institute (OCCRI) and the Oregon Climate Service (OCS)	OCCRI, housed at Oregon State University, is authorized to: 1. Facilitate research by Oregon University System faculty on climate change and its effects on natural and human systems in Oregon 2. Serve as a clearinghouse for climate change information 3. Provide climate change information to the public in integrated and accessible formats 4. Support the Oregon Global Warming Commission in developing strategies to prepare for and to mitigate the effects of climate change on natural and human systems 5. Provide technical assistance to local governments to assist them in developing climate change policies, practices and programs In addition, at least once each biennium, OCCRI assesses the state of climate change science as it relates to the state of Oregon, and the likely effects of climate change on the state and delivers the assessment to the Governor's Office and the Legislative Assembly. OCS is part of the College of Earth, Ocean, and Atmospheric Sciences at OSU, and has been absorbed by OCCRI. OCS: 1. Collects, maintains and distributes Oregon weather and climate data; 2. Educates Oregonians on current and emerging climate issues; and 3. Performs research related to climate issues.	HB 3543 (2007)
Department of Environmental Quality (DEQ)	Works to protect and maintain waters of the state for public health and safety as well as for all future beneficial uses under EPA delegated programs from the Clean Water Act and Safe Drinking Water Act. Emergency actions related to natural hazards must meet environmental protection requirements. If a natural hazard were to result in hazardous materials being released into the environment, DEQ's Emergency Response Program is designed to respond. DEQ's Environmental Cleanup Division takes action should a release occur or the threat of a release. DEQ assists OEM, DLCD, and FEMA in conducting environmental assessments related to watershed restoration, hazard mitigation projects, and provides matching grants for projects under the Clean Water Act. DEQ plays a central role in the disposal of disaster debris. DEQ also works with Oregon Natural Events Action Plan for Wildfire Smoke. DEQ offers the Wildfire Air Quality Rating to monitor air pollution throughout the state to ensure that air quality standards are being met.	ORS, Chapter 468, water pollution control, enables DEQ to protect all future beneficial uses of waters of the state (surface and groundwater), and allows DEQ to act should there be a threat of release or a spill. ORS, Chapter 468a, enables the DEQ to regulate and monitor air quality. ORS, Chapters 465 and 466 enables the DEQ to respond to hazardous waste and materials that have been released into the environment.

State IHMT Agency	Hazard Mitigation Roles and Responsibilities	Natural Hazards Mitigation Legal Authority
Oregon Department of Fish and Wildlife (ODFW)	Has a primary role in determining the effects of potential hazard mitigation projects on fish and wildlife habitats and recommending measures that enhance or at least do not degrade such habitats; administers the state's Riparian Tax Incentive Program and Restoration and Enhancement Program, and can provide cost-share funding, grants and technical assistance.	ORS, Chapter 496 (application, administration, and enforcement of wildlife laws), Chapter 497 (licenses and permits), Chapter 498 (hunting, angling and trapping) and Chapter 501 (refuges and closures).
Oregon Department of Forestry (ODF)	Works to protect communities from wildfires through the implementation of the Communities at Risk Assessment Program. ODF Identifies communities and assigns each a low, moderate, or high risk rating for the following categories: risk, hazard, protection, capability, value, and overall. ODF works with communities to create Community Wildfire Protection Plans (CWPP): a process involving collaboration between communities and agencies interested in reducing wildfire risk. ODF is responsible for all aspects of wildland fire protection on private, state and BLM forestlands. ODF administers regulations, including landslide mitigation, on non-federal lands. ODF does all of the following things which advance natural hazards mitigation: requires landowners to control fires on their lands; controls fires that other landowners cannot control; administers the industrial fire prevention program; investigates wildfires; administers the Forest Practices Act; coordinates with other agencies; maintains technical expertise on wildfire sciences, geosciences, and hydrology; completes debris flow hazard mapping for Western Oregon; and leads many aspects of the *Oregon Plan for Salmon and Watersheds.*	ORS, Chapter 477 addresses the fire protection of forests and vegetation, including sections on urban interface fire protection, hazard abatement, fire abatement, fire prevention, and related sections. Chapter 527 contains provisions which pertain to timber harvest and road construction regulations in landslide areas.
Department of Geology and Mineral Industries (DOGAMI)	Works to develop geologic maps and data to enable Oregonians to understand geology and to mitigate the hazards resulting from earthquakes, tsunamis, landslides, and other hazards; works with project partners, to develop a statewide seismic needs assessment; focuses much effort on risk reduction, often in partnership with other federal, state, and local agencies, and the private sector; provides information which leads to the construction of safer buildings; works on siting of natural gas cogeneration power plants, correctional facilities, gas pipelines using policy decisions related to geologic, seismic and coastal hazards; also works with local partners to develop systematic evaluations of risk to people and property so mitigation efforts can be prioritized.	ORS, Chapter 516 creates and defines the duties; Section 516.030(3) directs DOGAMI to administer on a cooperative basis studies and programs that will reduce the loss of life and property by understanding and mitigating geological hazards.
Oregon Health Authority — Public Health Division (OHA)	The Oregon Health Authority's Health Security, Preparedness and Response (HSPR) Program develops public health systems to prepare for and respond to major, acute threats and emergencies that impact the health of people in Oregon. The Program addresses eight of the 11 natural hazards in the Oregon NHMP, extreme heat, and bioterrorism.	ORS 431 provides authority for state and local administration and enforcement of health laws including public health emergency planning and response.

State IHMT Agency	Hazard Mitigation Roles and Responsibilities	Natural Hazards Mitigation Legal Authority
Department of Land Conservation and Development (DLCD)	Manages the statewide land use planning program; Goal 7 of which addresses development in places subject to natural hazards, requiring that jurisdictions apply "appropriate safeguards" when planning for development there. The goal requires local comprehensive plans to include inventories, policies, and ordinances which will reduce losses. DLCD supports local government efforts to address natural hazards through technical assistance during periodic plan review; provides workshops and responds to local government requests for information. As of 2013, DLCD is responsible for facilitating updates of the Oregon Natural Hazards Mitigation Plan. DLCD manages the National Flood Insurance Program (NFIP) in the State of Oregon through an agreement with FEMA. As part of the NFIP the DLCD manages the Risk MAP Program. DLCD also manages the Oregon Coastal Management Program, which implements a coastal hazards and assessment program.	ORS, Chapter 197 provides the basis for comprehensive land use planning in the State of Oregon, including provisions governing development in floodplains and in other areas subject to natural hazards, which are intended to mitigate the effects of such hazards. ORS, Chapter 476 provides the basis for the Conflagration Act.
Department of State Lands (DSL)	Responsible for a variety of service-related functions relating to land management and implementation of state removal-fill law. DSL's role in hazard mitigation is in the issuing of removal and fill permits or enforcement actions on wetlands waters of the state.	ORS 196 and 390 address wetlands, removal and fill permits or enforcement actions on the beds and banks of the waters of this state. Many of these provisions have a tangential effect on floodplain management and flood hazard mitigation.
Oregon Military Department, Office of Emergency Management (OEM)	Convenes the IHMT and provides overall coordination of natural hazards mitigation in the State of Oregon. The State Hazard Mitigation Officer (SHMO) is on the staff of the Oregon Office of Emergency Management. Among OEM's related responsibilities are chairing the Oregon Emergency Response System (OERS) Council, staffing the Oregon Seismic Safety Policy Advisory Commission (OSSPAC), developing and maintaining the State *Emergency Management Plan* and related documents, managing the Chemical Stockpile Emergency Preparedness Program and providing training and other assistance which help mitigate hazards.	ORS, Chapter 401 Includes many of the state's emergency management statutes one section of which states that the general purpose of the law is to reduce the vulnerability of the State of Oregon to loss of life, injury to persons or property, human suffering, and financial loss resulting from emergencies.
Oregon State Police, Office of State Fire Marshal (OSFM)	Develop, promote, and maintain protection of life, property, and the environment from fire and other perils through leadership, direct action, and coordination of public safety resources; provides hazard mitigation through programs to educate, inspect, survey, investigate, respond to emergency incidents, and communicate with the public and emergency responders. The Conflagration Act and the State Fire Services Mobilization Plan are coordinated at all levels of state, county, and city government and they foster cooperation in responding to fires and emergency incidents. OSFM employs Regional HazMat Emergency Response Teams to help ensure public safety regarding hazardous materials incidents occurring throughout the state. OSFM provides education and programs, inspections, information, reports, data and brochures, training programs, and emergency responses to incidents for the schools, governments, and the public.	ORS, Chapters 453 and 476-480 authorize the State Fire Marshal to perform a wide variety of education and training programs, inspections, investigative and information reports and other activities related to fire prevention, safety, and management.

State IHMT Agency	Hazard Mitigation Roles and Responsibilities	Natural Hazards Mitigation Legal Authority
Public Utility Commission (OPUC)	A regulatory agency for certain electric, gas, telecommunication, and water utility companies; enforces the National Electrical Safety Code and the Federal Gas Pipeline Safety Regulations, which address utility operations under both normal and emergency conditions; monitors utilities' actions and infrastructure under a wide variety of conditions, including natural hazards, to ensure code compliance and prudent practices. OPUC promotes effective vegetation management practices to improve system safety and reliable service delivery by its ongoing enforcement of Oregon statutes and administrative rules, specifically in Chapter 860, Division 024.	ORS, Chapters 756-759, 772, and 774 authorize the PUC to carry out its purpose.
Oregon Department of Transportation (ODOT)	Is the road authority for all state highways in Oregon, including interstate highways; works to maintain drainage, open culverts, clean ditches, and perform hydraulic studies; helps prevent or reduce damage to the state highway system caused by floods or landslides. ODOT invites and works with local public works agencies to become participating parties in the Oregon Public Works Emergency Response Cooperative Assistance Agreement. ODOT and local agencies completed a seismic retrofit prioritization study of Oregon's bridges in 1997. As of January 1999, ODOT completed seismic retrofit projects on 124 state bridges.	ORS, Chapter 810 designates ODOT as the road authority for all state highways and specifies a wide range of maintenance, operations, and analysis activities related to hazard mitigation, for example: drainage maintenance, culvert inventory, and the bridge seismic retrofit program.
Water Resources Department (OWRD)	Responsible for allocation of the water that is produced by watersheds each year; quantifies and provides public notification of flows throughout the state, and insures safe operation of certain dams and other hydraulic structures.	ORS Chapter 540 provides OWRD statutory authorities for dam safety and a statewide hydrographic program for measuring river and stream flows.
Oregon Parks & Recreation Department (OPRD)	Works to provide and protect outstanding natural, scenic, cultural, historic, and recreational sites for the enjoyment and education of present and future generations. OPRD is responsible for land stewardship, marine conservation , rocky shores, several permit programs, department-wide resource policies, and park plants and animals. OPRD strives to provide a safe environment while maintaining the natural beauty and historic importance of our parks. In certain areas providing a safe environment for park users involves planning for natural disasters.	ORS Chapter 390 provides deals with the role of OPRD in dealing with state and local parks, recreation programs, scenic waterways and recreation trails
Oregon Partnership for Disaster Resilience (OPDR)	OPDR is a coalition of public, private, and professional organizations working collectively toward the mission of creating a disaster resilient and sustainable state. Developed and coordinated by the Community Service Center at the University of Oregon, OPDR employs a service learning model to increase community capacity and enhance disaster safety and resilience statewide. Primary activities include community plan and project development support; applied research and technical resource development; training programs and capacity building; and the development of strategic alliances.	N/A

Cascadia Regional Earthquake Workgroup

The Cascadia Region Earthquake Workgroup (CREW) is a coalition of private and public representatives working together to improve the ability of Cascadia Region communities to reduce the effects of earthquake events.

CREW's goals include the following:

- Promote efforts to reduce the loss of life and property damage from earthquakes.
- Educate and motivate decision makers, managers, and the general public to reduce risks associated with earthquakes.
- Foster productive linkages between scientists, critical infrastructure providers, businesses, and governmental agencies in order to improve the viability of communities after an earthquake event.

Drought Council

The Drought Council is responsible for assessing the impact of drought conditions and making recommendations to the Governor's senior advisors. The Drought Council is, in turn, advised by the Water Availability Committee, a subcommittee of technical people who monitor conditions throughout the state and report these conditions monthly. In this manner the Drought Council keeps up-to-date on water conditions. Members combine this knowledge with information they bring from their organizations and differing geographic areas of the state in order to make recommendations for policy, response, and mitigation.

The Drought Council is chaired and facilitated by the Oregon Office of Emergency Management. Members of the Council include state and federal agencies, and private organizations involved in drought forecasting, assessment, response, or recovery. The goal of the Drought Council is to "strive to reduce the effects of an impending drought through a coordinated federal, state, local, and voluntary effort, consisting of the development of drought plans, policies, and procedures, and through coordinated state response." (Oregon Office of Emergency Management, 2014 rev.)

Specific tasks of the Drought Council include:

- Monitoring meteorological and hydrological conditions to determine the current and future severity of a drought;
- Estimating the severity of a drought and its impact on electric power consumption and generation, agricultural production, essential human needs, industrial output, fish and wildlife, state forests, and other areas as appropriate;
- Developing an inventory of physical, economic, or other resources available for responding to anticipated drought impacts;
- Determining potential conflicts between water users and electric power users, and initiating actions to minimize these conflicts;
- Coordinating drought response and recovery efforts;
- Acting as a clearinghouse for questions and requests for state and federal drought declarations;
- Assisting the Governor and the Oregon Office of Emergency Management in determining the need for various federal disaster declarations and other federal assistance;
- Reporting to the Governor's Natural Resource Advisor;

- Facilitating and coordinating development of water and power conservation plans; and
- Facilitating and coordinating public information processes that encourage voluntary conservation measures.

Energy Facility Siting Council

The Energy Facility Siting Council reviews proposed energy facilities for seismic vulnerability through its structural standard, Oregon Administrative Rule (OAR) 345-022-0020. This standard is a safety standard rather than a reliability standard. It ensures that structural failure at an energy facility will not endanger workers or the public. It does not require that energy facilities be proven to remain operable in a seismic event because the Council assumes that key safety facilities such as hospitals will have backup electricity.

The standard requires that:

- The applicant, through appropriate site-specific study, has adequately characterized the site as to appropriate seismic design category and expected ground motion and ground failure, taking into account amplification during the maximum credible and maximum probable seismic events;
- The applicant can design, engineer, and construct the facility to avoid dangers to human safety presented by seismic hazards affecting the site that are expected to result from all maximum probable seismic events (as used in the rule, "seismic hazard" includes ground shaking, landslide, liquefaction, lateral spreading, tsunami inundation, fault displacement, and subsidence);
- The applicant, through appropriate site-specific study, has adequately characterized the potential geological and soils hazards of the site and its vicinity that could, in the absence of a seismic event, adversely affect, or be aggravated by, the construction and operation of the proposed facility; and
- The applicant can design, engineer and construct the facility to avoid dangers to human safety presented by the hazards identified.

The Council reviews proposed energy facilities such as power plants, major electric transmission lines, major gas pipelines (greater than 16 inch diameter) for compliance with this standard. They do so in consultation with Oregon Department of Geology and Mineral Industries under an interagency agreement.

In response to an electricity shortage, the 2001 Oregon Legislature created an expedited review process for certain qualifying power plants. These power plants are generally not required to meet the structural standard; however, the Oregon Office of Energy, in consultation with Oregon Department of Geology and Mineral Industries, can still impose conditions on these plants related to the structural standard.

Hazard Mitigation Grant Review Board

The Hazard Mitigation Grant Review Board is an intergovernmental body which when convened reviews, discusses, ranks, and recommends project selections for funding under Section 404 of the Stafford Act (also known as the Hazard Mitigation Grant Program — HMGP).

With requirements for FEMA-compliant (201.6) local mitigation plans to be eligible for Section 404 grants, the need to convene the Hazard Mitigation Grant Review Board has been largely replaced by project actions and priorities identified in those local mitigation plans. In order to expedite the Section 404 grant offering early in the post-disaster recovery process, HMGP project funding is first prioritized to the disaster-declared counties (and all eligible applicant entities therein) on a pro rata share basis of their Public Assistance and Individual Assistance eligible costs as initially determined during the Preliminary Damage Assessment. The pro rata applicant share can be further refined at either the 12-month or 18-month HMGP lock-in. HMGP planning grant funding is available statewide from the onset of the program's availability.

During the PA and HMGP Applicant Briefing, the state promulgates broad priorities and project categories for Section 404 project pre-applications that tend to focus on the nature of the disaster and related mitigation opportunities. Representatives from the Hazard Mitigation Grant Review Board and the State IHMT are encouraged to provide their input into establishing the broad priorities and project categories for Section 404 project pre-applications early in the process. The Hazard Mitigation Grant Review Board plays a key role in selecting state 5% initiative projects as there are often many more "5%" projects than available funding.

Board membership includes:

- Director of the Oregon Office of Emergency Management or designee (most usually the Section Director, Mitigation and Recovery Services who is also the State Coordinating Officer for major disaster declarations), who chairs the Board;
- State NFIP Coordinator of the Department of Land Conservation and Development (DLCD) or designee;
- President of the Oregon Emergency Management Association (OEMA) or designee;
- A representative of the Association of Oregon Counties (AOC) and/or the League of Oregon Cities (LOC); and
- For flood disasters and related projects, Chief of the Emergency Management Branch, Portland District, U.S. Army Corps of Engineers (USACE) or designee.

The State Hazard Mitigation Officer (SHMO) of the Oregon Office of Emergency Management provides staff and technical assistance and presents hazard mitigation projects to the Board, but is not a voting member.

Oregon Board of Geologist Examiners

In 1990 the Oregon Board of Geologist Examiners adopted guidelines to assist professionals in preparing engineering geologic reports in the state. Then in 1996, the Board adopted additional guidelines for site-specific seismic hazard reports for essential and hazardous facilities, major structures, and special occupancy structures as provided in ORS 455.447. A complete listing of all report elements is included in Section 1802.6.1 of the *Oregon Structural Specialty Code.* In 2001, the Board established a Memorandum of Understanding with the Engineering & Land Surveying Examiners Board to clarify the roles of Certified Engineering Geologists and Geotechnical Engineers.

Oregon Emergency Management Association

Oregon Emergency Management Association (OEMA) is the association for Oregon's emergency management professionals. OEMA provides over 200 public, private, and non-profit members with the following:

- A network for training, education, and preparedness information and professional development;
- A forum for the sharing of knowledge, ideas, processes and building partnerships; and
- A collective and unified voice for emergency management issues in Oregon.

OEMA promotes the efforts of Oregon's communities to plan for all natural and human caused hazards through improved mitigation, preparedness, response, and recovery capabilities.

Oregon Lidar Consortium

Formed by the Department of Geology and Mineral Industries, the Oregon Lidar Consortium (OLC) develops cooperative agreements for the collection of high-quality lidar that benefits the public at large, the business community, and agencies at all levels of government. The goal of the OLC is to provide high-quality lidar coverage for the entire state. The collection of lidar data can assist governments in better identifying hazardous areas.

Oregon Seismic Safety Policy Advisory Committee

OSSPAC is a state advisory commission created in February 1990 through an executive order from Governor Neil Goldschmidt and established in statute by the 1991 Oregon Legislature (ORS 401.337).

It is made up of 18 members with interests in earthquake safety: Building Codes Division, Oregon Office of Emergency Management, Department of Geology and Mineral Industries, Department of Land Conservation and Development, Oregon Department of Transportation, two representatives from the Oregon Legislature, one local government representative, one member from education, three from the general public and six members from affected industries, such as homebuilders and banking industries.

The purpose of the work of OSSPAC is to reduce exposure to Oregon's earthquake hazards by:

- Developing and influencing policy at the federal, state, and local government levels;
- Facilitating improved public understanding and encouraging identification of earthquake risk; and
- Supporting research and special studies, appropriate mitigation, response, and recovery.

The Commission has proposed concepts to the Oregon Legislature on improving seismic safety in Oregon. They have prepared a document entitled *Oregon at Risk,* which outlines seismic hazards in the state. In 2004 the Commission provided a venue to the General Obligation (GO) Bond Task Force to develop policy recommendations for implementation of SB 14 & 15 (2001). These bills and general obligation bonds for funding of the grant program would improve the earthquake safety of public schools and emergency response facilities across the state.

Oregon Sea Grant Extension

The Oregon State University Extension Service conveys research-based knowledge to a variety of businesses owners, growers, foresters, youth and community leaders in an effort to improve their lives, their homes, their businesses and their communities. The Oregon Sea Grant program provides education regarding watershed health and creating hazard resilient coastal communities with particular attention placed to earthquake and tsunami hazards.

Pacific Northwest Seismograph Network

The Pacific Northwest Seismograph Network operates seismograph stations and locates earthquakes in Oregon and Washington. They are funded by the U.S. Geologic Survey, the Department of Energy, and the State of Washington. The PNSN website provides information on Pacific Northwest earthquake activity and hazards.

Pacific Northwest Wildfire Coordinating Group

The Pacific Northwest Wildfire Coordinating Group provides leadership in interface and wildland fire management for local, tribal, state, and federal agencies. The PNWCG is comprised of USDA-Forest Service, USDOI-Bureau of Land Management, Bureau of Indian Affairs, National Park Service, Fish and Wildlife Service, Oregon Department of Forestry, Washington Department of Natural Resources, Washington Association of Fire Chiefs, Oregon Fire Chiefs Association, the Oregon State Fire Marshal, and the Washington State Fire Marshal.

State Pre-Disaster Hazard Mitigation Programs

Conservation Reserve Program (CRP)

CRP retires eligible cropland from agricultural production and plants the land to permanent grass cover that reduces erosion and benefits wildlife populations. CRP does a very good job of providing cover that reduces windblown dust and has been effective in reducing soil erosion in the areas most prone to wind erosion. However, silt soils easily stay suspended for long periods of time and can move great distances affecting visibility on roads away from the protected fields. The strategy to encourage a strip of CRP along the freeway has been determined to probably be ineffective at reducing dust storm intensity. Also, the fire hazard could be worse than the dust hazard. In Umatilla County, NRCS has designated an area near I-84 as a wind erosion priority area to influence enrollment into the Conservation Reserve Program.

Community Rating System Users Groups

The NFIP's Community Rating System (CRS) is a voluntary program that rewards communities for engaging in floodplain management activities that exceed the minimum NFIP requirements by discounting flood insurance premium rates to reflect the reduced flood risk resulting from those activities. Other benefits resulting from community participation in the CRS program include:

- Reducing flood damage to insurable property,
- Strengthening and supporting the insurance aspects of the NFIP, and
- Encouraging a comprehensive approach to floodplain management.

Relatively few of Oregon's communities participate in the CRS Program. In 2014, DLCD convened two new CRS Users Groups (northern and southern) to encourage greater participation. The two groups are open to communities already participating in the CRS program and to any other community interested in floodplain management best practices. DLCD is the coordinating body.

The State, FEMA, and FEMA's Insurance Support Organization provide technical support. Through CRS Users' Groups, participating CRS communities can obtain assistance in increasing their CRS classifications and new communities can find peer-to-peer support as they join the CRS program.

Each CRS Users' Group meets a minimum of three times per year in person or virtually. DLCD established and administers an online forum for both groups to use between meetings as a way to share documents, discuss ideas, and post projects.

Oregon Coastal Management Program

The Oregon Coastal Management Program (OCMP) is the combined effort of 32 cities, seven counties, and a host of state agencies to carry out the statewide lad use program on the Oregon Coast. OCMP's mission is to work in partnership with coastal local governments, state and federal agencies, and other stakeholders to ensure that Oregon's coastal and ocean resources are managed, conserved, and developed consistent with statewide planning goals.

To accomplish this mission OCMP provides substantial financial and technical assistance to coastal local governments for planning, capacity building, and special projects. OCMP also coordinates and integrates programs of local, state, and federal agencies to support local planning and to protect and restore coastal natural resources, and reviews state and federal permits to ensure compliance with local, state, and federal program requirements. OCMP also uses the Internet to provide coastal data and information to a wide public through the Oregon Coastal Atlas.

DOGAMI Partnership with U.S. Geological Survey National Landslide Hazard Program

DOGAMI has entered into a collaborative partnership with the U.S. Geological Survey National Landslide Hazard Program, centered on three targeted goals for Western Oregon: (a) develop inventory maps and digital databases of existing deep-seated landslides, (b) develop predictive hazard maps of areas prone to rapidly moving landslides, and (c) develop susceptibility maps of deep-seated landslides for targeted developable areas. The second of these incorporates the mandates of Oregon Revised Statutes 195.260 (2003) to produce *further review areas* of rapidly moving landslide hazard. This will be conducted in cooperation with local governments and will provide some technical assistance to local governments to facilitate the use and application of this information. A Landslide Advisory Committee consisting of local government stakeholders and state and federal agencies will aid the agency in prioritizing projects.

DOGAMI Earthquake Hazard Mitigation Program

DOGAMI's enabling statute gives the agency broad responsibility and authority for evaluating all geologic hazards statewide, including earthquake hazards. DOGAMI has published numerous maps and reports on the earthquake hazards of the state. The agency, in partnership with other state and federal agencies, has undertaken a wide-ranging 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 Tsunami Hazard Mitigation Program

The primary goal of the Oregon Tsunami Hazard Mitigation Program is to reduce loss of life and property damage from tsunamis. Additionally, the program aims to promote community preparedness through development of mitigation products and the implementation of a coastwide, volunteer driven education and outreach initiation to support the National Weather Service's *TsunamiReady*™ program. Funding granted from the National Tsunami Hazards Mitigation Program is being used to complete the next generation of tsunami inundation maps along Oregon's 43 *TsunamiReady*™ communities.

ODF National Fire Plan Implementation in Oregon

Under the National Fire Plan (NFP), funding opportunities for local wildland-urban interface (WUI) planning, prevention and mitigation projects first became available in 2000. Since that time, Oregon has aggressively sought funding for a wide variety of projects, including fuels reduction work, education and prevention projects, community planning, and alternative uses of fuels. The majority of these monies have been used to fund fuels reduction projects on individual properties and to establish community fuel breaks in the most wildfire prone portions of the state. NFP funds have also been used to expand fire prevention efforts, to educate local officials about how they may help address the WUI situation, to implement Senate Bill 360, to improve public awareness about the wildfire problem, and to better identify areas especially exposed to wildland fire.

ODFW Habitat Resources Program — Riparian Lands Tax Incentive

The Riparian Tax Incentive Program, authorized by ORS 308A.350 through 308A.383, offers a property tax incentive to property owners for improving or maintaining qualifying riparian lands. Under this program, property owners receive complete property tax exemption for their riparian property. This can include land up to 100 feet from a stream.

When the Riparian Tax Incentive law was passed in 1981, the Oregon Legislative Assembly declared that "it is in the best interest of the state to maintain, preserve, conserve, and rehabilitate riparian lands to assure the protection of the soil, water, fish, and wildlife resources of the state for the economic and social well-being of the state and its citizens." Healthy riparian zones are important to the resource by providing cooler water due to shading resulting in better habitat for salmon, trout, and steelhead; more and better varieties of habitat for wildlife; increased water during summer low flow periods; erosion control by stabilizing stream banks with protective vegetation; and flood control.

ODFW Fisheries Restoration and Enhancement Program

The Fisheries Restoration and Enhancement Program is a comprehensive program to restore state-owned hatcheries, enhance natural fish production, expand hatchery production, and provide additional public access to fishing waters. The R&E Program provides increased sport fishing opportunities, and also supports and improves the commercial salmon fishery.

The program was authorized by the Oregon Fisheries and Enhancement Act of 1989 and was renewed in 2009. The program focuses on projects that increase fish production (either hatchery or natural production), increase recreational or commercial opportunities or access to the fish resources, or improve fish management capabilities. Restoration projects that facilitate fish passage may also provide flood-control benefits.

OEM Pre-Disaster Mitigation Planning and Project Activities

State pre-disaster mitigation planning and project activities are an integral component of OEM's mission. OEM's Mitigation and Recovery Services Section provides oversight and administration of financial services and related funding that is sub-granted to local governments. Specifically, the Section Director, SHMO, Alternate SHMO, Facilities Engineer (Public Assistance Officer), Seismic Grants Coordinator, and financial support staff work together closely on pre-disaster mitigation grant programs and project activities. Although OEM has limited staff support available for mitigation planning and project implementation activities, the state is able to effectively secure and manage FEMA's PDM and FMA grants.

The success of mitigation planning activities statewide combines Oregon's past history of land use planning and goals with the integration of resources from FEMA's mitigation grants leveraged through the Oregon Partnership for Disaster Resilience. The concept of aggregating regional, jurisdictional mitigation planning needs that leverage and target financial and technical resources to geographic areas around the state has proven to be successful in securing funding and completing local mitigation plans.

OPDR Pre-Disaster Mitigation Planning Program

Despite the growing recognition of the need for long-term coordination to reduce risk from natural disasters, many communities in Oregon continue to experience difficulty in developing and implementing natural hazard risk reduction plans, policies and activities. Communities regularly suffer from a lack of technical and funding assistance, as well as insufficient coordination among public, private, and non-profit sectors at the local, regional, and statewide levels. OPDR works to address these challenges and offers a model of how increased communication, coordination, and collaboration between diverse partners can assist communities in reducing their risk from natural hazards. The Pre-Disaster Mitigation (PDM) program is completely funded by nationally competitive federal grants with in-kind match coming from local communities and the University of Oregon. Mitigation planning occurs in partnership with the Oregon Office of Emergency Management, the Department of Land Conservation and Development, Department of Geology and Mineral Industries, FEMA Region X, and local governments throughout Oregon.

OPDR Disaster Resilient University Initiative

The Oregon Disaster Resilient University (Oregon-DRU) is a new initiative between University of Oregon Emergency Management, Oregon Partnership for Disaster Resilience and Oregon's post-secondary institutions. The concept is to build a collaborative service center model between campuses in Oregon to link the skills, expertise, resources, and innovation of post-secondary education, federal agencies, professional and trade organizations, and state agencies to reduce risk on Oregon campuses. The Oregon-DRU has five specific service areas geared to enhance and support emergency management and risk reduction efforts within post-secondary institutions in Oregon.

ODF Community Wildfire Protection Plans

A Community Wildfire Protection Plan (CWPP) is developed by a community in an area at-risk from wildfire. CWPs have three primary requirements: (a) they must be developed collaboratively between local and state government representatives in consultation with federal agencies and other interested parties, (b) they must identify and prioritize areas for hazardous fuels reduction treatments while also recommending methods for treatments that will protect at-risk communities and essential infrastructure, and (c) they must recommend measures that homeowners and communities can take to reduce ignitability of structure throughout the plan area. The statutory definition of a CWPP appears in Title I of the Healthy Forest Restoration Act of 2003. Oregon has 35 County CWPPs and 26 additional community CWPPs.

Oregon Plan for Salmon and Watersheds — Covered in Policies

"The Oregon Plan" is the state's program to restore native salmon and trout populations and to improve water quality. The overall goal of the Oregon Plan is to restore fish populations to productive and sustainable levels that will provide substantial environmental, cultural, and economic benefits.

Statewide Land Use Planning Program

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of that program is a set of 19 statewide planning goals. The goals express the State's policies on land use and related topics, such as citizen involvement, housing, and natural resources. Oregon Statewide Planning Goal 7- *Areas Subject to Natural Hazards* was developed to protect people and property from natural hazards in Oregon. Goal 7 provides guidelines for local government planning officials to follow that can reduce their vulnerability to natural hazards. These guidelines include what factors local governments can consider in adopting policies and measures to protect people and property from natural hazards, and several ways in which local governments can implement mitigation measures more effectively.

NFIP, Map Mod, Risk MAP, and Cooperating Technical Partners

NFIP: The Oregon Department of Land Conservation and Development serves as the state NFIP coordinating agency, partnering with BCD, DOGAMI, and OEM. These agencies are responsible for existing flood mitigation strategies and programs. In addition to state programs, the NFIP is designed to help minimize flood losses through local floodplain management. The NFIP relies on flood hazard mapping, flood insurance, and floodplain development standards implemented at the local level to reduce flood losses. In Oregon, 259 cities and counties and two tribal nations participate in the NFIP (total of 259 "NFIP" communities) and thus play a key role in flood mitigation.

Map Mod: Map Modernization is responding to National Flood Insurance requirements and feedback provided by Federal, State, and Local Program stakeholders. Flood hazard conditions are dynamic, and many NFIP maps may not reflect recent development or natural changes in the environment. Map modernization is the cornerstone for helping community officials and citizens be better prepared for flood related disasters. In 2014, the Map Mod is almost complete with two communities' maps under appeal. The Map Mod program has progressed into the Risk MAP program.

Risk MAP: Risk Mapping, Assessment, and Planning (Risk MAP) is the Federal Emergency Management Agency (FEMA) Program that provides communities with flood information and tools they can use to enhance their mitigation plans and take action to better protect their citizens. Through more precise flood mapping products, risk assessment tools, and planning and outreach support, Risk MAP strengthens local ability to assess risks and identify actions to reduce vulnerability to those risks, enabling communities to enhance their mitigation plans and actions. In 2014 more than a dozen Risk MAP projects were active in Oregon.

Cooperating Technical Partners: The Map Modernization Management Support (MMMS) partnership mechanism provides the opportunity to pool resources and extend the productivity of limited public funds. MMMS partners include State or regional agencies and federally recognized tribes that serve communities participating in the National Flood Insurance Program (NFIP). MMMS partner activities include, but are not limited to, assessing mapping needs, reviewing hydrologic and hydraulic studies prepared for flood map revisions, and providing an inventory of base maps.

FEMA partners with State and regional organizations in the management of Risk MAP activities for the following reasons:

- Management participation will help ensure that the products resulting from Risk MAP do not conflict and are complementary, not duplicative;
- MMMS provides a means to interject a tailored, local focus into a national program. Where unique conditions may exist, special approaches to communication, coordination, and compliance that may be necessary can be taken; and
- The MMMS partnership mechanism provides the opportunity to combine resources and extend the productivity of limited public funds.

Oregon Coastal Management Program

Oregon's Coastal Management Program (OCMP) is the combined effort of 32 cities, seven counties, and a host of state agencies to carry out the statewide land use program on the Oregon coast. All statewide planning goals apply to the coast, but the OCMP emphasizes four coastal-related goals: Goal 16, Estuarine Resources; Goal 17, Coastal Shorelands; Goal 18, Beaches and Dunes; and Goal 19, Ocean Resources. The Department of Land Conservation and Development is the state's Coastal Management Agency and provides overall program administration and coordination. The OCMP assists coastal planners to identify and plan for costal hazards to prevent property damage and avoid loss of life. The OCMP also works with the Oregon Department of Geology and Mineral Industries and Oregon Sea Grant to identify and communicate natural hazards such as shoreline erosion and tsunami inundation.

Oregon Emergency Response System

Oregon's Emergency Response System coordinates and manages state resources in response to natural and technological emergencies and civil unrest involving multijurisdictional cooperation between all levels of government and the private sector. Established in 1972, OERS was the first state plan of its kind, it serves as the primary point of contact by which any public agency reports the state with notice of an emergency or disaster or from which they can request access to state or federal resources.

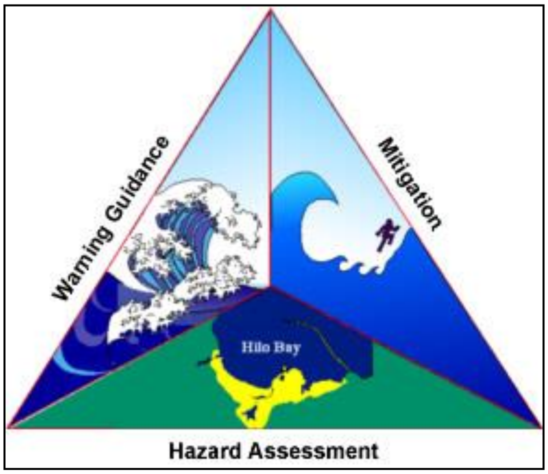
Oregon's Wetlands Protection Program

Oregon's Wetlands Program was created in 1989 to integrate federal and state rules concerning wetlands protection with the Oregon Land Use Planning Program. The Wetlands Program has a mandate to work closely with local governments and the Division of State Lands (DSL) to improve land use planning approaches to wetlands conservation. A Local Wetlands Inventory (LWI) is one component of that program. DSL also develops technical manuals, conducts wetlands workshops for planners, provides grant funds for wetlands planning, and works directly with local governments on wetlands planning tasks.

National Tsunami Hazard Mitigation Program

The National Tsunami Hazard Mitigation Program (NTHMP) is a state and federal partnership. The program's Coordinating Committee includes emergency management and geoscience representatives from the original five Pacific states (Alaska, California, Hawaii, Oregon, and Washington), emergency management representatives from the Atlantic and Gulf Coast states, the United States Geological Survey (USGS), the Federal Emergency Management Agency (FEMA), National Oceanographic and Atmospheric Administration (NOAA), and the National Science Foundation (NSF). Funds to administer the program are provided by NOAA and have been available every fiscal year since federal FY 1997.

Figure 3-2. Tsunami Hazard Mitigation Program



The 2006 *Tsunami Warning and Education Act* (PL 109-424) called for a Forecasting and Warning Program, a Tsunami Hazard Mitigation Program, and a Tsunami Research Program. These programs include the upgrade of seismic networks and installation of open ocean tsunami detection equipment designed to reduce the number of false alarms; development of tsunami inundation models and maps; and education, preparedness, and mitigation work, including an implementation plan to insure that the goals of the program were met.

Water Resources Department Dam Safety Program

The Water Resources Department Dam Safety Program reviews design plans, reports and specifications and approves for construction, modification or enlargement all hydraulic structures greater than or equal to 10 feet height and 3,000,000 gallons reservoir capacity (ORS 540.350). Design approval for High Hazard hydraulic structures typically includes a satisfactory review of Emergency Action Plans and inundation maps.

The Dam Safety Program maintains for the National Inventory of Dams, a database of all Oregon dams and reservoirs that exceed statutory size criteria regardless of ownership. The program also performs regular inspections of all existing non-federal dams statewide. The OWRD dam safety program participates cooperatively with existing established federal dam safety programs such as U.S. Army Corps Engineers, U.S. Bureau Reclamation, Federal Energy Regulatory Commission and others in their design review and inspection of federal project dams, reservoirs, and appurtenant works.

OWRD is the designated state agency and the Hydroelectric Licensing Program is the lead for review and license permitting for new and existing hydroelectric projects. OWRD's licensing program collects data and requests from other state agencies, negotiates settlements, and assembles the state's criteria for power development and operation. When the process is completed, the conditions and requirements are incorporated into and apply concurrently with issuance of the federal license for all regulated hydroelectric projects statewide (ORS 543, ORS 543A).

Wildfire Awareness Week

Since 2001, when Governor John Kitzhaber proclaimed Oregon's first Wildfire Awareness Week, this interagency effort has grown with each passing year. That year, a coalition led by the Office of State Fire Marshal, and including the Department of Forestry, structural fire agencies, insurance industry representatives, and others developed and distributed a campaign tool kit with model proclamations and recorded public service announcements designed for distribution to media outlets. In 2008, the Keep Oregon Green Association became the caretaker of the annual campaign.

OEM Statewide Earthquake and Tsunami Drills

Earthquake and tsunami drills are conducted annually by OEM. On January 25, 2011 the first annual Great Oregon Shake Out occurred throughout Oregon with over 39,000 participants. In partnership with DOGAMI, OEM also conducts voluntary tsunami evacuation drills. The community-wide drills incorporate aircraft public address systems in addition to the tsunami warning issued by the National Weather Service in areas where sirens have limited coverage.

ODOT Winter Maintenance Practices

ODOT's winter maintenance practices include plowing, sanding, and applying anti-icing liquids in order to increase efficiency of snow removal and to reduce motor vehicle crashes. To increase motorist safety in collaboration with local media, ODOT Region 5 publishes a special multi-page flyer known as the Winter Roadway Guide as an annual newspaper insert. Additionally, ODOT publishes winter driving tips and information on its website geared to motorists and bicyclists.

Public Health Mitigation Planning

The Oregon Public Health Emergency Preparedness Program is an effort to anticipate, detect, assess, and understand health risks associated with an emergency. The mitigation aspect focuses on long-term measures for reducing or eliminating risk including technological and policy changes. The department promotes guidance from the National Health Security Strategy, Interim Implementation Guides, and Community Mitigation Strategies.

Oregon Seismic Safety Policy Advisory Commission

The Oregon Seismic Safety Policy Advisory Commission has the unique task of promoting earthquake awareness and preparedness through education, research, and legislation. The mission of OSSPAC positively influence decisions and policies regarding pre-disaster mitigation of earthquake and tsunami hazards, increase public understanding of hazard, risk, exposure, and vulnerability through education seminars, etc., and be responsive to the new studies and or issues raised around earthquakes and tsunamis.

As a result of the Loma Prieta Earthquake in the Bay Area of California in 1989, Oregon residents wanted the State to address the earthquake hazard and preparedness. As a result, the Interagency Seismic Task Force recommended that a new state commission be formed in response to this need. OSSPAC was formed as a result of Senate Bill 96 in 1991. Since this time, OSSPAC has continued to increase Oregon's awareness to earthquake hazards by supporting earthquake education, research, and legislation. Every 2 years, OSSPAC provides a summary report to the Governor of the Commission's activities. OSSPAC has also formed relationships with the Western States Seismic Policy Council (WSSPC) and the California Seismic Safety Commission which provides a persuasive advantage to affect federal policy for the West Coast.

National Programs & Organizations

American Planning Association (APA)

The APA's Hazards Planning Research Center brings together solutions from multiple disciplines into a single source. The center provides original and applied research to identify best practices that that protect communities from natural and man-made hazards. APAs efforts are accomplished through research, outreach, education, policy and resource guides and other publications. The APA is currently in the midst of an update of its 1998 PAS report, *Planning for Post-Disaster Recovery and Reconstruction* (No. 483/484). Updates on the project status and other news are provided on the websites blog, *Recovery News*.

Firewise

Firewise is a program developed within the National Wildland-Urban Interface Fire Protection Program, and it is the primary federal program addressing interface fire. It is administered through the National Wildfire Coordinating Group whose extensive list of participants includes a wide range of federal agencies. The program is intended to empower planners and decision makers at the local level. Through conferences and information dissemination, Firewise increases support for interface wildfire mitigation by educating professionals and the general public about hazard evaluation and policy implementation techniques. Firewise offers online wildfire protection information and checklists, as well as listings of other publications, videos, and conferences.

FireFree Program — Bend, Oregon

FireFree is a unique private/public program for interface wildfire mitigation involving partnerships between an insurance company and local government agencies. It is an example of an effective non-regulatory approach to hazard mitigation. Originating in Bend, the program was developed in response to the city's "Skeleton Fire" of 1996, which burned over 17,000 acres and damaged or destroyed 30 homes and structures. Bend sought to create a new kind of public education initiative that emphasized local involvement. Safeco Insurance Corporation was a willing collaborator in this effort. Bend's pilot program included:

- A short video production featuring local citizens as actors, made available at local video stores, libraries, and fire stations
- Two city-wide yard debris removal events
- A 30-minute program on a model FireFree home, aired on a local cable television station
- Distribution of brochures, featuring a property owner's evaluation checklist and a listing of fire-resistant indigenous plants

The program continues to provide educational materials on fire risk reduction strategies and fire resistant plants.

National Flood Insurance Program (NFIP)

The function of the NFIP is to provide flood insurance to homes and businesses located in floodplains at a reasonable cost, and to encourage the location of new development away from the floodplain. The program is based upon mapping areas of flood risk, and requiring local implementation to reduce that risk, primarily through restrictions on new development in floodplains. Elevation Certificates are forms published by FEMA required to be maintained by communities participating in the NFIP. New development is required to be elevated or otherwise designed to protect against flooding. The NFIP requires local governments to obtain certificates for all new construction in floodplains and to keep the certificates on file. Local governments must insure that elevation certificates are filled out correctly for structures built in floodplains.

V-Zone Construction

In many of Oregon's coastal communities, FEMA has mapped "V zones" (velocity zones), areas of special flood hazard that are subject to high velocity wave action from storm surges or seismic events. Because of the potential force associated with this wave action, special regulations apply for new construction and substantial improvements in "V zones."

Community Rating System (CRS)

Community Rating System (CRS) is a program operated by the NFIP that recognizes communities who go beyond the minimum requirements of the NFIP. CRS offers reduced flood insurance premiums for communities who adopt higher standards and encourages community activities that reduce flood losses, facilitate accurate insurance rating, and promote flood insurance awareness.

FEMA Region 10 Policy on Fish Enhancement Structures in the Floodway

Local communities regulate development in the floodway. The regulations require that a community prohibit encroachments (including fill, new construction, and other development) within the floodway unless it is demonstrated by engineering analysis that the proposed encroachment will not result in any increase in flood levels during the occurrence of a 100-year flood event. The recent designation of several northwest salmon and steelhead runs as threatened or endangered has resulted in an increased effort to restore fish habitat. Restoring habitat often involves placing structures in stream.

Army Corps of Engineers Permit Program

The U.S. Army Corps of Engineers is responsible for the protection and development of the nation's water resources, including navigation, flood control, energy production through hydropower management, water supply storage, and recreation. The Corps administers a permit program to ensure that the nation's waters are used in the public interest, and requires any person, firm, or agency planning work in the waters of the United States to first obtain a permit from the Corps. Permits are required even when land next to or under the water is privately owned. It is a violation of federal law to begin work before a permit is obtained and penalties of fines and/or imprisonment may apply. Examples of activities in waters that may require a permit include: construction of a pier, placement of intake and outfall pipes, dredging, excavation, and depositing of fill. Permits are generally issued only if the activity is found to be in the public interest. In Oregon, the Division of State Lands (DSL) and the U.S. Army Corps of Engineers jointly issue permits for development of these activities. As mentioned in the discussion of DSL permits, local planning agencies are required to sign off on any permits issued by DSL and the U.S. Army Corps of Engineers and water quality certification is required by the Department of Environmental Quality.

Pre-Disaster Hazard Mitigation Projects

Tsunami Evacuation Signs

The Oregon Department of Transportation (ODOT) collaborated with DOGAMI, OEM, and coastal counties to develop signs denoting tsunami hazard zones, evacuation routes, and evacuation sites. ODOT manufactures the signs and makes them available to local governments at cost. The signs also have been used in California, Washington, Alaska, the Philippines, and Japan.

A project started in 2003 with OEM, DOGAMI, and coastal counties involved the development of signs that tell motorists when they are entering or leaving a tsunami hazard zone. The new signs are placed on US-101, the Pacific Coast Highway, when local communities establish the locations of their tsunami evacuation routes.

As local tsunami evacuation plans are developed, ODOT will work with communities to develop corresponding alternate route plans for U.S. 101 and other state highways.

Wind Erosion Control Practices

The Natural Resources Conservation Service (NRCS) and local soil and water conservation districts (SWCD) have long sought to reduce wind erosion of cropland. Farming practices commonly used in dryland cropping areas, such as reduced tillage and residue management, reflect this interest. However, occasionally after long periods with little or no precipitation any activities that disturb soil or reduce vegetation can lead to conditions conducive to dust storms.

Nationally, NRCS has developed quality criteria for wind erosion control practices and use a wind erosion equation model for predicting potential wind erosion under various farming systems.

Since 1985, to maintain eligibility for USDA Farm Program benefits, landowners have been required to meet minimum standards for control of erosion, both from water and wind. Participating farmers have developed and are responsible for implementing conservation plans for all farmland designated as highly erodible. Plans address practices such as residue management, tillage methods, and irrigation management.

At this time, wind erosion control is a requirement under the Federal Farm Bill for certain commodities such as wheat and corn, but depending on the rotation, may not be a requirement for other commodities such as potatoes or vegetables. USDA-NRCS is generally responsible for these programs.

Wind erosion is ranked high among concerns for funding under the Environmental Quality Incentive Program, the current USDA cost-share program available to landowners.

No-Till Cropping

SWCDs have been actively promoting, through education and incentives, direct seeding methods. Direct seeding or no-till cropping systems use technology that places seed and fertilizer into undisturbed soil and residue from the previous crop. This results in minimal soil disturbance and reduced potential for wind and water erosion.

Research funded by the Cooperative State Research, Education, and Extension Service (CSREES) research on the Columbia Plateau has demonstrated that no-till cropping can reduce predicted dust emissions by 94% during severe wind events, compared to conventional wheat-fallow. Research continues on measuring dust emissions from fields on the Columbia Plateau, a 50,000 square-mile region in Washington, Oregon, and Idaho containing one of the driest, yet most productive, rain-fed wheat regions in the world. No-till only works for some crops under certain conditions, however, and even in situations where it does work, some farmers find that they need to till the soil periodically to reduce diseases and redistribute soil moisture.

Trip Check

TripCheck is an online travel planning resource, developed by the Oregon Department of Transportation (ODOT) to provide travelers with the latest travel conditions and information via road cameras, continuous winter travel updates, year-round highway construction details, and other valuable tips. Several projects were included in providing the public with this resource, including installation of closed circuit television cameras on remote state highways, installation of Road Weather Information Systems (RWIS) on state highways. The RWIS's are used to make winter road maintenance decisions, and data is shared with the public. Installation of Wind Warning Systems on state highways to alert drivers to hazardous wind conditions at bridge crossings and along coastal highways.

Highway Advisory Radio

ODOT has coordinated the installation of Highway Advisor Radio transmitters for Highway Advisory Radio in select travel corridors. Locations include; installation of radio transmitters along I-84 in Morrow and Umatilla Counties for, and along the full length of US-101.

When an emergency occurs, the ODOT District 12 office selects the appropriate pre-recorded message on the system and transmits it via radio. At the same time, ODOT activates yellow flashing beacons. Motorists seeing the signs and flashing lights should tune to 1610 AM and comply with any messages. In the case of a dust storm, motorists are advised to slow down and exit the freeway as soon as possible. ODOT worked with OEM's Chemical Stockpile Emergency Preparedness Program office in Pendleton and local emergency management personnel on this project.

Also installed in the system is the ability to re-broadcast National Weather Service (NWS) weather information. NOAA Weather Radio is re-broadcast on a continuous basis unless there is an emergency. An emergency broadcast then overrides the NOAA Weather Radio service

ODOT Mitigation Efforts

ODOT has several implemented several hazard mitigation measures and increase motorists' safety, including:

- Installation of debris flow warning signs at designated locations on three at-risk highways: OR-38, OR-6, and I-84;
- Installation of automated flood warning systems on some state highways to monitor water levels and to notify maintenance crews and the public of potentially hazardous conditions;
- Installation of snow zone signs on state highways notifying motorists of chain and traction tire requirements ahead;
- Installation of tsunami zone signs on state highways; and
- Establishment of a 511 statewide toll-free telephone number allowing drivers to hear road and weather information by phone.

