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.

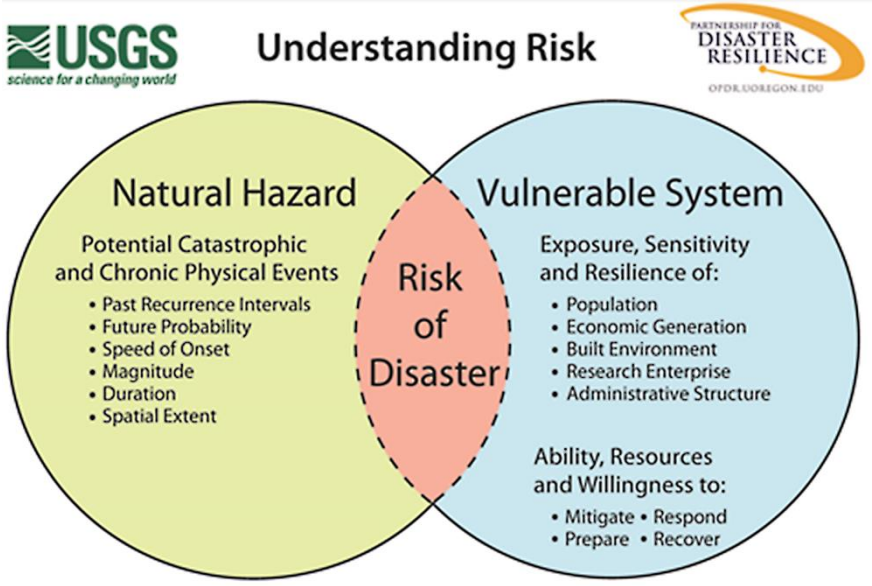
2.1 Introduction

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.

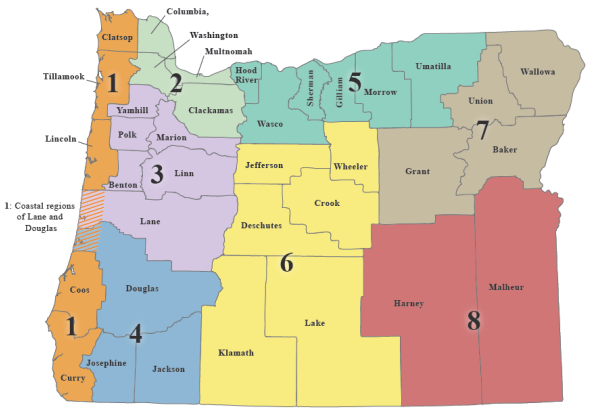
A vulnerability assessment combines information from the hazard characterization with an inventory of the existing (or planned) property and population exposed to a hazard and attempts to predict how different types of property and population groups will be affected by each hazard. Vulnerability is determined 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.