Publications/Studies

Energy Assurance Plan

As the designated State Energy Office, the Oregon Department of Energy (ODOE) is responsible for developing and maintaining the State Energy Emergency Plan under the State Energy Program. ODOE was required to review and update the State Energy Emergency Plan annually for submission to USDOE as the state energy Plan of Record.

The September 2009 Oregon Energy Emergency Response Plan was revised and renamed the Oregon State Energy Assurance Plan as a result of a grant awarded to ODOE by the USDOE's Office of Electricity Delivery and Energy Reliability (USDOE-OE) to enhance state government energy assurance resiliency. As a result, new information was added to the state's 2009 plan.

The Plan includes information on seismic vulnerabilities and earthquake impacts on the critical energy infrastructure in Oregon from a magnitude nine Cascadia Subduction Zone earthquake. Furthermore, the state is considering the integration of new energy portfolios like alternative fuels as well as smart grid technologies into Oregon's response strategies to energy emergencies to improve energy assurance resiliency.

"Resiliency" is defined as the ability of critical infrastructure to absorb, adapt to, and rapidly recover from a potentially severe and disruptive event. "Critical infrastructure" includes energy lifelines that, if disrupted, could significantly impact public health and safety, the economy, or national security. Any prolonged interruption of the supply of basic energy — whether it is petroleum products, electricity, or natural gas — could do considerable harm. As a result, improving energy assurance and resiliency in Oregon's energy infrastructure is intended to help mitigate the impacts of an energy supply interruption and help the state return to normal conditions as quickly as possible, regardless of the cause of the interruption.

Oregon's energy assurance and resiliency planning takes into account four key components: (a) understanding the energy infrastructure, Oregon's Energy Profile, and system interdependencies; (b) assessing potential risks and hazards threatening the state's critical energy infrastructure and considering short- and long-term mitigation measures to reduce risk and vulnerability; (c) developing effective plans and procedures to help minimize the impacts of an energy supply interruption and rapidly restore the energy infrastructure should an emergency occur; and (d) increasing public awareness. The Oregon State Energy Assurance Plan is designed to provide an overview of the first three components to help achieve the fourth component, which is to increase general awareness of the energy infrastructure, risks to the state energy lifelines, and the state's approach to restore fuel, power, and natural gas should an emergency occur.

The Oregon State Energy Assurance Plan is an introduction to how Oregon prepares for, responds to, and recovers from energy emergencies. The Oregon State Energy Assurance Plan complies with the National Association of State Energy Officials (NASEO) guidelines, the NASEO Energy Assurance Planning Framework, the National Response Framework, the National Infrastructure Protection Plan, and the National Incident Management System. The Oregon Energy Assurance Plan is also consistent with the Oregon Emergency Management Plan and Oregon Revised Statute (ORS) 401 to "coordinate the activities of all public and private organizations providing emergency services within this state." ODOE will review and update the Oregon State Energy Assurance Plan annually or as needed to reflect changing response trends and strategies and to incorporate

Oregon Climate Change Adaptation Framework (2010)

This document provides a framework for state agencies to identify authorities, actions, research, and resources needed to increase Oregon's capacity to address the likely effects of a changing climate.

Given the broad range of expected changes to Oregon's climate in the coming decades, the breadth of state-level responsibilities, authorities, and programs that will likely need to respond to the effects of future climate conditions, and limited time, it has only been possible to begin the development of a climate change adaptation strategy for Oregon. This report constitutes a *framework* for the continued development of strategies and plans to address future climate conditions. This Climate Change Adaptation Framework provides context, identifies risks, lays out short-term priorities, and provides momentum and direction for Oregon to prepare for future climate change. The framework has been developed in parallel with the Oregon Climate Assessment Report (OCAR) by the Oregon Climate Change Research Institute (OCCRI). The OCAR and this framework are intended to complement each other. The OCAR identifies the most likely impacts from climate change, which will help the state prioritize resources to prepare for and adapt to a changing and variable climate. OCCRI assisted in the development of this Framework.

This Framework lays out expected climate-related risks, the basic adaptive capacity to deal with those risks, short-term priority actions, and several steps that will evolve into a long-term process to improve Oregon's capacity to adapt to variable and changing climate conditions.

Oregon Climate Assessment Report (2010)

In 2007, the Oregon State Legislature charged the Oregon Climate Change Research Institute, via HB 3543, with assessing the state of climate change science including biological, physical, and social science as it relates to Oregon and the likely effects of climate change on the state. This inaugural assessment report is meant to act as a compendium of the relevant research on climate change and its impacts on the state of Oregon. This report, published December 2010, draws on a large body of work on climate change impacts in the western United States from the Climate Impacts Group at the University of Washington and the California Climate Action Team.

State Emergency Management Plan

This Natural Hazards Mitigation Plan is a document within Volume I, Preparedness and Mitigation, of the State Emergency Management Plan, administered by the Oregon Office of Emergency Management. The other volumes of the Emergency Management Plan are: Volume II, Emergency Operations Plan, and Volume III, Relief and Recovery.

Volume I: “Preparedness and Mitigation” includes the plans and guidance necessary for the state to prepare and mitigate the effects of a disaster. It includes the state disaster hazard assessment, exercise and training programs, and plans to lessen the physical effects of a disaster to citizens, the environment, and property. Volume I also includes this natural hazards mitigation plan.

Volume II: “Emergency Operations Plan,” which is also referred to as the Basic Plan, describes in broad terms the organization used by the state to respond to emergencies and disasters. The EOP is supplemented by emergency Support Function Annexes, Support Annexes, and Incident Annexes. It describes common management functions including areas common to most major emergencies or disasters such as communications, public information, and others.

Volume III: “Relief and Recovery” gives guidance, process, and rules for assisting Oregonians with recovering from the effects of a disaster. It includes procedures to be used by government, business, and citizens.

State Fire Services Mobilization Plan

The State Fire Services Mobilization Plan is an all-hazard based plan used to mobilize fire resources to any incident beyond local fire service capabilities that are necessary to protect life, property, and the environment. It assumes the prior existence of mutual aid agreements that organize district and regional firefighting forces to cope with local emergencies.

The primary purpose of mutual aid is to supplement resources of a fire agency during a time of critical need. Mutual aid is based on reciprocal, non-reimbursed contributions for services rendered and is contingent upon a responding fire chief’s approval. Mutual aid is given only when equipment and resources are available and dispatch will not jeopardize local firefighting capabilities.

Under the Emergency Conflagration Act, local firefighting forces will be mobilized when the state fire marshal believes that a fire or emergency is causing, or may cause, undue jeopardy to life or property and the Act is invoked by the governor.

For purposes of this Plan, Oregon has been divided into fire defense districts. The Emergency Conflagration Act fire suppression resources of each fire defense district include the county, city, and rural fire protection departments and districts, as well as any other resources available through mutual aid agreements.

The Mobilization Plan may be used separately from the Conflagration Act to mobilize local structural fire agencies for any emergency situation exceeding local mutual aid resources. However, reimbursement for responding resources is assured only when the governor invokes the Conflagration Act. Federal or state disaster assistance reimbursement may or may not apply to emergency services mobilizations.

The objectives of the Oregon Fire Service Mobilization Plan are:

- To provide organizational structure and operating guidelines for the expeditious mobilization and direction of Oregon fire service forces;
- To promote effective communication among agencies during the preparation for, progress of, and demobilization from a fire suppression operation or other emergency response activity;
- To effectively cooperate and coordinate the efforts of various participating agencies through the use of a common command structure and terminology;
- To ensure prompt, accurate and equitable apportionment of fiscal responsibility for fire suppression or other emergency response activity; and
- To provide an OSFM Incident Management Team for effective support to local agencies and fire defense districts during major operations.

Oregon's Communities at Risk Assessment

A statewide task force was formed in February 2004 as part of the Oregon Department of Forestry's Fire Program Review to develop a statewide assessment of *Communities at Risk*. The assessment was used to develop a statewide fuels strategy, and to help set large-scale priorities across geographic areas. A *Community at* Risk is a "geographic area within and surrounding permanent dwellings with basic infrastructure and services, under a common fire protection jurisdiction, government, or tribal trust or allotment, for which there is significant threat due to wildfire." The assessment identifies communities and assigns each a *low, moderate,* or *high* risk rating for *Risk, Hazard, Protection, Capability, Value,* and *Overall*.

The Water Quality Model Code and Guidebook is a companion to the Model Development Code and User's Guide for Small Cities. These documents were developed by the Department of Land Conservation and Development and the Department of Transportation under the Transportation and Growth Management Program (TGM). This guidebook integrates many of the "smart development" inspired code recommendations of the TGM project with recommended code language to achieve water quality objectives. The goal of this guidebook is to provide local communities, both small cities and counties, with a practical guide to protecting and enhancing water quality through improved land use regulations. The guidebook includes both model zoning code ordinances and comprehensive plan policies that are ready for implementation. It also provides references to other publications and resources which provide background information on the link between development activity and water quality.

While Goal 7 does not point specifically toward the issue of water quality, Goal 7 compliance entails measures that will help improve water quality. This goal notes that comprehensive plans "should consider as a major detriment, the carrying capacity of the air, land, and water resources… (and) should not exceed the carrying capacity of such resources." In protecting against floods and other natural disasters, local governments may jointly address issues of water quality, such as limiting development within floodways and reducing impervious surfaces that increase runoff and flooding.

DOGAMI Tsunami Evacuation Maps

The Department of Geology and Mineral Industries has statutory authority to take a lead role in the mitigation of geologic hazards statewide and assists the BCD in administering ORS 455.446

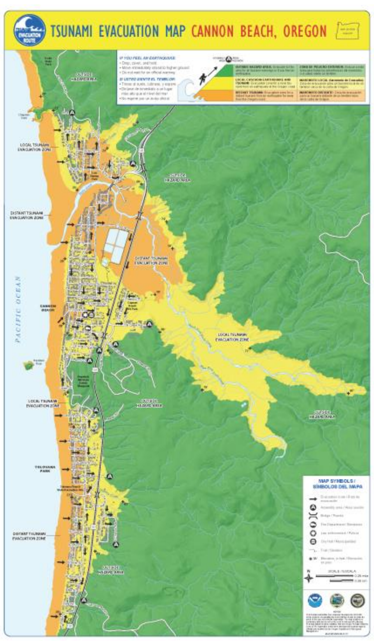
and .447. Tsunamis can potentially cause the most loss of life of any geologic hazard in the state, so mitigation and assessment of these hazards has a high priority in the agency.

DOGAMI's Newport Coastal Field Office, in collaboration with OEM and DLCD, is developing tsunami evacuation maps for every coastal population center. These maps and evacuation routes are also being compiled into an online Geographic Information System that is being developed for the coast by DLCD. Strong ground shaking at the coast should trigger evacuation of the Cascadia zone, whereas the NOAA warning system will trigger evacuation of the distant tsunami zone.

DOGAMI, in collaboration with the Oregon Health and Science University and NOAA, has developed detailed tsunami inundation maps for several areas on the coast, including Gold Beach, Coos Bay, Siletz Bay (southern Lincoln City), Alsea Bay (Waldport), Yaquina Bay (Newport), Cannon Beach, Seaside-Gearhart, and Warrenton/Astoria.

The Cascadia Subduction Zone earthquake sources developed for maps produced prior to 2008 were also used as standards for similar mapping in Washington State. These sources for the northern Oregon coast and Washington were updated in a 2008 pilot study of Cannon Beach by DOGAMI (**Figure 3-3**).

Figure 3-3. Cannon Beach Tsunami Evacuation Map, 2013



Source: DOGAMI website, http://www.oregongeology.org/tsuclearinghouse/pubs-evacbro.htm

These more detailed maps are used as guides for emergency response planning. DOGAMI plans to develop detailed inundation maps for other areas according to a priority list. Local steering groups established for each map project ensure that maps meet local needs. Local emergency officials review inundation and evacuation maps in the field to ensure that the boundaries are accurate and meet the practical necessities of local government.

DOGAMI also administers, in collaboration with local building codes officials, ORS 455.446 and ORS 455.447 that limit construction of critical/essential facilities in an official tsunami inundation zone. This regulatory zone was mapped along the entire coastline by DOGAMI in 1995. This zone is not appropriate for evacuation planning, but still gives some indication of the potential severity of tsunami flooding from a local earthquake on the Cascadia Subduction Zone.

The Public Education Team at DOGAMI develops and distributes numerous educational materials aimed at tsunami hazard mitigation. These materials can be obtained online (

DLCD Tsunami Land Use Guide

DLCD released *Preparing for a Cascadia Subduction Zone Tsunami: A Land Use Guide for Oregon Coastal Communities* (http://www.oregon.gov/lcd/ocmp/docs/publications/tsunamiguide20140108.pdf) on January 15, 2014. Its purpose is to assist vulnerable communities as they incorporate tsunami resilience measures into their local land use programs. The guide can be tailored by communities for their individual risk and location. It includes information on map amendments, sample tsunami related comprehensive plan text and policies, a model tsunami hazard overlay zone, financing and incentive concepts, evacuation route planning assistance, and web links to other helpful information. The guide is designed to be used with the Department of Geology and Mineral Industries' Tsunami Inundation Maps (TIMs).

DLCD Water Quality Model Code and Guidebook

In Oregon it is no longer possible to ignore the connection between urban development and degraded water quality. Extensive findings demonstrate that our urban streams do not meet state water quality standards, and do not adequately support native salmon populations. The best way to reverse these trends is to think differently about land use planning at the local level. Local governments are already rethinking the connection between land use and transportation as it relates to air quality. The new challenge is to amend local plans and codes to protect water quality.

Mount Hood Coordination Plan

The Mount Hood Coordination Plan provides vital Mount Hood volcanic event response information for the areas that will be most affected by a volcanic event. The purpose of the Mount Hood Coordination 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 Mount Hood volcano. The plan strives to ensure timely and accurate dissemination of warnings and public information.

Planning for Natural Hazards: Oregon Technical Resource Guide, 2000

Developed for DLCD by the Community Service Center's Oregon Natural Hazards Workgroup at the University of Oregon, the Technical Resource Guide (TRG) provides contacts, documents, and internet resources to assist planners, emergency managers, and citizens in mitigating earthquake hazards along with several other hazards.

Natural Hazards Mitigation in Oregon: An Evaluation of Natural Hazards Mitigation Planning and Implementation in Oregon

In January 2010, the Oregon Partnership for Disaster Resilience (OPDR) at the University of Oregon's Community Service Center received a grant from the Hazard Mitigation Grant Program

(HMGP) to facilitate and document the State's Enhanced Natural Hazards Mitigation Plan update process. As part of the plan update process, OPDR and the Department of Land Conservation and Development (DLCD) were tasked with conducting a survey of natural hazards mitigation planning in Oregon. This report is a summary of the findings of the natural hazards mitigation planning survey.

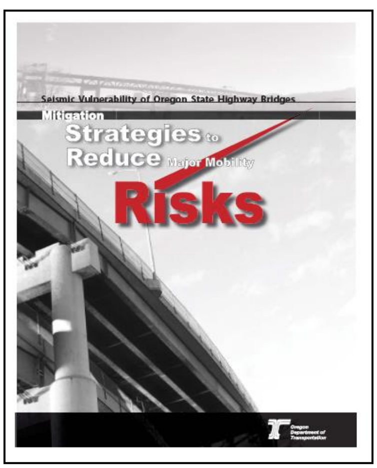
The survey assessed (a) the extent to which natural hazards mitigation strategies were being implemented at the local level and (b) the availability and applicability of technical resources designed to assist jurisdictions in planning for or mitigating the effects of natural hazards. Additionally, the survey asked for suggestions on how to make hazards planning and mitigation more effective at both the state and local levels.

Where applicable, results are compared to a similar survey that was conducted by DLCD and the University of Oregon's Community Planning Workshop (CPW) in 1998. Survey results will be used to inform content within the State's Enhanced Natural Hazards Mitigation Plan and to develop more effective long-term statewide mitigation efforts.

Seismic Vulnerability of Oregon State Highway Bridges, Mitigation Strategies to Reduce Major Mobility Risks, Oregon Department of Transportation, November 2009

This report describes potential damage to state highway bridges from six representative earthquake scenarios that are thought most likely to occur in Oregon. The study found that highway mobility would be severely reduced after a major Cascadia Subduction Zone event, as well as after a significant crustal earthquake. The report also considers possible mitigation, including bridge retrofit and strengthening to withstand seismic damage.

Figure 3-4. Seismic Vulnerability Report



Source: ODOT, 2009

Oregon Transportation Plan

A sound transportation network is what enables Oregonians to reach jobs and recreation access goods and services, and meet daily needs. Due to the extent of the existing transportation infrastructure, and the importance of sustaining that infrastructure, there are numerous ways in which Oregon's transportation system could be adversely affected by any of Oregon's natural hazards. Just as other critical infrastructure can be vulnerable to natural hazards, so too can Oregon's transportation system. The Oregon Transportation Plan addresses the risk and vulnerability to natural hazards by outlining strategies for reducing risk, such as "Evaluate the impacts of geological hazards and natural disasters including earthquakes, floods, landslides and rockfalls, on the efficiency and sustainability of the location and design of new or improved transportation facilities as appropriate."

Oregon Highway Plan

Oregon's state highways are a critical component of the state's transportation network. Oregonians rely on highways to go between the state's widespread cities, towns, parks, forests, and businesses. Oregon's industries, including agriculture, timber, tourism, and technology, all depend on highways.

The Oregon Department of Transportation owns, operates, and maintains 7,483 miles (12,040 kilometers) of roads in every corner of Oregon. The state highway system is as diverse as Oregon itself–ranging from six-lane, limited access freeways with metered ramp entrances in the Portland area to the gravel road from Prineville to Brothers. The challenge facing Oregon is to efficiently and effectively guide this diverse highway system into the next millennium. Oregon will continue to grow. Forecasts predict that the state will have 1.2 million new residents by 2020. With limited funding, intelligent investment strategies must be devised to help Oregon meet its long-term goals. Intelligent investments include planning for, and reduce vulnerability to natural hazards. The Oregon Highway Plan addresses this issue by recommending actions and policy elements that include identifying hazards, and improving the safety of potentially hazardous sites and corridors. Mitigation measures listed within the recommended actions include advance maintenance, structural reinforcement, flood proofing, emergency response planning, and development of emergency alternative routes. These risk reduction efforts can also bolster the State of Oregon's emergency response and post-disaster recovery efforts.

Drought Annex to the State Emergency Operations Plan

Droughts occur within drainage basins (watersheds) that usually involve more than one city or county. Some cities and counties benefit by planning on a regional level. The state Drought Annex provides information to facilitate regional planning efforts, model water curtailment measures for water utilities, and other strategies. It describes the state system for addressing drought emergencies, but it does not carry the force of law. Its purpose is to coordinate local, state, and federal agency response to drought emergencies and to provide water supplies for human consumption and use under conditions of inadequate supply.

Post-Disaster Hazard Mitigation Programs and Capabilities

Hazard Mitigation Grant Program

The state and local communities integrate mitigation into post-disaster recovery operations by taking advantage of Hazard Mitigation Grant Program (HMGP) dollars that become available after presidentially declared disasters.

OEM Disaster Recovery and Post-Disaster Mitigation

State post-disaster mitigation planning and project activities following disasters are an integral component of OEM's mission. OEM's Mitigation and Recovery Services Section provides oversight and administration of financial services and related funding that is passed through to local governments. Additionally, the Mitigation and Recovery Services Section manages disaster recovery activities for state and local governments in the event of a devastating emergency or disaster. Specifically, the Section Director, SHMO, Alternate SHMO, Facilities Engineer (Public Assistance Officer), Seismic Grants Coordinator, and financial support staff work together closely post-disaster mitigation grant programs and project activities. Although OEM has limited staff support available for post-disaster mitigation planning and project implementation activities, the state is able to effectively secure and manage FEMA's HMGP grants.

OEM also staffs county liaisons that are assigned specific counties to support operations both during and after disasters. By working closely with the state's Public Assistance Officer, the state is able to identify early mitigation opportunities immediately following a disaster declaration that can frequently be implemented quickly as a component of Section 406 disaster assistance.

BCD Post-Earthquake Inspection Program

BCD supports training to inspectors, architects, engineers, contractors and post-earthquake inspectors by providing funding to agencies that provide training. Various classes in seismic design and construction techniques have been sponsored by the division during the last several years Other classes covering subjects such as soils classification, excavation and grading and landslides, which are often related to earthquakes, have also been sponsored.

BCD maintains a roster of persons qualified to inspect buildings following an earthquake. As part of this program, the division adopted rules establishing qualifications and training required to be registered as a post-earthquake damage inspector.

DEQ Emergency Response Program

DEQ's Emergency Response Program is designed to carry out legislative direction to work with other agencies and industry to prevent and respond to spills of oil and hazardous materials. Oil and hazardous material spills pose a major potential threat to Oregon's waters, air, land, and wildlife. Large volumes of oil move along the Columbia River and along the coast. Hazardous materials are shipped along the highways and by rail. DEQ works with other agencies and industry to prevent and respond to spills of these materials. The program also coordinates removal of drug lab materials which would otherwise present a risk to the public.

Office of State Fire Marshal — Conflagration Act

OSFM works in a collaborative role in helping to respond to WUI fire issues. As part of its fire prevention program, OSFM provides statewide standardization and technical assistance to local fire agencies and to communities with no structural fire protection. Coordination of structural firefighting resources occurs pursuant to the *Conflagration Act.* When directed by the Governor, the Act allows the State Fire Marshal to mobilize structural firefighting personnel and equipment, when a significant number of structures or lives are threatened by fire, and the local capacity to provide structural protection has been exhausted.

The *Conflagration Act* was established as a civil defense measure to provide a mechanism to mobilize structural fire suppression resources for massive urban fires. It was first used in 1959 to coordinate aid resulting from the explosion of a dynamite filled truck in downtown Roseburg. The Act was not invoked again until 1972, when a wildland fire in Yamhill County exceeded the capacity of local structural agencies to protect isolated structures and agricultural lands. Since then, the Act has been invoked more and more frequently — and nearly always for lightning caused wildfires threatening structures in the WUI. In the decade after 1977, the average number of declared conflagrations was about one per year. In the decade after 1987 (a record year) the average number of declarations per year more than doubled. Since 1998, the average has doubled again.

Under this law, only the Governor may invoke the Act to mobilize fire suppression resources from the across the state, but only if local resources, including what is available under mutual aid agreements, has first been fully committed. The increasing frequency of *Conflagration Act* utilization has caused funding concerns and challenges because no dedicated funds are set aside for this purpose. Especially troubling is the increasing frequency and public expectation to use the Act to protect structures in communities having minimal or nonexistent structural protection. Since 2002, with onset of stronger mitigation efforts, *Community Wildfire Protection Plans* along with ODF's surge in initial attacks on wildfires threatening structures, the use of the Act has dropped significantly.

OPDR Post-Disaster Recovery Planning for Catastrophic Disasters

In collaboration with the Cascadia Region Earthquake Workgroup (CREW), the United States Geological Survey (USGS), the City of Cannon Beach, and the Oregon Office of Emergency Management, OPDR developed a pilot long-term catastrophic post-disaster recovery planning process in the City of Cannon Beach. [2006]

OPDR developed a Post-Disaster Recovery Planning Forum: How-To Guide for communities desiring a framework to identify redevelopment issues they will face after a disaster. [2007]

OPDR assisted Douglas County in obtaining over $250,000 in grant funding from the Federal Emergency Management Agency to develop long-term, catastrophic post-disaster recovery plans for Coos, Curry, Douglas, and Lane Counties. [2009–2011]

3.4.1.3 Funding Sources

Funding Overview

Oregon uses a number of local, state, and federal funding sources to support natural hazard mitigation projects and planning. In general, FEMA Hazard Mitigation Assistance (HMA) grants figure prominently in the state's funding strategy. Several of the grant programs are available "pre-disaster" while others are available only after a federally declared disaster has occurred.

State funding to support hazard mitigation and risk reduction remains limited. However, Oregon has an excellent track record of leveraging limited local resources to successfully complete mitigation planning and projects throughout the state. State funding often consists of "General Fund" money that pays for the labor costs of state officials who are working to support local and statewide hazard mitigation activities. These labor costs are often used as non-federal cost-share for projects that are otherwise federally funded. For example, all of OEM's mitigation staff are funded in part by state dollars that are used to match other federal, homeland security based funding sources. Notably, the majority of state-level staff positions dedicated to hazard mitigation planning and implementation (and a growing number of those at the local level) are funded through federal programs or grants.

Chief among the federal funding sources used to support local mitigation planning in Oregon is FEMA's Pre-Disaster Mitigation Grant Program (PDM). PDM funds generally support one or more local mitigation projects each year as well. The Flood Mitigation Assistance Program (FMA) provides federal funds for flood mitigation projects. FEMA's Risk MAP Program also provides funding for hazard studies, flood mapping products, risk assessment tools, mitigation, and planning and outreach support.

Post-disaster, the Hazard Mitigation Grant Program (HMGP), Public Assistance (PA) Program, and Small Business Association's (SBA) Physical Disaster Loan Program each support varying levels and types of mitigation planning and projects. Oregon has experienced ten presidentially declared disasters over the past 10-years. Each of these disaster declarations has opened up funds through HMGP that Oregon has used to support local and statewide hazard mitigation planning as well as numerous local mitigation projects.

In addition, cities, counties, and special districts use a variety of funding mechanisms to support local mitigation projects. Capital improvement funds, service fees, general funds, levies, and local grants are used to support mitigation projects across Oregon. For example, Lincoln County voters have approved several bond measures that specifically supported the relocation of schools outside the tsunami inundation zone. In one case, local bond funds leveraged the first FEMA supported (PDM) tsunami school buy-out in the nation. These examples reflect the creative, innovative and proactive methods communities in Oregon are using to support risk reduction.

Federal Funding Sources Pre-Disaster

Unified Hazard Mitigation Assistance (HMA)

According to the 2013 HMA Program Guidance, U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA) HMA programs present a "...critical opportunity to reduce the risk to individuals and property from natural hazards while simultaneously reducing reliance on Federal disaster funds." HMA programs include the (a) Pre-Disaster Mitigation Grant Program, (b) Flood Mitigation Assistance Program, and (c) Hazard Mitigation Grant Program. Together, they fund hazard mitigation plans and projects and span pre- and post-disaster environments. HMA programs are intended to reduce community vulnerability to disasters. Specific information about each HMA grant program is presented below.

Pre-Disaster Mitigation Grant Program

The annual Pre-disaster Mitigation Program grants funds for:

- Mitigation planning,
- Non-flood mitigation projects, and
- Flood mitigation projects.

PDM funds support several local mitigation plan updates in Oregon each year. Like FMA, PDM is administered by OEM as the applicant (grantee when funded), who works with eligible sub-applicants and then as sub-grantees to implement their funded projects. The State IHMT has a long-standing relationship with the University of Oregon's Partnership for Disaster Resilience, which has facilitated the creation and update of the majority of Oregon's local plans using PDM grants. OPDR will continue in this role into the future. PDM grants have sometimes been sub-awarded to individual cities and counties to complete their mitigation plans. Sub-awards to cities will continue to be made on a case-by-case basis. Sub-awards also have been made to DLCD for local plan updates. As the state's regulatory land-use planning agency, DLCD not only assists jurisdictions with their hazard mitigation plan maintenance, but also facilitates integration of plan action items into local comprehensive plans.

FEMA's Risk MAP program supplements these hazard mitigation plan efforts by providing funding for hazard studies, flood mapping products, risk assessment tools, mitigation, and planning and outreach support. DLCD is Oregon's Risk MAP coordinating agency. FEMA also has awarded Risk MAP funds to OPDR and the Department of Geology and Mineral Industries to complete specialized studies.

PDM can also be used to fund flood and non-flood mitigation projects. The state generally uses FMA to fund flood mitigation projects and PDM for non-flood hazard mitigation projects. However, the State may reconsider this position because of a FEMA Mitigation Policy Directive dated June 18, 2014 (FP 204-078-112-1) that allows PDM to be used for projects related to the construction, demolition, or improvement of dams, dikes, levees, floodwalls, seawalls, groins, jetties, breakwaters, and certain erosion control projects.

Flood Mitigation Assistance Program

The Flood Mitigation Assistance (FMA) Program was authorized by the National Flood Insurance Reform Act of 1994 and amended by the Biggert-Waters Flood Insurance Reform Act of 2012. Among other provisions, the amendments dissolved the Severe Repetitive Loss and Repetitive Flood Claims Programs, incorporating their provisions into other existing programs. The FMA Program provides Federal grant funds to pay for up to 100% of the cost of eligible mitigation activities, such as acquiring and demolishing, or elevating SRL structures. In some cases, moving a structure out of the floodplain to high ground (relocation) is a practicable alternative. In addition, mitigated properties may qualify for reduced flood insurance rates.

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. As of this writing FMA prioritizes mitigation projects on SRL and RL properties. Examples include:

- Acquisition or relocation of at-risk structures and conversion of the property to open space,
- Elevation of existing structures,
- Relocation of structures out of the floodplain, and
- Dry floodproofing of historic properties.

The State of Oregon prefers, where possible, to acquire and demolish, or relocate SRL structures and RL structures, especially those located in the floodway.

The Oregon Military Department's Office of Emergency Management (OEM_ is the applicant for FMA Program grants; cities and counties are eligible sub-applicants. OEM submits project sub-applications for FEMA's consideration in accordance with FEMA and State priorities for the annual grant offering. FEMA's priorities are set forth each year in the grant solicitation. The State then ranks qualifying projects accordingly to ensure a high likelihood of grant award. OEM, with assistance from DLCD, annually reaches out to communities with FEMA-identified SRL and RL properties before FEMA's formal program announcement to make them aware of the program, to train potential sub-applicants on the application and grants management process, and to collect information necessary to develop projects, including owner's willingness to participate voluntarily. Once FEMA releases a formal program announcement, OEM and DLCD follow up with specific technical assistance to help develop sub-applications for projects that are both ready to proceed and most likely to receive grant funding.

The FMA Program also offers funding for:

- Planning — to prepare flood mitigation plans (as part of a community's natural hazards mitigation plan, and
- Management Cost Funding — for the sub-grantee and grantee to help administer the FMA program and activities.

Although FMA can provide federal funds for flood hazard planning, Oregon generally does not pursue planning grants under FMA because funds can only be used to update the flood hazard chapter of a local mitigation plan and we are generally successful at developing and updating all-hazards mitigation plans through the annual Pre-Disaster Mitigation Program (PDM).

NOAA Coastal Zone Management Program

Coastal Zone Management Program works with coastal states and territories to address a wide range of issues including climate change, coastal hazards, coastal development, public access, habitat protection, water quality, ocean governance and planning, and planning for energy facilities. Key elements of the program include:

- protecting natural resources,
- Managing development in high hazard areas,
- Giving development priority to coastal-dependent uses,
- Providing public access for recreation,
- Prioritizing water-dependent uses, and
- Coordinating state and federal actions.

While the legislation includes basic requirements for state partners, it also allows the flexibility needed to design programs that best address local challenges and work within state and local laws and regulations. By using both federal and state funds, the program strengthens the capabilities of each partner to address coastal issues.

National Fire Plan

Under the National Fire Plan (NFP), funding opportunities for local wildland-urban interface (WUI) planning, prevention and mitigation projects first became available in 2000. Since that time, Oregon has aggressively sought funding for a wide variety of projects, including fuels reduction work, education and prevention projects, community planning, and alternative uses of fuels. As of early 2007 the ODF had received approximately $25 million. The majority of these monies have been used to fund fuels reduction projects on individual properties and to establish community fuel breaks in the most wildfire prone portions of the state. NFP funds have also been used to expand fire prevention efforts, to educate local officials about how they may help address the WUI situation, to implement Senate Bill 360, to improve public awareness about the wildfire problem, and to better identify areas especially exposed to wildland fire.

Federal Funding Sources Post-Disaster

Hazard Mitigation Grant Program

FEMA’s Hazard Mitigation Grant Program (HMGP) was created in November 1988 under the authority of the Stafford Act, Section 404. The HMGP assists states and local governments to implement long-term hazard mitigation measures following a Presidential major disaster declaration. Initially, the federal cost-share for projects was established at 50%; however, in 1993 that portion was increased to 75% of a project’s total eligible costs. Objectives of HMGP include:

- preventing loss of lives and property due to disasters,
- implementing state and local hazard mitigation plans,
- enabling mitigation measures to be implemented during immediate recovery from a disaster, and
- providing funding for previously identified mitigation measures that benefit the disaster area.

Effective November 2004, the state and its applicants must minimally have a FEMA-approved natural hazards mitigation plan (44 CFR Section 201) to qualify for HMGP funding. Eligible applicants for the HMGP are the same as for the Public Assistance Program (Stafford Act, Section 406):

- state and local governments (including special districts),
- certain private nonprofit organizations or institutions, and
- Native American nations and authorized organizations (in Oregon these entities have a direct relationship with FEMA and do not apply through the state).

Homeowners and businesses whose properties can benefit from hazard mitigation measures cannot apply directly for HMGP funding, but rather must be represented by an eligible applicant, such as the city or county in which their project is located.

HMGP activities are managed by the Oregon Office of Emergency Management as grantee. The state develops a program administrative plan, solicits applicant interest and project applications, establishes priorities and selection criteria, reviews, and selects projects. FEMA reviews all projects submitted by the state, conducts the required environmental reviews and benefit-cost analyses, and approves projects for funding.

The amount of HMGP funding available to the state is calculated at 15% of the federal funds spent on FEMA Public Assistance and Human Services Programs (minus administrative expenses) for each disaster. When a state has a FEMA-approved *enhanced* state hazard mitigation plan (Section 201.5), the calculated amount of HMGP funding increases to 20% of the federal funds spent on FEMA Public Assistance and Human Services Programs.

HMGP allows the state to set-aside up to 5% of the total obligation for projects that are not specifically hazard mitigation, such as warning systems. Another set-aside of 7% of the total HMGP obligation can be earmarked to state and local natural hazards mitigation planning.

Although HMGP project funding is intended for use in the disaster-declared counties, it can be, at the state’s request, used in non-declared counties for eligible hazard mitigation projects.

Public Assistance Program

The FEMA Public Assistance (PA) Program (Stafford Act, Section 406) provides disaster response and recovery assistance to communities following a Presidential Disaster Declaration. PA primarily supports debris removal, emergency protective measures, and the repair, replacement, or restoration of disaster-damaged, publicly owned facilities and the facilities of certain private non-profit (PNP) organizations. However, PA also encourages protection of these damaged facilities from future events by providing assistance for hazard mitigation measures during the recovery process. Federal assistance is provided at 75% or more of the eligible costs with the balance of funds provided by the grantee or sub-grantee.

Physical Disaster Loan Program

When Physical Disaster Loans are made to homeowners and businesses by the U.S. Small Business Administration (SBA) following disaster declarations, up to 20% of the loan amount can be used to take specific measures to protect against recurring damage in similar future disasters.

Increased Cost of Compliance (ICC)

The standard Flood Insurance Policy has a provision that will pay the policy holder to comply with a state or local floodplain management law or ordinance regulating repair or reconstruction of a structure that has suffered flood damage and meets other eligibility criteria, such as receiving a substantial damage or repetitive loss determination from a local official. Mitigation activities eligible for payment are: elevation, floodproofing, relocation, or demolition (or any combination of these activities) of the structure. The private-party premium payments are considered non-federal cost share as long as the claim is made within the timeframes allowed by the NFIP. In addition, if the ICC payment is being used as a sub-applicant's non-federal cost share, the NFIP policy holder must assign the claim to the sub-applicant (city or county). Policyholders may receive up to $30,000 under this coverage.

Federal Funding Sources Pre- and Post-Disaster

Community Assistance Program — State Support Services Element (CAP-SSSE)

The CAP-SSSE program is part of the NFIP. It provides grants to states at 75% with a 25% non-federal match to evaluate local governments' NFIP performance and provide technical assistance to help communities successfully implement the various facets of the NFIP. These funds cover the following activities and more:

- Strategic Planning,
- Ordinance Assistance,
- Community Assistance Visits,
- Outreach, Workshops and Other Training,
- General Technical Assistance,
- Mapping Coordination Assistance, and
- Assistance to Communities in Responding to Disasters.

Secure Rural Schools and Community Self-Determination Act

Title III of the Rural Schools and Community Self-Determination Act (frequently referred to simply as "Title III") funds the Firewise and Community Wildfire Protection Plan Programs by passing federal funding through the State of Oregon to its counties. Counties may also be reimbursed for search and rescue and other emergency services, including firefighting, that are performed in national forests.

State Funding Sources

General Fund

State general fund money pays for the labor costs of state officials who are working on mitigation projects for their agencies; these labor costs can be used as non-federal cost-share for projects that are otherwise federally funded. The state also occasionally contributes cash match through one of several funding mechanisms, such as portions of state agency budgets that are funded by a state source of revenue.

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. Administration of the SRGP was transferred from the Oregon Office of Emergency Management (OEM) to Business Oregon's Infrastructure Finance Authority (BusOR-IFA) on January 1, 2014. The SRGP is a competitive grant program that provides state funds on a reimbursable basis for seismic rehabilitation of critical public buildings:

- Hospital buildings with acute inpatient care facilities;
- Fire stations;
- Police stations;
- Sheriffs' offices; and
- Other facilities used by state, county, or district municipal law enforcement agencies.

In addition, eligible school buildings must (a) have a capacity of 250 or more persons; (b) be routinely used for student activities by K-12 public schools, community colleges, education service districts (ESDs), and higher education institutions; and (c) be owned by the State Board of Higher Education, a school district, an education service district, a community college district, or a community college service district.

The SRGP program is subject to the availability of funding, as well as any directive or restriction made with respect to such funds. SRGP grants are awarded on a competitive basis, and the maximum grant award is $1.5 million.

Table 3-7. SRGP Awarded Projects, 2009-2010

School District/Entity	Project	Award Amount	Project Status
Linn Benton Community College	Science Technology Building	$565,016	complete
Three Rivers School District	Applegate School	$826,018	complete
Beaverton School District	Elmonica Elementary School	$200,200	complete
Beaverton School District	Cooper Mountain Elementary School	$162,640	complete
Beaverton School District	McKay Elementary School	$320,035	complete
Beaverton School District	Oak Hills Elementary School	$120,600	complete
Western Oregon University	Todd Hall	$1,190,895	complete
Lake County School District	Lakeview High School	$589,700	complete
Lake County School District	Fremont Elementary School	$398,100	complete
Medford School District	Washington Elementary School	$271,000	complete
Medford School District	Medford Opportunity High School	$200,926	complete
David Douglas School District	Floyd Light Middle School	$1,489,766	complete
Yamhill Carlton School District	Yamhill Carlton Intermediate School	$76,500	complete
North Clackamas School District	Milwaukie Elementary School	$1,088,604	complete
2009-2010 Schools SRGP Sub-Total		***$7,500,000***	
Emergency Services	**Project**	**Amount Awarded**	**Project Status**
Tuality Healthcare	Tuality Hospital, Building A	$1,380,480	complete
City of Dallas Fire Department	Dallas Fire Station	$887,725	complete
City of Albany Fire Department	Station 12	$280,023	complete
City of Gresham Fire and Emergency Services	Stations 71 (Public Safety Building) and 72	$273,866	complete
Netarts Oceanside Fire District	Station 61	$170,000	complete
City of St. Helens Police Department	St. Helens Police Station	$20,000	complete
Klamath County Fire District No. 1	Station 6	$1,311,704	complete
City of Eugene	Danebo Fire Station Number 8	$66,739	complete
Silverton Fire District	Scotts Mills Station	$131,207	complete
Oregon Health and Science University	University Hospital South	$1,478,256	complete
City of Coos Bay	Coos Bay City Hall	$1,500,000	complete
2009-2010 Emergency Services SRGP Sub-Total		***$7,500,000***	

Source: Business Oregon, Infrastructure Finance Authority

Table 3-8. SRGP Awarded Projects, 2010-2011

	Project	Award Amount	Project Status
School District/Entity			
Greater Albany Public Schools	Central Elementary School	$1,500,000	Open
Klamath Falls City Schools	Mills Elementary School Auditorium	$1,495,212	complete
Tigard-Tualatin School District	Twality Middle School	$835,750	complete
2010-2011 Schools SRGP Sub-Total		***$3,830,962***	
Emergency Services			
Langlois RFPD	Langlois Fire Station	$249,894	complete
City of Garibaldi	Garibaldi Fire Station	$270,000	complete
City of Grants Pass	Hillcrest Public Safety Building	$477,024	complete
City of Astoria	Public Safety Building	$1,500,000	complete
Santa Clara Fire District	Station 1	$570,000	complete
City of Hood River	Hood River Fire Department	$291,225	complete
Woodburn RFPD	Station 22	$310,895	complete
2010-2011 Emergency Services SRGP Sub-Total		***$3,669,038***	

Source: Business Oregon, Infrastructure Finance Authority

Table 3-9. SRGP Awarded Projects, 2011-2012

School District/Entity	Project	Amount Awarded	Project Status
Portland Public Schools	Alameda Elementary School	$1,500,000	complete
Lake County School District	Daly Middle School	$1,186,251	complete
Rogue River School District	Rogue River Elementary School	$1,500,000	complete
Lane Community College	Building 11	$708,718	open
Myrtle Point School District	Myrtle Point High School	$1,470,939	complete
Philomath School District	Philomath Middle School	$284,920	complete
Hillsboro School District	North Plains Elementary School	$593,623	complete
Springfield Public Schools	Walterville Elementary School	$255,549	complete
2011-2012 Schools SRGP Sub-Total		***$7,500,000***	

Source: Business Oregon, Infrastructure Finance Authority

Two projects remain open. The 2013–2015 state budget includes $30 million in voter-approved bonds that fund this program. No new SRGP projects were funded in 2013. The 2014 project application window was July 1 through September 30, 2014. SRGP project funds will be made available following bond sales expected in spring of 2015.

Community Development Block Grant

Community Development Block Grants (CDBG) are made available to communities in the State of Oregon, usually via the Infrastructure Finance Authority with funding provided by the U.S. Department of Housing and Urban Development (HUD). While these grants originate with a federal agency, the funding is usually considered non-federal for matching grant purposes (i.e., CDBG can usually be used as non-federal match to other federal funding sources).

In 1981, Congress amended the Housing and Community Development Act of 1974 (HCD Act) to give each state the opportunity to administer CDBG funds for "non-entitlement" areas: local jurisdictions that do not receive CDBG funds directly from HUD through the entitlement program and are (a) cities with populations of less than 50,000 or (b) counties with populations of less than 200,000.

The primary statutory objective of the CDBG Program is to develop viable communities by revitalizing neighborhoods, expanding affordable housing and economic opportunities, and improving community facilities and services, principally for persons of low and moderate income. The state must ensure that a specified percentage of its CDBG grant funds are used for activities that benefit low- and moderate-income persons over a 3-year time period.

However, states may also use their funds to meet other urgent community development needs. A need is considered urgent if it poses a serious and immediate threat to the health or welfare of the community, has arisen in the past 18 months, and the project would serve primarily low- to moderate-income residents. For example, funds can be used as the non-federal match for eligible HMGP, PDM, and FMA Program projects.

Community Development Block Grant — Disaster Recovery

In addition to CDBG funds made available to the state on an annual basis, special HUD funding can become available to the state as a result of natural disasters. This HUD assistance supplements assistance from FEMA and other federal agencies. Traditionally, funds provided via HUD disaster recovery initiatives can be used for long-term recovery efforts, property acquisitions, relocations, and other efforts to reduce future damage. The program is intended to give communities flexibility in meeting local needs quickly. Unless restricted by regulation, these funds can also be used as non-federal, local match for eligible HMGP, PDM, and FMA Program projects.

Congressional supplemental appropriations provide HUD disaster funds. For example, in late 1998, funds were provided to address unmet disaster-related needs in communities affected by recent Presidentially declared disasters. Unmet needs were those that were not addressed by federal disaster relief and recovery programs following these declared disasters. OECDD (now Business Oregon-Infrastructure Finance Authority) was directed to administer these supplemental funds in Oregon for the Crook County and Prineville floods of May and June 1998. These particular HUD funds carried a requirement for other non-federal match.

Oregon Watershed Enhancement Board

Previously known as the Governor's Watershed Enhancement Board (GWEB), the Oregon Watershed Enhancement Board (OWEB) was created by the 1987 Oregon Legislature. OWEB is charged with supporting implementation of *The Oregon Plan for Salmon and Watersheds*, which includes the Oregon Coastal Salmon Restoration Initiative (OCSRI) and the Healthy Streams Partnership.

In 1995 the Legislature directed OWEB to provide support to watershed councils. OWEB directs a grant program through the Natural Resources Division of the Oregon Department of Agriculture by which each of the state's 45 soil and water conservation districts may apply for funds for watershed enhancement projects.

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.

Oregon Local Disaster Assistance Loan and Grant Account

Through the Local Disaster Loan and Grant Account, the Oregon Legislature makes loans to local governments, special districts, and school districts to match federal disaster relief funding for federally declared disasters. It also provides loans and grants to the same entities for paying the costs of responding to disasters whether or not they are federally declared. The Oregon Military Department may use a small percentage of the loan amount to cover the cost of administering the loan. Prior to the 2012 legislative session, this account was a source of loans only. The 2012 Oregon Legislature amended the program to make this account a source of grant funds as well. In 2012, the Account was used to provide grant funds assisting Columbia County with the Vernonia School District Acquisition Project and the City of Salem with financing a flood warning system on the Mill Creek Tributary.

Table 3-10. Potential Hazard Mitigation Funding Programs

Program Activity	Type of Assistance	Agency & Contact
Basic and Applied Research/Development		
Community Resilience to Coastal Hazards and Climate Change	Physical and social science **research** aimed at better understanding ocean and coastal processes and the socio-economic barriers to hazard and climate change preparation.	Oregon State University — Oregon Sea Grant http://seagrant.oregonstate.edu/coastal-hazards-and-climate-change
Decision, Risk, and Management Science (DRMS) Program	**Funding** for **research** and related educational activities on risk, perception, communication, and management (primarily technological hazards)	**NSF —** Directorate for Social, Behavioral and Economic Science, Division of Social Behavioral and Economic Research, Decision, Risk, and Management Science Program (DRMS). http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5423
Disaster Resilience for Rural Communities	Basic **research** in engineering and in the social, behavioral, and economic sciences on enhancing disaster resilience in rural communities.	**USDA** — National Institute of Food and Agriculture http://www.csrees.usda.gov/fo/disasterresilienceforruralcommunities.cfm
Disaster Resilient Oregon	**Coalition** of public, private, and professional organizations working collectively with graduate students and University of Oregon faculty toward the mission of creating a disaster resilient and sustainable state.	University of Oregon — Oregon Partnership for Disaster Resilience http://csc.uoregon.edu/opdr/
Hazard Mitigation and Structural Engineering (HMSE)	Supports fundamental **research** to mitigate impacts of natural and anthropogenic hazards on civil infrastructure and to advance the reliability, resiliency, and sustainability of buildings and other structures.	National Science Foundation (NSF), Directorate for Engineering, Division of Civil, Mechanical and Manufacturing Innovation. www.nsf.gov/funding/pgm_summ.jsp?pims_id=13358&org=CMM
National Earthquake Hazard Reduction Program (NEHRP) in Earth Sciences	**Research** into basic and applied earth and building sciences.	**NSF —** Directorate for Geosciences, Division of Earth Sciences: (703) 306-1550 http://www.nehrp.gov/index.htm
Natural Hazards Gateway	**Research** into the natural hazards facing the nation. Additionally, provides education and real-time data on natural hazards.	**USDOI —** U.S. Geological Survey (USGS) www.usgs.gov/hazards
Societal Dimensions of Engineering, Science, and Technology Program	**Funding** for **research** and related educational activities on topics such as ethics, values, and the assessment, communication, management and perception of risk	**NSF —** Directorate for Social, Behavioral and Economic Science, Division of Social, Behavioral and Economic Research, Societal Dimensions of Engineering, Science and Technology Program. http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5323&org=NSF
Science, Technology and Society Program	Funding for **research** into the historical, philosophical, and sociological questions that arise in connection with science, engineering, and technology, and their respective interactions with society.	**NSF —** http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5324
Technical and Planning Related Assistance		
Coastal Management Training	Program provides **training** on subjects ranging from coastal hazards to climate adaptation. User selects training format (in-person, on-line, etc.)	NOAA Coastal Services Center (CSC) http://www.csc.noaa.gov/training/

Program Activity	Type of Assistance	Agency & Contact
Community Assistance Grants	Grants to communities in Oregon and Washington for **planning** and projects related to wildfire.	Oregon Department of Forestry (via National Forest Service and the Pacific Northwest Wildfire Coordinating Group). http://www.fs.fed.us/r6/fire/fireplan/apply/
Disaster Mitigation Planning and Technical Assistance	**Technical and planning assistance** grants for capacity building and mitigation project activities focusing on creating disaster resistant jobs, workplaces and economies.	U.S. Department of Commerce (**USDOC**), U.S. Economic Development Administration (USEDA) http://www.eda.gov/funding-opportunities/ http://csc.uoregon.edu/eda/
Emergency Management / Mitigation Training	**Training** in disaster mitigation, preparedness, planning.	Federal Emergency Management Agency (FEMA) Emergency Management Institute (EMI) http://www.training.fema.gov/
Environmental Quality Incentives Program (EQIP)	**Technical**, educational, and limited **financial assistance** to encourage environmental enhancement.	**USDA-NRCS** www.nrcs.usda.gov
National Dam Safety Program	**Technical assistance,** training, and grants to help improve State dam safety programs.	Federal Emergency Management Agency (FEMA) http://www.fema.gov/about-national-dam-safety-program
National Earthquake Hazard Reduction Program	**Technical and planning assistance** for activities associated with earthquake hazards mitigation.	**FEMA, USDOI-USGS** Earthquake Program Coordinator: http://www.nehrp.gov/
National Flood Insurance Program	**Formula grants to States** to assist communities to comply with NFIP floodplain management requirements (Community Assistance Program).	FEMA http://www.fema.gov/business/nfip/
Risk Mapping, Assessment, and Planning (Risk MAP) Program	Risk MAP provides **technical assistance** aimed at delivering quality data that increases public awareness and leads to action that reduces risk to life and property.	Federal Emergency Management Agency (FEMA) http://www.fema.gov/risk-mapping-assessment-planning Department of Land Conservation and Development http://www.oregonriskmap.com/
Silver Jackets (Oregon)	Interagency team dedicated to establish and strengthen **intergovernmental partnerships** at the state level as a catalyst in developing comprehensive and sustainable solutions to state flood hazard challenges	U.S. Army Corps of Engineers; Federal Emergency Management Agency; Oregon Interagency Hazard Mitigation Team. http://www.nfrmp.us/state/factOregon.cfm
Volcano Hazards Program	**Technical assistance**: Volcano hazard warnings and operation of four volcano observatories to monitor and assess volcano hazard risk.	**USDOI-USGS** Volcanic Hazards http://volcanoes.usgs.gov/
Watershed Protection and Flood Prevention Program	Watershed and Flood Prevention Operations provides **technical and financial assistance** in authorized watershed projects which have public sponsors.	USDA-NRCS http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/wfpo/
Hazard ID and Mapping		
Climate Data, Products and Services	Provides **science and information** for a climate-smart nation.	NOAA http://www.climate.gov/maps-data
Conservation Gateway	The Gateway provides information on **conservation planning and adaptive management**, conservation topics and geographic implications. Includes the West Wide Wildfire Risk Assessment in addition to many other tools.	The Nature Conservancy https://www.conservationgateway.org/Pages/default.aspx https://www.conservationgateway.org/Files/Pages/west-wide-wildfire-risk-a.aspx

Program Activity	Type of Assistance	Agency & Contact
National Flood Insurance Program: Flood Mapping	**Flood insurance rate maps** and flood plain management maps for all NFIP communities;	FEMA https://msc.fema.gov/webapp/wcs/stores/servlet/FemaWelcomeView?storeId=10001&catalogId=10001&langId=-1
National Flood Insurance Program: Technical Mapping Advisory Council	**Technical guidance and advice** to coordinate FEMA's map modernization efforts for the National Flood Insurance Program.	USDOI-**USGS —** National Mapping Division:
National Digital Orthophoto Program	Develops **topographic quadrangles** for use in mapping of flood and other hazards.	USDOI-USGS — National Mapping Division: http://www.ndop.gov/
National Earthquake Hazards Program	**Seismic mapping for U.S.**	USDOI-USGS http://www.nehrp.gov/ http://earthquake.usgs.gov/ http://earthquake.usgs.gov/earthquakes/map/
National Geophysical Data Center (NGDC)	NGDC provides stewardship, products, and services for **geophysical data** from our Sun to Earth and Earth's sea floor and solid earth environment, including Earth observations from space.	http://maps.ngdc.noaa.gov/index.html http://maps.ngdc.noaa.gov/viewers/hazards/
Oregon Hazard Mapping	Results of **geologic studies** presented in a variety of formats including CD-ROM disks, computer files, and publications such as maps, books, open-file reports, special papers and brochures. Includes the Oregon Lidar Consortium, Oregon HazVu and other mapping resources.	Oregon Department of Geology and Mineral Industries http://www.oregongeology.org/sub/pub%26data/pub%26data.htm http://www.oregongeology.org/sub/hazvu/index.htm http://www.oregongeology.org/sub/projects/olc/
Oregon Explorer	**Information** to help citizens, planners, and policymakers make more informed decisions about Oregon's natural resources and communities.	Oregon State University — Institute for Natural Resources http://oregonexplorer.info/northcoast/NaturalHazards
Risk Mapping, Assessment, and Planning (Risk MAP) Program	Risk MAP provides **technical assistance** aimed at delivering quality data that increases public awareness and leads to action that reduces risk to life and property.	Federal Emergency Management Agency (FEMA) http://www.fema.gov/risk-mapping-assessment-planning Department of Land Conservation and Development http://www.oregonriskmap.com/
Sea Level Rise and Coastal Flooding Impacts Viewer	**Tool** visualizes potential impacts from sea level rise.	NOAA Digital Coast http://www.csc.noaa.gov/digitalcoast/tools/slrviewer
Soil Survey	**Maintains soil surveys** of counties or other areas to assist with farming, conservation, mitigation or related purposes.	USDA-NRCS http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
Stream gauging and Flood Monitoring Network	Operation of a **network of over 7,000 stream gaging stations** that provide data on the flood characteristics of rivers.	USDOE, USGS http://water.usgs.gov/wid/FS_209-95/mason-weiger.html
U.S. Drought Monitor	Maintains up to date national and regional **drought map resources**.	Partnership between the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. http://droughtmonitor.unl.edu/

Program Activity	Type of Assistance	Agency & Contact
Project Support		
The Agricultural Conservation Easement Program (ACEP)	Provides **financial and technical assistance** to help conserve agricultural lands and wetlands and their related benefits.	USDA Natural Resources Conservation Service http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/easements/acep/?cid=stelprdb1242695
Aquatic Ecosystem Restoration	**Direct support** for carrying out aquatic ecosystem restoration projects that will improve the quality of the environment.	DOD-USACE http://www.aquatics.org/
Association of State Floodplain Managers	Promotes education, policies, and activities **(information)** that mitigate current and future losses, costs, and human suffering caused by flooding, and to protect the natural and beneficial functions of floodplains - all without causing adverse impacts.	ASFPM http://www.floods.org/
Beneficial Uses of Dredged Materials	**Direct assistance** for projects that protect, restore, and create aquatic and ecologically-related habitats, including wetlands, in connection with dredging an authorized Federal navigation project.	DOD-USACE http://el.erdc.usace.army.mil/dots/budm/budm.cfm
Clean Water Act Section 319 Grants	**Grants to States** to implement nonpoint source programs, including support for non-structural watershed resource restoration activities.	Environmental Protection Agency http://water.epa.gov/polwaste/nps/cwact.cfm
Coastal Zone Management Program	**Grants** for planning and implementation of non-structural coastal flood and hurricane hazard mitigation projects and coastal wetlands restoration.	U.S. Department of Commerce (**USDOC**) National Oceanic and Atmospheric Administration (**NOAA**) http://coastalmanagement.noaa.gov/funding/welcome.html
Coastal Services Center Grant Opportunities	**Formula and program enhancement grants** for implementing and enhancing Coastal Zone Management programs that have been approved by the Secretary of Commerce.	National Oceanic and Atmospheric Administration (NOAA) http://www.csc.noaa.gov/funding/
Coastal Wetlands Conservation Grant Program	Matching **grants to states** for acquisition, restoration, management, or enhancement of coastal wetlands.	U.S. Fish and Wildlife Service http://www.fws.gov/Coastal/CoastalGrants/index.html
Community Assistance and Protection Program	Mitigation/prevention experts offer mitigation/prevention **support, education, and outreach** that addresses reduction of wildland fire threats and losses to communities and natural resources by taking actions before a fire starts.	Bureau of Land Management (BLM), Fire and Aviation http://www.blm.gov/nifc/st/en/prog/fire/community_assistance.html

Program Activity	Type of Assistance	Agency & Contact
Community Development Block Grant (CDBG) State Administered Program	**Grants to States** to develop viable communities (e.g., housing, a suitable living environment, expanded economic opportunities) in non-entitled areas, for low- and moderate income persons. Includes suite of relevant programs including Entitlement Communities, Section 108 Loan Guarantee Program, and Disaster Recovery Assistance.	U.S. Department of Housing and Urban Development **(HUD)** http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs
Community Development Block Grant (CDBG) Disaster Recovery Assistance	Provides **flexible grants** to help cities, counties, and States recover from Presidentially declared disasters, especially in low-income areas, subject to availability of supplemental appropriations	U.S. Department of Housing and Urban Development http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs/drsi
Disaster Assistance for State Units on Aging (SUAs)	Provide **disaster relief funds** to those SUAs and tribal organizations who are currently receiving a grant under Title VI of the Older Americans Act.	Administration on Aging. http://www.aoa.gov/
Economic Administration Grants	EDA provides **support and funds** post disaster (pending congressional approval) to support economic recovery and mitigation in disaster areas.	Economic Development Administration http://www.eda.gov/about/disaster-recovery.htm
Emergency Watershed Protection Support Services	**Funds** for public and private landowners to implement emergency measures in watersheds to relieve imminent hazards to life and property created by a natural disaster.	**USDA Natural Resources Conservation Service.** http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/ewp/
Farm Service Agency Conservation Programs	Transfers title of certain inventory farm properties owned by FSA to Federal and State agencies for **conservation** purposes (including the restoration of wetlands and floodplain areas to reduce future flood potential)	U.S. Department of Agriculture (**USDA**) –Farm Service Agency (**FSA**) http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=landing
Federal Land to Parks Program	Identifies, assesses, and transfers available Federal real property for **acquisition** for State and local parks and recreation, such as open space.	USDOI-National Park Service http://www.nps.gov/ncrc/programs/flp/index.htm
Firewise Communities Program	To save lives and property from wildfire, NFPA's Firewise Communities program **teaches** people how to adapt to living with wildfire and encourages neighbors to work together and take action now to prevent losses.	Firewise Communities http://www.firewise.org/
Forest Stewardship Program	Helps family forestland owners with hazard reduction **training and funding** to assist with thinning and other actions to reduce wildfire hazard.	**USDA — U.S. Forest Service** http://www.fs.fed.us/spf/coop/programs/loa/fsp.shtml
Hazard Mitigation Assistance	Grant programs designed to provide **funding** to protect life and property from future natural disasters.	Federal Emergency Management Agency (FEMA) http://www.fema.gov/hazard-mitigation-assistance
Highway Bridge Replacement and Rehabilitation	Deficient highway **bridges** on all public roads may be eligible for replacement or rehabilitation.	USDOT — Federal Highway Administration https://www.fhwa.dot.gov/bridge/hbrrp.cfm

Program Activity	Type of Assistance	Agency & Contact
HOME Investment Partnerships Program	Provides **formula grants to States** and localities to fund a wide range of activities including building, buying, and/or rehabilitating affordable housing for rent or homeownership.	U.S. Department of Housing and Urban Development http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/affordablehousing/programs/home/
Indian Housing Assistance (Housing Improvement Program)	**Project grants and technical assistance** to substantially eliminate sub-standard Indian housing.	HUD Office of Public and Indian Housing http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing
Land Trusts	Land trusts assist with the **preservation** of open spaces, scenic vistas, working landscapes and natural areas.	Coalition of Oregon Land Trusts (for more information) http://oregonlandtrusts.org/
National Database of State and Local Wildfire Hazard Mitigation Programs	**Information clearinghouse** related to nonfederal policies and programs that seek to reduce the risk of loss of life and property through the reduction of hazardous fuels on private lands.	USDA — U.S. Forest Service http://www.wildfireprograms.usda.gov/
National Flood Insurance Program (NFIP)	Makes available **flood insurance** to residents of communities that adopt and enforce minimum floodplain management requirements.	FEMA http://www.fema.gov/business/nfip/
National Tsunami Hazard Mitigation Program	Program provides a coordinated, national effort to **assess** tsunami threat, **prepare** community response, issue timely and effective **warnings**, and **mitigate** damage.	Coordinated by **NOAA**, **USGS,** and **FEMA**. http://nws.weather.gov/nthmp/
Partners for Fish and Wildlife Program	Provides **financial and technical assistance** to **private landowners** interested in restoring degraded wildlife habitat.	U.S. Fish and Wildlife Service http://www.fws.gov/partners/
Public Assistance Program (Infrastructure)	**Grants to States and communities** to repair damaged infrastructure and public facilities, and help restore government or government-related services. Mitigation funding is available for work related to damaged components of the eligible building or structure.	Federal Emergency Management Agency (FEMA) http://www.fema.gov/public-assistance-local-state-tribal-and-non-profit
Public Housing Modernization Reserve for Disasters and Emergencies	**Funding** to public housing agencies for modernization needs resulting from natural disasters (including elevation, floodproofing, and retrofit). (24 CFR 968.104)	Housing and Urban Development http://www.hud.gov/ http://www.gpo.gov/fdsys/granule/CFR-2011-title24-vol4/CFR-2011-title24-vol4-sec968-104
Rural Fire Assistance and Volunteer Fire Assistance Grants	**Grants** to fund to improve firefighter skills and to purchase needed equipment; priority areas are located in or adjacent to WUI areas.	Oregon Department of Forestry http://www.oregon.gov/odf/pages/fire/grantopps.aspx
Rural Development Assistance — Utilities	USDA Rural Development provides **funding opportunities** in the form of payments, grants, loans, and loan guarantees, for the development and commercialization of vital utility services.	**USDA**-Rural Development http://www.rurdev.usda.gov/Utilities_Assistance.html

Program Activity	Type of Assistance	Agency & Contact
Rural Development Assistance –Housing	USDA Rural Development provides **funding** for single family homes, apartments for low-income persons or the elderly, housing for farm laborers, childcare centers, fire and police stations, hospitals, libraries, nursing homes, schools, and much more.	**USDA**-Rural Development http://www.rurdev.usda.gov/LP_Subject_HousingAndCommunityAssistance.html
Title III Funds	The Self-Determination Act (SRS Act) has recently been reauthorized and now includes specific language regarding the Firewise Communities program. Counties seeking funding under Title III must use the **funds** to perform work under the Firewise Communities program.	USDA Forest Service http://www.fs.usda.gov/wps/portal/fsinternet/!ut/p/c4/04_SB8K8xLLM9MSSzPy8xBz9CP0os3gjAwhwtDDw9_AI8zPwhQoY6BdkOyoCAPkATlA!/?ss=119985&navtype=BROWSEBYSUBJECT&cid=FSE_003853&navid=091000000000000&pnavid=null&position=BROWSEBYSUBJECT&ttype=main&pname=Secure%20Rural%20Schools-%20Home
Watershed Protection and Flood Prevention Program	**Funds** for soil conservation; flood prevention; conservation, development, utilization and disposal of water; and conservation and proper utilization of land.	USDA Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/wfpo/
Wetlands Protection — Development Grants	**Grants** support the development and enhancement of State and tribal wetlands protection programs.	U.S. Environmental Protection Agency (**EPA**) http://www.epa.gov/owow/wetlands/initiative/#financial
Watershed Protection and Flood Prevention Program	**Funds** for soil conservation; flood prevention; conservation, development, utilization and disposal of water; and conservation and proper utilization of land.	USDA Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/wfpo/
Financing and Loan Guarantees		
Physical Disaster Loans and Economic Injury Disaster Loans	**Disaster loans** to non-farm, private sector owners of disaster damaged property for uninsured losses. Loans can be increased by up to 20% for mitigation purposes.	Small Business Administration (**SBA**) http://www.sba.gov/services/disasterassistance/
Conservation Contracts	**Debt reduction** for delinquent and non-delinquent borrowers in exchange for conservation contracts placed on environmentally sensitive real property that secures FSA loans.	USDA-FSA http://www.fsa.usda.gov/FSA/webapp?area=home&subject=fmlp&topic=landing
Clean Water State Revolving Funds	**Loans** at actual or below-market interest rates to help build, repair, relocate, or replace wastewater treatment plants.	EPA Office of Water State Revolving http://water.epa.gov/grants_funding/cwsrf/cwsrf_index.cfm
Section 108 Loan Guarantee Program	**Loan guarantees** to public entities for community and economic development (including mitigation measures).	HUD http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs/108
Section 504 Loans for Housing	**Repair loans, grants and technical assistance** to very low-income homeowners to repair, improve, or modernize their dwellings or to remove health and safety hazards.	U.S. Department of Agriculture (**USDA**) — Rural Housing Service (**RHS**) http://www.rurdev.usda.gov/had-rr_loans_grants.html

Program Activity	Type of Assistance	Agency & Contact
Single Family Housing Loans and Grants	Provides **loans, loan guarantees, and technical assistance** to low- and moderate-income rural Americans through **several loan, grant, and loan guarantee** programs. The programs also make funding available to individuals to finance vital improvements necessary to make their homes decent, safe, and sanitary.	USDA-Rural Development http://www.rurdev.usda.gov/hsf_sfh.html
Community Facilities Direct Loan Program, Guaranteed Loan Program, and Grant Program	**Provide loans, grant and loan guarantee**s for essential community facilities in rural areas. Priority is given to health care, education, and public safety projects. Typical projects are hospitals, health clinics, schools, fire houses, community centers and many other community based initiatives.	USDA — Rural Development http://www.rurdev.usda.gov/hcf_cf.html
Rural Development Assistance –Utilities	Provides funding opportunities in the form of **payments, grants, loans, and loan guarantee**s, for the development and commercialization of vital utility services.	**USDA**-Rural Development http://www.rurdev.usda.gov/utilities_assistance.html
Farm Service Agency Disaster Assistance Programs	**Provides assistance for natural disaster losses**, resulting from drought, flood, fire, freeze, tornadoes, pest infestation, and other calamities	USDA-Farm Service Agency http://www.fsa.usda.gov/FSA/webapp?area=home&subject=diap&topic=landing
Farm Ownership Loans	**Direct loans, guaranteed/insured loans, and technical assistance** to farmers so that they may develop, construct, improve, or repair farm homes, farms, and service buildings, and to make other necessary improvements.	USDA-Farm Service Agency http://www.fsa.usda.gov/FSA/webapp?area=home&subject=fmlp&topic=dflon

Source: OPDR

3.4.2 Local Capability Assessment

3.4.2.1 Policies, Programs, and Capabilities

Table 3-11. Local Policies, Programs, Capabilities, and Their Effectiveness

Local Policies, Programs, Capabilities and Their Effectiveness			
Policy/Program/Capability	**General Description**	**Applicability**	**Effectiveness**
Comprehensive Land Use Planning (ORS 197; OAR 660-003, OAR 660-018) Statewide Land Use Planning Goals (ORS 197.225; OAR 660-015, OAR 660-025) Goal 7, Areas Subject to Natural Hazards (RE: Landslides — ORS195.250-195-275; OAR 629-623	In Oregon, comprehensive planning is directed through 19 statewide land use planning goals. Goal 7 is entitled *Areas Subject to Natural Hazards.* Its stated goal is "To protect people and property from natural hazards." Goal 7 requires local governments to adopt inventories, policies, and implementing measures to reduce risk to people and property from floods, landslides, wildfires, earthquakes and related hazards, tsunamis, and coastal erosion, and allows communities to plan for protection from other natural hazards as well. It encourages local governments to use both regulatory and non-regulatory strategies to achieve risk reduction.	All cities and counties in Oregon must have a comprehensive plan acknowledged by the state as compliant.	Land use plans can be used to guide new development to a community's less hazardous areas. Additionally, they can identify opportunities for redevelopment projects that will improve hazard mitigation by adjusting current land uses, and by requiring up-to-date building codes and standards for rehabilitation of existing structures. Compliance with Goal 7 is dependent on the availability of hazard inventory information. Many jurisdictions have not updated the Goal 7 section of their comprehensive plans in many years. Recently, there has been increased interest in addressing landslide hazards and the much anticipated Cascadia earthquake event and resulting tsunami. Landslide susceptibility maps based on lidar have been produced for a few areas of the state, and funding is being pursued to do additional studies, eventually covering the entire state. As these studies are completed, DLCD will be working with local governments to incorporate the new information into their comprehensive plans, development regulations, and other programs to improve loss reduction. Several communities are updating the Goal 7 section of their comprehensive plans on their own initiative. The City of Madras is undertaking a pilot project to integrate its comprehensive plan and NHMP by update its comprehensive plan Goal 7 section and incorporating within it elements of its NHMP. The City of Eugene is undertaking another pilot project to explicitly align and integrate climate change considerations into its comprehensive plan, NHMP, and Climate & Energy Action Plan.

Local Policies, Programs, Capabilities and Their Effectiveness			
Policy/Program/Capability	**General Description**	**Applicability**	**Effectiveness**
Zoning (ORS 215, ORS 227)	Zoning consists of a map and text that outlines where and how development is to occur within a jurisdiction. Definitions, general provisions, zoning district regulations, special development standards and administration and enforcement are typical elements of a zoning ordinance.	All cities and counties in Oregon must have a zoning ordinance that implements provisions of the comprehensive plan.	Zoning is used to specify the type and location of development within a jurisdiction. In this respect, zoning is a very effective tool to reduce hazard risk in a community. Hazard overlay zones can prohibit or restrict certain types of development within areas known to contain hazards. Hillside development, flood, tsunami and wildland-urban interface zones are some examples of zoning regulations that can be used to control development on lands subject to natural hazards. Flood zones, which can be found in all of Oregon's NFIP participating jurisdictions, are the most commonly used hazard zone. Other types of local hazard zones found in Oregon include geologic hazard (e.g., Marion County), landslide (e.g., City of Salem), tsunami inundation (e.g., Douglas County), and wildfire safety (e.g., Jackson County) overlay zones.
Land Division Ordinances (ORS 92)	Land division ordinances (including partitions and subdivisions) govern the division of land into two or more parcels. Land development ordinances include both standards and procedures that must be followed in order to legally divide land.	All cities and counties in Oregon must have a land division ordinance that implements provisions of the zoning ordinance and comprehensive plan.	Land division ordinances are used to ensure that land is made ready for development in an orderly manner. In addition, the land division process ensures that public improvements are available to serve the area when development occurs. For example, subdivision regulations ensure that emergency service personnel have adequate access and infrastructure in place in order to respond to hazard events or other emergencies. Land division ordinances also provide jurisdictions with the opportunity to require site specific evaluations of potentially hazardous areas to ensure the area is suitable and safe to build on. All jurisdictions in Oregon have adopted land division regulations.

Local Policies, Programs, Capabilities and Their Effectiveness			
Policy/Program/Capability	**General Description**	**Applicability**	**Effectiveness**
Building Codes (ORS 445; OAR 918)	Oregon building codes establish uniform standards for all residential and commercial buildings in Oregon. The codes prohibit local governments from enacting conflicting regulations. The Oregon Building Codes Division (BCD) provides code development, administration, inspection, plan review, licensing, and permit services to ensure the safe and effective construction of structures in Oregon.	Building codes govern the construction, reconstruction, alteration, and repair of buildings and other structures throughout Oregon.	The mission of the Building Codes Division is to work with Oregonians to ensure safe building construction while promoting a positive business climate. This mission is accomplished through (a) adopting and administering uniform statewide building codes, (b) providing code and rule interpretation, (c) assisting local government building departments and facilitating dispute resolution, (d) enforcing license, code, and permit requirements, (e) certifying inspectors and licensing trade professionals, (f) facilitating economic development efforts around the state, and (g) conducting inspections where local entities do not. At the local level, all jurisdictions have building codes. This allows cities and counties in Oregon to ensure that new construction is built to minimum standards. Certain provisions of the building code apply to the design and construction of buildings located in areas prone to natural hazards. For example, buildings in the Special Flood Hazard area are required to be constructed with a first floor elevation one foot above the Base Flood Elevation (BFE). Several cities have taken this one step further by adopting regulations that supplement the building code and require first floors to be elevated 2-3 feet above the BFE or the flood of record, whichever is higher.
Tsunami Inundation Zone (ORS 455.446 and 455.447; OAR 632-005)	Senate Bill 379 restricts the construction of certain essential facilities, hazardous facilities, major structures, and special occupancy structures in the tsunami inundation zone.	All incorporated and unincorporated land in Oregon westward of the statutorily identified building line.	ORS 455.446 and 455.447 restrict the construction of certain essential facilities, hazardous facilities, major structures, and special occupancy structures in the tsunami inundation zone, with some exemptions. The zone is enforced through local building codes at the time of development. Certain structure types require additional review by and consultation with DOGAMI before development can proceed to the development phase. Provisions of the zone are enforced at the local level. Some coastal communities have proactively relocated critical facilities such as schools (e.g., City of Waldport) and fire stations (e.g., city of Cannon Beach) east of the statutory line.

Local Policies, Programs, Capabilities and Their Effectiveness			
Policy/Program/Capability	**General Description**	**Applicability**	**Effectiveness**
Open Space Preservation (ORS 197; OAR 660-16, 660-023, OAR 660-017, OAR 660-020; OAR 660-034)	In Oregon, comprehensive planning is directed through 19 statewide land use planning goals. Goal 5 is entitled Natural Resources, Scenic and Historic Areas and Open Space. Its stated goal is "To protect natural resources and conserve scenic and historic areas and open spaces." Goal 5 requires local governments to adopt inventories, policies, and implementing measures to protect natural resources and conserve scenic, historic, and open space resources for present and future generations.	All cities and counties in Oregon must have a comprehensive plan acknowledged by the state as compliant.	Land use plans can be used to ensure communities have adequate supply of and access to resources that promote healthy and safe environments. Resource areas and open spaces offer natural mitigation opportunities by buffering development from or absorbing the impacts of natural hazards. For example, riparian buffers along streams serve multiple functions from flood control and storage to habitat preservation and stormwater filtration. Compliance with Goal 5 requires that communities (a) inventory local occurrences of resources listed in Goal 5 and decide which ones are important; (b) identify potential land uses on or near each resource site and any conflicts that might result; (c) analyze economic, social, environmental, and energy, (ESEE) consequences of such conflicts; (d) decide whether the resource should be fully or partially protected and justify the decision; and (e) adopt measures such as zoning to put that decision into effect. Resources inventoried under Goal 5 number more than a dozen resources, including threatened and endangered species, critical habitats, scenic and historic places and aggregate. Emphasis is placed on wetlands, riparian zones and wildlife habitats. Jurisdictions are required to update Goal 5 under Oregon Administrative Rule 660 during their next "periodic review" of the goal or "when they amend their current land-use plan or ordinances."

Local Policies, Programs, Capabilities and Their Effectiveness			
Policy/Program/Capability	**General Description**	**Applicability**	**Effectiveness**
Local Natural Hazards Mitigation Plans	Many Oregon cities and counties have prepared local NHMPs, in great measure through the state's Pre-Disaster Mitigation (PDM) program. The primary aim of the program is to help communities develop or update local natural hazards mitigation plans. It systematically provides funding and technical assistance targeted annually to local governments in specific planning regions identified by OEM for the purpose of developing or updating existing local natural hazards mitigation plans. The PDM planning program was established by OPDR and OEM in 2004 and is carried out in partnership with DLCD, DOGAMI, FEMA Region X, and local governments with FEMA funding.	Oregon cities and counties	Historically, OPDR has offered grant writing support, technical assistance, and Historically, OPDR has offered grant writing support, technical assistance, and human resource capacity to jurisdictions across the state. Recent administrative changes at the University of Oregon, where OPDR is housed, have made it more challenging for OPDR to maintain its current operational structure. It is unclear if or how these changes may impact OPDR's role in local natural hazards mitigation planning in the future. While OPDR has provided the majority of this assistance to local governments, private consulting firms have also assisted local communities. As Clatsop County is currently doing, some jurisdictions undertake development or updates of NHMPs on their own. Until 2013, jurisdictions in the Portland Metro Region received varying degrees of Urban Area Security Initiative (UASI) support for mitigation planning. Plans are tracked and inventoried at the county level (36 Oregon counties). **Table 3-12** shows the status of local NHMPs in Oregon.

Local Policies, Programs, Capabilities and Their Effectiveness			
Policy/Program/Capability	**General Description**	**Applicability**	**Effectiveness**
Capital Improvement Plans (ORS Chapter 223; OAR 660-011-0000, OAR 660 — 12-0000, OAR 660-013-0010)	Local jurisdictions maintain capital improvement plans and programs to ensure that infrastructure is developed and maintained at an adequate level to serve the needs of the community.	Oregon Cities, Counties and Special Districts	Many communities are directly or indirectly addressing hazard mitigation through their capital improvement plans. Such plans are generally maintained on a five to six-year basis. Capital Improvement Plans distribute the expense of major capital construction projects over time. Long-range infrastructure improvement projects are implemented annually through the jurisdictions standard budget process. In many cases, bonds are used to finance projects. In recent years, state and federal grants have been used to offset the costs of local infrastructure improvements. The primary opportunity to mitigate projects comes when old infrastructure is improved in ways that eliminate or reduce hazard impacts. For example, bridges can be retrofitted to address seismic impacts; culverts can be upsized to reduce localized flood impacts; electrical lines can be buried to avoid impacts associated with snow, ice, and wind storms. These efforts may not be seen by the community as mitigation, but bringing the infrastructure or facilities up to code reduces the vulnerability of those systems. For example, the Harney Electric Cooperative in south-central Oregon has planned or completed three power line undergrounding projects to offset impacts from winter storm events in that region.
Erosion Control Management Plans (ORS Chapter 568; OAR 340-041, OAR 603-095)	Erosion control aims to reduce soil loss from wind and water through a variety of control techniques including vegetative cover, buffer strips, contour plowing, riparian enhancements, and windbreaks.	Erosion control plans can apply to any lands where erosion is a concern. Wind erosion control is a requirement under the Federal Farm Bill for certain commodities such as wheat and corn, but depending on the rotation, may not be a requirement for other commodities such as potatoes or vegetables.	The Natural Resources Conservation Service (NRCS) and local soil and water conservation districts (SWCD) have long sought to reduce wind erosion of cropland. Specific requirements for erosion control plans apply to certain agricultural lands. Nationally, NRCS has developed quality criteria for wind erosion control practices and use a wind erosion equation model for predicting potential wind erosion under various farming systems. Since 1985, USDA-NRCS has been responsible for agriculture programs that require wind and water erosion control as a requirement under the Federal Farm Bill for certain commodities such as wheat and corn. Participating farmers develop and implement conservation plans for all farmland designated as highly erodible. Plans address practices such as residue management, tillage methods, and irrigation management. The Environmental Quality Incentive Program provides funds and technical assistance to agricultural producers and owners of non-industrial forest lands. Eligibility requires that applicants “be in compliance with the highly erodible land and wetland conservation requirements.”

Local Policies, Programs, Capabilities and Their Effectiveness			
Policy/Program/Capability	**General Description**	**Applicability**	**Effectiveness**
Floodplain Management (ORS Chapter 536, ORS Chapter 549)	Floodplain management aims to reduce losses associated with flood events and encourage restoration and protection of natural floodplain function.	Oregon has 258 cities and counties that are subject to flooding, and all participate in the National Flood Insurance Program (NFIP) thereby making flood insurance available to their residents and businesses.	The NFIP has three basic components: flood hazard mapping, floodplain insurance, and floodplain regulations. Does the combination of mapping, regulations, and insurance work to reduce flood damages? Yes! According to FEMA, flood insurance provides an alternative to publicly-funded disaster assistance that reduces the ever-escalating costs of repairing damage to buildings and their contents caused by floods. FEMA further reports that flood damages are reduced by nearly $1 billion a year nationally through communities implementing sound floodplain management requirements and property owners purchasing flood insurance. Newer buildings constructed in compliance with floodplain regulations suffer approximately 80% less damage annually than those not built to current standards. Oregonians make use of floodplains for a variety of purposes. Floodplain management involves recognition that our use of floodplains can negatively impact floodplain functions and that communities will be faced with making choices about land uses in the floodplain. Water quality and endangered species benefits also result from proactive floodplain management. Development within floodplains is generally not prohibited. Rather, floodplain management involves regulatory, construction, and public education measures designed to avoid and minimize potential risk to development from flood hazards. Floodplain management also entails implementation of specific actions intended to prevent future damages and threats to human life and public health. Local floodplain programs are built upon statewide requirements for land use planning and implementation of building codes. Local governments implement flood damage prevention ordinances through floodplain development permits, and the state building codes via local building permits. Many local governments in Oregon adopt higher regulatory standards into their flood damage prevention ordinances. For example, some jurisdictions require two or three feet of freeboard (e.g., City of Scio), regulate an area larger than the floodplain shown on FEMA FIRMs, require balanced cut and fill in the floodplain, etc. Table 3-12 shows the status of local jurisdiction participation in the NFIP in Oregon.

Local Policies, Programs, Capabilities and Their Effectiveness			
Policy/Program/Capability	**General Description**	**Applicability**	**Effectiveness**
Community Rating System (CRS)	The National Flood Insurance Program's (NFIP) Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements.	All NFIP Communities in Oregon are eligible to participate.	The National Flood Insurance Program's (NFIP) Community Rating System (CRS) effectively addresses the flood hazard by discounting flood insurance premium rates. CRS participating communities (a) reduce flood damage to insurable property, (b) strengthen and support the insurance aspects of the NFIP, and (c) encourage a comprehensive approach to floodplain management. Local governments in Oregon are encouraged to join CRS. The CRS provides an important avenue for Oregon's NFIP communities to obtain recognition for their local floodplain programs. With recent NFIP reforms (i.e., Biggert Waters), many communities in Oregon are interested in joining or enhancing their current participation in the CRS program. As of May 2014, 21 cities and seven counties participate in the CRS program. The City of Portland has the highest rating in the state at five; 18 other cities have ratings of six or 7 with the remainder falling at eight or above. **Table 3-12** shows the status of local jurisdiction participation in the CRS program in Oregon.
CRS Users Groups	In 2014, DLCD convened two new CRS Users Groups (northern and southern Oregon) to encourage greater participation in the CRS Program. Through CRS Users' Groups, participating CRS communities can obtain assistance in increasing their CRS classifications and new communities can find peer-to-peer support as they join the CRS program. Each CRS Users' Group meets a minimum of three times per year in person or virtually. An online forum allows both groups to share documents, discuss ideas and post projects between meetings.	The CRS Users Groups are open to communities already participating in the CRS program and to any other community interested in floodplain management best practices.	The CRS Users Groups were established in the latter half of 2014, so there is no data on their effectiveness at this time. Effectiveness will be measured by the level of local participation, CRS classification maintenance and increases, and new CRS membership over the life of the 2015 Oregon NHMP.

Local Policies, Programs, Capabilities and Their Effectiveness			
Policy/Program/Capability	**General Description**	**Applicability**	**Effectiveness**
Mitigation of Repetitive Loss and Severe Repetitive Loss Properties through FEMA's Flood Mitigation Assistance (FMA) Program	FEMA's FMA program provides funds each year for projects to elevate, acquire, or relocate NFIP-insured structures. The State focuses on helping local governments and homeowners or businesses access these funds for mitigation of structures that have been repeatedly damaged by floods.	Local governments may apply for funding on behalf of homeowners or business owners.	While these projects are almost always cost-effective, and FEMA covers 75-100% of the cost, other issues make it very difficult to successfully complete an acquisition or relocation project. First, the FMA grants are reimbursement grants, so the local government or property owner must be willing and able to finance the project and wait for reimbursement from FEMA. The property owner must also be willing to absorb up to 25% of the project cost. Further the local government must have staff with both federal grant management and project management expertise to successfully execute the project.
Leveraging Mitigation of Repetitive Loss and Severe Repetitive Loss Properties through partnerships with Community Action Teams (CATs)	Community Action Teams are non-profit organizations that provide a range of services and resources to address the needs of the economically disadvantaged.	Eligibility varies by program and service.	One of the services that CATs provide is home weatherization. When a Repetitive Loss or Severe Repetitive Loss property will be weatherized, the State and local governments assist the property owner with leveraging this opportunity to also elevate the property above the base flood elevation to avoid future flood damage.

Local Policies, Programs, Capabilities and Their Effectiveness			
Policy/Program/Capability	**General Description**	**Applicability**	**Effectiveness**
Community Wildfire Protection Planning (Related Statute: ORS 477; OAR 629-042, OAR 629-043; OAR 629-044; OAR 629-048)	A Community Wildfire Protection Plan (CWPP) is developed by a community in an area at-risk from wildfire. The CWPP establishes strategies aimed at reducing wildfire risk.	Primarily counties; plan boundaries may include sub-county regions (e.g., Fire Protection District, unincorporated communities, watersheds, etc.) as well as multi-jurisdictional plans. Certain types of federal funding require the adoption of a CWPP under the provision of the Healthy Forest Restoration Act.	The purpose of a CWPP is to establish a strategic vision (normally five-years in duration) for long-term wildfire risk reduction activities and public outreach. CWPPs outline wildfire mitigation goals, strategies, and activities and highlight other relevant plans and partnerships, including: land use, natural resource, capital improvement, and emergency operation plans. All 36 counties in Oregon have adopted a CWPP; the Oregon Department of Forestry identifies 28 additional sub-county CWPPs. The statutory definition of a CWPP appears in Title I of the Healthy Forest Restoration Act of 2003 (HFRA). The HRFA decrees that communities which have a CWPP in place will be a priority for receiving hazardous fuels reduction funding administrated by the U.S. Forest Service and Bureau of Land Management. Plans developed to address the requirements of the 2003 Healthy Forests Restoration Act (HFRA) must meet three minimum requirements: • Collaboration: Local and state government representatives, in consultation with federal agencies and other interested parties, must collaboratively develop a CWPP. • Prioritized Fuel Reduction: A CWPP must identify and prioritize areas for hazardous fuel reduction treatments and recommend the types and methods of treatment that will protect at-risk communities and essential infrastructure. • Treatment of Structural Ignitability: A CWPP must recommend measures that homeowners and communities can take to reduce the ignitability of structures. The Healthy Forest Restoration Act (HFRA) requires that three decision-makers mutually agree to the final contents of the CWPP. The three are the local government (i.e., counties or cities), the local fire department(s) and the state entity responsible for forest management (ODF). These three are directed to consult with and involve local representatives of the USFS and BLM and other interested parties or persons in the development of the CWPP.

Local Policies, Programs, Capabilities and Their Effectiveness			
Policy/Program/Capability	**General Description**	**Applicability**	**Effectiveness**
Local Emergency Planning Committees (OAR 104-040; OAR 837-085, OAR 837-120)	Under the Emergency Planning and Community Right-to-Know Act (EPCRA), Local Emergency Planning Committees (LEPCs) must develop an emergency response plan, review the plan at least annually, and provide information about chemicals in the community to citizens.	All designated emergency planning districts established under 42 U.S.C. 116§11001(c).	In 1986, the federal government established the Emergency Planning and Community Right to Know Act (EPCRA). The intent of this law was to give citizens the right to know what types of hazardous materials were in their communities, so they could be prepared to respond if a release occurred. Part of this law provided states with the opportunity to create Local Emergency Planning Committees (LEPCs). LEPCs work to understand chemical hazards in the community, develop emergency plans in case of an accidental release, and look for ways to prevent chemical accidents. The Office of State Fire Marshal (OSFM) has created a State Emergency Response Commission Advisory Board, to help Oregon communities establish LEPCs and support them in their activities. OSFM currently recognizes 11 LEPCs in the state. In addition, OSFM is actively supporting Community Capability Assessments, a planning approach that “aids emergency responders in evaluating, coordinating and enhancing the cohesiveness of their emergency response plans” in communities with active LEPCs. LEPC members include people from emergency management, police, fire, emergency medical services, transportation, health, broadcast and print media, industry, community groups, colleges, and the public. Notably, many of these organizations are also typically involved in the development of local natural hazards mitigation plans.

Local Policies, Programs, Capabilities and Their Effectiveness			
Policy/Program/Capability	**General Description**	**Applicability**	**Effectiveness**
Local Fire Prevention Cooperatives (ORS 447)	Fire prevention cooperatives are nonprofit interagency fire service groups engaged in fire prevention and public education within their communities. They promote an exchange of ideas, programs, and resources in both wildland and structural fire prevention and public education. They also promote, coordinate, and actively support interagency participation in fire prevention activities.	Any collective group of agencies interested and engaged in fire prevention and education can form an LFPC.	A wide range of community-based fire prevention efforts exist across Oregon. Many of these efforts are developed and implemented by local fire prevention cooperatives. Since the mid-1970s, fire prevention cooperatives have been highly successful at the creation and delivery of cost-effective fire prevention programs, developed to address specific local situations. Cooperatives multiply the effectiveness of community fire prevention efforts by identifying common needs among neighboring agencies, then developing a single, joint approach to addressing those needs. The cooperative concept recognizes that no single agency usually has the personnel, expertise, community recognition, or financial resources to develop, implement and deliver a comprehensive package of fire awareness, education and public safety needs for a local area. In addition to identifying, designing and implementing unique local programs, fire prevention cooperatives serve as highly effective distributors of materials and programs developed by others. One example is their increasing involvement in Wildfire Awareness Week programs. ODF lists the following communities on the current LFPC roster: • Baker County Interagency Fire Prevention Team • Central Oregon Fire Prevention Cooperative • Clackamas County Fire Prevention Cooperative • Clatsop County Fire Fighter's Association • Columbia County Fire Prevention Cooperative • Douglas County Fire Prevention Cooperative • Grant-Harney County Fire Prevention Cooperative • Klamath Fire Prevention Cooperative • Lane Fire Prevention Cooperative • Northwest Passage Fire Prevention Cooperative • Rogue Valley Fire Prevention Cooperative • Southwest Oregon Public Safety Association • Wallowa County Fire Prevention Cooperative

Local Policies, Programs, Capabilities and Their Effectiveness			
Policy/Program/Capability	**General Description**	**Applicability**	**Effectiveness**
Local Fire Departments and Fire Protection Districts (ORS 476)	City fire departments, rural fire protection districts, county special service districts, and commercial subscription based entities provide both structural and non-structural fire protection.	Authority to establish and maintain LFDs and FPDs is granted in ORS 476.060.	Most structural fire protection in Oregon is provided by city fire departments, rural fire protection districts, county special service districts, and commercial subscription based entities. Specialized agencies also provide structural protection, such as the Portland Airport Fire Department and the National Park Service. A variety of volunteer organizations also exist. In some locations, such as the area immediately west of Portland, structural fire agencies have complete responsibility for the prevention and suppression of all fires, both wildland and structural. Across much of the state, structural fire agencies and the ODF share jurisdiction in Wildland-Urban Interface areas. In some parts of Oregon, property owners may be subject to the protection, assessment and taxation of both a local structural fire agency and ODF. In such areas, the structural fire department and ODF jointly protect properties, with the fire departments focused on protecting improvements and ODF focused on protecting the forest resources. To facilitate this joint responsibility, mutual aid agreements signed by both the structural district or department and ODF typically provide up to 24 hours of non-reimbursed firefighting assistance for fires that threaten each other's protected property and resources. The Oregon State Fire Marshal's office currently lists 301 distinct local fire departments in Oregon.
Rangeland Fire Protection Associations (ORS 477)	Formed under ORS 477.315, RFPAs are nonprofit, locally governed and operated landowner associations organized to provide fire protection on rangeland areas of eastern Oregon which lack both structural and wildland fire protection.	RFPA membership is voluntary.	State law provides for the formation of these RFPAs under the authority of the Oregon Board of Forestry, with assistance from ODF. There are currently 14 RFPAs that collectively protect over 3.2 million acres of private land in Eastern Oregon. The RFPA's also protect approximately a half-million acres of State lands. These lands are primarily Department of State Lands, with lesser amounts of Department of Fish & Wildlife, and Parks & Recreation Department. In 2005, the state established a Rangeland Fire Protection Coordinator position. Since that time, federal grants have supported state program administration. In addition, ODF contributes approximately $30,000 per biennium to support associations and reimburse, primarily to reimburse insurance and administration costs. ORS 477.317(2) limits state funding support for the program to "50 percent of the total of budgeted operating costs and the cash equivalent of in-kind supplies and services of the association in any fiscal year." RFPAs also rely on a variety of additional federal grants for funding support.

3.4.2.2 Local Hazard Mitigation Planning

Table 3-12. Local Jurisdiction NHMP, NFIP, and CRS Participation Status through December 2014

Local Jurisdiction NHMP, NFIP, And CRS Status								
#	**County**	**Jurisdiction**	**Plan Title**	**Expiration Date**	**LNHMP Comments**	**NFIP?**	**CRS Level**	**NFIP Comments**
1	**Baker**	**Baker County**	NE Oregon - Region 7 HMP	**Jun-19**		**Yes**	—	
2	Baker	Baker City	NE Oregon - Region 7 HMP	**Jun-19**		**Yes**	—	
3	Baker	Greenhorn			No Plan	**No**	—	**Never mapped**
4	Baker	Haines			No Plan	**Yes**	—	
5	Baker	Halfway	NE Oregon - Region 7 HMP	**Jun-19**		**Yes**	—	
6	Baker	Huntington			No Plan	**Yes**	—	
7	Baker	Richland			No Plan	**No**	—	**Never mapped**
8	Baker	Sumpter			No Plan	**Yes**	—	
9	Baker	Unity			No Plan	**No**	—	**Never mapped**
10	Benton	Benton County	Benton County Hazard Mitigation Plan	Feb-16	Stand-alone County NHMP Update funded.	Yes	**6**	
11	Benton	Adair Village			No Plan	No	—	Has FIRM
12	Benton	Corvallis	Corvallis HMP	**Jan-13**	Stand-alone City NHMP Update funded.	**Yes**	**6**	
13	Benton	Monroe			No Plan	**Yes**	—	
14	Benton	Philomath			No Plan	**Yes**	—	

Local Jurisdiction NHMP, NFIP, And CRS Status								
#	**County**	**Jurisdiction**	**Plan Title**	**Expiration Date**	**LNHMP Comments**	**NFIP?**	**CRS Level**	**NFIP Comments**
15	**Clackamas**	**Clackamas County**	Clackamas County HMP	**Apr-18**		**Yes**	**6**	
16	Clackamas	Barlow			No Plan	**Yes**	—	
17	Clackamas	Canby	Clackamas County HMP	**Apr-18**		**Yes**	—	
18	Clackamas	Damascus	Clackamas County HMP	**Apr-18**		**Yes**	—	
19	Clackamas	Estacada	Clackamas County HMP	**Apr-18**		**Yes**	—	
20	Clackamas	Gladstone	Clackamas County HMP	**Apr-18**		**Yes**	—	
21	Clackamas	Happy Valley	Clackamas County HMP	**Apr-18**		**Yes**	—	
22	Clackamas	Johnson City	Clackamas County HMP	**Apr-18**		**No**	—	**All X zone**
23	Clackamas	Lake Oswego	Clackamas County HMP	**Apr-18**		**Yes**	—	
24	Clackamas	Milwaukie	Clackamas County HMP	**Apr-18**		**Yes**	—	
25	Clackamas	Molalla	Clackamas County HMP		Approved Pending Adoption. Chose not to adopt.	**Yes**	—	
26	Clackamas	Oregon City	Clackamas County HMP	**Apr-18**		**Yes**	**7**	
27	Clackamas	Rivergrove			No Plan	**Yes**	—	
28	Clackamas	Sandy	Clackamas County HMP	**Apr-18**		**Yes**	—	
29	Clackamas	West Linn	Clackamas County HMP	**Apr-18**		**Yes**	—	
30	Clackamas	Wilsonville	Clackamas County HMP	**Apr-18**		**Yes**	—	

Local Jurisdiction NHMP, NFIP, And CRS Status								
#	**County**	**Jurisdiction**	**Plan Title**	**Expiration Date**	**LNHMP Comments**	**NFIP?**	**CRS Level**	**NFIP Comments**
31	**Clatsop**	**Clatsop County**	Clatsop County HMP	**Nov-13**	Update in progress.	**Yes**	**—**	
32	Clatsop	Astoria	Clatsop County HMP	**Nov-13**		**Yes**	**—**	
33	Clatsop	Cannon Beach	Clatsop County HMP	**Nov-13**		**Yes**	**7**	
34	Clatsop	Gearhart	Clatsop County HMP	**Nov-13**		**Yes**	**—**	
35	Clatsop	Seaside			No Plan. Working on addendum to County Plan.	**Yes**	**—**	
36	Clatsop	Warrenton	Clatsop County HMP	**Nov-13**		**Yes**	**—**	
37	**Columbia**	**Columbia County**	Columbia County HMP	**Oct-19**		**Yes**	**—**	
38	Columbia	Clatskanie	Columbia County HMP	**Oct-19**		**Yes**	**—**	
39	Columbia	Columbia City	Columbia County HMP	**Oct-19**		**Yes**	**—**	
40	Columbia	Prescott		**Oct-19**		**Yes**	**—**	
41	Columbia	Rainier	Columbia County HMP	**Oct-19**		**Yes**	**—**	
42	Columbia	Scappoose	Columbia County HMP	**Oct-19**		**Yes**	**7**	
43	Columbia	St Helens	Columbia County HMP	**Oct-19**		**Yes**	**—**	
44	Columbia	Vernonia	Columbia County HMP	**Oct-19**		**Yes**	**—**	
45	**Coos**	**Coos County**	Coos County Multi-Jurisdictional NHMP 2010	**Aug-15**	Update funded.	**Yes**	**—**	
46	Coos	Bandon	Coos County 2005 HM Plan	**Jul-10**		**Yes**	**—**	
47	Coos	Coos Bay	Coos County Multi-Jurisdictional NHMP 2010	**Aug-15**		**Yes**	**—**	
48	Coos	Coquille	Coos County 2005 HM Plan	**Jul-10**		**Yes**	**—**	
49	Coos	Lakeside	Coos County 2005 HM Plan	**Jul-10**		**Yes**	**—**	

Local Jurisdiction NHMP, NFIP, And CRS Status								
#	**County**	**Jurisdiction**	**Plan Title**	**Expiration Date**	**LNHMP Comments**	**NFIP?**	**CRS Level**	**NFIP Comments**
50	Coos	Myrtle Point	Coos County Multi-Jurisdictional NHMP 2010	**Aug-15**		**Yes**	—	
51	Coos	North Bend	Coos County Multi-Jurisdictional NHMP 2010	**Aug-15**		**Yes**	—	
52	Coos	Powers	Coos County 2005 HM Plan	**Jul-10**		**Yes**	—	
53	**Crook**	**Crook County**	Crook County NHMP	**Mar-16**		**Yes**	—	
54	Crook	Prineville	Crook County NHMP	**Mar-16**		**Yes**	—	
55	**Curry**	**Curry County**	Curry County HM Plan 2010	**Sep-15**	Update funded.	**Yes**	—	
56	Curry	Brookings	Curry County HM Plan 2010	**Sep-15**		**Yes**	—	
57	Curry	Gold Beach	Curry County HM Plan 2010	**Sep-15**		**Yes**	—	
58	Curry	Port Orford	Curry County HM Plan 2010	**Sep-15**		**Yes**	—	
59	**Deschutes**	**Deschutes County**	Deschutes County HMP	**May-15**	Stand-alone County NHMP Update funded.	**Yes**	—	
60	Deschutes	Bend			No Plan	**Yes**	—	
61	Deschutes	La Pine			No Plan	**Yes**	—	
62	Deschutes	Redmond			No Plan	**Yes**	—	
63	Deschutes	Sisters			No Plan	**Yes**	—	
64	**Douglas**	**Douglas County (Inland)**	Douglas County 2010 HM Plan	**Apr-15**	Update funded.	**Yes**	**8**	
65	**Douglas**	**Douglas County (Coastal)**			Not Applicable	**Yes**	—	
66	Douglas	Canyonville	Douglas County 2003 HM Plan	**Dec-08**		**Yes**	—	
67	Douglas	Drain	Douglas County 2003 HM Plan	**Dec-08**		**Yes**	—	
68	Douglas	Elkton	Douglas County 2003 HM Plan	**Dec-08**		**Yes**	—	

Local Jurisdiction NHMP, NFIP, And CRS Status								
#	**County**	**Jurisdiction**	**Plan Title**	**Expiration Date**	**LNHMP Comments**	**NFIP?**	**CRS Level**	**NFIP Comments**
69	Douglas	Glendale	Douglas County 2003 HM Plan	**Dec-08**		**Yes**	—	
70	Douglas	Myrtle Creek	Douglas County 2003 HM Plan	**Dec-08**		**Yes**	—	
71	Douglas	Oakland	Douglas County 2003 HM Plan	**Dec-08**		**Yes**	—	
72	Douglas	Reedsport	Douglas County 2010 HM Plan	**Apr-15**		**Yes**	—	
73	Douglas	Riddle	Douglas County 2003 HM Plan	**Dec-08**		**Yes**	—	
74	Douglas	Roseburg	Douglas County 2003 HM Plan	**Dec-08**		**Yes**	**8**	
75	Douglas	Sutherlin	Douglas County 2003 HM Plan	**Dec-08**		**Yes**	—	
76	Douglas	Winston			No Plan	**Yes**	—	
77	Douglas	Yoncalla	Douglas County 2003 HM Plan	**Dec-08**		**Yes**	—	
78	**Gilliam**	**Gilliam County**	Gilliam County HMP	**Apr-18**		**Yes**	—	
79	Gilliam	Arlington	Gilliam County HMP	**Apr-18**		**Yes**	—	
80	Gilliam	Condon	Gilliam County HMP	**Apr-18**		**Yes**	—	
81	Gilliam	Lonerock	Gilliam County HMP	**Apr-18**		**No**	—	**Never mapped**
82	**Grant**	**Grant County**	NE Oregon - Region 7 HMP	**Jun-19**		**Yes**	—	
83	Grant	Canyon City			No Plan	**Yes**	—	
84	Grant	Dayville			No Plan	**Yes**	—	
85	Grant	Granite			No Plan	**No**	—	**Never mapped**
86	Grant	John Day	NE Oregon - Region 7 HMP	**Jun-19**		**Yes**	—	
87	Grant	Long Creek			No Plan	**Yes**	—	

Local Jurisdiction NHMP, NFIP, And CRS Status								
#	**County**	**Jurisdiction**	**Plan Title**	**Expiration Date**	**LNHMP Comments**	**NFIP?**	**CRS Level**	**NFIP Comments**
88	Grant	Monument			No Plan	**Yes**	—	
89	Grant	Mt Vernon			No Plan	**Yes**	—	
90	Grant	Prairie City			No Plan	**Yes**	—	
91	Grant	Seneca			No Plan	**Yes**	—	
92	**Harney**	**Harney County**	Harney County HMP	**Jun-18**		**Yes**	—	
93	Harney	Burns	Harney County HMP	**Jun-18**		**Yes**	—	
94	Harney	Hines	Harney County HMP	**Jun-18**		**Yes**	—	
95	Harney	*Harney Electric Co-op Special District*	Harney County HMP	**Jun-18**		**N/A**	—	
96	**Hood River**	**Hood River County**	Hood River County HMP	**Dec-17**		**Yes**	—	
97	Hood River	Cascade Locks	Hood River County HMP	**Jan-12**		**Yes**	—	
98	Hood River	Hood River (City)	Hood River County HMP	**Jan-12**		**Yes**	—	
99	**Jackson**	**Jackson County**	Jackson County HMP	**Feb-18**		**Yes**	**7**	
100	Jackson	Ashland	Jackson County HMP	**Feb-18**		**Yes**	**7**	
101	Jackson	Butte Falls			No Plan	**Yes**	—	
102	Jackson	Central Point	Central Point HMP	**Dec-16**	Stand-alone City NHMP	**Yes**	**6**	
103	Jackson	Eagle Point	Jackson County HMP	**Feb-18**		**Yes**	—	
104	Jackson	Gold Hill			No Plan	**Yes**	—	
105	Jackson	Jacksonville			No Plan	**Yes**	—	
106	Jackson	Medford	Medford HMP	**Oct-15**	Stand-alone City NHMP Update funding pending.	**Yes**	**8**	

Local Jurisdiction NHMP, NFIP, And CRS Status								
#	**County**	**Jurisdiction**	**Plan Title**	**Expiration Date**	**LNHMP Comments**	**NFIP?**	**CRS Level**	**NFIP Comments**
107	Jackson	Phoenix			No Plan	**Yes**	**—**	
108	Jackson	Rogue River	Jackson County HMP	**Feb-18**		**Yes**	**7**	
109	Jackson	Shady Cove	Jackson County HMP	**Feb-18**		**Yes**	**—**	
110	Jackson	*Southern Oregon University Special District*	Southern Oregon University	**Jul-17**	Stand-alone Special District Plan	**N/A**	**—**	
111	Jackson	Talent			No Plan	**Yes**	**9**	
112	**Jefferson**	**Jefferson County**	Jefferson County HMP	**Feb-19**		**Yes**	**—**	
113	Jefferson	Culver	Jefferson County HMP	**Dec-13**	Expired. Declined participation in update.	**Yes**	**—**	
114	Jefferson	Madras	Jefferson County HMP	**Feb-19**		**Yes**	**—**	
115	Jefferson	Metolius	Jefferson County HMP	**Feb-19**		**No**	**—**	**Never applied**
116	**Josephine**	**Josephine County**	Josephine County HMP	**Jan-17**		**Yes**	**—**	
117	Josephine	Cave Junction		**Oct-09**	After partial participation in the 2011-12 process, decided not to finish.	**Yes**	**—**	
118	Josephine	Grants Pass	Josephine County HMP	**Jan-17**		**Yes**	**9**	
119	**Klamath**	**Klamath County**	Klamath County HMP	**Nov-16**		**Yes**	**—**	
120	Klamath	Bonanza			No Plan	**Yes**	**—**	
121	Klamath	Chiloquin			No Plan	**Yes**	**—**	
122	Klamath	Klamath Falls	Klamath County HMP	**Nov-16**		**Yes**	**—**	
123	Klamath	Malin			No Plan	**No**	**—**	**No FIRM**
124	Klamath	Merrill			No Plan	**No**	**—**	**No FIRM**

Local Jurisdiction NHMP, NFIP, And CRS Status								
#	**County**	**Jurisdiction**	**Plan Title**	**Expiration Date**	**LNHMP Comments**	**NFIP?**	**CRS Level**	**NFIP Comments**
125	Klamath	*Oregon Tech Special District*	Oregon Tech	**Mar-18**	Stand-alone Special District Plan	**N/A**	—	
126	**Lake**	**Lake County**	Lake County HMP	**Sep-18**		**Yes**	—	
127	Lake	Lakeview	Lake County HMP	**Sep-18**		**Yes**	—	
128	Lake	Paisley	Lake County HMP	**Sep-18**		**Yes**	—	
129	**Lane**	**Lane County (Inland)**	Lane County HMP	**Mar-17**	Stand-alone County NHMP	**Yes**	**7**	
130	Lane	**Lane County (Coastal)**			Not Applicable	**Yes**	—	
131	Lane	Coburg			No Plan	**Yes**	—	
132	Lane	Cottage Grove	Cottage Grove HMP	**May-17**	Stand-alone City NHMP	**Yes**	—	
133	Lane	Creswell			No Plan	**Yes**	—	
134	Lane	Dunes City	Dunes City Addendum to the City of Florence NHMP	**Feb-14**	Stand-alone City NHMP - Addendum to City of Florence NHMP	**Yes**	—	
135	Lane	Eugene	Eugene-Springfield Multi-Jurisdictional NHMP	**Feb-15**	Stand-alone joint City NHMP - Eugene-Springfield NHMP Update funded.	**Yes**	**7**	
136	Lane	Eugene-Springfield Metro			Not Applicable	**N/A**	—	
137	Lane	Florence	City of Florence NHMP	**Feb-14**	Stand-alone City NHMP	**Yes**	—	
138	Lane	Junction City			No Plan	**Yes**	—	
139	Lane	Lowell			No Plan	**Yes**	—	
140	Lane	Oakridge			No Plan	**Yes**	—	
141	Lane	Springfield	Eugene-Springfield Multi-Jurisdictional NHMP	**Feb-15**	Stand-alone joint City NHMP - Eugene-Springfield NHMP Update funded.	**Yes**	—	

Local Jurisdiction NHMP, NFIP, And CRS Status								
#	**County**	**Jurisdiction**	**Plan Title**	**Expiration Date**	**LNHMP Comments**	**NFIP?**	**CRS Level**	**NFIP Comments**
142	Lane	*University of Oregon Special District*	University of Oregon HMP 2011	**Sep-16**	Stand-alone Special District Plan	**N/A**	—	
143	Lane	Veneta			No Plan	**Yes**	—	
144	Lane	Westfir			No Plan	**Yes**	—	
145	**Lincoln**	**Lincoln County**	Lincoln County HMP	**Jul-14**	Update funded.	**Yes**	—	
146	Lincoln	Depoe Bay	Lincoln County HMP	**Jul-14**		**Yes**	—	
147	Lincoln	Lincoln City	Lincoln County HMP	**Jul-14**		**Yes**	—	
148	Lincoln	Newport	Lincoln County HMP	**Jul-14**		**Yes**	—	
149	Lincoln	Siletz	Lincoln County HMP	**Jul-14**		**Yes**	—	
150	Lincoln	Toledo	Lincoln County HMP	**Jul-14**		**Yes**	—	
151	Lincoln	Waldport	Lincoln County HMP	**Jul-14**		**Yes**	—	
152	Lincoln	Yachats	Lincoln County HMP	**Jul-14**		**Yes**	—	
153	**Linn**	**Linn County**	Linn County HMP 2010	**Dec-15**	Update funded.	**Yes**		
154	Linn	Albany	Albany HMP	**Feb-16**	Stand-alone City NHMP Update funding pending.	**Yes**	**6**	
155	Linn	Brownsville			No Plan	**Yes**	—	
156	Linn	Halsey			No Plan	**Yes**	—	
157	Linn	Harrisburg			No Plan	**Yes**	—	
158	Linn	Lebanon			No Plan	**Yes**	—	
159	Linn	*Linn-Benton Community College Special District*	Linn-Benton Community College	**May-18**	Stand-alone Special District Plan	**N/A**	—	

Local Jurisdiction NHMP, NFIP, And CRS Status								
#	**County**	**Jurisdiction**	**Plan Title**	**Expiration Date**	**LNHMP Comments**	**NFIP?**	**CRS Level**	**NFIP Comments**
160	Linn	Lyons	Linn County HMP 2010	**Dec-15**		**Yes**	—	
161	Linn	Mill City			No Plan	**Yes**	—	
162	Linn	Millersburg			No Plan	**Yes**	—	
163	Linn	Scio	Linn County HMP 2010	**Dec-15**		**Yes**	—	
164	Linn	Sodaville	Linn County HMP 2010	**Dec-15**		**No**	—	**Has FIRM**
165	Linn	Sweet Home	Sweet Home HMP	**Aug-14**	Stand-alone City NHMP	**Yes**	—	
166	Linn	Tangent	Linn County HMP 2010	**Dec-15**		**Yes**	—	
167	Linn	Waterloo			No Plan	**Yes**	—	
168	**Malheur**	**Malheur County**	Malheur County HMP	**May-19**		**Yes**	—	
169	Malheur	Adrian	Malheur County HMP	**Sep-13**	Did not participate in update	**Yes**	—	
170	Malheur	Jordan Valley	Malheur County HMP	**Sep-13**	Did not participate in update	**Yes**	—	
171	Malheur	Nyssa	Malheur County HMP	**May-19**		**Yes**	—	
172	Malheur	Ontario	Malheur County HMP	**May-19**		**Yes**	—	
173	Malheur	Vale	Malheur County HMP	**May-19**		**Yes**	—	
174	**Marion**	**Marion County**	Marion County HMP	**Jul-16**	Update funded.	**Yes**	**6**	
175	Marion	Aumsville			No Plan	**Yes**	—	
176	Marion	Aurora	Marion County HMP	**Jul-16**		**Yes**	—	
177	Marion	Detroit			No Plan	**Yes**	—	
178	Marion	Donald			No Plan	**No**	—	**All X zone**

Local Jurisdiction NHMP, NFIP, And CRS Status								
#	**County**	**Jurisdiction**	**Plan Title**	**Expiration Date**	**LNHMP Comments**	**NFIP?**	**CRS Level**	**NFIP Comments**
179	Marion	Gates			No Plan	**Yes**	—	
180	Marion	Gervais			No Plan	**Yes**	—	
181	Marion	Hubbard			No Plan	**Yes**	—	
182	Marion	Idanha			No Plan	**Yes**	—	
183	Marion	Jefferson (City)			No Plan	**Yes**	—	
184	Marion	Keizer	Marion County HMP	**Jul-16**		**Yes**	—	
185	Marion	Mt Angel			No Plan	**Yes**	—	
186	Marion	Salem	Salem HMP	**Dec-17**	Stand-alone City NHMP	**Yes**	**6**	
187	Marion	Scotts Mills			No Plan	**Yes**	—	
188	Marion	Silverton	Marion County HMP	**Jul-16**		**Yes**	—	
189	Marion	St Paul			No Plan	**Yes**	—	
190	Marion	Stayton			No Plan	**Yes**	—	
191	Marion	Sublimity			No Plan	**Yes**	—	
192	Marion	Turner	City of Turner	**Mar-18**	Stand-alone City NHMP	**Yes**	—	
193	Marion	Woodburn	Marion County HMP	**Jul-16**		**Yes**	—	
194	**Morrow**	**Morrow County**	Morrow County HMP	**Dec-11**		**Yes**	—	
195	Morrow	Boardman	Morrow County HMP	**Dec-11**		**Yes**	—	
196	Morrow	Heppner	Morrow County HMP	**Dec-11**		**Yes**	**8**	
197	Morrow	Ione	Morrow County HMP	**Dec-11**		**Yes**	—	

Local Jurisdiction NHMP, NFIP, And CRS Status								
#	**County**	**Jurisdiction**	**Plan Title**	**Expiration Date**	**LNHMP Comments**	**NFIP?**	**CRS Level**	**NFIP Comments**
198	Morrow	Irrigon	Morrow County HMP	**Dec-11**		**Yes**	**—**	
199	Morrow	Lexington	Morrow County HMP	**Dec-11**		**Yes**	**—**	
200	**Multnomah**	**Multnomah County**	Multnomah County HMP	**Jul-17**	Stand-alone County NHMP Update funded.	**Yes**	**—**	
201	Multnomah	Fairview	Fairview HMP	**Jan-16**	Stand-alone City NHMP	**Yes**	**—**	
202	Multnomah	Gresham	Gresham HMP	**Oct-18**	APA 08/02/13	**Yes**	**—**	
203	Multnomah	Maywood Park			No Plan	**N/A**	**—**	
204	Clackamas, Multnomah, Washington	Metro Region			Not Applicable	**N/A**	**—**	
205	Clackamas, Multnomah, Washington	Metro Region			Not Applicable	**N/A**	**—**	
206	Multnomah	Mount Hood Community College Special District	Mount Hood Community College NHMP	**May-17**	Stand-alone Special District Plan	**N/A**	**—**	
207	Multnomah	Portland	Portland Hazard Mitigation Plan	**Feb-16**	Stand-alone City NHMP	**Yes**	**5**	
208	Multnomah	Troutdale	Troutdale HMP	**Jan-16**	Stand-alone City NHMP	**Yes**	**7**	
209	Multnomah	Wood Village	Wood Village HMP	**Jan-16**	Stand-alone City NHMP	**Yes**	**—**	
210	**Polk**	**Polk County**	Polk County HMP	**Oct-14**	Update funded.	**Yes**	**8**	
211	Polk	Dallas	Polk County HMP		Did not adopt.	**Yes**	**—**	
212	Polk	Falls City	Polk County HMP		No Plan.	**Yes**	**—**	
213	Polk	Independence	Polk County HMP	**Oct-14**		**Yes**	**—**	
214	Polk	Monmouth	Polk County HMP	**Oct-14**		**Yes**	**—**	

Local Jurisdiction NHMP, NFIP, And CRS Status								
#	**County**	**Jurisdiction**	**Plan Title**	**Expiration Date**	**LNHMP Comments**	**NFIP?**	**CRS Level**	**NFIP Comments**
215	**Sherman**	**Sherman County**	Sherman County HMP	**Feb-19**		**Yes**	**—**	
216	Sherman	Grass valley	Sherman County HMP	**Feb-19**		**Yes**	**—**	
217	Sherman	Moro	Sherman County HMP	**Feb-19**		**No**	**—**	**Never mapped**
218	Sherman	Rufus	Sherman County HMP	**Feb-19**		**Yes**	**—**	
219	Sherman	Wasco (City)	Sherman County HMP	**Feb-19**		**Yes**	**—**	
220	**Tillamook**	**Tillamook County**	Tillamook County HMP	**Apr-17**	Update funding pending.	**Yes**	**—**	
221	Tillamook	Bay City	Tillamook County HMP	**Apr-17**		**Yes**	**—**	
222	Tillamook	Garibaldi	Tillamook County HMP	**Apr-17**		**Yes**	**—**	
223	Tillamook	Manzanita	Tillamook County HMP	**Apr-17**		**Yes**	**—**	
224	Tillamook	Nehalem	Tillamook County HMP	**Apr-17**		**Yes**	**7**	
225	Tillamook	Rockaway Beach	Tillamook County HMP	**Apr-17**		**Yes**	**—**	
226	Tillamook	Tillamook (City)	Tillamook County HMP	**Apr-17**		**Yes**	**7**	
227	Tillamook	Wheeler (City)	Tillamook County HMP	**Apr-17**		**Yes**	**—**	
228	**Umatilla**	**Umatilla County**	Umatilla County HMP	**May-19**		**Yes**	**—**	
229	Umatilla	Adams	Umatilla County HMP	**Jul-14**		**Yes**	**—**	
230	Umatilla	Athena	Athena Addendum to Umatilla County Plan	**Jul-14**		**Yes**	**—**	
231	Umatilla	Echo			No Plan	**Yes**	**—**	
232	Umatilla	Helix			No Plan	**Yes**	**—**	
233	Umatilla	Hermiston			No Plan	**Yes**	**—**	

Local Jurisdiction NHMP, NFIP, And CRS Status								
#	**County**	**Jurisdiction**	**Plan Title**	**Expiration Date**	**LNHMP Comments**	**NFIP?**	**CRS Level**	**NFIP Comments**
234	Umatilla	Milton-Freewater			No Plan	**Yes**	**—**	
235	Umatilla	Pendleton			No Plan	**Yes**	**—**	
236	Umatilla	Pilot Rock	Umatilla County HMP	**Jul-14**		**Yes**	**—**	
237	Umatilla	Stanfield			No Plan	**Yes**	**8**	
238	Umatilla	Ukiah			No Plan	**Yes**	**—**	
239	Umatilla	Umatilla (City)	Umatilla County HMP	**Jul-14**		**Yes**	**—**	
240	Umatilla	Weston	Weston Addendum to Umatilla County Plan	**Jul-14**		**Yes**	**—**	
241	**Union**	**Union County**	NE Oregon - Region 7 HMP	**Jun-19**		**Yes**	**—**	
242	Union	Cove			No Plan	**No**	**—**	**Never mapped**
243	Union	*Eastern Oregon University Special District*	Eastern Oregon University	**May-18**	Stand-alone Special District Plan	**N/A**	**—**	
244	Union	Elgin			No Plan	**Yes**	**—**	
245	Union	Imbler			No Plan	**No**	**—**	
246	Union	Island City			No Plan	**Yes**	**—**	
247	Union	La Grande	NE Oregon - Region 7 HMP	**Jun-19**		**Yes**	**—**	
248	Union	North Powder			No Plan	**Yes**	**—**	
249	Union	Summerville			No Plan	**Yes**	**—**	
250	Union	Union (City)			No Plan	**Yes**	**—**	
251	**Wallowa**	**Wallowa County**	NE Oregon - Region 7 HMP	**Jun-19**		**Yes**	**—**	
252	Wallowa	Enterprise	NE Oregon - Region 7 HMP	**Jun-19**		**Yes**	**—**	

Local Jurisdiction NHMP, NFIP, And CRS Status								
#	County	Jurisdiction	Plan Title	Expiration Date	LNHMP Comments	NFIP?	CRS Level	NFIP Comments
253	Wallowa	Joseph			No Plan	**Yes**	—	
254	Wallowa	Lostine			No Plan	**Yes**	—	
255	Wallowa	Wallowa (City)			No Plan	**Yes**	—	
256	**Wasco**	**Wasco County**	Wasco County HMP	**Jan-18**		**Yes**	—	
257	Wasco	Antelope			No Plan	**No**	—	**Never mapped**
258	Wasco	Dufur			No Plan	**Yes**	—	
259	Wasco	Maupin			No Plan	**Yes**	—	
260	Wasco	Mosier			No Plan	**Yes**	—	
261	Wasco	Shaniko			No Plan	**No**	—	**Never mapped**
262	Wasco	The Dalles			No Plan. Participated with Wasco County but decided not to update.	**Yes**	—	
263	**Washington**	**Washington County**	Washington County Hazard Mitigation Plan	**Feb-16**	Update funded.	**Yes**	—	
264	Washington	Banks			No Plan	**No**	—	**Never mapped**
265	Washington	Beaverton	Beaverton HMP	**Mar-16**	Stand-alone City NHMP Update funding pending.	**Yes**	—	
266	Washington	Cornelius	Washington County Hazard Mitigation Plan	**Feb-16**		**Yes**	—	
267	Washington	Durham			No Plan	**Yes**	—	
268	Washington	Forest Grove	Washington County Hazard Mitigation Plan	**Feb-16**		**Yes**	—	
269	Washington	Gaston			No Plan	**Yes**	—	
270	Washington	Hillsboro	Hillsboro HMP	**Apr-13**	Stand-alone City NHMP. Update underway.	**Yes**	—	
271	Washington	King City			No Plan	**Yes**	—	

Local Jurisdiction NHMP, NFIP, And CRS Status								
#	County	Jurisdiction	Plan Title	Expiration Date	LNHMP Comments	NFIP?	CRS Level	NFIP Comments
272	Washington	North Plains			No Plan	**Yes**	**—**	
273	Washington	Sherwood			No Plan	**Yes**	**—**	
274	Washington	Tigard	Washington County Hazard Mitigation Plan	**Dec-09**	Tigard did not participate in Washington County's HMP update so its plan is expired.	**Yes**	**—**	
275	Washington	Tualatin			No Plan	**Yes**	**—**	
276	**Wheeler**	**Wheeler County**	Wheeler County HMP	**May-19**		**Yes**	**—**	
277	Wheeler	Fossil	Wheeler County HMP	**May-19**		**No**	**—**	
278	Wheeler	Mitchell	Wheeler County HMP	**May-19**		**Yes**	**—**	
279	Wheeler	Spray	Wheeler County HMP	**May-19**		**No**	**—**	
280	**Yamhill**	**Yamhill County**	Yamhill County HMP	**Nov-19**		**Yes**	**—**	
281	Yamhill	Amity	Yamhill County HMP	**Nov-19**		**Yes**	**—**	
282	Yamhill	Carlton	Yamhill County HMP	**Jul-14**	Did not update.	**Yes**	**—**	
283	Yamhill	Dayton	Yamhill County HMP	**Nov-19**		**Yes**	**—**	
284	Yamhill	Dundee	Yamhill County HMP	**Nov-19**		**Yes**	**—**	
285	Yamhill	Lafayette	Yamhill County HMP	**Nov-19**		**Yes**	**—**	
286	Yamhill	McMinnville			No Plan	**Yes**	**—**	
287	Yamhill	Newberg	Yamhill County HMP	**Nov-19**		**Yes**	**—**	
288	Yamhill	Sheridan	Yamhill County HMP	**Nov-19**		**Yes**	**8**	
289	Yamhill	Willamina	Yamhill County HMP	**Nov-19**		**Yes**	**—**	

Local Jurisdiction NHMP, NFIP, And CRS Status								
#	**County**	**Jurisdiction**	**Plan Title**	**Expiration Date**	**LNHMP Comments**	**NFIP?**	**CRS Level**	**NFIP Comments**
290	Yamhill	Yamhill (City)	Yamhill County HMP	**Nov-19**		**Yes**	**—**	

3.5 Coordinating State and Local Mitigation Planning

(4) A section on the Coordination of Local Mitigation Planning that includes the following:

(i) A description of the State process to support, through funding and technical assistance, the development of local mitigation plans.

(ii) A description of the State process and timeframe by which the local plans will be reviewed, coordinated, and linked to the State Mitigation Plan.

(iii) Criteria for prioritizing communities and local jurisdictions that would receive planning and project grants under available funding programs, which should include consideration for communities with the highest risks, repetitive loss properties, and most intense development pressures. Further, that for non-planning grants, a principal criterion for prioritizing grants shall be the extent to which benefits are maximized according to a cost benefit review of proposed projects and their associated costs.

3.5.1 Funding and Technical Assistance

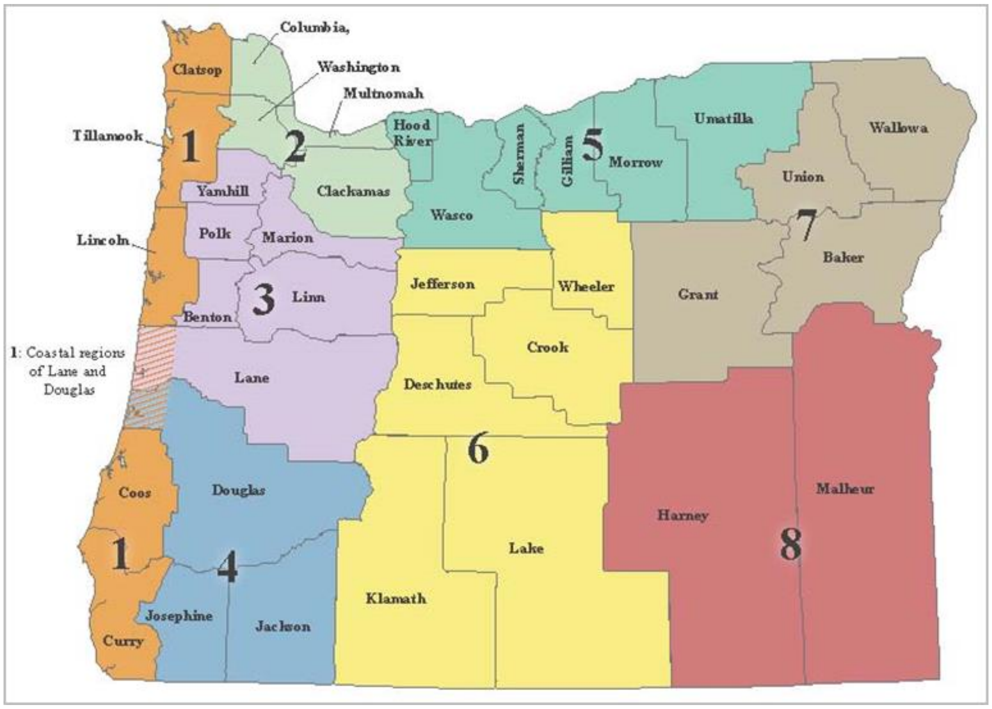
3.5.1.1 Funding and Technical Assistance Process

The State of Oregon continues to build local capacity in developing and implementing risk reduction strategies through plan development support, professional assistance, resource sharing, and technical assistance. Local mitigation planning continues to be accomplished in great measure through the state's Pre-Disaster Mitigation Planning Program, established in 2004 by the Oregon Office of Emergency Management (OEM) in partnership with the Oregon Partnership for Disaster Resilience (OPDR). The program systematically provides funding and technical assistance to local governments for the purpose of developing or updating existing local natural hazards mitigation plans with the goal of ensuring that each county and municipality in the State of Oregon maintains a FEMA-approved natural hazards mitigation plan.

Because local mitigation plans expire after 5 years, the State's strategy is to assist local jurisdictions with plan updates and new plan development on a 5-year rotational basis. OEM has divided the state into eight hazard mitigation regions for mitigation planning and emergency response purposes (**Figure 3-5**). **Table 3-13** presents the model mitigation planning schedule as it rotates through the mitigation planning regions from 2012 through 2020. Note that while some local jurisdictions elect not to participate in the regional planning cycle as scheduled, all 36 counties in Oregon currently participate in the five-year local plan update process.

In 2014, OEM and OPDR developed a "pre-application" process to screen local communities interested in participating in regional FEMA PDM grant applications. The process consisted of (a) personal communication between the State Hazard Mitigation Officer and local NHMP leads in jurisdictions with plans coming due, (b) an invitation to participate in the pre-application process, and (c) a questionnaire designed to solicit local interest in participating and determine the jurisdiction's capability to participate. The first time through the pre-application process, OEM and OPDR received six completed pre-applications. Of those, five are applying for PDM 14 grant funds through OPDR and the sixth jurisdiction's plan will be developed with funding still available in the PDM 12 grant. Because it was so successful, the state intends to continue using the pre-application process.

Figure 3-5. Oregon NHMP Natural Hazard Regions



Source: OEM

Table 3-13. Model 5-Year Rotational Mitigation Planning Schedule, 2012–2020

Planning Year	OEM Planning Region
2011-12	Region 5
2012-13	Regions 7 and 8
2013-14	Region 6
2014-15	Regions 1 and 3
2015-16	Region 2
2016-17	Region 5
2017-18	Regions 7 and 8
2018-19	Region 6
2019-20	Regions 1 and 3

Source: OPDR

3.5.1.2 Funding and Technical Assistance Provided

Direct State technical planning assistance for local NHMPs is provided primarily by OEM, DLCD, and DOGAMI. This assistance is funded by full or partial State support of FTE positions whose duties include providing technical assistance in mitigation planning and project implementation to local communities. Technical assistance is also provided indirectly, in the form of access to products and information.

At OEM, the State Hazard Mitigation Officer (SHMO) assists with mitigation project development, execution, and grant compliance. Others provide oversight of mitigation plans; assistance with mitigation for natural, cultural, and historic resources; public information and outreach, particularly for earthquake and tsunami hazards; and tsunami evacuation planning.

DLCD staff provide local governments assistance in complying with Statewide Planning Goal 7 which requires planning for hazard mitigation; integrating local NHMPs with comprehensive plans and implementing programs and regulations; implementing the NFIP and participating in the NFIP's CRS Program; developing and providing access to hazard data through the Risk MAP Program; and beginning in 2014, with updating and developing local NHMPs.

Together, OEM and DLCD provide technical assistance to property owners and local governments for mitigating repetitive loss (RL) and severe repetitive loss (SRL) properties. DLCD visits each property FEMA has identified as RL or SRL to verify its address, geolocation, and situation to assess its mitigation potential, then works with OEM to determine which are the most likely candidates for mitigation according to state and federal criteria. DLCD contacts the affected local government(s) who in turn contact the RL or SRL property owners, and when all criteria have been met, OEM helps the community(ies) prepare sub-applications. In addition to this routine work, Notice of Funding Availability letters will be sent directly to jurisdictions with validated RL and SRL properties whenever funding opportunities become available.

In addition to the Risk MAP Program's products, specific hazard information, risk, and vulnerability assessment products are provided by DOGAMI on a funding-contingent basis. When State funding is involved, it may come through DOGAMI itself or from other State agencies. One example is DOGAMI's study of statewide channel migration zone susceptibility which is fully supported with State funds. This is an important step forward in understanding the state's flood risk, and is expected to pave the way for further state and federal funding to support detailed channel migration zone delineations. Ultimately, these products will help save lives and reduce property damage from flooding. Another example is DOGAMI's recently launched flood hazard webpage, http://www.oregongeology.org/flood/default.htm.

Numerous other agencies — federal (e.g., FEMA, U.S. Geological Survey, U.S. Army Corps, etc.), State (e.g., ODF, ODOT, OHA, etc.) and local (counties, cities, councils of governments, special districts, etc.) — also contribute valuable technical information and support to local mitigation planning efforts.

A critical source of technical hazard mitigation planning assistance in Oregon, the Oregon Partnership for Disaster Resilience at the University of Oregon assists local jurisdictions with grant writing, local plan development, plan update, process facilitation, stakeholder engagement, public outreach, and hazard research services and serves as a liaison between local communities and state, federal and NGO partners during the mitigation planning process. OPDR strives to ensure that local communities: (a) receive the tools and resources to successfully facilitate and document plan development or plan update processes (b) establish regional partnerships to discuss collaborative projects and implementation strategies, and (c) engage with a variety of state and local agencies and organizations that can assist with local risk reduction strategies.

In June 2013, the agencies most actively involved in local mitigation planning and technical assistance (OEM, DLCD, DOGAMI, and OPDR) began meeting between the regularly scheduled State IHMT meetings to foster closer coordination and collaboration on mitigation activities, leverage existing resources, and develop additional resources to support state and local mitigation planning and projects. Topics discussed at these meetings include local mitigation planning project updates and priorities, funding coordination, and agency-level alignment of natural hazard legislation and policy recommendations. The discussions have been successful in improving coordination of (a) funding and technical assistance proposals for supporting local natural hazards mitigation planning and (b) agency legislative and budget proposals, resulting in enhanced funding and technical assistance for local jurisdictions.

Funding for the State's Pre-Disaster Mitigation Planning Program comes primarily from FEMA's PDM and HMGP grants, supplemented by state and local general funds, University of Oregon in-kind match, and other in-kind matching sources (e.g., local stakeholder match).

Focus on 2012-2014

Over the past 3 years, Oregon has used PDM funds to support plan updates in 21 of Oregon's 36 counties (**Table 3-14**). In addition, the state supported Yamhill County's NHMP update with state general funds through its Emergency Management Performance Grant (EMPG) Program. Other jurisdictions, such as Columbia County and the City of Central Point have funded NHMP updates with their own resources. **Table 3-14**, **Table 3-15**, and **Table 3-16** show other projects for which the state provided funding and technical assistance within the last 3 years as well as projects and disasters that are still open.

Table 3-14. Planning Grants Assistance Summary 2012–2014

Grant Program	Resource Offering	Assistance Title	Federal Share
PDM 11	FY2012	State of Oregon Local Plan Updates: Region 2 (Clackamas County) Region 5 (Hood River, Wasco, Sherman, Gilliam, Morrow, and Umatilla Counties) Region 6 (Wheeler County)	$400,000
PDM 12	FY2013	State of Oregon Local Plan Updates: Region 6 (Lake, Jefferson, and Deschutes Counties) Region 7 (Wallowa, Union, Baker, and Grant Counties) Region 8 (Harney and Malheur Counties)	$400,000
PDM 13	FY2013	State of Oregon Local Plan Updates: Region 1 (Curry, Coos, Douglas, and Lincoln Counties) Region 3 (Cities of Corvallis, Eugene, and Springfield)	$250,000
		Region 2 (City of Portland)	$266,000
EMPG	FY2013	Yamhill County — Plan Update	$10,000
PDM 14	FY 2014	Linn, Multnomah, Polk, Washington Counties	$250,000
		Tillamook County, Cities of Beaverton, Albany, and Medford	$215,000 Pending
		Oregon State University	$76,400 Pending

Source: OEM, compiled by OPDR

All Flood Mitigation Assistance (FMA) Program grants prior to and including FY 2012 are completed and closed with the FY2009 offering closed out with FEMA in December 2014. Although closed, of particular interest is the FY 2009 offering of the FMA grant program that included a supplemental allocation offered to the states on a first-come basis. Oregon seized this opportunity and received significant FMA funding for the projects listed in **Table 3-15**.

Table 3-15. Flood Mitigation Assistance Projects and Funding 2009–2014

Project	FMA Funding	Date Completed
City of Lexington (Fire Station/ City Hall Flood Acquisition)	$103,281.00	September 2014
City of Vernonia Home Elevations	$ 532,366.50	September 2014
Vernonia School District Floodplain Acquisition	$11,287,267.39	September 2014
West Oregon Electric Co-op Headquarters Acquisition	$813,774.75	September 2014
City of Madras Police Station/City Hall Floodway Acquisition	$412,497.75	September 2014
Lake Oswego Dam Spillway Retrofit Project	$957,702.75	September 2014

Source: OEM as reported in Federal share, EMS-2009-FM-E001

All PDM FY 2009 and previous year sub-grants are completed and closed out. Sub-grants from FY 2010 are on-going or awaiting closeout with a number of projects completed. Table 3-16 shows the history of FY 2006 and later sub-grants.

Table 3-16. Open PDM Competitive Grant Applications

Project	Status
FY10 PDM Competitive Grant Application	
Deschutes/Crook/Klamath Counties WUI Project	pending EHP
Harney Electric (utility undergrounding)	ongoing

Source: OEM

All past disaster HMGP sub-grant activities prior to 2007 and DR-1683 (declared in February 2007) have been completed. At the time of this 2015 plan update, there are seven actively open disasters, as shown in Table 3-17.

Table 3-17. Status of Open Disaster Grants as of December 2014

Disaster	Status
DR-1683	Project sub-grants completed
DR-1733	Period of Performance ended 12/31/14
DR-1824	Period of Performance ending 3/31/15
DR-1956	Period of Performance ending 2/17/16 with approved one-year extension
DR-1964	Period of Performance ending 3/25/16 with approved one-year extension
DR-4055	Period of Performance ending 3/1/16 with approved one-year extension
DR-4169	Period of Performance ending 4/4/19 with approved one-year extension

Source: OEM

Future Enhancements

Oregon is actively pursuing new resources through the State budget process to increase funding and enhance technical assistance for natural hazard planning.

Technical Assistance Grants

DLCD has a Technical Assistance Grant program to support local planning efforts. Historically this program has been used primarily to support economic development, and natural hazard mitigation has not been identified as a priority for funding. DLCD's Grants Advisory Committee discussed the need for including natural hazard mitigation planning (both local NHMPs and Comprehensive Plan Goal 7) as a priority in September 2014, and will consider including it as a priority in the 2015-17 Grants Allocation Plan. The Committee will recommend the Grants Allocation Plan to the Land Conservation and Development Commission for approval in 2015. The amount of funding allocated to this program has continued to be significantly reduced in recent years. DLCD has requested restoration of previous funding levels for the 2015-17 biennium. This funding would be used to leverage federal funding, making it worth 3 times the amount provided. This is a significant request, and indicates DLCD's commitment to statewide mitigation planning at the local level.

New State Agency Positions

For the 2015-17 biennium, DLCD, DOGAMI, and OEM are all requesting new funding to support hazard mitigation related staff positions in their respective agencies. New positions would increase state's capacity to develop data useful for local hazard mitigation planning; provide access for local jurisdictions to that data; provide technical assistance to local jurisdictions for mitigation planning, projects, and integrating local NHMPs with comprehensive plans, implementing programs and regulations.

New Risk Assessment Methodology

During the NHMP update process the State recognized that no standardized statewide risk assessment methodology is being used across all hazards. With HMGP funding from DR-1733, a subcommittee of the State IHMT developed a new risk assessment concept methodology. DLCD has requested funding to take the first steps in actualizing the new risk assessment model. When fully functional (which will take several years to achieve) the model will provide a standardized way to assess vulnerability to natural hazards in Oregon, allowing the state to strategically target mitigation resources. Once started, it is anticipated that additional state and potentially federal funding will be obtained to complete the model.

For additional information on funding sources used to support local mitigation planning, please refer to the **Funding Sources** section.

3.5.2 Prioritizing Local Jurisdictions for Mitigation Funding

3.5.2.1 Eligibility Criteria for Planning Grants

Grant proposals for developing initial local natural hazards mitigation plans or updating existing plans are evaluated on the basis of the following prioritized criteria:

1. The jurisdiction's plan status:
   - First Priority: Jurisdictions that have never developed a plan;
   - Second Priority: Jurisdictions that have expired plans;
   - Third Priority: Jurisdictions whose plans will expire within 18 months; and
   - Fourth Priority: Jurisdictions whose plans will not expire within 18 months.
2. Jurisdictions located in declared county(ies).
3. Jurisdictions with the required 25% cost-share.
4. Jurisdictions with the highest risks.
5. Jurisdictions with repetitive loss or severe repetitive loss properties.
6. Jurisdictions with the most intense development pressures.
7. Jurisdictions that:
   - Have a local champion to ensure the process moves forward and the plan is completed, and
   - Can spend the grant funds quickly.
8. Jurisdictions located outside the declared county(ies) and geographically diverse with respect to the Oregon NHMP Natural Hazard Regions (**Figure 3-5**).

3.5.2.2 Eligibility Criteria and Ranking System for Project Grants

Proposed hazard mitigation projects, including those proposed under Section 404 of the Stafford Act, are evaluated for FEMA funding eligibility on the basis of federal and State criteria enumerated in **Section 5.4.1.1**.

Oregon implements a pre-application process through which information used to determine eligibility is collected. Eligible projects are ranked based on the policy framework developed by the State Interagency Hazard Mitigation Team. Communities with current FEMA-approved Natural Hazards Mitigation Plans have top priority, and their projects that meet the benefit-cost requirements and have minimal environmental issues can generally be selected and approved quickly. Mitigating homes substantially damaged from flooding is a high-priority mitigation as well.

For detailed information on the ranking system see **Section 5.4.1.2**, and on the benefit-cost analysis see **Section 5.4.2**.

3.5.3 Local Plan Integration

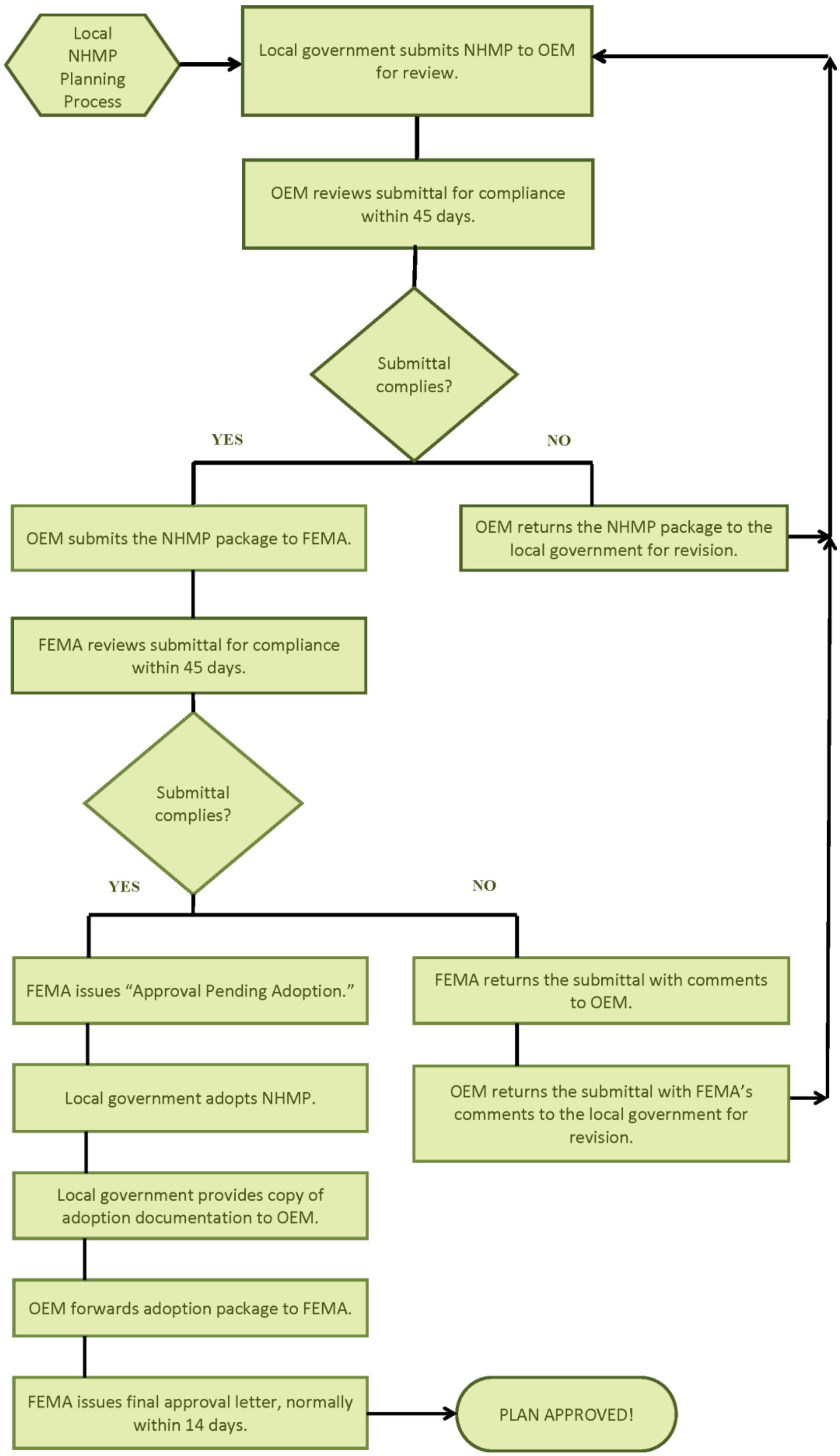
3.5.3.1 State Review of Local Mitigation Plans

Oregon is responsible for reviewing local jurisdictions' NHMPs prior to submittal to FEMA for review and approval (**Figure 3-6**). Once a local jurisdiction has completed a draft plan, it submits the plan to the OEM for review. If OEM finds that the draft plan does not meet all FEMA requirements, it returns the draft to the local jurisdiction for revision. Once OEM is satisfied that the draft plan is approvable, it forwards the draft to FEMA for review. Because of OPDR's extensive experience assisting local jurisdictions with developing NHMPs, the State delegates its review function to OPDR for those plans with which it assisted, and OPDR forwards approvable plans directly to FEMA for review.

If FEMA finds deficiencies, it returns the draft to OEM or OPDR which in turn returns it to the jurisdiction for revision. Once OEM or OPDR and FEMA are satisfied that the draft is approvable, FEMA issues *Approved Pending Adoption* (APA) status by letter to the highest elected official of the local jurisdiction. At this point, the local jurisdiction adopts its NHMP, usually by resolution, and sends a copy of the resolution and adopted NHMP to OEM or OPDR. OEM or OPDR verifies that the NHMP has not changed substantively since APA status was conferred, and forwards the adopted NHMP and resolution to FEMA. Upon receipt and verification that the NHMP has not changed substantively, FEMA issues final approval, again by letter to the highest elected official of the local jurisdiction.

In many cases, two or more local jurisdictions collaborate to develop a multi-jurisdictional NHMP. Most often this collaboration is among a county and some or all of its cities. In these cases, the county plan is primary, and the cities' plans are addenda to the county plan. The same process is followed, but the county adopts and receives final approval from FEMA first, then the cities follow suit. All jurisdictions that are parties to the plan receive the same effective date as the county.

Figure 3-6. State Process for Reviewing Local Mitigation Plans



3.5.3.2 Linking State and Local Plans

Mitigation Action Tracker

Prior to 2012, OPDR hosted a searchable action item database on its website. The purpose of the database was to provide a central, searchable, online location for mitigation actions found within Oregon's local natural hazards mitigation plans. OPDR supported the development, maintenance, and update of the database through FEMA Hazard Mitigation Grant Program funding that supported update of the Oregon Natural Hazards Mitigation Plan.

At the local level, communities used the database to gather ideas for actions, or to identify areas for potential intergovernmental partnerships. State agencies used the database to gain a better understanding of local mitigation needs and implement more effective mitigation actions on a statewide level.

In early 2012, FEMA developed and released a new *Mitigation Action Tracker* in conjunction with the FEMA Risk MAP program. The FEMA tool offers a web-based interface, custom reports and technical support from FEMA through a contractor. Also in 2012, the Oregon Department of Land Conservation and Development agreed to assume responsibility and the requisite grant funding needed to update the Oregon NHMP. The availability of FEMA's *Mitigation Action Tracker* and loss of grant funding led OPDR to discontinue support for the native database in late 2012.

Following conversations with FEMA Region X and state mitigation representatives, OPDR agreed to beta-test FEMA's *Mitigation Action Tracker* in the summer of 2012. OPDR uploaded one city and two county NHMP action sets into FEMA's *Mitigation Action Tracker* and provided FEMA Region X with recommendations for how to improve the tool. In its memo to FEMA Region X, OPDR concluded that *data entry will be more efficient and less subject to varying interpretations of data* using the FEMA database. The memo went on to state, *With the ability to edit and run reports in the FEMA database the database will be more user-friendly and more effective as a data storage and data reporting tool*.

FEMA's Mitigation Action Tracker is now functional and provides the benefit of states being connected directly to FEMA with access to mitigation actions from communities across the nation. However, because it is designed for FEMA regions to track and report only on Risk MAP progress at the regional level, its utility for coordinating state and local natural hazards mitigation planning is limited. Most importantly, it is not accessible to local governments. Oregon will investigate the efficacy of borrowing another state's natural hazards mitigation tracker software or developing a tracker of our own. Developing our own tracker would provide the opportunity to broaden the scope to include related programs and projects. It could be accessible to local governments, state agencies, and other partners. Whichever course is ultimately selected and implemented, using a tracker will ensure that both local and state mitigation planning partners will have a central place to gather ideas for mitigation actions and coordinate local and state mitigation priorities.

State and Local Natural Hazards Mitigation Plan Goals

In 2014, State and local NHMP goals were reviewed and the 2015 Oregon NHMP goals revised to improve the linkage between state and local NHMPs.

Oregon's 36 county-level NHMPs were reviewed to:

- Discern, if possible, whether the state NHMP goals were considered in developing local NHMP goals;
- Determine to what extent local and state NHMP goals are correlated; and
- Identify county-level goals that are not reflected in the Oregon NHMP.

At the local level, counties review the state's goals to inform their local goal identification. If a state goal is determined to be applicable it may be adopted into the local NHMP (often the wording of a goal is changed to account for local circumstances and needs). However, county NHMPs do not consistently reference their review of the state goals in an explicit manner. **Table 3-18** shows which local NHMPs contain a direct textual reference to the state goals. Only 10 of 36 or 28% do make a direct reference.

Table 3-18 also shows the linkage between state and local goals for all 36 counties. In some circumstances state goals are combined into a single goal at the local level (e.g., State Goals 1 and 2 are often combined at the local level.) When that is the case, both goals are shown in **Table 3-18** as appearing in the local plan.

Goal 1 appears in all 36 county NHMPs; Goal 2 appears in 35 (97%) and Goal 7 in 34 (94%). Goal 4 appears in 83% and Goal 3 in 56%. Goals 5, 6, and 8 appear in very few local NHMPs. Goal 5 has to do with the capability of the jurisdiction to carry out its Plan, Goal 6 concerns documenting and evaluating progress in achieving natural hazard mitigation, and Goal 8 promotes eliminating development in hazard areas where risk cannot be mitigated. A goal similar to Goal 8 was found in only one local NHMP.

There are several goals that appear in local NHMPs that were not reflected in the 2012 Oregon NHMP. The most relevant statewide are those with themes of protecting and mitigating risk to cultural and historic resources; enhancing partnerships and coordination among agencies at all levels of government; and integrating NHMPs with other plans. In its April 2014 meeting, the State IHMT decided to include three new goals addressing these themes to better coordinate state and local NHMPs (**Section 3.2.1**). Counties and cities should continue to be encouraged to review the Oregon NHMP goals when developing their NHMPs and to explicitly state their decisions to include or exclude state goal themes.

Table 3-18. Correlation of State and County NHMP Goals

Local Goals			State Goals								Local & State Goals
County	Plan Approve	# Goals	Goal 1	Goal 2	Goal 3	Goal 4	Goal 5	Goal 6	Goal 7	Goal 8	Goals Explicitly Linked?
			Protect life and reduce injuries resulting from natural hazards.	Minimize public and private property damages and the disruption of essential infrastructure and services from natural hazards.	Increase the resilience of local, regional, and statewide economies.	Minimize the impact of natural hazards while protecting and restoring the environment.	Enhance and maintain state capability to implement a comprehensive statewide hazard loss reduction strategy.	Document and evaluate Oregon's progress in achieving hazard mitigation.	Motivate the public, private sector, and government agencies to mitigate against the effects of natural hazards through information and education.	Eliminate development within mapped hazardous areas where the risks to people and property cannot be mitigated.	Are the local NHMP goals specifically linked with the Oregon NHMP goals?
Baker (NE Oregon)	2014	4	X	X	X	X			X		N
Benton	2011[b]	5	X	X	X				X		Y
Clackamas	2013	5	X	X		X			X		N
Clatsop	2015[a]	7	X	X	X	X			X		N
Columbia	2014	4	X	X	X	X			X		N
Coos	2010[b]	6	X	X	X	X			X		Y
Crook	2011	5	X	X		X			X		N
Curry	2010[b]	6	X	X	X	X			X		Y
Deschutes	2010[b]	5	X	X		X			X		N
Douglas	2010[b]	8	X	X			X		X		N
Gilliam	2013	3	X	X					X		N
Grant (NE Oregon)	2014	4	X	X	X	X			X		N
Harney	2013	6	X	X	X	X			X		N
Hood River	2012	7	X	X	X	X	X		X		N
Jackson	2013	7	X	X		X			X		N
Jefferson	2014	6	X	X		X			X		N
Josephine	2012	6	X	X	X	X			X		Y
Klamath[c]	2011	6	X	X	X	X	X	X			N
Lake	2013	4	X	X	X	X	X		X		N
Lane	2012	6	X	X	X	X			X		N
Lincoln	2009[b]	5	X			X			X		N
Linn	2010[b]	3	X	X		X			X		N
Malheur	2014	5	X	X	X	X			X		N
Marion	2011[b]	7	X	X	X	X			X		Y
Morrow	2006	7	X	X		X			X	X	Y
Multnomah	2012[b]	5	X	X		X	X		X		Y

(table continued on next page)

Table 3-18. Correlation of State and County NHMP Goals *(continued)*

Local Goals			State Goals								Local & State Goals
County	Plan Approve	# Goals	Goal 1	Goal 2	Goal 3	Goal 4	Goal 5	Goal 6	Goal 7	Goal 8	Goals Explicitly Linked?
			Protect life and reduce injuries resulting from natural hazards.	Minimize public and private property damages and the disruption of essential infrastructure and services from natural hazards.	Increase the resilience of local, regional, and statewide economies.	Minimize the impact of natural hazards while protecting and restoring the environment.	Enhance and maintain state capability to implement a comprehensive statewide hazard loss reduction strategy.	Document and evaluate Oregon's progress in achieving hazard mitigation.	Motivate the public, private sector, and government agencies to mitigate against the effects of natural hazards through information and education.	Eliminate development within mapped hazardous areas where the risks to people and property cannot be mitigated.	Are the local NHMP goals specifically linked with the Oregon NHMP goals?
Polk	2009[b]	6	X	X		X			X		N
Sherman	2014	4	X	X					X		Y
Tillamook	2012[b]	4	X	X	X	X			X		N
Umatilla	2014	6	X	X		X			X		N
Union (NE Oregon)	2014	4	X	X	X	X			X		N
Wallowa (NE Oregon)	2014	4	X	X	X	X			X		N
Wasco	2013	7	X	X	X	X			X		N
Washington	2011[b]	3	X	X	X	X	X				Y
Wheeler	2014	3	X	X					X		N
Yamhill	2014	6	X	X		X		X	X		Y
Percent Includ	-	-	**100%**	**97%**	**56%**	**86%**	**17%**	**6%**	**94%**	**3%**	**28%**

Notes:
[a]Clatsop County's plan is in the process of being updated. It is expected to be adopted and approved before the 2015 Oregon NHMP is approved.
[b]These plans are funded for updates during the period 2014-2017.
[c]Klamath County is the only county in the state that directly imports Goals 1 - 6 of the 2012 Oregon NHMP into its Plan.

Chapter 4 PLANNING PROCESS

In This Chapter

The Oregon NHMP Planning Process is divided into three sections: (a) Introduction, (b) Developing the 2015 Plan, and (c) Maintaining the 2015 Plan.

1. **Introduction:** States the purpose of this chapter.
2. **Developing the 2015 Plan:** Describes the participants and details the 2015 Plan development process. Demonstrates how the 2015 Oregon NHMP is integrated with other State, regional, and federal initiatives. Includes a table identifying changes from the 2012 Plan.
3. **Maintaining the 2015 Plan:** Analyzes the efficacy of the method and schedule for monitoring, evaluating, and updating the 2012 Oregon NHMP and establishes a method and schedule for monitoring, evaluating, and updating the 2015 Oregon NHMP. Summarizes how mitigation measures and project closeouts will be monitored. Identifies a system for reviewing progress toward achieving Plan goals and mitigation actions. Describes how the mitigation action tables are used to show whether mitigation actions in the 2012 Oregon NHMP were implemented as planned.

4.1 Introduction

> **44 CFR §201.4(b), Planning process.** An effective planning process is essential in developing and maintaining a good plan. The mitigation planning process should include coordination with other State agencies, appropriate Federal agencies, interested groups, and be integrated to the extent possible with other ongoing State planning efforts as well as other FEMA mitigation programs and initiatives.

The Disaster Mitigation Act of 2000 (44 CFR 201) had required that states update their multi-hazard mitigation plans every 3 years to maintain eligibility for federal disaster assistance. Effective May 27, 2014, amendments to 44 CFR 201 changed the state mitigation planning update cycle from 3 to 5 years. Due to contract obligations, Oregon is completing the three-year update already in progress with a deadline of March 2, 2015. However, the State requested and received a one-year no-cost extension to better align the update with the State budget process. Oregon first completed a Natural Hazards Mitigation Plan (Oregon NHMP or Plan) in 1992 with subsequent updates occurring in 2000, 2004, 2006, 2009, 2012, and now 2015. The purpose of this chapter is threefold:

- To describe the process used to develop the 2015 Oregon NHMP,
- To describe the process to be used for tracking progress on mitigation activity and goal achievement during the life of the 2015 Plan, and
- To describe the method and schedule for monitoring, evaluating, and updating the 2015 Plan.

4.2 Developing the 2015 Plan

> **Requirement 44 CFR §201.4(c), Plan content.** To be effective the plan must include the following elements:
>
> **Requirement 44 CFR §201.4(c)(1)** Description of the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how other agencies participated.

The purpose of this section is to describe the process used to develop the 2015 Oregon NHMP. Key meetings, participants, decision points, interagency coordination, and public outreach efforts are described. In addition, other state and federal planning efforts with which the 2015 Plan is integrated are identified, as are the sections of the 2012 Plan that were revised.

4.2.1 Participants and Coordination

The State Interagency Hazard Mitigation Team (IHMT)

Prior to the spring of 1996, what is today the State IHMT was an informal group of state agencies whose representatives met on an ad hoc basis following Presidentially-declared disasters. On March 4, 1997, in response to the floods and landslides of the autumn and winter of 1996-1997, Governor Kitzhaber directed OEM to make the State Interagency Hazard Mitigation Team a permanent body with regular meetings. The State Hazard Mitigation Officer, housed in OEM, chairs the State IHMT. Today the State IHMT meets quarterly to understand losses arising from natural hazards; to recommend and coordinate strategies to mitigate loss of life, property, and natural resources; and to maintain the Oregon NHMP.

State IHMT member agencies:

- Business Oregon — Infrastructure Finance Authority
- Oregon Climate Change Research Institute and Oregon Climate Service
- Oregon Department of Administrative Services — Chief Financial Office
- Oregon Department of Administrative Services — Enterprise Asset Management
- Oregon Department of Administrative Services — Enterprise Goods and Services
- Oregon Department of Administrative Services — Geospatial Enterprise Office
- Oregon Department of Agriculture
- Oregon Department of Consumer and Business Services — Building Codes Division
- Oregon Department of Consumer and Business Services — Insurance Division
- Oregon Department of Environmental Quality
- Oregon Department of Fish and Wildlife
- Oregon Department of Forestry
- Oregon Department of Geology and Mineral Industries
- Oregon Department of Land Conservation and Development
- Oregon Department of State Lands
- Oregon Department of Transportation
- Oregon Health Authority — Health, Security, Prevention, and Response Program
- Oregon Health Authority — Public Health Division
- Oregon Military Department — Office of Emergency Management
- Oregon Parks and Recreation Department

- Oregon Public Utility Commission
- Oregon State Police — Office of State Fire Marshal
- Oregon Water Resources Department
- University of Oregon — Emergency Management and Continuity
- University of Oregon — Oregon Partnership for Disaster Resilience

State IHMT meetings are open to the public, and representatives from non-state IHMT agencies and organizations are added as needed. During the 2013-2015 plan update process, IHMT meetings included a standing agenda item for topics related to the Oregon NHMP update.

State IHMT agencies provided staff and other resources to accomplish the update. State IHMT agency Hazard Leads reviewed and updated portions of the Plan. The Hazard Leads were organized into related Hazard Groups (**Table 4-1**) to foster interagency communication and collaboration, specifically while updating hazard characterizations and mitigation actions, and more generally beyond this project. A state-sponsored collaborative electronic workspace was provided to facilitate project information sharing among hazard groups.

Table 4-1. State IHMT Hazard Groups

Hazard Groups	Leads	Other Member Agencies
Coastal Hazards/Climate Change	Coastal Erosion: DOGAMI Climate Change: DLCD and OCCRI/OCS	ODFW, OHA, DSL, DLCD, OPRD, ODOT, OCCRI/OCS
Wildfires/Droughts/Dust Storms	Wildfires: ODF Droughts: OWRD Dust Storms: ODOT and OEM	ODFW, DEQ, DSL, DLCD, ODF, OEM, OSFM, ODOT, OHA
Earthquakes/Tsunamis/Volcanoes	Earthquakes: DOGAMI and OEM Tsunamis: DOGAMI Volcanoes: DOGAMI	DLCD, DEQ, OEM, OHA, OPRD, PUC
Floods/Landslides/Windstorms/ Winter Storms	Floods: DLCD Landslides: DOGAMI Windstorms: PUC and OCCRI Winter Storms: ODOT and OEM	OWRD, DSL, ODFW, DEQ, OEM, ODOT, OHA, OPRD, PUC

Source: DLCD

DLCD managed and facilitated the update process with oversight and direction from the State IHMT, guidance from FEMA, and in close cooperation with OEM and the State Hazard Mitigation Officer, DOGAMI, and OPDR. Other state and federal agencies also contributed substantively and substantially to the update.

The hazard characterizations and probability and vulnerability assessments were reviewed and revised by subject matter experts from State IHMT agencies, the Oregon Climate Change Research Institute (OCCRI) and Oregon Climate Service (OCS). Significantly, OCCRI and OCS became involved in the State's natural hazards mitigation planning process for the first time during this cycle, lending expertise in the areas of climate change, drought, and windstorms. The Regional Profiles were developed by OPDR. Information about state-owned and leased buildings and critical/essential facilities was provided by DAS and analyzed and reported by DOGAMI. ODOT provided information about seismic lifelines. The Local Capability Assessment, Coordination of Local Mitigation Planning, and Funding sections were reviewed and revised by OPDR, OEM, and DLCD. The Enhanced Plan was developed by OEM. Mitigation actions were reviewed, evaluated, revised, and prioritized by State IHMT agency representatives and other hazard leads, then reviewed, revised, and approved by the State IHMT. Goals were reviewed, revised, and approved by the State IHMT.

The State IHMT's Risk Assessment Sub-Committee (RAS-C), comprised of personnel from OEM, DLCD, DOGAMI, DEQ, Business Oregon's Infrastructure Finance Authority, the University of Oregon, and FEMA developed a new concept methodology for a risk assessment that could, if fully developed, be used to assess risk for all hazards at both the state and local levels.

The Silver Jackets, a U.S. Army Corps of Engineers program is implemented in Oregon as another sub-committee of the State IHMT. It brings together a number of federal and State agencies and has been instrumental in moving flood hazard mitigation forward during this update cycle. This is a new and successful initiative in federal and State collaboration and coordination since approval of the 2012 Oregon NHMP.

Another successful initiative was establishment of quarterly coordination phone calls between FEMA and State IHMT agencies the week prior to State IHMT meetings. This is continuing to improve lines of communication and enhance coordination by providing a regular forum for information exchange.

Because DLCD, DOGAMI, OEM, and OPDR are working on a variety of related mitigation projects together and separately, they have also begun bi-monthly coordination meetings that are providing a useful avenue for enhancing coordination and collaboration and better serving local governments.

Further, FEMA's Risk MAP Program as implemented in Oregon is providing another important link between state agencies, OPDR, local governments, and FEMA and NOAA programs in addressing natural hazard mitigation (particularly flooding) as well as climate change impacts. Oregon's Risk MAP coordinator is also involved with state agencies, universities, and others in a number of initiatives to make natural hazard information available to and accessible by local governments and the public.

4.2.2 The Planning Process

A major change occurred in the planning process during this update cycle: DLCD took responsibility for updating and maintaining the Oregon NHMP. Prior to this, OPDR had facilitated Oregon NHMP updates. Oregon demonstrated its ever-strengthening commitment to natural hazard mitigation by taking this step, and by hiring two natural hazards planners to manage the plan update and implement other natural hazard mitigation initiatives. The transfer of responsibility and hiring process consumed the first year of the update cycle, significantly abbreviating the project timeline. Therefore, plan update tasks were undertaken simultaneously rather than sequentially, then reviewed and revised as necessary to ensure consistency. In September 2014 the State requested a one-year no-cost extension for the project to ease the abbreviated timeline and better align the grant performance period with the state legislative session. FEMA granted the extension in December 2014. The 2015 Oregon NHMP is therefore the result of a two-and-a-half year, collaborative interagency plan update process.

Table 4-2. Chronology

2012	• DLCD took responsibility for updating and maintaining the Oregon NHMP.
February 2013	• DLCD hired two natural hazards planners.
March 2013	• DLCD developed a scope of work, work program, and timeline. Together these documents described a two-year work plan for developing the 2015 Oregon NHMP, and clearly identified roles and responsibilities, requirements, tasks, deliverables, and timelines for task completion. • DLCD convened the State IHMT Risk Assessment Sub-Committee (RAS-C) and began facilitating a process with the State IHMT's Risk Assessment Subcommittee (RAS-C) to develop a new risk assessment concept methodology intended to address the lack of a clear and common methodology for identifying the most vulnerable geographic areas in the state. This process closed successfully in August 2013. The concept methodology has not been tested and could not be used for this update. The state is seeking funding from the state legislature and other funding opportunities to continue this work, looking forward to completing development and implementation over several NHMP update cycles. For more information, see **Future Enhancements to the State Risk Assessment**.
April 2013	• The planning process began in earnest in April 2013 with a letter from the DLCD's Director, Jim Rue, to directors of other State IHMT agencies' announcing the beginning of the 2015 Oregon NHMP update cycle, requesting their commitment to it and their attendance at the April 2013 meeting of the State IHMT. • Development of goals for the update and organization of the planning process were the first orders of business at the April 2013 State IHMT meeting. The scope of work, work program, and timeline were presented and agreed to by the State IHMT. These goals for the update were articulated and agreed to by the State IHMT: ○ Improve interagency coordination and collaboration on natural hazard mitigation activities. ○ Enhance the risk assessment methodology. ○ Regain "Enhanced Plan" status. ○ Address climate change and sea level rise in the risk assessment. ○ Make project information easily available to interested parties. ○ Make risk assessment data accessible to local jurisdictions. ○ Prioritize actions for funding based on the enhanced risk assessment. ○ Eliminate redundancy and increase consistency throughout the Plan. ○ Review action items to ensure they are SMART (specific, measurable, achievable, realistic, and time-oriented).

	○ Make the 2015 Plan a "living document." • DLCD also introduced the process for developing a new risk assessment concept methodology at this meeting. • The RAS-C identified risk assessment evaluation criteria. DLCD, OPDR, and InfoGraphics conducted literature reviews of risk assessment methods found in academic literature and other state Natural Hazards Mitigation Plans.
May 2013	• FEMA approved the scope of work, work program, and timeline. • The RAS-C discussed literature review findings and how to integrate emerging trends into an Oregon-tailored model. • DLCD identified State IHMT agency staff leads for each hazard to review and update portions of the Plan, and organized related Hazard Groups (Section 5.2.1 and Table 5-1). A state-sponsored collaborative electronic workspace was provided to facilitate project information sharing among hazard groups. • DLCD met with Hazard Leads to discuss vulnerability data: theme, source, quality, and accessibility.
June 2013	• InfoGraphics facilitated a discussion with the RAS-C about big picture objectives, technical approach and data inputs for the new risk assessment model. • The Earthquake/Tsunami/Volcano and Flood/Landslide/Windstorm/Winter Storm Hazard Groups held their first meetings. They were introduced to the update project and the collaborative electronic workspace, and discussed their tasks and timelines. • To facilitate local government and public involvement, a website for the plan update project was established on DLCD's website. A listserv was also developed to provide project information to interested parties. • DLCD's Regional Representatives were apprised of the project, website, and listserv, and provided with a spreadsheet showing the NHMP and NFIP status of each city and county in the state. DLCD continued throughout the update process to provide revised spreadsheets to the appropriate regional representative whenever a community received "approval pending adoption" or final approval of its NHMP from FEMA. • The Regional Representatives provided contact information for local government officials who were emailed an invitation to join the listserv, visit the website, and comment on posted draft documents. They were also encouraged to pass this information along to other interested parties.
July 2013	• The Fire/Drought/Dust Storm and Coastal Hazards/Climate Change Hazard Groups held their first meetings. They were introduced to the update project and the collaborative electronic workspace, and discussed their tasks and timelines. • DLCD took delivery of the 2012 Oregon NHMP document files from OPDR.

- State IHMT held its quarterly meeting at which DLCD discussed progress and next steps for the update, highlighting the launch of the project website and listserv. DLCD also discussed progress on development of the new risk assessment concept methodology.

August 2013

- InfoGraphics presented a concept model, 3-year work plan, and budget to the RAS-C.
- To facilitate local government and public involvement, a website for the State IHMT was established on OEM's website. DLCD's Regional Representatives were apprised of the website launch and were encouraged to pass this information along to other interested parties.
- The Hazard Group Leads met to discuss integrating climate change into the hazard characterizations.
- Hazard Leads began reviewing the 2012 Oregon NHMP mitigation actions in preparation for a September discussion of them with all hazard group members.

September 2013

- DLCD developed a method for reorganizing and streamlining the 2015 Oregon NHMP. It included a new approach to the Risk Assessment section of the Plan that integrates the Hazard chapters, reducing redundancies and streamlining the update process.
- The Hazard Groups met and discussed the status of the mitigation actions in the 2012 Oregon NHMP and which should be retained, removed, changed, or added. For more detail, see **Mitigation Actions**.

October 2013

- RAS-C members gave unanimous support to the risk assessment concept model and discussed possible funding opportunities.
- The State IHMT held its quarterly meeting. DLCD briefed the State IHMT on progress, and received approval to continue with its proposals for streamlining the document and prioritizing mitigation actions. DLCD also updated the IHMT on the final work plan, timeline and budget presented by InfoGraphics for the new risk assessment concept model, and discussed possible funding opportunities.
- DLCD met with Hazard Leads and presented 2015 Risk Assessment update tasks. Each Hazard Lead was provided with templates and instructions for updating the state and local (regional) risk assessments including hazard characterizations, probabilities, and vulnerabilities. The Hazard Leads worked on the Risk Assessments through March 2014. DLCD continued meeting and communicating with the Hazard Leads individually to refine the updates and produce a preliminary draft risk assessment.
- DLCD provided its Regional Representatives and OPDR with an informational piece about the update and requested they provide it to their contacts in local jurisdictions and other contacts who may be interested.

November 2013	• DLCD together with OHA and DOGAMI submitted a grant proposal to NOAA that to further development of the risk assessment concept model. The proposal was not approved for funding. • DLCD and Hazard Leads continued work on updating the risk assessment. • DLCD continued readying the mitigation actions for prioritization.
December 2013	• The Hazard Leads met and began prioritizing mitigation actions by scoring each "priority" action on several criteria. Next, managers were asked to identify their agencies' level of support for each action. For more detail, see **Mitigation Actions**. • DOGAMI completed updating statewide hazard maps for coastal erosion, earthquakes, floods, landslides, tsunamis, volcanic hazards, and wildfires.
January 2014	• DLCD posted the prioritized mitigation actions on the project website for public review and comment. • The State IHMT held its quarterly meeting. DLCD provided an update on project progress, including the risk assessment and a presentation of the prioritized mitigation actions. The State IHMT requested the actions be organized by hazard. • The Silver Jackets hosted a presentation by DLCD and discussion of the Oregon NHMP update process at its regular meeting and followed up with suggestions for action. • DOGAMI completed updating the inventory of state-owned/leased buildings and critical/essential facilities and non-state-owned/leased critical/essential facilities.
February 2014	• DLCD continued work on prioritizing and re-organizing mitigation actions and updating the State Risk Assessment. • DOGAMI completed updating the database of state-owned/leased buildings and critical/essential facilities. • Work on regional profiles, mitigation strategy, and plan maintenance and monitoring began and continued through the summer.
March 2014	• DLCD prepared a preliminary draft of the state-level Risk Assessment for public review. • DLCD prepared spreadsheets showing revised and prioritized mitigation actions for public review.

April 2014	• The State IHMT held its quarterly meeting. The State IHMT reviewed the existing goals and revised one for better alignment with agency policy and activities. A review of county NHMP goals against Oregon NHMP goals revealed areas where the state goals could better reflect local goals, and the State IHMT added three new goals to achieve that consistency. Several mitigation actions were reviewed, revised, and added. The IHMT decided to consider prioritizing hazards for the next Plan update. DLCD presented the Preliminary Draft State Risk Assessment. • The Preliminary Draft State Risk Assessment and one regional risk assessment were prepared and furnished to FEMA for review. • The State Risk Assessment and prioritized mitigation actions were posted on the project website for public review and comment. A notice was sent to the listserv.
May–June 2014	• DLCD continued to work with the Hazard Leads and OPDR through the summer of 2014, pursuing enhancements to both the state and local (regional) level risk assessments in response to FEMA's comments and to continue to fill gaps and improve the Risk Assessment. • Work also continued on the Mitigation Strategy, Planning Process, and Enhanced Plan chapters.
July 2014	• The State IHMT held its quarterly meeting. DLCD presented a brief update on overall progress of the project, the status of the Preliminary Draft 2015 Oregon NHMP, finalization of mitigation actions, development of mitigation success stories, and next steps. • Work continued on refining the mitigation action tables; refining maps; collecting mitigation success stories; and completing unfinished portions of the Preliminary Draft 2015 Plan. Formatting and editing began.
August 2014	• A Preliminary Draft 2015 Oregon NHMP was posted to the project website for public review and comment. One set of comments was received. DLCD and Hazard Leads responded to comments. See **Appendix 9.4.17**. • Work continued on completing unfinished portions, formatting and editing the August 2014 Preliminary Draft 2015 Oregon NHMP into a Draft 2015 Oregon NHMP to be posted for public comment. • OEM, the Oregon Parks & Recreation Department, the State Historic Preservation Office, and the Oregon Heritage Commission advanced work on developing a coordinated, long-term approach to mitigating impacts to cultural and historic resources from natural hazards. For the first time, the Oregon NHMP includes a section describing potential future enhancements to the risk assessment and mitigation strategy intended to protect and

	preserve cultural and historic resources.
September 2014	• By letter dated September, 23, 2014 to the State Hazard Mitigation Officer, DLCD requested a one-year no-cost extension for the project to ease the abbreviated timeline and better align the grant performance period with the state legislative session. • Work continued on preparing the Draft 2015 Oregon NHMP. • The Grants Advisory Committee discussed the need for including natural hazard mitigation planning (both local NHMPs and Comprehensive Plan Goal 7) as a priority for Technical Assistance Grants.
October 2014	• By letter dated October 22, 2014 to FEMA, the State Hazard Mitigation Officer requested a one-year no-cost extension for this and other projects. • Work continued on preparing the Draft 2015 Oregon NHMP. • The State IHMT held its quarterly meeting. The State Hazard Mitigation Officer reported on the one-year no-cost extension requests, including the request for this project, and that work is continuing on the Draft 2015 Oregon NHMP.
November 2014	• Work continued on preparing the Draft 2015 Oregon NHMP.
December 2014	• By letter dated December 12, 2014, FEMA approved the requested one-year no-cost extension to March 1, 2016. • Content of the Draft 2015 Oregon NHMP was largely completed; formatting and editing continued.
January 2015	• Formatting and editing continued. • FEMA began an informal review of the 2nd Preliminary Draft Plan. • The Grants Advisory Committee directed staff to include natural hazard mitigation planning (both local NHMPs and Comprehensive Plan Goal 7) as Priority #3 for Technical Assistance Grants in the Draft 2015-17 Grants Allocation Plan.
February 2015	• DLCD posted the formatted and edited Draft 2015 Oregon NHMP to the project website for public review and comment. FEMA provided comments based on its informal review of the 2nd Preliminary Draft Plan.

March 2015	• The public review and comment period ended. • DLCD and Hazard Leads responded to comments. See **Appendix 9.4.18**. • Additional necessary formatting and editing was done.
April 2015	• The Draft 2015 Oregon NHMP was published for final comments. • DLCD and Hazard Leads responded to comments. See **Appendix 9.4.19**. • The State IHMT held its quarterly meeting. The Draft 2015 Oregon NHMP and public comments were reviewed. The Draft was approved with revisions for formal submittal to FEMA. • Revisions were made and editing continued. • The Grants Advisory Committee recommended the adoption of Draft Grants Allocation Plan, including natural hazards mitigation planning as Priority #3 for Technical Assistance Grants, to the Land Conservation and Development Commission (LCDC).
May 2015	• On May 12, 2015, the State Hazard Mitigation Officer submitted the Final Draft 2015 Oregon NHMP to FEMA for formal review. • FEMA's 45-day review period began. • LCDC approved the Grants Allocation Plan with natural hazards mitigation planning as Priority #3 for Technical Assistance Grants. • DLCD began developing materials and systems for plan implementation.
June 2015	• On June 15, 2015, FEMA issued a letter granting "Approved Pending Adoption" status to the 2015 Oregon NHMP.
July 2015	• On July 1, 2015, Governor Brown issued a letter promulgating the 2015 Oregon Natural Hazards Mitigation Plan. • On July 13, 2015, DLCD received approval from FEMA for copy editing prior to final submittal. Copy editing began. • On July 16, 2015, the State IHMT held its quarterly meeting. Plan maintenance was discussed and the progress report form and schedule was reviewed.

August 2015	• Copy editing continued. • Individual Mitigation Action Trackers were provided to all leads electronically and in hard copy. • The first NHMP progress reports covering the period January – June 2015 were submitted to DLCD
September 2015	• Copy editing was completed. • On September 18, 2015, the State Hazard Mitigation Officer submitted the 2015 Oregon NHMP to FEMA for final approval. • FEMA approved the 2015 Oregon NHMP on September 24, 2015.

Source: DLCD

4.2.3 Revisions to the 2012 Oregon Natural Hazards Mitigation Plan

Table 4-3. Revisions to the 2012 Oregon Natural Hazards Mitigation Plan

2012	2015	Explanation
Overview and Organization	**Chapter 1: Introduction to the Plan**	
Introduction	Section 1.1 Background	revised
Plan Mission and Goals	Section 3.2 Mission, Vision, and Goals	revised; three new goals added; Goal 4 revised
Plan Structure and Organization	Sections 1.2, 1.3, 1.4	revised; the 2015 Plan has been wholly reorganized
Section I: Planning Process	**Chapter 5: Planning Process**	
Documentation of the Planning Process	Section 5.2.2 The Planning Process	reorganized, revised
Coordination Among Agencies and Program Integration	Section 5.2.1 Participants and Coordination	reorganized, revised
2012 Plan Review Process	Section 5.2.2 The Planning Process	reorganized, revised
Appendix 1-A: Plan Changes	Section 5.2.3 Revisions to the 2012 Oregon Natural Hazards Mitigation Plan	reorganized, revised
Section 2: Risk Assessment	**Chapter 2: Risk Assessment**	reorganized, revised, updated
Hazard Overview	Section 2.2.1.1 Overview	Updated
No Equivalent	Section 2.2.1.2 Introduction to Climate Change	new
State Vulnerabilities	Section 2.2.2 Oregon Vulnerabilities	reorganized, revised, updated new: • description of each methodology used to identify communities most vulnerable to each hazard • Section 2.2.2.4 Local and State Vulnerability Assessment Comparison • Section 2.2.2.6 Seismic Transportation Lifeline Vulnerabilities Section 2.2.3 Future Enhancements
Regional Profiles and Natural Hazard Risk Assessments: Summary	Section 2.3 Regional Risk Assessments	reorganized; this section was divided and moved to each respective regional risk assessment
State Facility Vulnerability Assessment	Section 2.2.2.5 State-owned/Leased Facilities and Critical/Essential Facilities Exposure Assessment	revised and updated

2012	2015	Explanation
Appendix 2-A: Regional Profiles and Hazard Assessments	Section 2.3 Regional Risk Assessments	revised and updated new for each region: • Regional Summary (including climate change) • Identification of state identified most vulnerable communities • Enhanced description of impacts • Seismic Transportation Lifeline Vulnerabilities State-owned/leased facilities and critical/essential facilities maps for each hazard
Appendix 2-B: State Vulnerability Assessment Tables	Section 9.10 Appendix Statewide Loss Estimates: State-owned Facilities and Critical and Essential Facilities Loss Estimates Table (Excel) and 9.11 (PDF)	revised and updated
Appendix 2-C: Threat and Hazards Identification and Risk Assessment	Section 9.1.14 Appendix 2014 Threat and Hazard Identification and Risk Assessment (THIRA)	updated
Section 3: Hazard chapters	**No Equivalent**	The Hazard chapters were divided according to content and exported to different sections of the 2015 Plan. The Introduction and Hazard Characterization and Analysis sections were incorporated into the 2015 State and Regional Risk Assessments. The information from the Existing Strategies and Programs sections was incorporated into the State Capability Assessment, Section 3.4.1.2 Policies, Programs, and Capabilities. Mitigation Success Stories are located in Section 3.3.5.
Coastal Erosion chapter	Section 2.2 State Risk Assessment Section 2.3 Regional Risk Assessments Section 3.4.1.2 Policies, Programs, and Capabilities Section 3.3.5 Mitigation Successes	reorganized, updated, revised
Droughts chapter	Section 2.2 State Risk Assessment Section 3.4.1.2 Policies, Programs, and Capabilities Section 3.3.5 Mitigation Successes	reorganized, updated, revised
Dust Storms chapter	Section 2.2 State Risk Assessment Section 3.4.1.2 Policies, Programs, and Capabilities Section 3.3.5 Mitigation Successes	reorganized, updated, revised

2012	2015	Explanation
Earthquakes chapter	Section 2.2 State Risk Assessment Section 3.4.1.2 Policies, Programs, and Capabilities Section 3.3.5 Mitigation Successes	reorganized, updated, revised
Fire chapter	Section 2.2 State Risk Assessment Section 3.4.1.2 Policies, Programs, and Capabilities Section 3.3.5 Mitigation Successes	reorganized, updated, revised
Flood chapter	Section 2.2 State Risk Assessment Section 3.4.1.2 Policies, Programs, and Capabilities Section 3.3.5 Mitigation Successes	reorganized, updated, revised
Landslides and Debris Flows chapter	Section 2.2 State Risk Assessment Section 3.4.1.2 Policies, Programs, and Capabilities Section 3.3.5 Mitigation Successes	reorganized, updated, revised
Tsunamis chapter	Section 2.2 State Risk Assessment Section 3.4.1.2 Policies, Programs, and Capabilities Section 3.3.5 Mitigation Successes	reorganized, updated, revised
Volcanic Hazards chapter	Section 2.2 State Risk Assessment Section 3.4.1.2 Policies, Programs, and Capabilities Section 3.3.5 Mitigation Successes	reorganized, updated, revised
Windstorms chapter	Section 2.2 State Risk Assessment Section 3.4.1.2 Policies, Programs, and Capabilities Section 3.3.5 Mitigation Successes	reorganized, updated, revised
Winter Storms chapter	Section 2.2 State Risk Assessment Section 3.4.1.2 Policies, Programs, and Capabilities Section 3.3.5 Mitigation Successes	reorganized, updated, revised
Section 4: Mitigation Strategies	**Chapter 3: Mitigation Strategy**	
Introductions	Section 3.1 Introduction	updated, revised
State Capability Assessment	Section 3.4.1 State Capability Assessment	updated, revised Section 3.4.2 Local Capability Assessment
Mitigation Actions	Section 3.3 Mitigation Actions	reorganized, updated, revised
Funding Sources	Section 3.3.4 Funding Sources for Mitigation Actions	revised

2012	2015	Explanation
Appendix 4-A: Action Item Evaluation Table	Appendix 9.2.1 Mitigation Actions: Progress and Initial Evaluation Appendix 9.2.2 Mitigation Actions: Prioritization Score Sheet Appendix 9.2.3 Mitigation Actions: Priority Scoring Appendix 9.2.4 Mitigation Actions: Level of Support	reorganized, updated, revised
Appendix 4-B: Action Item Descriptions	No equivalent	mitigation action item descriptions are contained in the mitigation action tables: Priority, Ongoing, Removed
Appendix 4-C: Hazard Mitigation Successes	Section 3.3.5 Mitigation Successes	updated the 2012 Plan contains a compendium of mitigation success stories through 2012; the 2015 Plan contains only mitigation success stories since then, 2012–2014
Appendix 4-D: Policies, Programs, Capabilities and Funding	Section 3.4.1.2 Policies, Programs, and Capabilities	updated
Section 5: Coordination of Local Mitigation Planning	**Section 3.5 Coordinating State and Local Mitigation Planning**	because this section (a) focuses on providing funding and technical assistance to local governments and (b) discusses the relationship between local and state NHMPs, it was considered part of the overall mitigation strategy and incorporated into the 2015 Plan's Chapter 3: Mitigation Strategy
Local Funding and Technical Assistance	Section 3.5.1 Funding and Technical Assistance Process Section 3.5.2 Funding and Technical Assistance Provided	updated, revised
Local Plan Coordination	Section 3.5.3 Local Plan Integration	updated, revised
Prioritizing Local Assistance	Section 3.5.2 Prioritizing Local Jurisdictions for Mitigation Funding	updated, revised
Section 6: Plan Maintenance Process	**Section 5.3 Maintaining the Plan**	Plan monitoring and maintenance is considered to be part of the planning process, and so was moved into the 2015 Plan's Chapter 5: Planning Process
Analysis of 2012 Plan Maintenance Process	Section 5.3.1 Analysis of the 2012 Plan Maintenance Process	revised
Monitoring, Evaluating and Updating the Plan	Section 5.3.2 Monitoring, Evaluating, and Updating the 2015 Plan	revised
Monitoring Progress of Mitigation Activities	Section 5.3.2.2 Monitoring Mitigation Actions and Project Closeouts	revised
Section 7: Enhanced State Hazard Mitigation Planning Program	**Chapter 4 Enhanced Plan**	reorganized, updated, revised
Integration with Other Planning Initiatives	Section 4.3 Integration with Other Planning Initiatives	updated, revised
Project Implementation Capability	Section 4.1 Project Implementation Capability	updated, revised

2012	2015	Explanation
Benefit - Cost Analysis of Natural Hazard Mitigation Projects	Section 4.1.2 Benefit-Cost Analysis of Natural Hazard Mitigation Projects	updated, revised
Program Management Capability	Section 4.1.3 Program Management	updated, revised
Assessment of Mitigation Actions	Section 4.2 Mitigation Action Assessment	updated, revised
Effective Use of Mitigation Funding	Section 4.3 Effective Use of Available Mitigation Funding	updated, revised
Commitment to a Comprehensive Mitigation Program	Section 4.4 Commitment to a Comprehensive Mitigation Program	updated, revised
Section 8: Appendices	**Chapter 9: Appendices**	the 2012 Plan had appendices at the end of each chapter; the 2015 Plan has one section of appendices for the entire plan at the end; the contents of the two sets of appendices differ significantly
Appendix A: Principle References	**Chapter 8: References**	updated, revised
Appendix B: Acronyms	**Chapter 6: Acronyms**	updated, revised
Appendix C: Glossary	**Chapter 7: Glossary**	updated, revised
Appendix D: Federal Agencies' Hazard Mitigation Roles, Responsibilities, and Authorities	no equivalent	

Source: DLCD

4.3 Maintaining the Plan

Requirement 44 CFR §201.4(c), Plan content. To be effective the plan must include the following elements:

Requirement 44 CFR §201.4(c)(5)(i-iii), A Plan Maintenance Process that includes: (i) An established method and schedule for monitoring, evaluating, and updating the plan; (ii) A system for monitoring implementation of mitigation measures and project closeouts; and (iii) A system for reviewing progress on achieving goals as well as activities and projects identified in the Mitigation Strategy.

The purpose of this section is to describe procedures for maintaining the Oregon NHMP. Plan maintenance involves monitoring progress in achieving mitigation actions and Plan goals as well as monitoring, evaluating, and updating the Oregon NHMP itself.

The procedures described in this section are informed by analyses of previous Plan maintenance methods and schedules and the State's current and projected capabilities. Because this Plan and the State's capabilities are ever-evolving, the systems and processes described herein are subject to change. The information collected and documented through the Plan maintenance process will serve as the basis for the next Plan update. The process of updating the Plan provides the state with an opportunity to review its progress in achieving mitigation goals and chart its course for the next mitigation planning cycle.

4.3.1 Analysis of the 2012 Plan Maintenance Process

The Oregon NHMP was last updated and formally adopted by Governor Kitzhaber on March 5, 2012. As described earlier in this chapter, DLCD first took on responsibility for updating the Plan during 2012 and hired two positions to manage the effort in 2013. The process of transferring responsibility and gearing up to execute consumed the first 14 months of the update cycle. Subsequently and necessarily, all available resources were allocated to the update; therefore, the detailed plan maintenance and monitoring process for the plan and mitigation actions set forth in the 2012 Plan was not able to be followed. FEMA acknowledged this situation through the 2015 Plan update funding negotiation. Nevertheless, a thorough review and evaluation of the entire 2012 Plan was undertaken through the plan update process — including Plan goals and mitigation actions — substituting effectively for the Plan maintenance and monitoring process envisioned in the 2012 Plan. All sections of the 2012 plan were reviewed and revised, augmented, or deleted. Some new sections were added. The 2012 Plan was also reorganized for 2015. See **Section 4.2.3** for details. Whether mitigation actions were implemented as anticipated is indicated by their status on the mitigation action tables. 2012 actions that appear on the 2015 *Priority* table have not yet been accomplished. Those in the *Ongoing* table are being implemented. Those that are done, not being done, replaced or covered by another action appear on the *Removed* table with the reason for removal. **Table 3-4** shows the disposition of the 2012 mitigation actions in the 2015 Plan. **Section 3.3.3** discusses the changes in mitigation action priorities from 2012 to 2015.

In 2012, Oregon lost enhanced plan status due to program management issues. Much effort has been expended during this update cycle on making the changes necessary to regain enhanced plan status. OEM and the State Hazard Mitigation Officer led the charge, working closely with FEMA. On February 27, 2015, FEMA re-approved the 2012 Oregon NHMP as an enhanced plan.

4.3.2 Monitoring, Evaluating, and Updating the 2015 Plan

4.3.2.1 Monitoring the 2015 Plan

DLCD, with input and involvement from State IHMT agency representatives will prepare an annual NHMP progress report. While it is anticipated that the report will be prepared during the first quarter of the calendar year to be delivered to the State IHMT at its regularly scheduled April meeting, this schedule may be amended as circumstances dictate (e.g., a disaster declaration might require an adjustment). The first annual report for this planning cycle will be prepared in 2016 for 2015. Annual reports will be suspended for the last 2 years of the planning cycle (2019 report on 2018, and 2020 report on 2019) to conserve scarce resources by avoiding duplication of effort, as the information developed during that period will be part of the plan update.

The annual report will document any declared disaster events that have occurred in the previous year and milestones in plan implementation, such as key meetings, decision points, interagency coordination, public outreach efforts, mitigation action status, and mitigation success stories. The report will also document progress toward achieving Plan goals by correlating mitigation action status and successes with the goals and other state mitigation-related activities and initiatives. The information in the annual reports will be included in the Plan update.

Further, at a regular quarterly meeting as soon as feasible following a declared disaster event in Oregon, the State IHMT will discuss the event in the context of the Oregon NHMP and provide any necessary direction for updating the Plan. This discussion will be documented and any directed plan revisions will be included in the annual report or Plan update depending on when the disaster event occurred.

4.3.2.2 Monitoring Mitigation Actions and Project Closeouts

Progress on state mitigation actions will be monitored through the annual reporting process. Progress of “Priority” mitigation actions will be noted; completed actions or those that will not be completed will be deleted from the “Priority” list and entered on the “Removed” list with a brief explanation. Progress of “Ongoing” mitigation actions will be noted. Mitigation action monitoring was not pursued as a plan maintenance activity during this update cycle due to its unique circumstances. The work was done as part of the update process.

In addition, OEM will continue systematically monitoring the implementation of FEMA-funded mitigation actions and projects for which it is the grantee at both state and local levels using required sub-grantee quarterly reporting; telephone and e-mail communications; and project site visits as required. Successful project implementation requires open communication between the grantee and sub-grantee to ensure schedules, budget, and deliverable requirements are met. Project closeouts are always conducted on site allowing the grantee and sub-grantee to certify completion of the project activity (performance component) and that all eligible expenses have been submitted, reviewed for eligibility and reimbursed (financial component). OEM documents project closeout by summary performance and financial reports making sure the sub-grantee is aware of documentation retention requirements, audit requirements and maintenance schedule (if required) to ensure the performance of the mitigation over the life of the project. The State Hazard Mitigation Officer is responsible for reporting this information to the State IHMT for projects funded by the Hazard Mitigation Grant, Pre-Disaster Mitigation and Flood Mitigation Assistance programs.

Outside of the traditional FEMA mitigation grant programs, state and local governments identify and often implement mitigation actions and projects using their own capabilities and resources. At the local level, this may include the development and adoption of local ordinances and regulations that have a hazard mitigation component; mitigation codes and standards as part of ongoing transportation and public works programs; hazard-related components of local comprehensive land use plans; and so forth. While it may not be possible to track and report on every mitigation accomplishment in local mitigation plans, communities will see the positive cumulative impacts of these efforts in reduced disaster losses. The state encourages the seamless integration of mitigation activities into the day-to-day operations of state and local government programs.

4.3.2.3 Evaluating the 2015 Plan

DLCD will manage and facilitate the plan update process, beginning with review and evaluation of the 2015 Oregon NHMP. The criteria to be used for evaluation of the 2015 Plan are:

- Accuracy and utility of the State and Regional Risk Assessments in the context of any disaster events that may have occurred during the update cycle,
- Progress toward "Future Enhancements" discussed in **Section 2.2.3**,
- Progress toward completion of mitigation actions,
- Progress in coordinating State and local mitigation planning, and
- Progress toward achieving Plan goals,

Results of the evaluation will be documented and serve as the basis for updating the Plan.

4.3.2.4 Updating the 2015 Plan

DLCD will manage the update of the 2015 Oregon NHMP for 2020. The process will begin in 2018 following completion of the annual report for 2017. The information from the plan maintenance process's three annual reports (2016 for 2015, 2017 for 2016, and 2018 for 2017) will be included in the update.

DLCD will analyze the 2015 Plan and present alternative approaches and a recommendation to the State IHMT. Once the approach is agreed upon, DLCD will develop a scope of work and timeline, present it to the State IHMT for review and approval, and then forward the approved scope and timeline to FEMA for its approval.

During the 2015 update process, the suite of natural hazards the State is addressing in its NHMP was questioned. The State IHMT also became aware of substantial differences in the amount and availability of data and technical expertise for certain hazards. During the next update cycle, the State IHMT will re-evaluate the established suite of hazards, potentially making changes, and prioritize the final suite of hazards to address these issues and make optimum use of resources. The decisions on which hazards to address and to what extent will have a profound effect on the approach to and scope of work for the 2020 Oregon NHMP update.

Other issues that would affect 2020 plan update approach and scope of work include:

- The extent of progress on developing and implementing the new risk assessment concept methodology;
- The availability of new or updated hazard, probability, and vulnerability data, including climate change and cultural and historic resources;
- The extent of progress on enhancing state and local natural hazards mitigation planning and coordination; and
- Any new requirements included in FEMA's revised state NHMP guidance effective 2016.

One goal of the 2015 update is to produce the Oregon NHMP as a "living document" that staff can update continually during its life, while maintaining a static version for public use. If that goal is achieved and implemented effectively, it could provide a head start on the 2020 update.

Chapter 5 ENHANCED PLAN

In This Chapter

The Oregon NHMP Enhanced Plan is divided into eight sections:

1. **Introduction:** Provides background on the Oregon Natural Hazards Mitigation Plan and states the purpose of an enhanced plan.
2. **Compliance with Standard Plan:** Establishes compliance with standard plan requirements, a prerequisite for enhanced plans.
3. **Integration with Other Planning Initiatives:** Demonstrates integration, to the extent practicable, of the Oregon NHMP with FEMA and other state or regional initiatives.
4. **Project Implementation Capability:** Details how the State manages natural hazard mitigation projects.
5. **Program Management Capability:** Details how the State manages natural hazard mitigation programs.
6. **Mitigation Action Assessment:** Explains how the state evaluates the effectiveness of completed mitigation projects.
7. **Effective Use of Available Mitigation Funding:** Demonstrates that the State uses the mitigation funding it receives through FEMA programs to achieve its mitigation goals.
8. **Commitment to a Comprehensive Mitigation Program:** Demonstrates the State's commitment to a comprehensive natural hazard mitigation program by describing different facets of the program, areas of progress, and how the State continually strives to improve the program.

5.1 Introduction

Requirement 44 CFR §201.5, Enhanced State Mitigation Plans. (a) A State with a FEMA approved Enhanced State Mitigation Plan at the time of a disaster declaration is eligible to receive increased funds under the HMGP, based on twenty percent of the total estimated eligible Stafford Act disaster assistance. The Enhanced State Mitigation Plan must demonstrate that a State has developed a comprehensive mitigation program, that the State effectively uses available mitigation funding, and that it is capable of managing the increased funding. In order for the State to be eligible for the 20 percent HMGP funding, FEMA must have approved the plan within three years prior to the disaster declaration.

Oregon's first DMA2K compliant plan — a 44 CFR §201.5 Standard Plan — was approved by the Federal Emergency Management Agency (FEMA) in October 2004. The state's first Enhanced Plan was approved in 2006 and updated in 2009. While an Enhanced Plan was submitted for FEMA's consideration in 2012, FEMA approved the plan as a Standard Plan because of a lack of program management capacity.

In May 2014, the federal mitigation planning rules were revised to extend the life of state mitigation plans from 3 to 5 years. By letter dated May 27, 2014, FEMA notified the Governor that the 2012 Oregon Natural Hazards Mitigation Plan's approval would remain effective through March 4, 2017. This extension presented an opportunity for the state to pursue re-approval of the 2012 Oregon NHMP as an enhanced plan. After a concerted and lengthy effort to improve program management, Oregon met the criteria for reconsideration and with the support of FEMA Region X began the enhanced plan approval process. On February 27, 2015, FEMA re-approved the 2012 Oregon NHMP as an enhanced plan.

Enhanced plan approval constitutes FEMA's recognition that a state has demonstrated its commitment to maintaining a comprehensive natural hazard mitigation program and supporting that commitment through skilled and effective management of mitigation funding, projects, and planning; support of local mitigation plans and projects; integration of mitigation plans and projects with other state and federal plans, programs, and initiatives; and continual progress in implementation. This exceptional level of effort and demonstration of excellence yields dividends in the form of increased federal mitigation funding after disaster strikes.

The purpose of this chapter is to demonstrate that the 2015 Oregon Natural Hazards Mitigation Plan meets all the Enhanced State Mitigation Plan requirements set forth in 44 CFR 201.5 (See the Enhanced State Hazard Mitigation Plan Review Crosswalk dated September 24, 2015, in **Appendix 9.4.20**).

5.2 Compliance with Standard Plan

The 2015 Oregon Natural Hazards Mitigation Plan meets all the Standard State Mitigation Plan requirements as set forth in 44 CFR 201.4 and documented in the Standard State Hazard Mitigation Plan Review Crosswalk dated September 24, 2015 (**Appendix 9.4.20**).

5.3 Integration with Other Planning Initiatives

Requirement 44 CFR §201.5(b)(1), Demonstration that the plan is integrated to the extent practicable with other State and/or regional planning initiatives (comprehensive, growth management, economic development, capital improvement, land development, and/or emergency management plans) and FEMA mitigation programs and initiatives that provide guidance to State and regional agencies.

Goals and strategies outlined in the Oregon NHMP are integrated to the extent practicable with other state, regional, and FEMA initiatives that provide primary guidance for hazard mitigation-related activities. The Oregon Military Department, Office of Emergency Management works closely with other agencies, organizations, and individuals to ensure that activities, programs, and plans are integrated to the greatest extent possible to incorporate hazard mitigation wherever possible and practicable. In a few instances (e.g., statewide land use planning goals, tsunami inundation mapping), the state has influenced the incorporation of hazard mitigation into existing programs, regulations, and activities as well.

The Oregon NHMP is one component of the first volume of the State Emergency Management Plan, administered by the Oregon Military Department's Office of Emergency Management.

Figure 1-1 illustrates this organizational relationship. Relationships with other state and federal plans and programs are also noted in the Mitigation Action Tables, **Table 3-1** and **Table 3-2**.

The 2015 Oregon NHMP goals are:

1. Protect life and reduce injuries resulting from natural hazards.
2. Minimize public and private property damages and the disruption of essential infrastructure and services from natural hazards.
3. Increase the resilience of local, regional, and statewide economies.
4. Minimize the impact of natural hazards while protecting, restoring, and sustaining environmental processes.
5. Enhance and maintain state capability to implement a comprehensive statewide hazard loss reduction strategy.
6. Document and evaluate Oregon's progress in achieving hazard mitigation.
7. Motivate the public, private sector, and government agencies to mitigate against the effects of natural hazards through information and education.
8. Eliminate development within mapped hazardous areas where the risks to people and property cannot be mitigated.
9. Minimize damage to historic and cultural resources.
10. Increase communication, collaboration, and coordination among agencies at all levels of government and the private sector to mitigate natural hazards.
11. Integrate local NHMPs with comprehensive plans and implementing measures.

Table 5-1 shows the major, though not all, programs and plans that integrate the goals with state and regional initiatives. While this is not a comprehensive list, it does illustrate the key programs and plans that show the integration of NHMP goals.

Table 5-1. Integration of Oregon NHMP Goals with Other Initiatives

Lead Agency or Organization	Name of Plan or Program	Satisfies Mitigation Goals	Description
OEM	quarterly mitigation coordination calls with FEMA	1–11	Updates on planning, grant offerings, policy and regulations. This coordination generally occurs the week before the regularly scheduled quarterly meetings of the State IHMT and provides current information for the State IHMT.
OEM and FEMA	**Appendix 9.3.1, Hazard Mitigation Grant Program: DR-4169 Administrative Plan**	1–11	This plan provides policy and guidelines for administering hazard mitigation grants. It complies with the Stafford Act and the Sandy Recovery Improvement Act. It has been updated since the last state mitigation plan was approved by FEMA in 2012 to include major disaster declarations DR-4055 and DR-4169.
OEM and FEMA	Public Assistance Program	1-11	Funds restoration of eligible public facilities damaged by a Presidentially-declared disaster. Mitigation may be completed simultaneously with restoration.
OEM and FEMA	Hazard Mitigation Grant Program	1-11	Funds post-disaster mitigation projects damaged by a Presidentially-declared disaster. Undamaged parts of a facility may be eligible for funding under the Public Assistance Program
OEM and FEMA	Flood Mitigation Assistance Program	1-11	Funds used primarily for elevations and acquisitions with focus on repetitive and severe repetitive loss properties.
OEM, FEMA, OPDR, DLCD	Pre-Disaster Mitigation	1-11	Funds used primarily for assisting local jurisdictions with developing new and updating existing local natural hazard mitigation programs.
OEM, FEMA, DLCD, DCBS-BCD	National Flood Insurance Program	1-11	DLCD serves as the state NFIP coordinating agency, partnering with DCBS-BCD and OEM. The NFIP is designed to help minimize flood losses through local floodplain management. The NFIP relies on flood hazard mapping, flood insurance, and floodplain development standards implemented at the local level to reduce flood losses.
OEM	Oregon Local Disaster Assistance Loan and Grant Account (ORS 401.536)	1–6, 9	Appropriated per biennium by the legislature, the Oregon Local Disaster Assistance and Loan and Grant Account provides loans and grants to local governments and school districts to cover any required cost share in full or in part. Funds may also be used for non-federally declared disasters, and to help pay for administration of loans.
OEM, Colleges and Universities	Community College and University Campus Mitigation Plans	1-11	This initiative encourages universities and colleges throughout the country to identify their risks and assess their vulnerability to natural and man-made hazards, and to develop a hazard mitigation plan.
OSSPAC	**Appendix 9.2.5, Oregon Resilience Plan**	1–3, 5–7, 9, 11	This plan reviews policy options, summarizes relevant reports and studies by state agencies, and makes recommendations on policy direction to protect lives and keep commerce flowing during and after a Cascadia Subduction Zone earthquake and tsunami.

Lead Agency or Organization	Name of Plan or Program	Satisfies Mitigation Goals	Description
DLCD	North Coast Resilience Project	1–4, 7-11	This project is a collaborative effort of DLCD, OPDR, and Oregon Sea Grant, and the communities of Gearhart, Seaside, Cannon Beach, and Clatsop County with funding from NOAA. The purpose of the project is to provide information about community resilience and a structured approach that can be used by other communities to improve their resilience to disturbances like natural hazards.
DLCD	Oregon Statewide Planning Goal 7: Areas Subject to Natural Hazards	1–5, 7–9, 11	This statewide land use planning goal requires all local city and county comprehensive plans to include measures to reduce the risk to people and property from natural hazards. DLCD has developed a guide for land use planning to mitigate damage from tsunamis and is actively working with coastal communities to implement it. DLCD is also encouraging local communities to integrate the hazard information and mitigation actions contained in their NHMPs with the Goal 7 inventories, policies, and implementation measures contained in their comprehensive plans. DLCD works with communities to use new hazard information to enhance mitigation.
DLCD	Oregon Risk MAP	1–11	This website is a hub for information about natural hazards. At this time it is primarily focused on flooding and floodplain mapping issues and projects, with plans to gradually address other natural hazards. Risk MAP is a collaborative program coordinated by DLCD and involving FEMA, other state agencies, local governments, and the public..
DOGAMI	Lidar-Based Risk Assessment Initiative	1–2, 4–5, 7–8, 10–11	This initiative provides high-resolution digital elevation mapping (lidar) so that Oregon communities can better understand their risks from floods, landslides, earthquakes, and wildfires. The consortium enables State acquisition of more lidar than it would otherwise be able to afford.
ODOT	Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification (2012)	1–3, 5–7	This report documents the process conducted and conclusions reached in the Oregon Seismic Lifelines Route identification (OSLR) project. It identifies a specific list of highways and bridges recommended to comprise the seismic lifeline system, and establishes a three-tiered system of lifeline corridors to help prioritize seismic retrofits on state-owned highways and bridges.
ODOT	**Appendix 9.1.12, Statewide Loss Estimates: Oregon Highways Seismic Options Report** (2013)	1–3, 5–7	This report assesses the risk of a major seismic event to highway facilities in Oregon and outlines options for phased retrofitting.
State IHMT	Oregon Silver Jackets Team	1–7, 10	The Silver Jackets Team is a subcommittee of the State Interagency Hazard Mitigation Team. It establishes and strengthens intergovernmental partnerships to better develop solutions to state flood hazard challenges.
Oregon Climate Change Research Institute (OSU)	**Appendix 9.1.19, Oregon Climate Change Adaptation Framework** (2010)	1–5, 7	The Framework identifies risks and subsequent measures to reduce Oregon's vulnerability to the effects of climate change.

Lead Agency or Organization	Name of Plan or Program	Satisfies Mitigation Goals	Description
Business Oregon	State Seismic Rehabilitation Grant Program (ongoing)	1-2, 5	This grant program, administered by the Infrastructure Finance Authority of Business Oregon, provides state funds to rehabilitate critical public buildings, particularly schools and emergency service facilities.
Business Oregon	HUD Disaster Resilience Competition (2014–2017)	1–9	Nearly $1 billion will be available nationally through HUD's Community Development Block Grant-Disaster Recovery fund. It will fund projects to help communities rebuild from a declared disaster and increase their resilience to future disasters. With FEMA's update and release of the HMA Program Guidance for FY2015, Climate Change and resilience must now be considered for FEMA mitigation project funding.
Oregon Water Resources Department	Integrated Water Resources Strategy (2012)	2–4, 6-7	This plan increases the understanding of Oregon's water needs and identifies strategies to meet them. As water resource issues are often also natural hazard issues (e.g., flood, drought, landslide, wildfire), some of the strategies are also mitigation actions.

Source: Oregon Office of Emergency Management.

More detailed descriptions of several of the items listed in **Table 5-1** and others follow, illustrating how plans and programs integrate the goals of the NHMP.

- **Community College and University Campus Mitigation Plans.** In 2003, FEMA initiated its Disaster-Resistant University Initiative. Given the importance of colleges and universities to the economy and future success of the country, the initiative is an important investment in our institutions of higher education. This initiative encourages universities and colleges throughout the country to identify their risks and assess their vulnerability to natural and man-made hazards, and to develop a hazard mitigation plan.

  The guidance for colleges and universities is similar to that provided to local communities. Currently, seven Oregon community colleges and universities — Eastern Oregon University, Linn-Benton Community College, Mount Hood Community College, Oregon Tech, Southern Oregon University, University of Oregon, and Western Oregon University — all have approved mitigation plans, while Oregon State University is initiating development of a campus-wide (multi-location) hazard mitigation plan.

- **North Coast Resilience Project.** In 2013, DLCD's Oregon Coastal Management Program received a grant from NOAA to conduct a pilot project focused on improving community resilience to natural hazards, including hazards related to climate change. The project was led jointly by DLCD, OPDR, and Oregon Sea Grant with several other state agencies providing support throughout the project. Four communities participated: Clatsop County, Gearhart, Seaside, and Cannon Beach. Through the project, the agencies and communities developed an approach to planning for community resilience at the local level and established a network of people, organizations, and communities to improve community resilience to coastal hazards.

- **City of Madras Natural Hazards Mitigation Plan Integration.** The University of Oregon's Community Planning Workshop completed a successful pilot project assisting the City of Madras with integrating its NHMP into its Comprehensive Plan. FEMA's new Whole Community concept is oriented toward integration of the NHMP into the Comp Plan: "A Whole Community approach to building community resilience requires finding ways to support and strengthen the institutions, assets, and networks that already work well in communities." Through this successful pilot project, the Goal 7 section of Madras's Comprehensive Plan was updated and integrated with its recently updated and FEMA-approved NHMP, supporting one another more effectively. The project team also created educational materials to help residents of Madras understand the NHMP, the Comprehensive Plan, and what their integration means.

- **Portland Lidar Consortium.** Coordinated by DOGAMI, the Portland Lidar Consortium is a group of federal, state, and local governments that are working together to fund lidar mapping for portions (or all) of Clatsop, Tillamook, Washington, Clackamas, Multnomah, Hood River, Marion, and Yamhill Counties. Seventeen agencies have worked together to map 2,200 square miles of lidar data. This coordination reduced the cost of collecting the data, and increased the quality and standardization of the data acquired.

  Based in part on the success of the Portland Lidar Consortium, the Oregon Legislature provided some funding and directed DOGAMI to expand lidar collection efforts to other parts of the state in 2007. The state continues to work with local governments and other organizations to expand lidar mapping efforts.

- **Oregon Silver Jackets Team.** The Oregon Silver Jackets Team is a subcommittee of the State Interagency Hazard Mitigation Team dedicated to improving intergovernmental partnerships focused on developing comprehensive and sustainable solutions to state flood hazard challenges. The following agencies comprise the team:
  - Oregon Department of Land, Conservation, and Development,
  - Oregon Office of Emergency Management,
  - U.S. Army Corps of Engineers Portland District,
  - Federal Emergency Management Agency Region X,
  - Oregon Department of Geology and Mineral Industries,
  - National Weather Service's Northwest River Forecast Center, and
  - U.S. Geological Survey

  The Oregon Silver Jackets Team's goals are aligned with those of the 2015 Oregon NHMP, including: develop strategies to reduce the threat, vulnerability, and consequences of flooding in Oregon; increase communication and capacity of state government to solve issues related to flooding and thereby improve the capacity of local governments to reduce loss; increase and improve flood risk communication and outreach by helping to motivate others to mitigate through information and education; and much more.

- **Statewide Planning Goals.** DLCD is the State's land use planning agency and is responsible for implementing 19 Statewide Planning Goals, including Goal 7, Areas Subject to Natural Hazards, which requires comprehensive plans and implementing measures to reduce risk to people and property from natural hazards. The state and FEMA share this goal. With its added natural hazard planning capacity, DLCD has been able to begin encouraging and assisting local governments with integrating their NHMPs and comprehensive plans. In January 2014, DLCD released its guidance document, *Preparing for a Cascadia Subduction Zone Tsunami: A Land Use*

Guide for Oregon Coastal Communities (http://www.oregon.gov/lcd/ocmp/docs/publications/tsunamiguide20140108.pdf) and is actively assisting coastal communities with tsunami mitigation planning.

- **Community Wildfire Protection Plans.** The Oregon Department of Forestry (ODF) produces data on wildfire hazards throughout the State. It also works with communities on Community Wildfire Protection Plans (CWPPs) which often are used as the wildfire hazard section of local NHMPs. Both are updated on five-year cycles and ODF, OPDR, OEM, and DLCD are interested in instituting this integration, and fostering integration with comprehensive plans.

- **Climate Change.** Oregon is competing for a portion of nearly $1 billion available nationally through HUD's Community Development Block Grant-Disaster Recovery fund to cover unmet needs from previous declared disasters. If secured, it would fund projects to help communities rebuild and increase their resilience to future disasters. With FEMA's update and release of the HMA Program Guidance for FY2015, Climate Change & Resilience must now be considered for incorporation into FEMA mitigation project funding in the following ways:
    - The Guidance encourages communities to become more resilient and to incorporate climate change considerations in their project scoping and development.
    - The benefit-cost analysis allows for the incorporation of additional benefits into the calculations, such as the benefits of sea level rise mitigation, and environmental benefits associated with the acquisition of properties in green open space and riparian areas.
    - Applicants and sub-applicants can use the HMGP Five Percent Initiative to incorporate disaster-resistant building codes.
    - The Guidance promotes the inclusion of mitigation strategies that foster community resilience and smart development growth within mitigation plans."

  DLCD has a lead role in planning for climate change in Oregon, and along with OCCRI and OCS has brought expertise and the Oregon Climate Change Adaptation Framework into the NHMP planning process.

- **NFIP and Risk MAP.** DLCD houses the State NFIP Coordinator and the State Risk MAP Coordinator. Together, DLCD and FEMA sponsor robust NFIP Implementation and Risk MAP Programs. The NFIP Implementation Program provides in-depth technical assistance to local governments, property owners, and other stakeholder and interest groups and coordinates with the State Hazard Mitigation Officer to sustain an active program of mitigating repetitive loss, severe repetitive loss, and substantially damaged properties. In 2014 the NFIP Implementation Program initiated two Community Rating System (CRS) Users' Groups to provide a forum for CRS communities and those contemplating joining the CRS Program to share information and expertise and ultimately increase participation throughout the State. The State NFIP Coordinator was called upon to testify before the Senate Banking Committee on the Biggert-Waters Flood Insurance Reform Act of 2012 and is currently serving Oregon and the United States as a member of FEMA's Technical Mapping Advisory Council. The State NFIP Coordinator works closely with the State Risk MAP Coordinator on flood hazard identification and mitigation studies, levee certification, and other issues. The State Risk MAP Coordinator also works closely with FEMA to plan and prioritize Oregon Risk MAP activities; with DOGAMI on developing and analyzing multi-hazard data and making it accessible to local governments through the Risk MAP Program; and with OPDR on helping communities understand and implement Risk MAP studies.

- **Geologic Hazards.** DOGAMI is the source of much of Oregon's hazard data, conducting research in coastal hazards, earthquakes and related hazards, floods, landslides, volcanic hazards, and tsunamis. DOGAMI works closely with DLCD, OPDR, and other entities to apply its research and help prevent and mitigate potential losses from natural hazards.

- **Seismic Rehabilitation Grant Program.** Business Oregon's Infrastructure Finance Division administers the Oregon Seismic Rehabilitation Grant Program (SRGP) which provides state funds for seismic rehabilitation of critical public buildings, particularly public schools (K-12, community colleges, education service districts, and universities) and emergency services facilities (hospital buildings with acute inpatient care facilities, fire stations, police stations, sheriff's offices, 9-1-1 centers and Emergency Operations Centers).

- **Health, Security, Preparedness, and Response.** The Oregon Health Authority's Health Security, Preparedness and Response (HSPR) Program develops public health systems to prepare for and respond to major, acute threats and emergencies that impact the health of people in Oregon. The Program addresses eight of Oregon's 11 natural hazards, plus extreme heat and bioterrorism.

- **Oregon Office of Emergency Management.** OEM is the hub of emergency planning for the State of Oregon. It houses the State Hazard Mitigation Officer, supports the State IHMT, and is responsible for all stages of the disaster cycle — mitigation, preparation, response, and recovery — for human-caused hazards as well as natural hazards. The 2015 Natural Hazards Mitigation Plan constitutes Volume 1 of the Oregon Emergency Operations Plan with which all other emergency plans are coordinated.

- **Emergency Management Performance Grants Program.** OEM also administers the Emergency Management Performance Grants Program (EMPG) which passes through funding from FEMA to state, local, tribal and territorial governments for preparing for all hazards. One requirement for local and tribal governments to obtain this funding is to have a current, FEMA-approved NHMP.

5.4 Project Implementation Capability

Requirement 44 CFR §201.5(b)(2), Documentation of the State's project implementation capability, identifying and demonstrating the ability to implement the plan, including:

Requirement 44 CFR §201.5(b)(2)(i), Established eligibility criteria for multi-hazard mitigation measures.

Requirement 44 CFR §201.5(b)(2)(ii), A system to determine the cost effectiveness of mitigation measures, consistent with OMB Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, and to rank the measures according to the State's eligibility criteria.

FEMA's Hazard Mitigation Assistance Program (HMA) encompasses three of the programs upon which the State of Oregon relies to fund natural hazards mitigation planning and projects: Pre-Disaster Mitigation (PDM), Flood Mitigation Assistance Program (FMA), and the post-disaster Hazard Mitigation Grant Program (HMGP). The State of Oregon complies with funding criteria outlined in the Unified Hazard Mitigation Assistance Guidance developed and updated by FEMA. In addition, the State complies with FEMA requirements for the Benefit-Cost Analysis used to evaluate all mitigation project applications as well as environmental and historic preservation review processes. Mitigation project feasibility, benefit-cost analysis, and environmental and historic review are all critical paths when considering potential mitigation project eligibility for FEMA funding. Although not specifically a mitigation grant program, there is a mitigation component to FEMA's Public Assistance program that allows for cost-effective integration of mitigation during the repair and restoration of public infrastructure following a Presidential disaster declaration.

5.4.1 Established Eligibility Criteria & Ranking System for Multi-Hazard Mitigation Measures

5.4.1.1 Eligibility Criteria

Proposed hazard mitigation projects, including those proposed under Section 404 of the Stafford Act, are evaluated for FEMA funding eligibility on the basis of the following federal and State criteria:

1. Be consistent with, support, and help implement the goals and objectives of the state's natural hazards mitigation plan developed under Sections (standard plan) 201.4 or (enhanced plan) 201.5 of the Stafford Act;
2. Be consistent with, support, and help implement the goals, objectives, and mitigation actions of local hazard mitigation plans in place for the geographic area in question developed under Section 201.6 of the Stafford Act;
3. Have significant potential to reduce damages to public and/or private property to reduce the cost of recovering from future disasters;
4. Be the most practical, cost-effective, and environmentally sound alternative after a consideration of a range of alternatives;
5. For federally-funded projects, meet federal requirements for benefit-cost requirements by having a benefit-cost ratio ≥ 1.0;
6. Address a repetitive loss or substantial damage problem, or one that has the potential to have a major impact on an area, reducing the potential for loss of life, loss of essential services or personal property, damage to critical facilities, economic loss, hardship, or suffering;
7. Solve a problem independently, or constitute a portion of a solution where there is a likelihood that the project as a whole will be completed;
8. Conform with 44 CFR Part 9, Floodplain Management and Protection of Wetlands, and not contribute to or encourage development in wetlands or in floodplains;
9. Conform with 44 CFR Part 10, Environmental Considerations;
10. Be based on a hazard vulnerability analysis of the geographic area in question;
11. Be feasible (both technically and within an approved scope of work and budget) and be ready to proceed when approved and funded;
12. Meet applicable permit requirements;
13. Not encourage new development in hazardous areas;
14. Contribute to a permanent or long-term solution to the problem, and have manageable maintenance and modification costs;
15. Whenever possible, be designed to accomplish multiple objectives, including damage reduction, environmental enhancement, and economic development or recovery; and
16. Whenever possible, use existing agencies or programs to implement the project.

Mitigation of repetitive loss properties (those with an NFIP insurance history of flood losses) have been identified by FEMA as a top priority for mitigation by elevation, relocation or acquisition. FEMA preferentially supports these properties for mitigation funding through the NFIP-ICC claims process, benefit-cost waiver for substantial damage by flooding, and by baseline cost-effectiveness determinations that expedite project identification, selection, and approval. NFIP loss data report that one third of all NFIP flood loss claims can be attributed to repetitive loss properties. In Oregon, the repetitive (and severe repetitive) loss list of NFIP-insured properties represents generally straightforward, achievable mitigation projects. When identified prior to the next flood loss and, particularly, if substantially damaged by flooding, these properties are Oregon's top priority for flood mitigation.

5.4.1.2 Ranking System

Oregon implements a pre-application process through which information used to determine eligibility is collected. Eligible projects are ranked based on the policy framework developed by the State Interagency Hazard Mitigation Team (IHMT) to ensure that post-disaster implementation strategies accomplish those projects that address repetitive losses, are the most cost-effective and have the potential to quickly demonstrate success by reducing future disaster losses. In addition, communities with FEMA-approved, current 44 CFR Section 201.6 natural hazards mitigation plans will have top priority status and projects identified in these communities can generally be selected and approved quickly if they meet the benefit-cost requirements and have minimal environmental issues. For flood losses, homeowners that sustain substantially damaged homes (whether insured through the NFIP or not) present high priority mitigation opportunities as well in any Presidentially-declared disaster or in any wet winter in Oregon.

When convened (generally only for larger disaster declarations), the **Hazard Mitigation Grant Review Board** reviews, ranks, and determines which project applications are selected for FEMA's funding consideration. FEMA reviews, considers and approves (or not) all FEMA-funded mitigation projects submitted by the state. Projects are first reviewed to determine if they meet all of the criteria (or could with minimal additional effort). Any projects that do not meet the eligibility criteria are set aside and not considered for funding. Eligible projects are then ranked based on priorities identified through the disaster-specific FEMA-State Hazard Mitigation Strategy report, State, and local hazard mitigation plans, and policy direction from the State IHMT. If there are more projects than dollars, the Board will select the most highly ranked projects up to 90% of the limit of the Federal Hazard Mitigation Grant Program (HMGP) lock-in. In addition, the Board may also consider the level of interest and commitment shown by sub-applicant to hazard mitigation activities and programs. Past success in mitigation does carry considerable weight when evaluating equal projects.

5.4.2 Benefit-Cost Analysis of Natural Hazard Mitigation Projects

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. Other mitigation benefits include those of an economic nature such as maintaining utility services (for example electricity and water) when there is a loss of function as a result of the disaster. 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. An objective benefit-cost analysis is a tool used to determine mitigation project eligibility when Federal funds come into play.

The FEMA Benefit-Cost Analysis (BCA) software program is used to determine the cost-effectiveness of proposed mitigation projects for FEMA's mitigation grant programs. The basis for BCA when federal funding is used to implement mitigation measures is found in OMB Circular A-94: "The goal of Circular A-94 is to promote efficient resource allocation through well-informed decision-making by the Federal Government. It provides general guidance for conducting benefit-cost and cost-effectiveness analyses. It also provides specific guidance on the discount rates to be used in evaluating Federal programs whose benefits and costs are distributed over time. The general guidance will serve as a checklist of whether an agency has considered and properly dealt with all the elements for sound benefit-cost and cost-effectiveness analyses." In 2008, FEMA collaborated with many applicants and sub-applicants on enhancements to calculations, methodologies, and the software's efficiency. The FEMA BCA tool, much like any other software tool, is subject to review, revisions, and improvement.

FEMA's BCA Reference Guide explains the current BCA tool (Version 5.0 released in April 2014) and provides BCA software users with an overview of the grant programs, application development, benefits and costs, the location of BCA guidance documents, and helpful information.

FEMA's BCA program is a key mechanism for evaluating certain hazard mitigation projects to determine eligibility and assist in Federal funding decisions. The FEMA BCA program is comprised of methodologies and software for a range of major natural hazards. To be eligible for Federal funding assistance, a BCA must show that the project is cost-effective and will reduce future damages and losses from natural disasters. Reduction in losses or prevention of future damages is the benefit of the project.

Cost, as it relates to mitigation, is the price to develop, implement, and maintain a mitigation project. The project cost estimate, as used in the FEMA mitigation grant guidance, includes all costs associated with the proposed mitigation project and represents the best estimated costs for the activity. Estimates are required for the following cost item categories:

- Anticipated cash and in-kind federal match,
- Equipment,
- Labor,
- Materials,
- Subcontract Costs, and
- Other costs are those that do not fall neatly into one of these categories but must be delineated in the BCA if applicable to the project.

The FEMA BCA tool uses a six-step cost-estimating methodology:

- Step 1: Develop an estimate of pre-construction or non-construction costs.
- Step 2: Develop an estimate of construction costs.
- Step 3: Develop an estimate of ancillary costs.
- Step 4: Develop an estimate of annual maintenance costs.
- Step 5: Adjust the estimate to account for project timing and whether the data is current.
- Step 6: Review and confirm the cost estimate.

FEMA has developed procedures and techniques to help sub-applicants use its BCA tool and develop thorough grant applications.

Since the last update and promulgation of this Plan in 2012, FEMA has continued to revise its BCA policies. For certain project categories, such as the acquisition of substantially damaged homes in the floodplain, FEMA allows for exceptions to a rigorous benefit-cost analysis. This exception and others are explained on a case-by-case basis in the Unified Hazard Mitigation Assistance program guidance.

Two notable new BCA policies (2013) are the Environmental Benefits Policy and the Baseline Policy. The Environmental Benefits Policy allows for incorporation of environmental benefits of acquisition projects under the HMA grant programs. The policy states that environmental benefits can be included for each structure when the project benefit-cost ratio (BCR) reaches 0.75. With an incremental addition of a BCR of up to 0.25 for environmental benefits, a project that was not cost-effective with a BCR of 0.75 becomes cost-effective with a BCR of 1.0.

The Baseline Policy is a formula for pre-calculated benefits to determine cost-effectiveness of elevations and acquisitions in Special Flood Hazard Areas. FEMA has determined in a policy dated October 3, 2013, that the acquisition or elevation of a structure located in the 100-year floodplain as delineated on the Flood Insurance Rate Map (FIRM) or best available data is considered cost-effective if it costs less than or equal to:

- $276,000 for property acquisition, or
- $175,000 for property elevation.

For those properties that have a history of repetitive flood losses or are substantially damaged by flooding, this “baseline” policy provides yet another opportunity to identify and streamline the implementation of priority mitigation projects.

5.4.2.1 Oregon Seismic Rehabilitation Grant Program: Oregon BCA Tool

Because Federal funding is not incorporated into the state-funded seismic retrofit program, the state is not obligated to use either the FEMA-prescribed BCA software or explicitly meet the requirements of OMB Circular A-94. However, standard methodologies and refinements to the FEMA BCA software provided a basis for the development of the Oregon BCA Tool.

The Oregon Office of Emergency Management created the Oregon BCA Tool for use by local jurisdictions when applying for state-sponsored mitigation funding through OEM programs such as the Seismic Rehabilitation Grant Program (SRGP). The Oregon BCA Tool uses detailed, USGS data specific to Oregon. The SRGP-based BCA tool was developed using methodologies from the FEMA BCA Tool at the time but with an emphasis on being tailored for Oregon projects (seismology, soil conditions, and building types) and an improved user interface. DOGAMI completed a Statewide Seismic Needs Assessment in June 2007, a key component in developing the Oregon SRGP BCA Tool. This assessment of school buildings and public safety facilities included a rapid visual screening (RVS) of such buildings and a ranking of these screenings based on need and risk. With the legislative authority to develop and implement the Oregon SRGP in 2009, BCA’s were required to be performed as prescribed by OEM. A draft Oregon BCA Tool was completed in October 2009 and a finalized public version released in June 2010, which was the first year the applications were solicited and funded. Seismic benefits calculated by FEMA’s most current BCA tool (4.8 and now 5.0) still seem to be undervalued, making it difficult for most seismic mitigation projects to meet the Federal BCA eligibility test. The SRGP will continue to use the Oregon-specific BCA tool for seismic projects.

For the Oregon Seismic Rehabilitation Grant Program, the following categories of damages and losses are considered:

- building damages,
- contents damages,
- displacement costs for temporary quarters,
- loss of public services, and
- casualties (deaths and injuries).

Benefit-cost analysis requires several types of input data, which requires quantitative assessments of the following factors:

- level of seismic hazard at the building's location,
- vulnerability of the building and contents to damage in future earthquakes,
- values of the building and contents,
- costs for temporary quarters if the building must be vacated for repair of future earthquake damage,
- value and importance of the public services provided from the building, and
- number of occupants in the building.

To compare future benefits with the present costs of seismic retrofits, the calculated future benefits of retrofitting are adjusted to net present value, taking into account the time-value of money. These calculations are done automatically by the Oregon BCA Tool, based on standardized assumptions about the useful lifetime of the project and the "discount rate" which reflects the time-value of money.

For benefit-cost analyses of seismic mitigation projects for the Oregon Seismic Rehabilitation Grant Program, a standard useful lifetime of 50-years and a discount rate of 2% are built into the Oregon BCA Tool. The Oregon BCA Tool does all of the many complicated calculations necessary for benefit-cost analysis automatically. The user must only enter the specified building-specific information in the designated cells in the spreadsheet.

For the Oregon Seismic Rehabilitation Grant Program, benefit-cost results are an important part of the evaluation and ranking process, but are not the sole determinant of whether or not a given project will be selected for funding. In some cases where other non-BCA factors are more important in final project selection, projects with benefit-cost ratios below 1.0 may be considered for funding.

5.4.3 Program Management Capability

Requirement 44 CFR §201.5(b)(2)(iii), Demonstration that the State has the capability to effectively manage the HMGP as well as other mitigation grant programs, including a record of the following:

(A) Meeting HMGP and other mitigation grant application timeframes and submitting complete, technically feasible, and eligible project applications with appropriate supporting documentation;

(B) Preparing and submitting accurate environmental reviews and benefit-cost analyses;

(C) Submitting complete and accurate quarterly progress and financial reports on time; and

(D) Completing HMGP and other mitigation grant projects within established performance periods, including financial reconciliation.

All program management is handled by the Oregon Office of Emergency Management, often in collaboration with staff at other agencies and organizations. Table 5-2 lists the primary committees and staff that are responsible for implementing and monitoring mitigation activities and projects as well as ensuring these activities achieve the goals of the Mitigation Strategy.

Table 5-2. Primary Committee and Staff Responsible for Monitoring Mitigation Activities and Programs

Lead Agency	Committee or Staff Title	Mitigation Management Role
OEM	State Interagency Hazard Mitigation Team (State-IHMT)	Develops policy framework for the State's pre- and post-disaster mitigation efforts. This policy framework is necessary to ensure that the post- disaster mitigation implementation strategies will effectively focus upon accomplishing the highest quality and most cost-effective projects. This policy framework is the cornerstone for the State's Hazard Mitigation Grant Program (Section 404 of the Stafford Act) and is articulated in the Oregon Natural Hazards Mitigation Plan. The State IHMT may also act as the Hazard Mitigation Grant Review Board for smaller disasters.
OEM	Hazard Mitigation Grant Review Board	Reviews, sets priorities, and selects projects for Hazard Mitigation Grant Program funding (Section 404 of the Stafford Act) for large, Presidentially-declared disasters. The Board acts to ensure consistency between the projects submitted and the policies and strategies promulgated by the State-IHMT including the *State Natural Hazards Mitigation Plan*. For smaller disaster declarations (such as DR-4169), discussions with the Hazard Mitigation Grant Review Board generally occur outside of formal meetings using mitigation priorities identified in the state and local mitigation plans as a basis for identifying HMGP project opportunities for further development.
OEM	State Coordinating Officer	The person appointed by the Governor to act in cooperation with the appointed Federal Coordinating Officer as key State staff on the delivery of disaster assistance programs.
OEM	Mitigation and Recovery Services Section	The purpose of this section is to provide oversight and administration of OEM´s financial services and related funding that is passed through to local governments, and to manage disaster recovery activities for state and local governments in the event of a devastating emergency or disaster.

Lead Agency	Committee or Staff Title	Mitigation Management Role
OEM	State Hazard Mitigation Officer (SHMO)	Official representative of State government who is the primary point of contact with FEMA, other federal agencies, state agencies, and local governments in mitigation planning and implementation of mitigation programs and activities required under the Stafford Act. The SHMO chairs the State IHMT, staffs the Hazard Mitigation Grant Review Board, oversees and coordinates FEMA-funded mitigation projects and planning grants. The SHMO position is expected to be filled on a full-time basis to provide continuity between major disaster declarations and to implement the state's mitigation plan.
OEM	Emergency Management Specialist and Special Projects Coordinator	Work with the SHMO on matters relating to Section 404 grant program, 406 mitigation and natural hazards mitigation planning activities.
OEM	Facilities Engineer — State Public Assistance Officer	Assists in reviewing project applications, providing technical assistance to sub-applicants and sub-grantees, substantiating costs, and conducting project inspections. The Special Projects Coordinator works closely with the Facilities Engineer and SHMO.
OEM	Grant Program Accountants (2)	Responsible for reviewing reimbursement expenses, determining eligible costs, issuing payments, and taking a supporting role in closing completed projects.
OEM	Fiscal Coordinator	Assists the State staff by performing administrative and accounting work in the Public Assistance and Hazard Mitigation Grant programs.
OEM	Disaster Response Staff	Due to post-disaster activities and requirements, or the size of the disaster, the State may appoint or hire additional staff to assist the State Hazard Mitigation Officer in managing the grant program. The State will submit an initial hazard mitigation staffing pattern to FEMA generally within 10 days of the opening of the Joint Field Office (JFO). The staffing requirements associated with grant program activities serve as the basis for determining State Management Costs.
OEM 2015 Legislature Policy Options Package	Requested: Two Program Analyst 2s	This Policy Options Package would establish two (2) new positions as well as services and supplies to help manage projects and provide direct, tailored, technical assistance to city, county, and tribal governments as it relates to Oregon's Hazard Mitigation Program.
DLCD	National Flood Insurance Program Coordinator	44 CFR 60.25 encourages states to demonstrate a commitment to the minimum floodplain management criteria under the NFIP by designating an agency of State government to be responsible for the coordination of floodplain management throughout the state.
DLCD	State Risk MAP Coordinator	DLCD is the State Coordinating Agency for Risk MAP charged with the delivery of quality data that increases public awareness and leads to action that reduces risk to life and property.
DOGAMI	Director, State Geologist	DOGAMI's mission is to provide earth science information and regulation to make Oregon safe and prosperous.

5.4.3.1 Hazard Mitigation Grant Review Board

The Hazard Mitigation Grant Review Board (the Board) is an intergovernmental body which when convened reviews, discusses, ranks, and recommends project selections for funding under Section 404 of the Stafford Act (i.e., Hazard Mitigation Grant Program — HMGP). For smaller, less complex disaster events, the State Interagency Hazard Mitigation Team (State IHMT) provides input to the HMGP selection process by recommending priorities for mitigation projects. By establishing project priorities early in the disaster recovery process, mitigation project opportunities can be more quickly identified based on the extent and nature of the disaster event. The State IHMT, in considering project priorities, respects mitigation actions and strategies developed in the state natural hazard's mitigation plan as well as recognizing and supporting local government mitigation actions and priorities. The State IHMT also supports the state's "incremental process" in providing technical assistance to sub-applicants by using a project pre-application (Notice of Interest) that can be used to vet projects for the program eligibility parameters. Projects that do not meet basic program eligibility parameters can be identified quickly and do not move forward to a full project sub-application for FEMA's consideration. Project sub-applications, when considering all of the program criteria, will only be submitted to FEMA when they are complete with all supporting documentation.

The Board was first established and used extensively during the three major disasters that occurred in 1996 (DRs: 1099, 1149 and 1160). At that time, there was no requirement for local mitigation planning to consider and identify mitigation project actions prospectively before the next disaster. In fact, the jurisdictions that participated in these HMGP offerings in 1996 and 1997 were required to develop a hazard mitigation plan, minimally, for the hazard that was the nature of their disaster losses. In those early years, the Board essentially reviewed and ranked project applications looking at criteria such as project feasibility, benefit-cost analysis, environmental considerations, and geographic diversity to evaluate proposed projects for state selection and funding consideration by FEMA. With the Sandy Recovery Investment Act of 2012, FEMA (and in turn the states) is directed to streamline HMGP activities and implement the program in a timelier manner. Moving HMGP activities forward in a more timely fashion is welcomed by Oregon and fits into the model the state developed during recent Joint Field Office operations for DR-4055 and during current disaster DR-4169.

With requirements for FEMA-compliant (201.6) local mitigation plans to be eligible for Section 404 grants, the need to convene the Hazard Mitigation Grant Review Board has been largely replaced (except for large scale disaster events) by project actions and priorities identified in local mitigation plans. In order to expedite the Section 404 grant offering early in the post-disaster recovery process, HMGP project funding is first prioritized to the disaster-declared counties (and all eligible applicant entities therein) on a pro rata share basis of their Public Assistance- and/or Individual Assistance-eligible costs as initially determined during the FEMA-State Preliminary Damage Assessment. Using this methodology to allocate HMGP funding to the declared counties in the disaster's HMGP offering ensures geographic diversity to showcase the benefits of mitigation in the disaster-impacted area. All things being equal, all HMGP projects must meet minimum state and FEMA project eligibility, and if the basic eligibility criteria are not met, HMGP funding will be offered to other applicants with eligible projects. When considering a number of mitigation projects, where there are generally more projects than available funding, those projects that reduce repetitive losses and address multiple hazard will generally have better benefit-cost ratios and ranked higher for selection consideration. The pro rata applicant share (total amount of HMGP funding) is now established at the 12 month (ceiling amount) HMGP lock-in as described in the 2015 Unified HMA Guidance. HMGP planning grant funding (based on a 7% planning set-aside cap) is available statewide from the onset of the program's availability. Considering planning sub-applications early in the HMGP offering often expedites funding of planning sub-grants, before project sub-grants can be developed for FEMA's review.

During the Public Assistance (PA) and HMGP Applicant Briefing, the state confirms priorities and project categories for Section 404 project pre-applications that tend to focus on the nature of the disaster declaration and related mitigation opportunities. Representatives from the State IHMT are asked to provide their input into establishing the priorities and project categories for Section 404 project pre-applications early in the process. With SRIA, Congress has requested and FEMA requires an HMGP roll-out that needs to occur much more quickly to ensure projects are identified early in the recovery process and implemented in a way that the benefits of mitigation can occur sooner. The State IHMT can play an important role in selecting 5% State Initiative Projects, those that are difficult to evaluate against traditional program cost-effectiveness criteria, as there are always many more "5% projects" than available funding.

HMGP funding restrictions:

- Up to 7% of the Grantee's HMGP ceiling may be used for sub-grants for prioritized state and local mitigation planning activities in compliance with 44 CFR Section 201.3(c)(4).
    - Because FEMA-approved hazard mitigation plans are required for FEMA-funded mitigation projects, having a current mitigation plan is a predominant criterion in evaluating planning sub-applications:
        - 1st priority: those that have never developed a plan,
        - 2nd priority: those with expired plans,
        - 3rd priority: those out 12–18 months to expiration, and
        - 4th priority: those out 18–30 months to expiration.
- Up to 5% of the Grantee's HMGP ceiling may be used for mitigation measures that are difficult to evaluate against traditional program cost-effectiveness criteria (the "5% State Initiative Projects).
    - State's Prioritization for HMGP 5% sub-grants:
        - Based on the nature of the disaster,
        - Warning Systems (such as those for the flood hazard),
        - Emergency Communication Systems & Capabilities (such as those for the windstorm and winter storm hazards), and
        - Projects for which a benefit-cost ratio is difficult to determine but are otherwise eligible.

Board Membership

Should there be a need to convene the Hazard Mitigation Grant Review (HMGR) Board, the following representatives would comprise the Board and meet to prioritize and guide the project selection process:

- Director of the Oregon Office of Emergency Management or designee (most usually the Section Director, Mitigation and Recovery Services who may also be State Coordinating Officer for major disaster declarations). This position serves as Chair of the Board;
- State NFIP Coordinator of the Department of Land Conservation and Development (DLCD) or designee;
- President of the Oregon Emergency Management Association (OEMA) or designee;
- A representative of the Association of Oregon Counties (AOC), as applicable
- A representative of the League of Oregon Cities (LOC), as applicable; and
- For flood disasters and related projects, a representative from the U.S. Army Corps of Engineers (USACE).

Membership may vary depending on the type of disaster and expertise needed.

The State Hazard Mitigation Officer (SHMO) of the Oregon Office of Emergency Management provides staff and technical assistance, but is not a voting member. The SHMO works with the Board to develop the state's HMGP Administrative Plan for each disaster. The HMGR Board relies on the SHMO's experience with mitigation project implementation to help the members understand mitigation needs and priorities representative of the geographic diversity of Oregon, and identify resources and opportunities for potential applicants. During large disasters, the SHMO's position can be augmented with additional staff if so approved by the agency head or by legislative authority.

In addition to the position's work with the HMGR Board, the SHMO serves as the state's primary point of contact for all of FEMA's HMA grant programs as well as mitigation programs administered by OEM. Working with local governments, the SHMO has a broad understanding of the state's natural hazards and risks, mitigation strategies and project treatments, planning resources, and grants management requirements associated with federal and state funding. All mitigation planning and project applications that are submitted to FEMA by OEM are submitted by the SHMO who has overall responsibility for managing the state's mitigation program.

5.4.4 Monitoring Mitigation Measures and Project Closeouts

OEM systematically monitors the implementation of FEMA-funded mitigation measures using (a) required sub-grantee quarterly reporting, (b) telephone and e-mail communications, and (c) project site monitoring as required. Successful project implementation requires open communication between the grantee and sub-grantee to ensure schedules, budget, and scope of work deliverable requirements are met. Project closeouts are always conducted on site allowing the grantee and sub-grantee to certify completion of the project activity (performance component) and that all eligible expenses have been submitted, reviewed for eligibility and reimbursed (financial component). All matters involving Environmental & Historic Preservation compliance as stipulated in the Record of Environmental Consideration at the time of project funding obligation must also be documented and certified at the time of project closeout. OEM documents project closeout by summary performance and financial reports making sure the sub-grantee is aware of documentation retention requirements, audit requirements, and maintenance schedule (if required) to ensure the performance of the mitigation over the life of the project. FEMA has developed checklists that facilitate the sub-grant closeout process.

The process used to monitor the implementation of mitigation measures and project closeouts includes tracking action items identified in both the state NHMP and local government NHMPs. The state IHMT is responsible for monitoring implementation of projects identified in the state NHMP and is further advised, annually, of progress made in implementing measures at the local government level for which OEM is the grantee for FEMA funding. The State Hazard Mitigation Officer (SHMO) is responsible for reporting this information to the State IHMT for projects funded by the Hazard Mitigation Grant, Pre-Disaster Mitigation, and Flood Mitigation Assistance programs.

Outside of the traditional FEMA mitigation grant programs, state and local governments identify and often implement mitigation measures using local capabilities and resources. This includes the development and adoption of local ordinances and regulations that include a hazard mitigation component, mitigation codes and standards as part of ongoing transportation and public works programs, hazard-related components of local comprehensive land use plans, and so forth. While it may not be possible to track and report on every mitigation accomplishment in state and local mitigation plans, communities will see the positive, cumulative impacts of these efforts in reduced disaster losses. The state encourages the seamless integration of mitigation activities into the day-to-day operations of state and local government programs.

All of the members of the State IHMT have a role in working with local communities and helping them consider, develop, and submit eligible, cost-effective Hazard Mitigation Assistance applications. This role, however, falls increasingly upon the State Hazard Mitigation Officer (SHMO) and State NFIP Coordinator who spend considerable time communicating with communities to help them develop proposals. And while a history of Oregon's mitigation grants management shows a capability to handle funds appropriately and to implement, monitor, and close out mitigation projects, current staffing levels and systems have been strained following large disasters with increased funds to handle, disperse to sub-grantees, and monitor while the grant is active and after closeout. Required FEMA monitoring and OIG audits which largely deal with retrospective matters and do not necessarily have a component of forward progress also consume the SHMO's time.

Present staffing levels and loss of knowledge and expertise due to staff turnover present challenges in grants management, project implementation, monitoring, and closeout. OEM submitted a request for increased funding which would allow the agency to hire two additional staff to assist the SHMO, in addition to working on other hazard mitigation activities.

The state of Oregon complies with all federally mandated reporting requirements. However, current staffing levels make it challenging to comply with reporting in a timely manner. Nevertheless, the state has redoubled its efforts and made significant progress in addressing federally required reporting criteria. By letter dated February 27, 2015, FEMA approved Oregon's 2012 Natural Hazards Mitigation Plan as an enhanced plan meeting all program management requirements.

5.5 Mitigation Action Assessment

Requirement 44 CFR §201.5(b)(2)(iv), A system and strategy by which the State will conduct an assessment of the completed mitigation actions and include a record of the effectiveness (actual cost avoidance) of each mitigation action.

The overall goal of hazard mitigation planning is the implementation of mitigation measures that avoid or reduce future disaster losses. By carefully documenting project implementation costs as well as post-disaster cost-avoidance, it is possible to measure the effectiveness of mitigation throughout the state. Mitigation project success stories, while not necessarily quantifying losses avoided, validate that mitigation can be incorporated both pre-disaster and during post-disaster recovery, and successfully reduce the impacts of future disaster events.

Calculating hazard event losses that were avoided as the result of a mitigation project requires pre- and post-disaster mitigation data. These data sets can be analyzed in detail using a process that is not unlike a benefit-cost analysis. As described within Table 5-3, the state continues to work with FEMA Region X mitigation staff to crosscheck the state's historic database of mitigation projects (mainly flood-related property acquisitions and elevations, facility earthquake retrofits, and electric utility projects that convert overhead power lines to underground) by completing project closeout assessments. Project closeout assessments are the basis from which mitigation success stories can be further quantified as losses avoided. Maintaining a detailed cost accounting of the mitigation project implementation costs, engineering specifications, as-built certifications, and the original benefit-cost analysis are the essential data sets needed to quantify losses avoided. When mitigation project costs are evaluated by post-disaster measures of success, the state is able to determine overall project effectiveness.

Table 5-3. Calculation of Hazard Event Losses

Project Closeout Assessment Track	Post-Event Assessment Track
Financial records and certifications Performance and as-built reports On-site final inspections Documentation retention • Per state and federal regulations • Local government financial requirements • NEMIS and e-Grants requirements Electronic file backups on programmatic certifications are maintained indefinitely	Annual EMPG reporting Local disaster events and reporting • IDA/PDA reporting process • NFIP loss data and insurance claims • Benefit-Cost Analysis from mitigation project application • Consumer-owned electric utility and special district reporting Documenting post-event mitigation success stories Calculating losses avoided

Source: OEM

Currently, the state does not have the staff or financial resources to systematically track potential losses avoided for each action taken. The state does, however, maintain documentation of "mitigation success stories" (**Section 3.3.5**). These are completed actions that have shown to be successful by (a) avoiding potential losses and/or (b) demonstrating cost-effectiveness through benefit-cost analysis or other quantitative assessment. Likewise, actions that support mitigation efforts, like risk or vulnerability assessment studies, are included in **Section 3.3.5**. Mitigation success stories are completed with input from the action's coordinating agency.

In the future, the state will capitalize on opportunities to record the actual effectiveness (quantitative measurement) of successful mitigation actions and losses avoided. Much like the Benefit-Cost Analysis Toolkit developed and required by FEMA, there is significant interest by FEMA in developing a similar toolkit to assist states and local governments in quantifying the success of mitigation projects. As of this writing, there is no prescribed methodology promulgated by FEMA to undertake this effort. The simplest approach, at least for the flood hazard, is to evaluate *previous* NFIP flood loss properties following successful mitigation treatments. In the simplest case, a damaging flood prior to mitigation should minimally have similar losses avoided following mitigation. For electric utility projects (overhead to underground power line conversions) the simplest metric to obtain from the utilities is the reduction (up to elimination) of power outages caused by "downed" power lines. Such was the case following FEMA disaster DR-4169 by outreach to public electric utility providers that unanimously reported on the effectiveness of FEMA-funded mitigation projects.

The state will take advantage of opportunities that arise in the future, when new hazard events occur and resources become available, especially during Joint Field Office (JFO) operations following major disaster declarations. It is the state's intention to take advantage of the Hazard Mitigation Technical Assistance Program and Community Education & Outreach resources during JFO operations to objectively quantify mitigation successes through loss avoidance reports and success stories. JFO procedures include the following opportunities that can be pursued pending available FEMA and state resources:

- FEMA-State Preliminary Damage Assessment Team (PDA) is convened, the state conducts an Initial Damage Assessment (IDA). The state will provide information on previously implemented mitigation projects to the impacted local governments to immediately consider not only for documenting successful mitigation projects but to identify new mitigation opportunities with both Public Assistance and stand-alone mitigation funding *pending* a major disaster declaration. Of course, not all disasters meet major disaster declaration thresholds, and these "initial" opportunities to quantify successful mitigation projects further support the notion that the success of those projects, in fact, helped reduce the overall losses associated with the disaster.
- When the FEMA-State PDA Team is convened but prior to field data collection, the state provides an inventory of completed mitigation projects to the PDA Team. Previously implemented mitigation projects will be discussed with potential applicants to capture mitigation successes and loss avoided data.
- When appropriate mitigation successes or data are available, the Hazard Performance and Analysis Group will be engaged to complete a loss avoidance study and the Community Education and Outreach group will complete success stories and best practice documentation.
- Additional follow-up on the success of previously implemented mitigation projects will be used as examples during the Public Assistance and Hazard Mitigation Grant Program applicant

briefings following a major disaster declaration. Additional information on losses avoided and success stories will be captured.

Of particular and specific interest for a detailed loss avoidance study are mitigated, repetitive flood loss properties in the City of Tillamook and around Tillamook County, the Johnson Creek / Lents area in Portland, and a large number of recently implemented projects in the City of Vernonia. A number of these previously mitigated properties have been challenged by new flood events with no or minimal property damage.

Objectively reporting on mitigation successes increases interest at all levels of government and within the community, and provides opportunities in partnering mitigation resources such as project funding and technical assistance. Oregon has been quite successful, through the Silver Jackets initiative, in leveraging Federal and state technical assistance in support of community flood awareness, preparedness, and mitigation. Furthermore, it can be expected that the accrued benefits from mitigation expenditures will continue to increase over the effective life of projects, as cumulative losses avoided grow with subsequent hazard events. Repetitive loss properties become repetitive mitigation success stories.

During the 3-year period covered by this state plan update, Oregon experienced three major disaster declarations: DR-1956, DR-1964, and DR-4055.

- DR-1964 was Oregon's first tsunami major disaster declaration (distant event originating from a massive subsea earthquake near Japan). Effects in Oregon from the trans-ocean tsunami were largely confined to rapid changes in sea levels at port facilities in Curry and Lincoln Counties. Previously developed tsunami evacuation planning and inundation mapping were used as a life-safety measure (no lives were lost to the tsunami wave activity) based on the Pacific-wide tsunami warning. The tsunami wave impacts, although much less than those from a near-field Cascadia event, provided further impetus for the City of Newport to consider and seek mitigation funding for a tsunami "safe haven" project that will retrofit an existing land feature as a high ground evacuation site. The Port of Brookings Harbor implemented a post-disaster, multi-hazard mitigation project to protect its port facility from distant tsunami waves and for storm surge waves that can occur during any winter season.
- Disasters DR-1956 and DR-4055 included regional flood and landslide impacts in western Oregon. Based on past experience with flood impacts to developed properties and the success of floodplain acquisition projects, the top mitigation priority for both disasters included the acquisition of residential properties substantially damaged by flooding and landslides. Residential property acquisition project opportunities in Clackamas, Columbia, Marion, Linn, Benton, Coos, and Curry Counties were identified during the PDA process and funded by sub-grants from their respective disasters' HMGP awards. By recognizing the success of past floodplain and landslide acquisition projects, the state was able to implement a mitigation strategy that has a clear record of eliminating future disaster losses. For DR-4055, floodplain elevation projects (residential properties not substantially damaged) were identified in Lane, Linn, Lincoln, and Polk Counties and also implemented using HMGP funding. Oregon's first (and only) floodplain property relocation project was also implemented using DR-4055 HMGP funding.
- Oregon was one of the first states to use funding from the Flood Mitigation Assistance (FMA) Program and the NFIP's Increased Cost of Compliance (ICC) benefit in the late 1990's. A number of residential properties along the lower Siletz River in Lincoln County that were impacted by

damaging floods in 1996, ’97, and ’98 were identified for mitigation and elevated. The success of that program continues to be a model for other properties in that watershed that have been subsequently elevated, including one property from DR-4055, HMGP.

5.5.1 Tillamook Bay Repetitive Flood Loss Properties

As staff and funding resources allow, OEM conducts loss avoidance studies that quantitatively assess the effectiveness of hazard mitigation projects. The most recent loss avoidance study, completed in September 2009, was supported by FEMA’s Hazard Mitigation Technical Assistance Program (HMTAP) under the auspices of DR-1824. The loss avoidance study was developed to evaluate the success of flood mitigation projects in Tillamook County which has experienced significant, repetitive flood losses beginning with Stafford Act assistance provided under DR-853 (January 1990 incident and declaration) through DR-1824 (December 2008 incident; March 2009 declaration), a total of four major declarations and at least another four significant flood events that were not declared. Flood Mitigation Assistance (FMA) program funding was also used to acquire and elevate flood-prone properties.

In this area, minor flooding of low-lying dairy and pasture land north and east of Tillamook can be expected when the water level exceeds 12 feet, particularly during high tides. Above 14 feet, widespread lowland and dairy land flooding begins. Sloughs north of the City, mainly Dougherty, begin to overflow. Minor flooding begins in the business district north of Tillamook and along US-101, particularly during high tides.

During the period 2011–2014, the following flooding on the Wilson River stream gage was reported:

- 13.50 ft on March 15, 2012,
- 12.36 ft on March 30, 2012,
- 14.69 ft on November 20, 2012, and
- 14.12 ft on December 21, 2014.

No building flood damages were identified during this reporting period as the water levels stayed just below significant flood height. Most of the low-lying buildings that would have been impacted from water levels exceeding 14 feet had been previously acquired or elevated. No major disaster declarations were related to these flooding events.

Low-lying areas between the Coast Range and the Pacific Ocean in southwestern Oregon are particularly vulnerable to severe flooding. The City of Tillamook, which is located in this region, has repeatedly experienced severe floods, most recently on January 8, 2009 (after DR-1824). In response to these repetitive events, the City and County of Tillamook implemented a number of non-structural flood mitigation projects to reduce damages from future flooding. The projects consisted of the acquisition, elevation, and relocation of flood-prone buildings. The local governments completed the projects with assistance from FEMA, the State of Oregon, other public agencies, and private entities.

Multiple flood events have occurred since the completion of the mitigation projects; the floods could have damaged the buildings if the projects had not been completed. To evaluate losses avoided by the projects, FEMA offered HMTAP assistance to Oregon to support a study to evaluate losses avoided by nine of the projects, the elevation of three commercial buildings and the acquisition and demolition of six commercial buildings along US-101 in the City of Tillamook.

FEMA calculated the value of the losses avoided and compared the value to the cost of mitigation. The aggregate losses avoided were valued at $3.1 million, and the aggregate project cost was valued at approximately $4.7 million (both values in 2009 dollars), resulting in a return on investment of 66%. FEMA estimates that elevation projects have an average useful life of 30 years, and that acquisition projects have a useful life of 100 years. The majority of the projects discussed in the Loss Avoidance Study: Oregon Property Acquisition and Structure Elevation were implemented after 2003. It is anticipated that the value of the losses avoided, and therefore the return on investment, will increase in the future as other flood events occur.

The complete *Loss Avoidance Study* is located in **Appendix** 9.3.2.

5.5.2 Johnson Creek Floodplain Acquisition and Restoration Project

Almost every year, whenever a large rainstorm event would pass through Portland, Johnson Creek would flood the flat, residential and commercial areas along Foster Road and SE 100th, 106th, and 108th Avenues if waters rose over 11 feet. Given the repeated flooding, the City of Portland invested in the voluntary acquisition of flood-prone homes and restoration of 70 acres of the Johnson Creek watershed.

A major storm in January 2012 tested the restoration efforts. Johnson Creek rose to 13 feet, and while it was close, homes and businesses were spared flooding. Water instead filled the restored floodplain that diverted floodways away from the roadway into 120 feet of new flood storage. The 60-acre site, called the *Foster Floodplain Natural Area* will be transferred to Portland Parks and Recreation to be managed as a natural area. According to Maggie Skenderian, Johnson Creek Watershed Manager for Portland Environmental Services, the city successfully addressed flood damage and made wildlife habitat improvements. “In the 1930s, they thought if they moved water downstream it would alleviate flooding — it didn’t work,” she said.

The city bought out the residents who lived on the 70 acres south of Johnson Creek. Buying and demolishing some 60 houses dating from the mid-20th century cost $12 million; a new bridge and floodplain restoration to open space cost $8 million. A portion of the project funding for the voluntary property acquisitions was initially provided by the Hazard Mitigation Grant Program from DR-1099, February 1996 Oregon Flood Disaster. A project to restore floodplain function and reduce the extent of flooding was provided by a Pre-Disaster Mitigation grant in 2005. Along with substantial city funding this project leveraged opportunities to reduce flood impacts in the community and eliminate future losses to the National Flood Insurance Program within the project area and reduce losses north of Foster Road. It is easy to see that with no improved properties to flood in this section of the Johnson Creek floodplain, there were no insured losses whatsoever amassing significant cost savings to the National Flood Insurance Fund.

The following success stories are in **Section 3.3.5**.

- **Oregon Storm Mitigation:** Mitigation brings Enhanced Safety and Reduces Losses. This project resulted in the state of Oregon working with utilities around the state on projects to underground power lines to enhance safety and reduce losses during winter storms.
- **Benton County and Consumer Power Inc.:** Mitigation for Winter Storms. Consumer Power, Inc. underground power lines to enhance safety and reduce losses during winter storms.

- **Lane County and Emerald People's Utility District Mitigation for Winter Storms:** Emerald People's Utility District undergrounded power lines to enhance safety and reduce losses during winter storms.
- **Springfield and the Springfield Utility District Mitigation for Winter Storms:** Springfield Utility Board undergrounded power lines to enhance safety and reduce losses during winter storms.
- **Vernonia Relocation and Replacement of Three Schools:** This project resulted in replacing three school buildings that had experienced repeated damage outside the floodplain.
- **Johnson Creek (Portland) Floodplain Acquisition and Restoration Project.** To reduce chronic flooding, the City of Portland voluntarily acquired and demolished 60 houses to restore the floodplain to open space.
- **Tillamook Bay Repetitive Flood Loss Properties (Southern Flow Corridor — Landowner Preferred Alternative Project).** The City and County of Tillamook implemented a number of non-structural flood mitigation projects to reduce damages from future flooding. The projects consisted of the acquisition, elevation, and relocation of flood-prone buildings.

5.6 Effective Use of Available Mitigation Funding

Requirement 44 CFR §201.5(b)(3), Demonstration that the State effectively uses existing mitigation programs to achieve its mitigation goals.

5.6.1 Current and Potential Funding

Funding to implement mitigation measures (including repetitive loss properties) can come from a number of sources, including government (local, state, and federal), private sector, foundations, insurance claims, and from citizens themselves. The funding can be in the form of grants that may or may not require a match as well as loans of different types. Prior to a disaster, grants and loans can be made available on a scheduled or special announcement basis. Following a disaster, when opportunities for mitigation are often best coupled with the recovery effort, post-disaster grants and loans come from a number of sources. Citizens themselves make significant contributions to mitigation projects, providing matching funds or even the full amount of funding from their own resources. In Oregon, residential property owners participating in the FEMA-funded property acquisition programs almost always provide the non-federal match contribution of 25% of the pre-disaster real market value of the property damaged by the disaster, realizing seventy-five cents on the dollar for their property (improvements and land valuation).

5.6.2 Funding Used to Implement Mitigation Actions

The Stafford Act provides FEMA the authority to fund the restoration of eligible public facilities that have sustained damage due to a presidentially declared disaster. Under FEMA's Public Assistance Program (Section 406 of the Stafford Act), when considering the restoration of damaged facilities, there are provisions for the consideration of funding additional measures that will enhance a facility's ability to resist similar damage in future events. Often, one of the best occasions to implement mitigation measures becomes evident when evaluating repair of disaster-damaged components of facilities. When implemented in conjunction with repair and restoration, cost-effective mitigation treatments can eliminate or reduce recurrence of similar damage from future, similar disaster events. Such measures are in addition to any measures undertaken to comply with applicable codes and standards, although such compliance itself could be considered a form of mitigation. Oregon's Public Assistance Program policy is to consider all potential, eligible mitigation opportunities when reviewing Public Assistance Program Project Worksheets for permanent repair and restoration of damaged facilities. Oregon's Public Assistance (Program) Officer works directly with FEMA staff to ensure all Project Worksheets are reviewed for mitigation consideration (406 Mitigation).

Table 5-4. Section 406 Mitigation Report — Disaster Summary 2012–2104

Disaster Declaration	# Project Worksheets Written	Worksheets w/Mitigation	406 Mitigation $ Awarded	Total $ Awarded on All Projects
DR-4055	520	81	$779,814.00	$20,920.469.83
DR-4169	50	0	$0.00	$8,183,833.20

Section 406 hazard mitigation funding and funding offered under the Hazard Mitigation Grant Program (HMGP, Section 404) are distinct but can actually work together. Section 406 mitigation is generally only applied on the parts of the facility that were actually damaged by the disaster with the mitigation measure providing protection from subsequent events. Components of a facility that were not damaged but could benefit from mitigation could become eligible for consideration under Section 404. Much like Section 406 mitigation, the Section 404 mitigation work must be cost-effective and reasonably performed as part of the work or measure which will reduce the potential for damage to a facility from a disaster event. In these instances, the application for Section 404 hazard mitigation funding must be submitted in a timely manner and consistent with State and local hazard mitigation plans. It is Oregon's mitigation policy to consider, where feasible and cost-effective, opportunities to accomplish joint 406/404 mitigation early in the disaster recovery process during Joint Field Office (JFO) operations. Public Assistance Project Worksheets and HMGP project applications can be developed in tandem and quickly evaluated for potential cost-effective mitigation measures. There is, of course, no guarantee that 406/404 mitigation opportunities will occur with every disaster but by considering these joint opportunities early in the recovery process good mitigation projects can be quickly identified, reviewed and approved, and implemented in such a way that mitigation benefits are enjoyed sooner rather than later. Each disaster-specific HMGP Administrative Plan will address evaluating opportunities for joint 406/404 mitigation and establish a state selection criterion as a priority for consideration during JFO operations.

Table 5-5. Sections 406/404 Joint Mitigation Report — Disaster Summary 2012–2014

Disaster Declaration	# Joint Mitigation Opportunities Identified	# Joint Mitigation Opportunities Implemented	404 Mitigation $ Awarded for Joint Projects (75% share)	Total 404 Mitigation $ Available (75% share)
DR-4055	2	1	$26,276	$2,977,380
DR-4169	1	0	$0.00	$953,345

Disaster DR-4169, declared in April 2014, was a severe winter storm with significant snow and ice impacts to public electric utility providers. Because most electric utilities implement permanent repairs to their damaged infrastructure (to quickly restore electric service to impacted customers), there were few stand-alone 406 and joint 406/404 mitigation opportunities identified. Stand-alone 404 HMGP projects from this disaster emphasize mitigation projects that convert overhead power lines (with a history of past losses) to underground service.

5.6.2.1 Hazard Mitigation Grant Program (HMGP)

All past disaster HMGP sub-grant activities prior to 2007, up to and including DR-1683 (declared in February 2007) have been completed. At the time of this 2015 plan update, there are seven actively open disasters, as shown in **Table 5-6**.

Table 5-6. HMGP Disaster Status and Funding (2007–2014)

Disaster (#Sub-grants)*	Federal Share Available*	Federal Share Obligated*	Explanation
DR-1683 (4)**	$828,838	$828,830	all sub-grants completed and closed out
DR-1733 (25)	$15,358,404	$15,348,380	PoP ended 12/31/14; currently in liquidation
DR-1824 (8)	$2,884,628	$1,729,014	PoP ends 3/31/15; two sub-applications were dropped when the non-federal cost share was lost due to the economic down-turn in 2009
DR-1956 (5)	$987,001	$779,949	PoP ends 2/17/16; pending phased project in Clackamas County will likely expend remaining federal funding
DR-1964 (5)	$1,211,616	$1,097,092	PoP ends 3/25/16; any remaining federal share funding would be applied to eligible cost overruns on (potentially) two sub-grants
DR-4055 (18)	$3,122,974	$3,015,382	PoP ends 3/1/16; any remaining federal share funding would be applied to eligible cost overruns on (potentially) three sub-grants
DR-4169 (3)	$999,964	$195,655	sub-application period still open (as of 12/31/14) with three sub-grants approved and obligated

*Includes State Management Cost sub-grant.

**DR-1683 did not have a direct State Management Cost sub-grant obligation.

Source: OEM

Beginning with DR-1733, grantee and sub-grantee administrative costs are no longer being provided by FEMA and have been replaced by a State management cost (SMC) calculation. The State, as the grantee, can choose to allocate SMC funding to sub-grantees to offset their costs for applying for and administering Federal sub-grant funding. For smaller disaster declarations, OEM has chosen not to extend HMGP state management funding to sub-grantees but rather to use those resources, in part, to provide direct technical assistance, including benefit-cost analysis training and application reviews, and developing approvable sub-applications for FEMA's consideration. OEM relies greatly on local jurisdiction mitigation plans to identify priority HMGP project activities that can be implemented quickly in the post-disaster environment.

5.6.2.2 Flood Mitigation Assistance (FMA) Program

Flood hazard mitigation became a top priority in Oregon in the mid-1990s, resulting in increased funding for hazard mitigation. Four areas that experienced repetitive flooding in 1996 and 1997 received the bulk of the project funding: Lower Johnson Creek in Portland; Tillamook County and City; the Lower Siletz area in Lincoln County; and the unincorporated area of Mapleton in Lane County. Many dozens of flood-loss properties have been elevated, relocated or acquired in these areas with very minimal or no damage to the mitigated properties during subsequent floods. In addition to these local governments, Vernonia, Wallowa County, Scio, and others have developed and successfully implemented strategies to address repetitive hazard losses. By proactively developing policies, engaging in planning, and implementing mitigation measures, local governments are developing policies, and building capability for reducing disaster losses.

Flood Mitigation Assistance (FMA) Program: All grants prior to and including FY 2012 are completed and closed with the FY2009 offering closed out with FEMA in December 2014. Although closed, of particular interest is the FY 2009 offering of the FMA grant program that included a supplemental allocation offered to the states on a first-come basis. Oregon seized this opportunity and received significant FMA funding (as reported in Federal share, EMS-2009-FM-E001) for the projects listed in **Table 5-7**.

Table 5-7. Flood Mitigation Assistance Projects and Funding (2009–2014)

Project	Federal Obligation	Funding Spent	Explanation
FMA FY2009			
City of Lexington Fire Station/City Hall Flood Acquisition	$103,281	$103,281	project completed and closed out
City of Vernonia Home Elevations	$532,367	$353,788	project completed and closed out; scope of work modified for properties that chose not to participate
Vernonia School District Floodplain Acquisition	$11,287,267	$11,287,267	project completed and closed out
West Oregon Electric Co-op Headquarters Acquisition	$813,775	$813,717	project completed and closed out
City of Madras Police Station/City Hall Floodway Acquisition	$412,498	$386,445	project completed and closed out; cost savings on demolition and site restoration
Lake Oswego Dam Spillway Retrofit Project	$957,703	$957,703	project completed and closed out
FMA FY 2010			
Multnomah County Flood Hazard Mitigation Planning	$19,000	$19,000	project completed and closed out
FMA FY 2012 (SRL)			
Lincoln City SRL 2012 Flood Elevation Project	$135,333	$135,333	project completed and closed out
FMA FY 2014 (SRL)			
Linn County SRL 2014 Flood Acquisition Project	$325,500	$297,678	project still underway; demolition yet to be completed

Source: OEM

The Vernonia School District Acquisition project is a showcase flood hazard mitigation project that would not have been possible without the unwavering support from FEMA Region X staff. This project essentially demolished and relocated the function of the Vernonia K-12 school campus from the Special Flood Hazard Area to a new site totally out of flood harm's way. The current school campus has a long history or repetitive flood losses particularly those occurring in 1996 (DR-1099) and 2007 (DR-1733). All of the projects have been completed as of September 2014. The state provided a non-federal match of $4 million for this project. Of the HMA grant programs, FMA has more rigorous project eligibility criteria and only addresses projects that mitigate the flood hazard, and for improved properties, only those that have NFIP insurance policies. Experience has shown this program requires significantly more grant management oversight by OEM to ensure projects are completed in a timely manner.

Although Oregon had only 11 Severe Repetitive Loss (SRL) properties in 2011, the State has made a concerted effort to mitigate them. Shortly after the SRL program was announced the State reviewed FEMA's vetted list of SRL properties to identify potentially ripe projects. The top candidate was a home in Lincoln City that could benefit from elevation. After numerous unsuccessful attempts to secure FY 2011 SRL funding, the state resubmitted the Lincoln City property to the FY 2012 offering of the SRL grant program. The project was funded, successfully implemented, and closed out in early 2014.

For the FY2013 offering of the FMA program (SRL was wrapped into FMA beginning this year) the State submitted a non-validated SRL property in Linn County for acquisition consideration. The property was brought to the attention of the State by a real estate agent who had listed the property for sale but could not find a buyer because of the building's flood history. Although the building met the definition of an SRL property (it apparently was missed in the vetting process), it was not selected for funding because it was not on FEMA's list of validated SRL properties. The State subsequently petitioned FEMA to include the Linn County property on the validated SRL list. It was added, resubmitted to the FY2014 FMA grant program offering and selected. Demolition is expected to be completed in the summer of 2015. One property dropped off the validated list in 2013 because it had not flooded within the rolling SRL 10-year eligibility window.

The State visited each of the remaining FEMA-validated SRLs in 2013 to gain a better understanding of what mitigation actions would most likely be successful and cost-effective. Of these, one building was already under contract to be elevated using HMGP. That project was completed in 2014. Each of the remaining eight buildings appear suitable for elevation or acquisition. The State annually contacts the Emergency Managers in the jurisdictions where these buildings are located to suggest they contact the owners to make them aware of and encourage them to participate in the SRL program before their eligibility expires.

Table 5-8. Flood Mitigation Assistance Severe Repetitive Loss (SRL) Projects and Funding (2012–2014)

Funding Source	Date Completed	Location	Mitigation Type
SRL Program FY 2012	1/9/2013	Lincoln City	elevation
HMGP DR-4055	12/9/2014	Lincoln County	elevation
FMA Program FY 2014	project currently underway; completion scheduled for 8/1/2015	Linn County	acquisition

Source: OEM

5.6.2.3 Pre-Disaster Mitigation (PDM) Competitive Grant Program

All PDM FY 2009 and previous year sub-grants are completed and closed out. Sub-grants from FY 2010 and later years are ongoing (or awaiting closeout) with a number of projects completed. Table 5-9 shows the history of FY 2006 and later sub-grants.

Table 5-9. Pre-Disaster Mitigation Projects and Funding (2007–2014)

Project	Federal Obligation	Funding Spent	Explanation
PDM FY 2007			
Deschutes & Crook Counties Wildland Fire Mitigation	$1,010,190	$845,850	project completed and closed out; project work exceeded original scope of work expectations
Gladstone Fire Station Seismic Upgrade	$158,566	$158,566	project completed and closed out
OPDR, Local Mitigation Planning in Regions 1 & 3	$250,000	$247,919	project completed and closed out
City of Salem, Fire Station Seismic Retrofits	$1,036,125	$1,036,125	project completed and closed out
PDM FY 2008			
Deschutes & Crook Counties Wildfire Fuels Reduction Project	$667,874	$229,841	project completed with a significant cost under-run and closed out
PDM FY 2009			
City of Corvallis, City Hall Seismic Retrofit	$842,924	$641,294	project completed and closed out
City of Gresham, Seismic Retrofit of Two Fire Stations	$391,723	$387,457	project completed and closed out
OPDR, State of Oregon Local Plan Updates	$228,821	$226,925	project completed and closed out
PDM FY 2010			
Harney Electric Co-op, Communication Site Mitigation	$264,413	$68,869	project in wrap-up phase
Deschutes, Crook & Klamath Counties, Central Oregon Wildfire Mitigation	$3,000,000	$0	EHP process underway; Federal funding not yet obligated
PDM FY 2011			
City of Canby, Water Reservoir Seismic Retrofit	$539,298	$539,298	project completed and closed out
OPDR, Multi-hazard County Mitigation Plan Updates — Columbia Gorge Region	$215,981	$212,458	project completed and closed out
PDM FY 2012			
Lincoln County School District, Waldport High School Tsunami Acquisition Project	$3,000,000	$3,000,000	project work completed
OPDR, Local NHMP Update Support	$399,999	$265,593	project work underway
PDM FY 2013			
OPDR, Local NHMP Updates	$250,001	$0	project work underway
City of Portland, Natural Hazards Mitigation Plan Update	$265,982	$0	project work underway
PDM FY 2014			
OPDR, PDM14 NHMP Updates	$250,000	$0	project work underway
DLCD Multi-hazard Mitigation Planning 2015-2017	$215,180	$0	pending FEMA approval and funding obligation
OSU Hazard Mitigation Plan	$76,388	$0	pending FEMA approval and funding obligation

Source: OEM

5.6.2.4 HMGP, FMA, PDM Grants Management Summary

The State of Oregon provides timely, complete, and accurate performance and financial quarterly reports on the FEMA-funded mitigation grants. To meet the consistent reporting deadlines to FEMA Region X, sub-grantees are required to submit their individual performance quarterly reports to OEM by the 15th of the month following the end of the traditional calendar quarter. The sub-grantee reports are reviewed and discussed with the sub-grantee (where required), synthesized, and submitted to FEMA Region X by the end of that month. Financial reports are provided in a similar fashion. Scheduled sub-grantee reporting to the state fulfills grants' monitoring requirements supplemented by on-site inspections (performance and financial) as required.

Table 5-10 presents a concise self-assessment of Oregon's overall capability to effectively manage HMGP, FMA, and PDM grant program activities from application to closeout.

Table 5-10. Grant Performance, Process, and Closeouts (as of 12/31/14)

Grant Program	Applications		EHP/BCA Information		Timely Reporting		Send for FEMA Closeout	
HMGP	**to State**	**to FEMA**	**Status**	**Eligibility**	**Grantee**	**Sub-grantee**	**Performance**	**Financial**
DR-853	closed	complete	closed	complete	yes	yes	closed	closed
DR-985	closed	complete	closed	complete	yes	yes	closed	closed
DR-1004	closed	complete	closed	complete	yes	yes	closed	closed
DR-1061	closed	complete	closed	complete	yes	yes	closed	closed
DR-1099	closed	complete	closed	complete	yes	yes	closed	closed
DR-1107	closed	complete	closed	complete	yes	yes	closed	closed
DR-1149	closed	complete	closed	complete	yes	yes	closed	closed
DR-1160	closed	complete	closed	complete	yes	yes	closed	closed
DR-1221	closed	complete	closed	complete	yes	yes	closed	closed
DR-1405	closed	complete	closed	complete	yes	yes	closed	closed
DR-1510	closed	complete	closed	complete	yes	yes	closed	closed
DR-1632	closed	complete	closed	complete	yes	yes	closed	closed
DR-1672	closed	complete	closed	complete	yes	yes	closed	closed
DR-1683	closed	complete	closed	complete	yes	yes	closed	closed
DR-1733	closed	complete	closed	complete	yes	yes	closing	Jun-2015
DR-1824	closed	complete	closed	complete	yes	yes	closing	Jun-2015
DR-1956	closed	phased	ongoing	ongoing	yes	yes	on target	
DR-1964	closed	complete	closed	complete	yes	yes	on target	
DR-4055	closed	complete	closed	complete	yes	yes	on target	
DR-4169	open	open	ongoing	ongoing	yes	yes	on target	
FMA (w/SRL)	**to State**	**to FEMA**	**Status**	**Eligibility**	**Grantee**	**Sub-grantee**	**Performance**	**Financial**
FY97	closed	complete	closed	complete	yes	yes	closed	closed
FY98	closed	complete	closed	complete	yes	yes	closed	closed
FY99	closed	complete	closed	complete	yes	yes	closed	closed
FY00	closed	complete	closed	complete	yes	yes	closed	closed
FY01	closed	complete	closed	complete	yes	yes	closed	closed
FY02	closed	complete	closed	complete	yes	yes	closed	closed
FY03	closed	complete	closed	complete	yes	yes	closed	closed
FY04	closed	complete	closed	complete	yes	yes	closed	closed

Grant Program	Applications		EHP/BCA Information		Timely Reporting		Send for FEMA Closeout	
FY05	closed	complete	closed	complete	yes	yes	closed	closed
FY06	closed	complete	closed	complete	yes	yes	closed	closed
FY07	closed	complete	closed	complete	yes	yes	closed	closed
FY08	closed	complete	closed	complete	yes	yes	closed	closed
FY09	closed	complete	closed	complete	yes	yes	closed	closed
FY10	closed	complete	closed	complete	yes	yes	closed	closed
FY11	closed	complete					no sub-grants awarded	
FY12 (SRL)	closed	complete	closed	complete	yes	yes	closed	closed
FY13 (SRL)	closed	complete					no sub-grants awarded	
FY14 (SRL)	closed	complete	closed	complete	yes	yes	on target	
PDM	**to State**	**to FEMA**	**Status**	**Eligibility**	**Grantee**	**Sub-grantee**	**Performance**	**Financial**
FY02	closed	complete	closed	complete	yes	Grantee	closed	closed
FY03	closed	complete	closed	complete	yes	yes	closed	closed
FY03-C	closed	complete	closed	complete	yes	yes	closed	closed
FY05-C	closed	complete	closed	complete	yes	yes	closed	closed
FY06-C	closed	complete	closed	complete	yes	yes	closed	closed
FY07-C	closed	complete	closed	complete	yes	yes	closed	closed
FY08-C	closed	complete	closed	complete	yes	yes	closed	closed
FY09-C	closed	complete	closed	complete	yes	yes	closed	closed
FY10-C	closed	complete	ongoing	complete	yes	yes	on target	
FY11-C	closed	complete	closed	complete	yes	yes	closed	closed
FY12-C	closed	complete	closed	complete	yes	yes	on target	
FY13-C	closed	complete	closed	complete	yes	yes	on target	
FY14-C	updating	updating	ongoing	ongoing	yes	yes	on target	

Note: "-C" indicates funding was from the nationwide competitive PDM program.
Source: OEM

5.6.2.5 Oregon's Seismic Rehabilitation Grant Program (SRGP)

The SRGP is a state of Oregon competitive grant program that provides funding for the seismic rehabilitation of critical public buildings, particularly public schools and emergency services facilities.

Eligible activities include structural improvements including non-structural elements, architecture and engineering, and project management. It does not fund demolition and rebuild, new construction, buildings located in the Tsunami Inundation Zone, or solely non-structural projects (e.g., chimney removal or bracing).

Buildings with a mix of eligible and ineligible uses can be considered if an entity pays for the ineligible portion of the building. Eligible projects can apply for as much as $1.5 million through the SRGP.

Public K-12 school districts, community colleges, education service districts and universities are eligible for the grant program. For emergency services facilities, the emphasis is on first responder buildings. This includes hospital buildings with acute inpatient care facilities, fire stations, police stations, sheriff's offices, 9-1-1 centers, and Emergency Operations Centers (EOCs). For more information visit the SRGP website, http://www.orinfrastructure.org/Infrastructure-Programs/Seismic-Rehab/.

The state anticipates selling bonds in spring 2015 to fund the program up to $30 million. An increased budget of $200 million has been requested for the 2015-17 biennium.

5.6.2.6 Oregon Watershed Enhancement Board (OWEB)

OWEB is a state agency that provides grants to help Oregonians take care of local streams, rivers, wetlands, and natural areas. Community members and landowners use scientific criteria to decide jointly what needs to be done to conserve and improve rivers and natural habitat in the places where they live. OWEB grants are funded from the Oregon Lottery, federal dollars, and salmon license plate revenue. A 17-member citizen board leads the agency. Membership is drawn from the public at large, Tribes, and federal and state natural resource agency boards and commissions.

The Oregon Constitution specifies that OWEB may fund projects involving the purchase of interests in land from willing sellers for the purpose of maintaining or restoring watersheds and habitat for native fish or wildlife. OWEB-funded interests in land may be held by local, state, and federal agencies, Tribes, not-for-profit land conservation organizations and trusts, state institutions of higher education, independent not-for-profit institutions of higher education, or political subdivisions of the state, as long as the entity continues to use the land for the purposes specified in the constitution.

OWEB may use its funds to purchase property, property rights, or conservation easements and to provide ecosystem enhancements near streams, rivers, wetlands, and natural areas, often assisting with flood mitigation. For more information visit http://www.oregon.gov/OWEB/Pages/index.aspx.

5.7 Commitment to a Comprehensive Mitigation Program

Requirement 44 CFR §201.5(b)(4)(i-vi), Demonstration that the State effectively uses existing mitigation programs to achieve its mitigation goals.

The State is committed to a comprehensive mitigation program to achieve its mitigation goals (**Section 3.2**). Programs and methods that demonstrate this commitment are detailed throughout this Plan.

5.7.1 Capacity Building

44 CFR §201.5(b)(4)(i), A commitment to support local mitigation planning by providing workshops and training, state planning grants, or coordinated capability development of local officials, including Emergency Management and Floodplain Management certifications.

The state of Oregon aims to build local capacity in developing and implementing risk reduction strategies through plan development support, professional assistance, resource sharing, and technical assistance. Local planning and mitigation requirements are accomplished in great measure through a coordinated effort that fosters partnerships among agencies, communities, academia, and organizations to determine needs, identify issues and resources, and develop strategies for risk reduction. The Oregon Partnership for Disaster Resilience (OPDR or the Partnership) continues to provide a foundation for direct technical assistance to local governments in support of a range of risk reduction activities. Since 2004, the Partnership has systematically leveraged funding opportunities (primarily through FEMA's mitigation grants, annual Emergency Management Performance Grant (EMPG) funding and in-kind contributions) to provide direct technical assistance to local governments for the purpose of developing or updating existing local natural hazards mitigation plans and establishing a course of action to secure funding for project implementation.

All 36 counties in Oregon have participated in a Natural Hazards Mitigation Planning process (**Table 3-12**). As plans mature the State of Oregon is committed to working with local jurisdictions to update and enhance them. It is envisioned that local mitigation plans in Oregon will be incrementally incorporated into local land use plans and implemented more directly through land use regulations. A demonstration project brought direct technical assistance to the City of Madras under PDM-12. Madras successfully integrated mitigation plan information (risk assessments, strategies, and actions) into its comprehensive land use plan. The City hopes to update its development code and regulations next, focusing first on the City's Flood Ordinance.

The Oregon Disaster Response Fund helps state agencies and local governments with the non-federal cost share required to obtain Public Assistance program and hazard mitigation project funding related to a major disaster declaration in Oregon. Further, the state is proposing to expand the scope of this funding source to include mitigation planning.

In addition, DLCD has requested the Grants Advisory Committee to expand the scope of activities funded through its Technical Assistance Grants (TAG) Program to include natural hazard mitigation activities. In addition, DLCD has requested increased funding for these grants in the 2015–17 biennium.

The State Floodplain Coordinator routinely provides technical assistance to local governments and individual property owners and also provides training workshops for a variety of technical and professional audiences. **Table 5-11** shows the trainings and presentations the State Floodplain Coordinator provided on topics related to flooding and the NFIP during the period 2012-2014.

Table 5-11. Flooding and NFIP Outreach, 2012-2014

Year	Description	Audience	CFM Credit?
2012			
	Lane County Multiple Listing Service	real estate agents	no
	Professional Land Surveyors of Oregon, Annual Meeting	surveyors, floodplain managers	yes
	The Seminar Group, “Impacts of FEMA Floodplain Mapping: Regulatory Changes and Implications for Local Jurisdictions and Property Owners”	lawyers	no
	Assisted STARR with Elevation Certificate training	floodplain managers	yes
	Assisted STARR with Elevation Certificate in Approximate A Zones training	floodplain managers	yes
	Code Enforcement Officers Workshop	code enforcement	no
	NFIP 101 training in Tillamook	floodplain managers	yes
	NFIP 101 training in Salem	floodplain managers	yes
	NFIP 101 in Hillsboro	floodplain managers	yes
	NFIP 101 in Fairview	floodplain managers	no
	Professional Land Surveyors of Oregon, Rogue Valley	surveyors	no
	Mid-Willamette Valley Council of Governments	floodplain managers	no
2013			
	Ticor Title, McMinnville	real estate agents	no
	Oregon Coastal Planners Network	planners	no
	Salem Association of Realtors	real estate agents	no
	NFIP Roundtable in Tillamook County	planners	no
	Clackamas County Association of Realtors	real estate agents	no
	Cannon Beach NFIP Workshop	public, planners	no
	Warrenton NFIP Workshop	public, planners	no
	League of Cities, Small Cities subcommittee	planners	no
	Neskowin Neighborhood Association	public	no
	Metro area Regional Solutions Team	planners	no
	Washington County Board of Realtors	real estate agents	no
	Tribal Roundtable, Economic Development Committee	tribal planners	no
	Marion County Association of Realtors	real estate agents	no
	Association of Oregon Counties Steering Committee	planners	no
	Conference for Oregon county appraisers and appraisal technicians	appraisers	no
	Silverton Association of Realtors	real estate agents	no
	Newport NFIP Workshop	planners. public	no
	Lincoln County NFIP Workshop	planners, public	no
	Professional Land Surveyors of Oregon, Annual Meeting	surveyors	yes
	Windermere, Eugene	real estate agents	no
	Keller Williams, Eugene	real estate agents	no
	Windermere, Albany	real estate agents	no
	Polk County Board of Realtors	real estate agents	no
	Santiam Board of Realty, Silverton	real estate agents	no
	John Scott, Eugene	real estate agents	no

Year	Description	Audience	CFM Credit?
	Mid-Willamette Valley Board of Realty	real estate agents	no
	Portland Regional Solutions Team	planners	no
	Tillamook County Open House	public	no
	Washington County Planning Directors	planners	no
	Keizer Rotary	public	no
	Willamette Valley Professional Land Surveyors of Oregon Regional meeting	surveyors	no
	Oregon State Board of Examiners for Engineering and Land Surveying Symposium	surveyors	no
2014			
	The Meadows Group, Portland	real estate agents	no
	Central Coast Board of Realty	real estate agents	no
	Newport Chamber of Commerce	business Leaders	no
	Professional Land Surveyors of Oregon annual conference	surveyors	yes
	Windermere Real Estate, Salem	real estate agents	no
	Jackson County floodplain managers, Medford	floodplain managers	no
	Board of Commissioners, Benton County	elected officials	no
	Oregon Association of Realtors, webinar	real estate agents	no
	Coos County Board of Realty	real estate agents	no
	Oregon Emergency Management Association	emergency managers	no
	Coldwell Banker, Lake Oswego	real estate agents	no
	Reedsport community meeting on flood insurance and levee issues	public	no
	ReMax, Lake Oswego	real estate agents	no
	Willamette Association of Realtors, Adair Village	real estate agents	no
	Clackamas County “Flood of Information” community meeting	public	no
	L-273 Managing Floodplain Development class in Eugene, OR	floodplain managers	yes
	Fidelity Title, Eugene	real estate agents	no
	Oregon Association of Counties	planners, elected officials	no
	Coastal Planners Network, South and North	planners	no

Source: DLCD

The state also encourages interested parties to become Certified Floodplain Managers (CFMs). The purpose of the certification program is to “ensur[e] that highly qualified individuals are available to meet the challenge of breaking the damage cycle and stopping its negative drain on the nation’s human, financial, and natural resources” (www.floods.org). DLCD awarded 21 FEMA-funded scholarships to Oregon planners to attend the 2014 Association of State Floodplain Managers (ASFPM) annual meeting held in Seattle in May 2014. Today there are 85 CFMs in Oregon; 33 of those — almost 40% — obtained certification during the period 2012-2014 (ASFPM, 2015).

In 2014, DLCD initiated and continues to support two Community Rating System Users Groups (northern and southern Oregon) to encourage current participants to maintain their participation and increase their ratings, and to encourage non-participating communities to join the CRS Program. An online forum encourages communication and mutual support, as do regular meetings three times each year.

OEM provides training workshops and events focusing on earthquake, tsunami, and volcanic hazard preparedness, mitigation, and evacuation on a regular basis. OEM also provides technical assistance to local governments to evaluate their risks and vulnerabilities in order to access funding for implementing risk reduction measures. Table 5-12 shows earthquake- and tsunami-related outreach events during the period 2012–2014. Table 5-13 shows FEMA trainings related to mitigation offered by OEM during the same period.

Table 5-12. Earthquake- and Tsunami-Related Outreach Events, 2012–2014

Date	Location	Event	Number of Attendees
2014			
10/18/2014	Beaverton, OR	Washington County Emergency Preparedness Fair	100
10/16/2014	Oregon	Great Oregon Shakeout	390,000
10/15/2014	Portland, OR	7x24	200
9/27/2014	Cannon Beach, OR	Race the Wave	100
9/19/2014	Hood River, OR	FBINAA	75
7/29/2014	Astoria, OR	Wayfinding Charrette	30
6/2/2014	Baker City, OR	Cascadia impact on Eastern Oregon	30
4/18/2014	Grants Pass, OR	two public workshops	150
4/17/2014	Medford, OR	two public workshops	125
3/27/2014	Astoria, OR	Vulnerable Populations Workshop	11
3/26/2014	Seaside, OR	Vulnerable Populations Workshop	6
3/21/2014	Tillamook, OR	Vulnerable Populations Workshop	15
3/20/2014	Lincoln City, OR	Vulnerable Populations Workshop	9
3/20/2014	Neskowin, OR	Public Workshop	20
3/19/2014	Newport, OR	Vulnerable Populations Workshop	28
3/18/2014	Florence, OR	Vulnerable Populations Workshop	15
3/17/2014	Reedsport, OR	Vulnerable Populations Workshop	10
3/14/2014	North Bend, OR	Vulnerable Populations Workshop	16
3/13/2014	Bandon, OR	Vulnerable Populations Workshop	11
3/13/2014	Bandon, OR	Public Workshop	60
3/12/2014	Gold Beach, OR	Vulnerable Populations Workshop	6
3/11/2014	Brookings, OR	Vulnerable Populations Workshop	12
2013			
11/25/2013	Corvallis, OR	OSU, GEO 380 Guest lecturer	45
11/13/2013	Medford, OR	Cascadia Ready of Not — Public Presentation	300
11/13/2013	Medford, OR	First Responder Forum	100
11/14/2013	Grants Pass, OR	Cascadia Ready of Not — Public Presentation	126
11/14/2013	Medford, OR	First Responder Forum	50
11/15/2013	Grants Pass, OR	First Responder Forum	38
10/19/2013	Corvallis, OR	LEGOS, OSU	57
10/17/2013		Great Oregon Shakeout	129,000
10/10/2013	Seaside, OR	NW Association of Industrial Hygienists, Seaside, OR	
10/5/2013	Salem, OR	West Salem CERT	
10/5/2013	Astoria, OR	Oct 5, 2013 — CETEEP, Astoria, OR	
10/1/2013	Salem, OR	Candlaria PTA	
9/23/2013	Grants Pass, OR	Anne Basker Auditorium, Grants Pass	120
9/23/2013	Roseburg, OR	Public Safety Building, Roseburg	26
9/20/2013	Grants Pass, OR	Southern Oregon Aspire, Grants Pass	36

Date	Location	Event	Number of Attendees
9/20/2013	Medford, OR	Medford City Hall	300
9/19/2013	Table Rock, OR	Table Rock Kiwanis	8
9/18/2013	Klamath Falls, OR	Klamath County Commissioners	8
9/18/2013	Klamath Falls, OR	Klamath Community College	10
9/17/2013	Klamath Falls, OR	Klamath Falls Library	38
9/16/2013	Lakeview, OR	Lakeview High School	24
9/12/2013	Seattle, Washington	American Association of Engineering Geologists	
6/4/2013	Klamath Falls, OR	Klamath County department heads	12
6/4/2013	Klamath Falls, OR	Klamath Kiwanis	24
6/4/2013	Klamath Falls, OR	Roboteers	18
5/21/2013	Salem, OR	City of Salem Department leader meeting	45
5/8/2013	Salem, OR	Roots Academy, Salem	
5/7/2013	Woodburn, OR	Woodburn Kiwanis	
4/19/2013	Salem, OR	Salem City Club	
4/10/2013	Salem, OR	NW Public Power Association	
3/24/2013	Gold Beach, OR	Tsunami Ready Celebration, Gold Beach Event Center	
3/24/2013	Port Orford, OR	Tsunami Ready Celebration, Port Orford City Hall	
3/23/2013	Brookings, OR	Tsunami Prep Talks — Public Presentation, Brookings Elks Lodge	
3/22/2013	Gold Beach, OR	Distant Tsunami Response Training	
3/22/2013	North Bend, OR	Tsunami Ready Celebration	
3/21/2013	North Bend, OR	Tsunami Prep Talks - Public Presentation, Southern Oregon Community College	
3/20/2013	Winchester, OR	Distant Tsunami Response Training	
3/19/2013	Florence, OR	Tsunami Prep Talks — Public Presentation, Florence Library	
3/19/2013	Florence, OR	Distant Tsunami Response Training	
3/18/2013	Newport, OR	Distant Tsunami Response Training	
3/15/2013	Lincoln City, OR	Tsunami Prep Talks — Public Presentation, Driftwood Public Library, Lincoln City	
3/14/2013	Rockaway Beach, OR	Distant Tsunami Response Training	
3/14/2013	Rockaway Beach, OR	Tsunami Prep Talks — Public Presentation	
3/13/2013	Tillamook, OR	Distant Tsunami Response Training	
3/12/2013	Warrenton, OR	Public Library Management Team, Warrenton City Hall	
3/12/2013	Astoria, OR	Tsunami Prep Talks — Public Presentation, Astoria Library	49
3/11/2013	Warrenton, OR	Distant Tsunami Response Training	
3/11/2013	Seaside, OR	Tsunami Prep Talks - Public Presentation, Seaside Library	
3/10/2013	Newport, OR	Japanese Tsunami exhibit at Hatfield Marine Science Center	78
2/11/2013	Newport, OR	Newport Tsunami Trail walk	24
1/30/2013		Association of Public-Safety Communications Officials	50
1/30/2013	Lincoln City, OR	APCO, Salishan, Lincoln City	
1/10/2013	Newport, OR	ODOT Japan Bridge Workshop, Newport	
2012			
12/6/2012	San Francisco, California	American Geophysical Union Fall Meeting	
11/16/2012	Eugene, OR	Lane County Emergency Prep Workshop	
11/3/2012	Wilsonville, OR	Wilsonville Oddfellows	24
10/23/2012	Salem, OR	Zombie Survival Workshop	36
10/18/2012	Oregon	The Great Oregon ShakeOut	129,000
10/12/2012	Newport, OR	ODOT/Japan Bridge Workshop	

Date	Location	Event	Number of Attendees
10/11/2012		Oregon Chapter Public Risk Management Association	
9/26/2012	Newport, OR	Hatfield Marine Science Center	48
9/21/2012		Oregon State Board of Examiners for Engineering and Land Surveying	56
7/18/2012	Corvallis, OR	OSU Cascadia Dam Failure Workshop	24
7/17/2012	Portland, OR	USDA Oregon Emergency Board	24
5/31/2012	Coos Bay, OR	Coos Bay Tsunami Drill	200
5/23/2012	Tillamook, OR	Tillamook Tsunami Drill	100
5/2/2012	Washington, DC	American Geophysical Union Science Policy Conference, Washington, DC	100
3/25/2012	Port Orford, OR	Port Orford Townhall	31
3/24/2012	Gold Beach, OR	Gold Beach Townhall	48
3/23/2012	Bandon, OR	Bandon Townhall	125
3/22/2012	Coos Bay, OR	Coos Bay Rally	235
3/21/2012	Roseburg, OR	Roseburg Townhall	24
3/20/2012	Winchester Bay, OR	Winchester Bay presentation	24
3/20/2012	Reedsport, OR	Reedsport Townhall	51
3/18/2012	Eugene, OR	Eugene Earthquake Townhall	19
3/17/2012	Newport, OR	Newport Readiness Fair	64
3/17/2012	Depoe Bay, OR	Depoe Bay Readiness Fair	40
3/16/2012	Yachats, OR	Yachats Readiness Fair	42
3/16/2012	Toledo, OR	Toledo Readiness Fair	61
3/15/2012	Lincoln City, OR	Lincoln City Readiness Fair	50
3/14/2012	Lincoln City, OR	Cutler City Tsunami Drill	24
3/11/2012	Tillamook, OR	Tillamook Tsunami Rally	200
3/10/2012	Cannon Beach, OR	Cannon Beach Tsunami walk	30
3/9/2012	Seaside, OR	Seaside Tsunami Townhall	41

Source: OEM

Table 5-13. FEMA Mitigation-Related Trainings Offered by OEM 2012–2014

Program	Jurisdiction	Date	Number Trained
2012			
MGT-315 Enhanced threat/risk	Portland	Apr 24–25, 2012	30
MGT-315 Enhanced threat/risk	Portland	May 19–20, 2012	38
MGT-315 Enhanced threat/risk	Portland	Oct 11–12, 2012	30
2014			
AWR-233 Volcano Crisis Awareness Class	Clackamas County	May 21–23, 2014	45
MGT-315 Enhanced Threat and Risk Assessment	Salem, OR	Dec. 3-4, 2014	chuck.cogburn@state.or.us

Source: OEM

Certification also exists for Emergency Managers at both national and state levels, and at full and associate certification levels (http://www.iaem.com/page.cfm?p=certification/intro). There are 16 nationally Certified Emergency Managers in Oregon, including two at the associate level. Nine were certified during the period 2012-2014 (http://www.iaem.com/page.cfm?p=certification/current-cem-aem). Twenty-two people received Oregon state certification as Emergency Managers during this period (OEM, personal contact). Eight of those also received national certification during this period.

5.7.2 Executive Actions

44 CFR §201.5(b)(4)(ii), A statewide program of hazard mitigation through the development of legislative initiatives, mitigation councils, formation of public/private partnerships, and/or other executive actions that promote hazard mitigation.

The State of Oregon has three key mitigation councils — the State Interagency Hazard Mitigation Team (State IHMT), the Oregon Seismic Safety Policy Advisory Commission (OSSPAC), and the Drought Council, all staffed by the Oregon Military Department, Office of Emergency Management.

Governor Kitzhaber formed the State IHMT in 1997. It typically meets quarterly to understand losses arising from hazards; recommend strategies to mitigate loss of life, property, and natural resources; and develop, update, and maintain the Oregon NHMP.

The Oregon Legislature created OSSPAC via Senate Bill 96 in 1991. Its mission is to reduce exposure to earthquake hazards in Oregon by developing and influencing policy at the federal, state and local levels; facilitating improved public understanding and encouraging identification of risk; supporting research and special studies; supporting appropriate mitigation; supporting response and recovery; and supporting and assisting in the coordination of a grant program for the disbursement of funds for seismic rehabilitation of schools and emergency facilities.

By House Resolution 3 (2011), the legislature directed the Oregon Seismic Safety Policy Advisory Commission (House Resolution 3) to lead an effort for Oregon to plan for a Cascadia earthquake and tsunami. The Oregon Resilience Plan was adopted on February 2013 and:

- Describes the current scientific research and likely physical effects of a magnitude 9.0 Cascadia subduction zone earthquake and tsunami;
- Assesses the workplace integrity, workforce mobility, and building systems performance needed to allow Oregon's businesses to remain operational following a Cascadia earthquake and tsunami;
- Assesses the unique risks faced by Oregon's coastal communities;
- Examines the main classes of public and private structures considered critical to resilience and sought to characterize the gap between expected seismic performance and desired seismic resilience;
- Assesses the seismic integrity of Oregon's multi-modal transportation systems, with special considerations pertaining to the Columbia and Willamette River navigation channels;
- Investigates the seismic deficiencies of Oregon's energy storage and transmission infrastructure, with a special emphasis on the vulnerability of the state's critical energy infrastructure hub; and
- Examines the inherent vulnerabilities of Oregon's information and communications systems and the consequences of service disruptions for the resilience of other sectors and systems
- Reviews vulnerabilities of the pipelines, treatment plants, and pump stations that make up Oregon's water and wastewater systems, and discusses the interventions needed to increase the resilience of under-engineered and antiquated infrastructure at potential failure points.

Senate Bill 33 (2013) established the Oregon Resilience Task Force to "facilitate a comprehensive and robust plan to implement the strategic vision and roadmap of the Oregon Resilience Plan (a product of OSSPAC) for responding to the consequences of naturally occurring seismic events associated with geologic shift along the Cascadia subduction zone." The Task Force reported to the Legislature on October 1, 2014 (**Appendix** 9.2.6) with a prioritized list of actions to begin implementation of the Oregon Resilience Plan.

The Drought Council was established as a result of a 1988 drought planning effort. It is comprised of state and federal agencies as well as private organizations and is responsible for assessing the impact of drought conditions and making recommendations to the Governor´s senior advisors. The Oregon Drought Plan also established a subcommittee of the Drought Council, titled the Water Availability Committee of Oregon (WACO). It is chaired by the Oregon Water Resources Department and its members include the Oregon Climate Service, Snow Survey Section of the Natural Resource Conservation Service, National Weather Service, Oregon Department of Forestry, U.S. Geological Survey, U.S. Army Corps of Engineers, and the Northwest River Forecast Center. WACO is charged with assessing water availability conditions within Oregon's 14 water availability basins and reports regularly to the Drought Council.

The state also formed and maintains a public-private partnership known as the Oregon Partnership for Disaster Resilience (OPDR). OPDR is a non-state supported coalition of public, private, and professional organizations working collectively toward the mission of creating a disaster resilient state. Developed and coordinated by the Community Service Center (CSC) at the University of Oregon, OPDR employs a service-learning model to increase community capacity and enhance disaster safety statewide. OPDR activities are organized on three levels: statewide, regional, and local (including university campuses). Each level of activity builds on the others, and contributes to a more coordinated and collaborative statewide program.

Oregon Solutions (http://orsolutions.org/about)began with the passage of the state of Oregon's Sustainability Act in 2001. The program uses cutting-edge dispute resolution programs and practices to assist civic leaders in resolving difficult public policy issues. Oregon Solutions also partners with the Governor's Regional Solutions Centers to assist with priority projects where state agency assistance and funding is available and needed. When an issue seems intractable, Oregon Solutions calls on Oregon Consensus to mediate and resolve conflict. Oregon Solutions has been instrumental in resolving natural hazard mitigation issues (http://orsolutions.org/projects):

- Columbia Levee Improvement Project (ongoing),
- Milton Freewater Levee (completed),
- Tillamook Basin Flooding Reduction (completed; led to Southern Corridor Flow Project), and
- Vernonia Schools (completed).

5.7.3 Non-Federal Match

44 CFR §201.5(b)(4)(iii), The state provides a portion of the non-federal match for HMGP and/or other mitigation projects.

The State of Oregon provides the non-federal match for projects for which a state agency is the sub-grantee or benefits directly from the mitigation project. The state also provides considerable direct technical assistance to local government sub-applicants, especially in the development of benefit-cost analyses that are required for determining mitigation project eligibility under HMGP or other mitigation grants to move forward in the sub-application and review process. In extraordinary circumstances, the state legislature will provide the non-federal cost share for a local government project. Such was the case with the Vernonia Schools Acquisition Project that acquired a flood-prone public school campus and built a new school on high ground outside the Special Flood Hazard Area. The Oregon Legislature provided a one-time, non-federal cost share contribution of $4 million toward acquisition of the property, including the special costs incurred for environmental and historic preservation compliance.

DLCD has requested the its Technical Assistance Grants (TAG) Program be made available to fund natural hazard mitigation activities. Should this request be approved, grants would provide a portion of the required cost share for FEMA local natural hazards mitigation planning grants.

5.7.4 Building Code

44 CFR §201.5(b)(4)(iv), To the extent allowed by state law, the state requires or encourages local governments to use a current version of a nationally applicable model building code or standard that addresses natural hazards as a basis for design and construction of state sponsored mitigation projects.

The adoption and effective enforcement of building codes are among the most important hazard mitigation tools related to the design and construction of structures for human occupancy. The state building code is composed of several specialty codes (e.g., plumbing, structural, mechanical, elevator, electrical, boiler, and pressure vessel). All buildings in Oregon must conform to the state's codes, which influences the way buildings are constructed with respect to seismic risk, wind, snow, wildfire, and flood hazards. Specifically:

- **NFIP and State Building Codes:** All but two Oregon communities that have a mapped flood risk participate in the NFIP, which sets minimum requirements for new buildings or substantially improved buildings in the communities' Special Flood Hazard Areas. NFIP standards are minimums, and do not always protect properties. Many Oregon communities do require a higher performance standard when building new or elevating exiting structures in the floodplain. In Tillamook County, for example, all new and substantially damaged or substantially improved structures must have their first floor at least three feet above the mapped 100-year base flood elevation. Once a community establishes how high above the base flood elevation first floors must be elevated, state building codes come into play to ensure that the building is constructed according to NFIP standards, such as use of flood resistant materials, anchoring, and installation foundation openings. Commercial buildings must be designed in accordance with Chapter 5 of the American Society of Civil Engineer's Standard 7-05 (ASCE 7-05), or American Society of Civil Engineer's Standard 25-05 (ASCE 24-05).

- **Manufactured Dwelling Installation Regulations:** Manufactured dwellings are particularly susceptible to damage because they are lighter and less resistant to natural forces. Their lower costs also mean that it takes less damage to establish a total economic loss. The state building code requires that manufactured dwellings be elevated and tied down in all designated flood areas and braced for wind in high wind areas, but there are no mandatory tie-down or bracing requirements for earthquakes. Nevertheless, there are standards for commercial seismic bracing systems that are sold for voluntary installation.

- **Seismic Safety and State Building Code:** The state's building code requires that commercial buildings be seismically designed in accordance with the American Society of Civil Engineer's

Standard 7-05 (ASCE 7-05). ASCE 7-05 was developed using FEMA's National Earthquake Hazards Reduction Program (NEHRP) recommended provisions which led to more comprehensive seismic design guidelines. One and two family dwellings and townhouses may follow a prescriptive path for construction, which accounts for regional seismic differences.

- **Local Wildfire Hazard Mitigation Provisions:** Local jurisdictions may adopt provisions addressing wildfire hazard mitigation in conjunction with criteria established by the Oregon Department of Forestry. The provisions address issues such as combustibility of roofing and premises identification.

- **Wind:** The state's building code requires that commercial buildings be designed in accordance with Chapter 7 of the American Society of Civil Engineer's Standard 7-05 (ASCE 7-05). Roof uplift standards must be applied for residential structures where winds exceed 85 mph as defined by basic wind speeds for a 50-year mean recurrence interval (published in the residential building code).

- **Snow:** The state's building code requires that commercial buildings be designed in accordance with Chapter 7 of the American Society of Civil Engineer's Standard 7-05 (ASCE 7-05). Residential buildings must be specifically engineered in areas with ground snow loads greater than 70 pounds per square foot (http://snowload.seao.org/lookup.html).

5.7.4.1 Retrofitting and Rehabilitation

Depending on the nature of the risk and the expected performance of the buildings and systems under defined hazard conditions — especially where the risk may not be severe — it may or may not be cost-effective to retrofit or rehabilitate buildings or infrastructure. For example, it may not be cost-effective to undertake a seismic retrofit of a public facility in the tsunami inundation zone where a newly constructed, seismically sound replacement facility outside the tsunami inundation zone makes better sense as a long-term investment and totally avoids the tsunami hazard.

An incremental approach to hazard mitigation can be effective over the long term by using ongoing maintenance and capital funds to reduce vulnerabilities. Such measures may be done voluntarily or may be contained in codes or regulations governing remodeling or sale of properties. Such is the case with seismic retrofit projects that are rarely undertaken without consideration for other actions such as deferred maintenance, energy upgrades, and improved facility access.

5.7.4.2 Removing Buildings from Harm's Way

Especially with respect to the flood hazard, although not exclusively so, rather than attempting to control the hazard, there is now an emphasis on moving structures — especially homes — out of harm's way by elevating them well above flood danger, relocating, or even acquiring and demolishing the structure so only open space remains in perpetuity. The National Flood Insurance Reform Act of 2012 and The Sandy Recovery Improvement Act of 2013 emphasize, streamline, and encourage — with FEMA grant funding — to remove, via acquisition, properties that have a repetitive history of flood losses. Oregon's priority is to use hazard mitigation funding from a number of federal programs, local governments and the private sector to accomplish this work with respect to the flood hazard. These elevation, relocation, or acquisition efforts are especially appropriate for homes that were built in floodplains prior to the establishment of the National Flood Insurance Program (1968), which have sustained repetitive flood losses over the years.

Oregon has also embraced the concept of moving buildings out of harm's way following disasters. For example, instead of only making repairs to flood-damaged buildings, opportunities to elevate, relocate, or acquire buildings are pursued soon after the flood waters recede to break the cycle of rebuilding and flooding again and again. When flood-prone homes are acquired or relocated, the once-developed land is returned to open space uses in perpetuity by means of deed restrictions. This removes the possibility of future disaster losses to buildings at that location. Since December 2007 (DR-1733) there have been a total of 42 residential elevation and 37 residential acquisition projects completed using FEMA mitigation grant funding and NFIP funds in the City of Vernonia alone. Additionally, six public and commercial properties have been acquired and one commercial property protected by a floodwall. The Vernonia mitigation project has systematically mitigated essentially all of the properties that were substantially damaged by flooding in the December 2007 event.

In some cases, acquisition or relocation of a building might be pursued to mitigate for other hazards, such as stream bank or coastal erosion, or debris flows.

5.7.4.3 Structural Projects

Measures that are intended to control the hazard so that it does not reach or damage developed areas are often called "structural." These measures are structural because they involve the construction of facilities. However, many structural projects are expensive to construct and maintain, and they may have other shortcomings such as environmental considerations and recurring maintenance costs. On the other hand, structural projects are occasionally the most cost-effective way to protect an area, especially a densely developed area, and can sometimes serve several objectives. Statewide there are numerous structural projects that have been constructed over the course of the past century. Some are for flood control and some are multi-purpose, such as Detroit Dam on the Santiam River, which was built for flood control and power generation as well as irrigation water and recreational purposes during the summer months. Structural control projects also include dike and levee facilities that protect communities and infrastructure from flooding. As structural control projects, levees require routine maintenance to maintain their effectiveness and if not inspected and certified, flood insurance rates can increase for the areas they protect.

5.7.5 Critical/Essential Facilities

44 CFR §201.5(b)(4)(v), A comprehensive, multi-year plan to mitigate the risks posed to the existing buildings that have been identified as necessary for post-disaster response and recovery operations.

The 2009 NHMP identified an action to develop a comprehensive multi-year plan to mitigate the risks posed to existing buildings that have been identified as necessary for post-disaster response and recovery. This has been partially completed through the statewide seismic needs assessment that assessed the earthquake risk to K-12 schools and critical facilities at the local level, completed and issued by DOGAMI in May 2007. The "Oregon Seismic Needs Assessment: Education & Emergency Facilities Report" provided the impetus for the state legislature to authorize funding for the **Seismic Rehabilitation Grant Program**. The purpose of the program is to retrofit first responder facilities, public schools, and hospitals so they will withstand the design earthquake event and remain functional for use during response and recovery.

5.7.6 Integration with Post-Disaster Recovery Operations

44 CFR §201.5(b)(4)(vi), A comprehensive description of how the state integrates mitigation into its post-disaster recovery operations.

The State and local communities integrate mitigation into post-disaster recovery operations by taking advantage of Hazard Mitigation Grant Program (HMGP) dollars that become available after presidentially declared disasters.

State post-disaster mitigation planning and project activities following disasters are an integral component of OEM's mission. OEM's Mitigation and Recovery Services Section provides oversight and administration of financial services and related funding that is passed through to local governments. Additionally, the Mitigation and Recovery Services Section manages disaster recovery activities for state and local governments in the event of a devastating emergency or disaster. Specifically, the Section Director, SHMO, Alternate SHMO, Facilities Engineer (Public Assistance Officer), Seismic Grants Coordinator, and financial support staff work together on post-disaster mitigation grant programs and project activities. Although OEM has limited staff support available for post-disaster mitigation planning and project implementation activities, the state is able to effectively secure and manage FEMA's HMGP grants. **Table 5-6** shows the status of the current HMGP grants. The state's most current HMGP disaster (DR-4169) remains open for new sub-applications through April 3, 2015. HMGP disaster DR-4055 was the state's first disaster to be included under the legislative changes authorized by the Sandy Recovery Improvement Act (SRIA) of 2013 that has generally streamlined the application, review, approval, and funding process. SRIA will greatly impact roll-out of HMGP activities for future disaster declarations with an emphasis of expediting all phases of the HMGP process so mitigation projects can be implemented much more quickly and efficiently from the onset of the declaration to availability of Federal mitigation project funding.

5.7.6.1 Expediting the HMGP Process

SRIA provides the following opportunities to expedite the HMGP process for future disaster in Oregon:

- **Streamlining Environmental and Historic Preservation (EHP) reviews including Section 106 Consultation.** The Oregon Office of Emergency Management developed and hosts an online EHP guide, *Emergency Management for Natural, Cultural, and Historic Resources: An Oregon Resource Dashboard* that provides a compendium of resources designed to streamline EHP processes both pre- and post-disaster. The EHP Resource Guide is intended to be updated with current information, essential for those who access the website. This page includes local, regional, and national level information related to Natural, Cultural, and Historic Resources (NCHR) protection requirements, best management practices, as well as primers for caretakers of these resources. This information is geared toward assisting emergency managers as well as people or agencies charged with protecting and preserving collections, sites, and artifacts in the short and long term.

OEM plans to continue working with its local, state, and national partners to increase the awareness of natural, cultural, and historic resources (NCHR) and seek additional opportunities to protect them through existing and unique site-specific plans and actions. In 2015, OEM intends to work with Oregon State Parks and Recreation to identify and publish NCHR inventories and resource specific information in a geographic information system map presentation (RAPTOR) that is managed by OEM for use by emergency managers. This information will be available and accessible to emergency managers during their planning, response, and recovery work to help guide their decision making and maximize protection and minimize impacts to NCHRs. Making this information available in a format that is simple to access and use, in a system that is already in place, should lead to a higher level of awareness and consideration of these resources in all phases of the disaster planning cycle. Today, NCHRs are included in the RAPTOR training being delivered to emergency managers to ensure they are aware of existing data sets that can assist them in their decision making process.

- **HMGP Program Administration by State.** This SRIA provision allows for states to assume more responsibility for HMGP activities and to expedite project approvals and delivery of funding resources. Currently, Oregon does not have sufficient staff to assume more state oversight of HMGP grant administration. Rather, Oregon's model to expedite HMGP administration will rely on working closely and efficiently with FEMA mitigation staff during JFO operations. This model was used during DR-4055 JFO operations and was successful in securing HMGP sub-grant approvals and funding obligations during the short time the JFO was operational.

- **HMGP Advance Assistance Funding.** SRlA also gives FEMA the authority to provide states up to 25% of the amount of estimated Hazard Mitigation Grant Program (HMGP) costs in advance of incurring eligible costs. The purpose of Advance Assistance is to provide resources to develop mitigation strategies and obtain data to prioritize, select, and develop complete HMGP applications in a timely manner. FEMA expects States that receive Advance Assistance to submit complete project applications up to or over the HMGP ceiling by the nominal one-year application deadline.

- **County Liaisons.** OEM also assigns staff liaisons to specific counties to support operations both during and after disasters. These "County Liaisons" provide valuable input into early implementation of HMGP mitigation strategies. By working closely with the state's Public Assistance Officer, the state is also able to identify mitigation opportunities immediately following a disaster declaration that can be implemented quickly as a component of Public Infrastructure Assistance (Section 406) disaster assistance. As a matter of standard protocol during JFO operations, all Public Assistance Project Worksheets (for permanent repair work) are reviewed for both Sections 406 (Public Assistance) and 404 (HMGP) mitigation where there are opportunities to mitigate undamaged components of a companion 406 mitigation project.

5.7.6.2 Exemplary Projects

The following projects describe successful use of grant funding to mitigate future hazard losses. These projects are still ongoing, to be completed in the near future. Completed projects are described in **Section 3.3.5**, Mitigation Successes.

DR-1964 — City of Newport: Tsunami Safe Haven Hill (Tsunami Life Safety Mitigation)

The entire Pacific Northwest coast is at extremely high risk from tsunamis generated by very large magnitude earthquakes on the Cascadia Subduction Zone. However, the life safety risk is most extreme for communities where accessible natural high ground safe areas (safe havens) are not reachable before the first arrival of tsunami waves. The South Beach community within the city of Newport faces an extreme life safety risk from tsunamis because:

- Virtually the entire community is at very low elevations and located within the mapped tsunami inundation zones.
- Safe Haven Hill is the only location high enough to be a safe area that is reachable within the very short time period of less than 30 minutes between the end of earthquake ground shaking and tsunami arrival.
- Safe Haven Hill has very poor access with very steep heavily forested slopes and only one marginal pathway on the opposite side from the highest population area.
- Without a suitable, accessible safe area, the death toll from the next major tsunami will be catastrophic, with over 1,000 deaths possible.

The HMGP mitigation project is to “retrofit” the existing natural hill feature to improve the existing safe area — the top of Safe Haven Hill — by making the site accessible and therefore reachable by many more people during the short time period between a major earthquake on the Cascadia Subduction Zone and the first arrival of tsunami waves in South Beach. The project scope includes the following elements to improve access to the safe area on Safe Haven Hill:

- Establish a cleared safe area at the top of Safe Haven Hill;
- Improve the existing crude trail on the north side and the existing gravel path on the southwest side of the hill and stabilize these pathways to prevent failure from slumping or sliding during strong earthquake ground shaking preceding tsunami arrival;
- Add a stairway on the south side of the hill to expedite access to the safe area for people approaching the hill from the south;
- Add a sidewalk on the east side of the hill (west edge of US-101) to ensure safe access for people coming from the east;
- Improve access, visibility, and awareness of the tsunami safe area with path lighting and signage; and
- Install a disaster supply shed in the safe area.

With a detailed project feasibility study, geotechnical analysis, cultural resources survey and benefit-cost ratio in double digits based on life-safety considerations, this project (when completed in summer 2015) will provide a “high ground option” for the community to significantly reduce loss of life to the tsunami hazard.

DR-4055 — City of Portland - Seismic Retrofits for Single-Family Homes Demonstration Project

The approved mitigation project consists of earthquake structural retrofits for single-family, wood-frame homes with cripple walls and/or sill plates that are not bolted to the foundation. This project was identified as an opportunity for the city to demonstrate the implementation of low-cost seismic mitigation treatments to residential homes that will significantly reduce catastrophic structural failure and would otherwise make a house unlivable.

Based on a sample of 36 previously completed seismic retrofits (sill plate bolting and/or cripple wall bracing) in Portland, the average retrofit cost per home is $4,967, with a range from $2,880 to $19,495. Most of the retrofit costs for these 36 homes fall between $3,000 and $7,000, with only one home below $3,000 and only four above $7,000. The retrofit costs vary with the size of the home as well as on other factors including which retrofit elements are needed for a given home, ease or difficulty of access to the buildings elements being retrofitted, and the extent (if any) to which additional foundation upgrades need to be done for some homes.

Most wood-frame single-family homes perform relatively well in earthquakes. However, homes with cripple walls and/or unbolted sill plates are a strong exception: homes with these types of construction details are highly vulnerable to extensive or complete damage in earthquakes by one or more of the failure modes. Based on the calculated benefits of the mitigation treatments and their costs, benefit-cost ratios of between 2 and 5 were calculated for this project. These retrofits are highly cost-effective because:

- They address major seismic deficiencies in single-family wood-frame homes built before the mid-1970s;
- The retrofits are highly effective in reducing seismic risk; and
- The retrofit costs are very low relative to building values.

Another aspect of this project creates opportunities to include energy efficiency upgrades (like improved insulation) with the seismic retrofit at the same time to leverage the invasive nature of both retrofits.

DR-4055 — Seal Rock Water District — Water System Intertie Project

The Seal Rock Water District is located in Lincoln County and serves a narrow strip of coastal land approximately 15 miles long along US-101 between the cities of Newport and Waldport. The District serves a population of about 4,300 people with both residential and commercial water service through approximately 2,400 meters. Because the sole source of Seal Rock's water supply is provided by the City of Toledo water system, any natural hazard event which interrupts the water supply from Toledo for durations long enough to deplete Seal Rock's limited in-system storage will result in complete loss of water supply to all of Seal Rock's customers. During the January 2012 disaster DR-4055, mudslides caused damage to facilities under the jurisdiction of the Seal Rock Water District. An area of South Bay Lane, a Lincoln County road, slumped and slid causing damage to a section of PVC water transmission line located in the south shoulder and ditch of the roadway. The damaged line was repaired and services restored under FEMA's Public Assistance program. During winter storms, this transmission line has a history of repetitive failures from landslides at several locations. This critical transmission line is also subject to failures in earthquakes.

Seal Rock Water District initially considered mitigating this section of water and other undamaged sections of water line by providing better protections from mudflows and landslides. Based on an analysis of the disturbed area and proposed project costs, it simply would not be a long-term, cost-effective solution to mitigate much of the water delivery line. Given these conditions in the Toledo water system, unusually long duration loss of potable water service in the Seal Rock water system appears virtually inevitable in future disaster events. Instead, Seal Rock Water District proposed a much more comprehensive mitigation project that would tie together two independent water systems providing each one backup if the other were to fail. The proposed project brings together the City of Newport municipal water system and the Seal Rock water system via an intertie that has pressure controls and backup emergency power. A detailed benefit-cost analysis of the intertie project delivered a conservative lower bound ratio of 1.95. At the time of this Plan update, the project is under FEMA's review with construction planned for the summer of 2014.

Oregon Solutions Team — Southern Flow Corridor

Mitigation work in the Tillamook area related to the Tillamook Bay Repetitive Flood Loss Properties Mitigation Success (**Section 3.3.5**) continues through Oregon's Solutions Team Southern Flow Corridor — Landowner Preferred Alternative Project (SFC-LPA). Oregon's then-Governor Kulongoski designated this area as an Oregon Solutions project in 2007. The purpose of this project is to "remove manmade impediments to flood flows to the maximum extent possible in the lower Wilson River floodplain" by "extensive removal of levees and fill." New tidal dikes will protect adjacent private lands from inundation of daily tides, and areas outside the setback levees will be restored as tidal marsh. Phase 1 of the project for permitting, design, baseline monitoring, EIS, and land and easement acquisition is scheduled from October 2014 through October 2015. Phase 2 construction from May to November 2016, and Phase 3 post-project management plan revision and monitoring will begin in October 2017. Total project costs are estimated to be $9.4 million. For more information visit http://tillamookoregonsolutions.com/.

Chapter 6 ACRONYMS and ABBREVIATIONS

A300	ANSI A300, Tree Care Operations Standards
AASHTO	American Association of State Highway and Transportation Officials
ACEP	Agricultural Conservation Easement Program
AH	Flood Insurance Rate Map (FIRM) zone: Areas subject to inundation by 1%-annual-chance shallow flooding (usually areas of ponding) where average depths are between one and three feet. Base Flood Elevations (BFEs) derived from detailed hydraulic analyses are shown in this zone. Mandatory flood insurance purchase requirements and floodplain management standards apply.
AHPS	Advanced Hydrologic Prediction Service
AHZ	Active Hazard Zone
AIA	American Institute of Architects
AKmax	hypothetical maximum Alaska tsunami
AM	Amplitude Modulation (AM)
ANSI	American National Standards Institute
ANSS	Advanced National Seismic System
AO	Flood Insurance Rate Map (FIRM) zone: areas subject to inundation by 1%-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between one and three feet. Average flood depths derived from detailed hydraulic analyses are shown in this zone. Mandatory flood insurance purchase requirements and floodplain management standards apply. Some Zone AO have been designated in areas with high flood velocities such as alluvial fans and washes. Communities are encouraged to adopt more restrictive requirements for these areas.
AOC	Association of Oregon Counties
APA	American Planning Association
APCO	Association of Public Safety Communications Officials
ARES	Amateur Radio Emergency Service
ARRA	American Recovery and Reinvestment Act
ARRL	Amateur Radio Relay League
ASCE	American Society of Civil Engineers
ASFPM	Association of State Floodplain Managers
ATC	Applied Technology Council
BCA	Benefit-Cost Analysis
BCD	Building Codes Division (State of Oregon, Department of Consumer and Business Services)
DCBS	Department of Consumer and Business Services

BCE	Before Common Era
BCR	Benefit-Cost Ratio
BFE	Base Flood Elevation
BLM	Bureau of Land Management (United States Department of the Interior)
BMP	Best Management Practice
BNSF	Burlington Northern-Santa Fe Railway
BPA	Bonneville Power Administration
BusOR-IFA	Business Oregon, Infrastructure Finance Authority
CAP	Community Assistance Program (NFIP)
CAP-SSSE	Community Assistance Program — State Support Services Element (NFIP)
CAV	Community Assistance Visit (NFIP)
CB	Coquille Bank
CBRL	Coos Bay Rail Link
CDBG	Community Development Block Grant
CD-ROM	Compact Disc Read-Only Memory
CEI	Critical Energy Infrastructure
CERT	Community Emergency Response Team
CFR	Code of Federal Regulations
CGIAR	Formerly "Consultative Group on International Agricultural Research." Since 2008, known simply as CGIAR, a global partnership that unites organizations engaged in research for a food secure future
CI	Critical Infrastructure/Essential Public Facilities
CMIP	Coupled Model Intercomparison Project
CMIP5	Coupled Model Intercomparison Project, 5th phase
CMZ	Channel Migration Zone
CNN	Cable News Network
CPO	Climate Program Office
CPW	Community Planning Workshop (University of Oregon)
CREP	Conservation Reserve Enhancement Program
CREW	Cascadia Region Earthquake Workgroup
CRP	Conservation Reserve Program
CRS	Community Rating System (National Flood Insurance Program)
CSC	Community Service Center (University of Oregon)
CSEPP	Chemical Stockpile Emergency Preparedness Program
CSO	combined sewer overflow
CSREES	Cooperative State Research, Education, and Extension Service

CST	Community Solutions Team
CSZ	Cascadia Subduction Zone
CTP	Cooperating Technical Partner (NFIP)
CVO	Cascades Volcano Observatory
CWPP	Community Wildfire Protection Plan
DAS	Department of Administrative Services (State of Oregon)
DAS-CFO	Department of Administrative Services-Chief Financial Office (State of Oregon)
DAS-CIO	Department of Administrative Services-Chief Information Office (State of Oregon)
DAS-EAM	Department of Administrative Services-Enterprise Asset Management (State of Oregon)
DAS-RM	Department of Administrative Services-Risk Management Division (State of Oregon)
DAS-GEO	Department of Administrative Services-Geospatial Enterprise Office (State of Oregon)
DCBS	Department of Consumer and Business Services (State of Oregon)
DCBS-ID	Department of Consumer and Business-Insurance Division (State of Oregon)
DEM	Digital Elevation Model
DEQ	Department of Environmental Quality (State of Oregon)
DLCD	Department of Land Conservation and Development (State of Oregon)
DMA	Disaster Mitigation Act of 2000 (federal)
DMA2K	Disaster Mitigation Act of 2000
DMV	Department of Motor Vehicles (State of Oregon)
DNR	Department of Natural Resources (Washington State)
DOD-USACE	United States Department of Defense-U.S. Army Corps of Engineers
DOGAMI	Department of Geology and Mineral Industries (State of Oregon)
DP	Demographic Profile
DPSST	Department of Public Safety Standards and Training (State of Oregon)
DR	Alphabetic designation or precursor for Disaster Declaration Number
DRMS	Decision, Risk, and Management Science
DRU	Disaster Resilient University
DSL	Department of State Lands (State of Oregon)
DTM	Digital Terrain Model
EAM	Enterprise Asset Management (State of Oregon Department of Administrative Services)
EAP	Emergency Action Plan
EAS	Emergency Alert System
ECC	Emergency Coordination Center
EDA	Economic Development Administration (U.S.)
EHP	Environmental and Historic Preservation

EIS	Environmental Impact Statement
EMI	Emergency Management Institute (FEMA)
EMPG	Emergency Management Performance Grant (State of Oregon)
ENSO	El Niño Southern Oscillation
EO	Education/Outreach
EOC	Emergency Operations Center
EOP	Emergency Operations Plan
EPA	Environmental Protection Agency (U.S.)
EPCRA	Emergency Planning and Community Right-to-Know Act
EQIP	Environmental Quality Incentives Program
ER	Emergency Relief
ESA	Endangered Species Act
ESD	Education Service District
ESEE	Economic, Social, Environmental, and Energy
EWP	Emergency Watershed Protection (NRCS Program)
FAA	Federal Aviation Administration
FAS	Federal Aid System (U.S. Highway Administration)
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FF	Flash Flood
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FM	Frequency Modulation
FMA	Flood Mitigation Assistance
FMAGP	Fire Management Assistance Grant Program
FPD	Fire Protection District
FSA/FMAGP	Fire Suppression Assistance/Fire Management Assistance Grant Program
FTA	Federal Transit Administration
FTE	Full Time Equivalent
FY	Fiscal Year
GCM	Global Climate Models
GED	General Education Development
GEO	Geospatial Enterprise Office (State of Oregon, DAS)
GIS	Geographic Information System

GNRO	Governor's Natural Resources Office (State of Oregon)
GO	General Obligation
GPS	Global Positioning System
GSA	General Services Administration (U.S.)
GSTF	Greatest-Savings-to-the-Fund (FEMA)
GTN	Gas Transmission Northwest
GWEB	Governor's Watershed Enhancement Board
H	High
Hazus	Hazards U.S.
HB	House Bill (State of Oregon)
HCD	Housing and Community Development Act of 1974
HFRA	Healthy Forest Restoration Act of 2003
HHZ	High Hazard Zone
HM	Hazard Mitigation
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HMSE	Hazard Mitigation and Structural Engineering
HMST	Hazard Mitigation Survey Team
HMTAP	Hazard Mitigation Technical Assistance Program (FEMA)
HR	House Resolution (State of Oregon legislature)
HRFA	Healthy Forest Restoration Act of 2003
HSPR	Health Security, Preparedness, and Response (Oregon Health Authority)
HUD	Housing and Urban Development (U.S.)
HWM	High Water Mark
ICBO	International Conference of Building Officials
ICC	Increased Cost of Compliance (NFIP)
ID	Insurance Division (Oregon Department of Consumer and Business Services)
IDA	Initial Damage Assessment
IEBC	International Existing Building Code
IFA	Infrastructure Finance Authority (Business Oregon)
IHMT	Interagency Hazard Mitigation Team
IMS	Interpretive Map Series (DOGAMI)
IPCC	Intergovernmental Panel on Climate Change
IPPM	Insect Pest Prevention and Management

IR	Indian Reservation
IRIS	Incident Response Information System
ISA	International Society of Arboriculture
ISO	Insurance Services Office
JFO	Joint Field Office (FEMA)
KOG	Keep Oregon Green
KPM	Key Performance Measure
L	Low
LCDC	Land Conservation and Development Commission (State of Oregon)
LEPC	Local Emergency Planning Committee
LFD	Local Fire Department
LFPC	Local Fire Prevention Cooperative
LHZ	Low Hazard Zone (coastal erosion)
LID	Low Impact Development
LLC	Limited Liability Company
LNG	Liquefied Natural Gas
LNHMP	Local Natural Hazards Mitigation Plan
LOC	League of Oregon Cities
LP	Legislative/Policy
LPA	Landowner Preferred Alternative
LU	Land Use/Development
LWI	Local Wetlands Inventory
M	Moderate
MAX	Metropolitan Area Express light rail, operated by Tri-County Metropolitan Transportation District of Oregon (TriMet)
MH	Multi-Hazard
MHHW	Mean High High Water
MJO	Madden Julian Oscillation
MLLW	Mean Lower Low Water
MMI	Modified Mercalli Index
MMMS	Map Modernization Management Support (FEMA)
MP	Mile Post or Maintenance/Planning
MV	Most Vulnerable
MVC	Motor Vehicle Collision
M_W	Moment earthquake magnitude scale
N/A	Not Available / Not Applicable

NARCCAP	North American Regional Climate Change Assessment Program
NASA	National Aeronautics and Space Administration
NASEO	National Association of State Energy Officials
NB	Nehalem Bank
NCC	Northwest Coordination Center
NCHR	Natural, Cultural, and Historical Resources
NDBC	National Data Buoy Center
NDWS	Native Database Web Service (Oracle)
NEHRP	National Earthquake Hazards Reduction Program
NEMIS	National Emergency Management Information System
NENA	National Emergency Number Association
NERC	North American Electric Reliability Corporation
NFIP	National Flood Insurance Program
NFP	National Fire Plan
NFPA	National Fire Protection Association
NGA	National Geospatial-Intelligence Agency
NGDC	National Geophysical Data Center
NGO	Non-Governmental Organization
NHMP	Natural Hazards Mitigation Plan
NID	National Inventory of Dams
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRC	National Resource Council
NRCS	Natural Resources Conservation Service (U.S.)
NSF	National Science Foundation
NSFHA	No Special Flood Hazard Area
NTHMP	National Tsunami Hazard Mitigation Program
NVEWS	National Volcano Early Warning System
NWAC	Northwest Weather and Avalanche Center
NWN	Northwest (NW) Natural Gas
NWRFC	Northwest River Forecast Center (National Weather Service)
NWS	National Weather Service
OAIRS	Oregon All Incident Reporting System (State Fire Marshal)
OAR	Oregon Administrative Rule

OBSMAP	Oregon Beach and Shoreline Mapping and Analysis Program
OCAR	Oregon Climate Assessment Report
OCCRI	Oregon Climate Change Research Institute
OCMP	Oregon Coastal Management Program
OCS	Oregon Climate Service
OCSRI	Oregon Coastal Salmon Restoration Initiative
ODA	Oregon Department of Agriculture
ODE	Oregon Department of Education
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
ODOE	Oregon Department of Energy
ODOT	Oregon Department of Transportation
ODR	Oregon Department of Revenue
ODTWG	Oregon Distant Tsunami Working Group
OE	Office of Electricity Delivery and Energy Reliability (U.S. Department of Energy)
OECDD	Oregon Economic and Community Development Department (now Business Oregon-IFA)
OEM	Oregon Office of Emergency Management
OEMA	Oregon Emergency Management Association
OERS	Oregon Emergency Response System
OFR	Open File Report
OGDC	Oregon Geologic Data Compilation
OGIC	Oregon Geographic Information Council
OHA	Oregon Health Authority
OHD	Oregon Health Division
OHIRA	Oregon Hazard Identification and Risk Assessment
OHP	Oregon Highway Plan
OIG	Office of Inspector General (U.S.)
OLC	Oregon Lidar Consortium
OMB	Office of Management and Budget (U.S.)
OMD	Oregon Military Department
OPDR	Oregon Partnership for Disaster Resilience
OPH	Oregon Public Health
OPRD	Oregon Parks and Recreation Department
OPUC	Oregon Public Utility Commission
OR-OSHA	Oregon Occupational Safety and Health Administration

ORP	Oregon Resilience Plan
ORS	Oregon Revised Statutes
OSBEELS	Oregon State Board of Examiners for Engineering and Land Surveying
OSBGE	Oregon State Board of Geologist Examiners
OSFM	Office of State Fire Marshal
OSG	Oregon Sea Grant (Oregon State University)
OSHA	Occupational Safety and Health Administration
OSLR	Oregon Seismic Lifeline Report
OSMB	Oregon State Marine Board
OSP	Oregon State Police
OSSPAC	Oregon Seismic Safety Policy Advisory Commission
OSU	Oregon State University
OUNS	Oregon Utility Notification System
OUS	Oregon University System
OWEB	Oregon Watershed Enhancement Board
OWRD	Oregon Water Resources Department
PA	Public Assistance
PAS	Planning Advisory Service (American Planning Association)
PDA	Preliminary Damage Assessment
PDF	Portable Document Format
PDM	Pre-Disaster Mitigation
PDSI	Palmer Drought Severity Index
PGE	Portland General Electric
PL	Public Law
PM_{10}	Particulate Matter less than 10 micrometers in diameter
PMT	Project Management Team
PNP	Private Non-Profit organization
PNW	Pacific Northwest
PNWCG	Pacific Northwest Wildfire Coordinating Group
PNWR	Portland & Western Railroad
POTB	Port of Tillamook Bay Railroad
PRISM	Parameter-elevation Relationships on Independent Slopes Model, an interpolation method and name of associated climate group at Oregon State University
PSA	Public Service Announcement
PSAP	Public Safety Answering Point
PSU	Portland State University

PUC	Public Utility Commission (State of Oregon)
PUD	People's Utility District
PVC	Polyvinyl Chloride
RACES	Radio Amateur Civil Emergency Services
RAFT	Rapid Assessment of Flooding Tool
RAPTOR	Real-Time Assessment and Planning Tool for Oregon
RARE	Resource Assistance for Rural Environments (University of Oregon)
RAS-C	Risk Assessment Sub-Committee (State of Oregon IHMT)
RCP	Representative Concentration Pathway
REDARS2	Risks from Earthquake Damage to Roadway Systems
RFC	Repetitive Flood Claim (NFIP)
RFPA	Rangeland Fire Protection Association
RFPD	Rural Fire Protection District
RGP	Regional General Permit (Oregon Department of State Lands)
RHS	Rural Housing Service (U.S. Department of Agriculture (USDA))
Risk MAP	Risk Mapping, Assessment, and Planning Program (FEMA)
RL	Repetitive Loss
RM	Risk Management Division (State of Oregon, Department of Administrative Services)
ROS	Rain on Snow
ROW	Right of Way
RPC	Recovery Planning Cell (State of Oregon Executive Order 08-20)
RVS	Rapid Visual Screening
RWIS	Road Weather Information System
SB	Senate Bill (Oregon Legislature)
SBA	Small Business Administration (U.S.)
SC	Steering Committee (OSLR)
SD	Substantial Damage
SEAO	Structural Engineers Association of Oregon
SFC-LPA	Southern Flow Corridor — Landowner Preferred Alternative
SFHA	Special Flood Hazard Area
SHMO	State Hazard Mitigation Officer
SI	Substantial Improvement
SJR	Senate Joint Resolution
SLIDO	Statewide Landslide Inventory Database for Oregon
SM	Snowmelt

SMART	Specific, Measurable, Achievable, Realistic, Time-oriented
SMC	State Management Cost
SNHMP	State Natural Hazards Mitigation Plan
SNOTEL	Snow Telemetry site; part of an automated system of snowpack and related climate sensors operated by the USDA NRCS.
SOI	Southern Oscillation Index
SoVI	Social Vulnerability Index
SRGP	Seismic Rehabilitation Grant Program (State of Oregon)
SRIA	Sandy Recovery Improvement Act of 2013
SRL	Severe Repetitive Loss (NFIP)
SRS	Self-Determination Act
SSF	State Support Function
SUA	State Unit on Aging
SUB	Springfield Utility Board
SWCD	Soil and Water Conservation District
TAG	Technical Assistance Grant (Land Conservation and Development Commission)
TDD	Transportation Development Division (ODOT)
TDR	Transfer of Development Rights
TGM	Transportation and Growth Management Program (Department of Transportation)
THIRA	Threat and Hazard Identification and Risk Assessment
TIM	Tsunami Inundation Map (DOGAMI)
TNC	The Nature Conservancy
TRG	Technical Resource Guide
U.S.C.	United States Code
UASI	Urban Area Security Initiative
UGB	Urban Growth Boundary
UO	University of Oregon
UP	Union Pacific (railroad)
URM	Unreinforced Masonry
US	United States
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USDOC	United States Department of Commerce
USDOE	United States Department of Energy
USDOI	United States Department of the Interior
USDOT	United States Department of Transportation

USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
V	Vulnerable
VE	Flood Insurance Rate Map (FIRM) zone: an area inundated by 1% annual chance flooding with velocity hazard (wave action); base flood elevations have been determined.
WACO	Water Availability Committee of Oregon
WHZ	Wildfire Hazard Zone
WRD	Water Resources Department (State of Oregon)
WREP	Wetlands Reserve Enhancement Program
WRH	Western Region Headquarters (NOAA National Weather Service)
WRP	Wetlands Reserve Program
WSSPC	Western States Seismic Policy Council
WSU	Washington State University
WUI	Wildland-Urban Interface
WWRA	West Wide Risk Assessment
WWTP	Wastewater Treatment Plant
YBP	Years Before Present

Chapter 7 GLOSSARY

100-year flood means a flooding condition which has a 1% chance of occurring each year. The 100-year flood is the benchmark upon which the National Flood Insurance Program (NFIP) is based.

Amplification is the modification of frequency or strength of seismic earth movement at a location due to thickness, topography, and physical properties of soft surface sediments.

Ash is composed of fine particles of volcanic rock and glass blown into the atmosphere by a volcanic eruption.

Bombs are fragments of tephra (particles ejected into the air during volcanic eruptions) larger than 2.5 inches.

Bedrock shaking is expected earth movement at a location due to seismic activity without considering soft sediment effects such as amplification and liquefaction.

Caldera is a large, generally circular, fault-bounded depression caused by the withdrawal of magma from below a volcano or volcanoes.

Cascadia Subduction Zone is the area where the seafloor plate (the Juan de Fuca or Gorda) is sliding down and below the North American plate.

Cinder is a bubbly (vesicular) volcanic rock fragment that forms when molten, gas-filled lava is thrown into the air, then solidifies as it falls.

Conflagration Act is state legal authority established as a civil defense measure to mobilize structural fire suppression resources for massive urban fires. It must be authorized by the Governor. The act includes authorization for OSFM to assign firefighting forces and equipment beyond mutual aid agreements. It also designates reimbursement for aid to those departments participating.

Conflagration, in the context of this Plan, means Governor-declared fires with an imminent threat to life or structures that have exhausted local and mutual aid suppression resources.

Disaster Mitigation Act of 2000 (DMA2K) amended the Stafford Act, establishing a national program for pre-disaster mitigation; streamlining the administration of disaster relief; changing FEMA's post-disaster programs for individuals and families; establishing minimum standards for public and private structures; requiring local and state natural hazards mitigation plans that meet a FEMA standard (Section 322); revising FEMA funding for the repair, restoration, and replacement of damaged facilities (Section 406); revising FEMA's participation in the costs of WUI fire suppression through an expanded and renamed Fire Management Assistance Grant Program (Section 420); removing the requirement for post-disaster IHMT or HMST meetings and reports; and other amendments.

El Niño-Southern Oscillation is a cycle in the Pacific Basin involving water and air temperatures that has a profound effect on weather patterns around the world; events typically last 6-18 months.

FireFree is an Oregon and national model developed in Oregon that predates the more recent nationally known Firewise. http://www.firefree.org/

Firewise is a program developed by the National Fire Protection Association (NFPA) featuring templates to help communities reduce risk and protect property from the dangers of wildland fires; an interactive, resource-rich website; and training programs throughout the nation. http://www.firewise.org/

Floodplain is a land area adjacent to a river, stream, lake, estuary, or other water body that is subject to flooding. These areas, if left undisturbed, act to store excess flood water.

Floodway is the channel of a river or other watercourse and adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot.

Flows are rapid to slow mass movement of saturated material moving down a slope. *Debris flows* occur when a landslide moves rapidly downslope as a semi-fluid mass scouring or partially scouring soils from the slope along its path. Other *flow* types include earthflows, mudflows, lahars, debris torrents, and creep.

Foredune is a dune lying parallel to the ocean, occurring at the landward edge of the beach or at the landward limit of the highest tide, which has been stabilized by vegetation.

Goal 7 of the Oregon Statewide Land Use Planning Program calls for local comprehensive plans to include inventories, policies, and implementing measures to guide development in hazard areas with the goal of reducing losses from flooding, landslides, earthquakes, tsunamis, coastal erosion, and wildfires.

Hazard is any situation that has the potential of causing damage to people, property, or the environment.

Hazard Mitigation Grant Program means the program authorized under Section 404 of the Stafford Act and implemented at 44 CFR Part 206, Subpart N, which authorizes funding for certain mitigation measures identified through the evaluation of natural hazards conducted under Section 322 of the Stafford Act. (44 CFR 201.2)

Hazard mitigation means any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards. (44 CFR 201.2)

Hazus (**HAZ**ards **U**nited **S**tates) is a loss estimation methodology that is a FEMA software program using mathematical formulas and information about building stock, local geology, and the location and size of potential earthquakes, economic data, and other information to estimate losses from potential earthquakes.

Hazus-MH (Hazus **M**ulti-**H**azards) is a methodology that expands on Hazus (cf.) by estimating potential losses from earthquakes, hurricane winds, and floods.

Lahar is a type of mudflow that originates on the slopes of volcanoes when volcanic ash and debris become saturated with water and flows rapidly downslope.

Lava is magma that reaches the Earth's surface through a volcanic eruption and when cooled and solidified, forms igneous rock.

Landslide is any detached mass of soil, rock, or debris that moves down a slope or a stream channel.

Lateral spreading is failure on very gentle slopes or flat terrain. The failure is usually associated with water-saturated, loose sediment spreading laterally due to liquefaction during earthquakes or human-caused rapid ground motion.

Lidar (Light Detection and Ranging) is an optical remote sensing technology that can measure the distance to, or other properties of a target by illuminating the target with light, often using pulses from a laser.

Liquefaction is the reaction of saturated soil to seismic earth movement causing the soil to behave like a liquid.

Littoral cells are beaches composed of sand, gravel, or both that may be bounded by prominent headlands limiting sand exchange.

Magma is molten rock that may be completely liquid or a mixture of liquid rock, dissolved gases and crystals.

Pyroclastic flow is an extremely hot mixture of gas, ash and pumice fragments that travels down the flanks of a volcano or along the surface of the ground at speeds of up to 150 miles per hour and tends to flow down valleys.

Magnitude (M) is a measure of the amount of energy released by an earthquake.

Major disaster means any natural catastrophe including any hurricane, tornado, storm, high water, wind-driven water, tidal wave, tsunami, earthquake, volcanic eruption, landslide, mudslide, snowstorm or drought, or, regardless of cause, any fire, flood, or explosion in any part of the United States, which in the determination of the President causes damage of sufficient severity and magnitude to warrant major disaster assistance to supplement the efforts and available resources of states, local governments, and disaster relief organizations in alleviating the damage, loss, hardship, or suffering caused thereby. (44 CFR 206.2)

Megathrust is both the giant fault that separates the two plates in a subduction zone and the giant earthquake that occurs when that fault moves.

National Fire Plan is a federal program that helps manage the impact of wildfire on communities. It has five main components: (a) firefighting, (b) rehabilitation and restoration, (c) hazardous fuel reduction, (d) community assistance, and (e) accountability.

National Flood Insurance Program is the program run by the federal government to improve floodplain management, reduce flood-related disaster costs, and provide flood insurance for residents of flood-prone communities.

Natural Hazards Mitigation Plan means a plan meeting the requirements of 44 CFR 201.4, 201.5, or 201.6.

Senate Bill 360 in 1997 established the policy and framework for meeting the fire protection needs of the wildland-urban interface.

Pacific Decadal Oscillation is a similar but longer-term cycle than the El Niño-Southern Oscillation with typical events lasting 20-30 years.

Public Assistance is that part of the disaster assistance program in which the federal government supplements the efforts and available resources of state and local governments to restore certain public facilities or services. Public Assistance includes emergency assistance, debris removal, community disaster loans, and the permanent repair, restoration, or replacement of public and designated private nonprofit facilities damaged or destroyed by a major disaster and is further described under Section 406 of the Stafford Act.

Pyroclastic surge is a dilute version of a pyroclastic flow, which can move even more rapidly and easily moves up and over ridges.

Shield volcano is a gently sloping volcano in the shape of a flattened dome and built almost exclusively of lava flows.

Rock falls are masses of rock fragments that break away from a steep slope and travel mostly by free fall, coming to rest at the base of a slope as talus debris.

Slides have a distinct zone of weakness that separates the overlying failed material from more stable underlying material. Types of slides include rotational (movement along a curved surface) and translational (movement along a flat surface).

Special Flood Hazard Area is the land in the floodplain within a community subject to a 1% or greater chance of flooding in any given year. (44 CFR 59.1)

Stafford Act means the Robert T. Stafford Disaster Relief and Emergency Assistance Act (PL 100-707, which amended PL 91-606 and PL 93-288; then was further amended by PL 106-390, the Disaster Mitigation Act of 2000; and PL 109-295, the Post-Katrina Emergency Reform Act).

State Hazard Mitigation Officer is the official representative of state government who is the primary point of contact with FEMA, other federal agencies, and local governments in mitigation planning and implementation of mitigation programs and activities required under the Stafford Act. In Oregon, the State Hazard Mitigation Officer position resides in the Oregon Military Department's Office of Emergency Management.

State Interagency Hazard Mitigation Team is a permanent body of state agency officials established in 1997 to understand losses arising from natural hazards and coordinate recommended strategies to mitigate loss of life, property, and natural resources.

Stratovolcano is a relatively long-lived volcano built up of both lava flows and pyroclastic material.

Structural fire protection is protection of structures by established municipal fire departments and rural fire protection districts with specific equipment and training.

Subduction zone is the area between two converging plates, one of which is sliding down and below the other.

Subduction zone earthquake is an earthquake along a subduction zone. In Oregon, usually refers to the Cascadia Subduction Zone (CSZ), which lies off shore of the Oregon coast.

Subduction is the process of one crustal plate sliding down and below another crustal plate as the two converge.

Surface fault is a fault that ruptures to the Earth's surface.

Tectonic refers to large-scale vertical or horizontal movement of the earth's crust.

Tectonic plate is a slab of rigid lithosphere (crust and uppermost mantle) that moves over the asthenosphere.

Tephra is a general term for all sizes of particles ejected into the air during volcanic eruptions. Tephra includes particles as tiny as volcanic ash and as large as bombs.

Tsunami is a series of waves generated by undersea earthquakes or landslides.

Vulnerability is the susceptibility of life, property, or the environment to damage if a hazard manifests to potential.

Wave runup is the swash of a broken wave as it travels up the beach face.

Wildfire hazard zone means the portion of a local government jurisdiction that has been determined to be at risk of a catastrophic wildfire.

Wildland-urban interface (also known as wildland interface, forestland-urban interface, interface) is an area where structures are adjacent to or are intermingled with natural vegetative fuels which is prone to the occurrence of wildland fires.

Chapter 8 REFERENCES

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Chapter 9 APPENDICES

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9.1.6 Windstorm: Information on 1931 Dust Storm

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THE END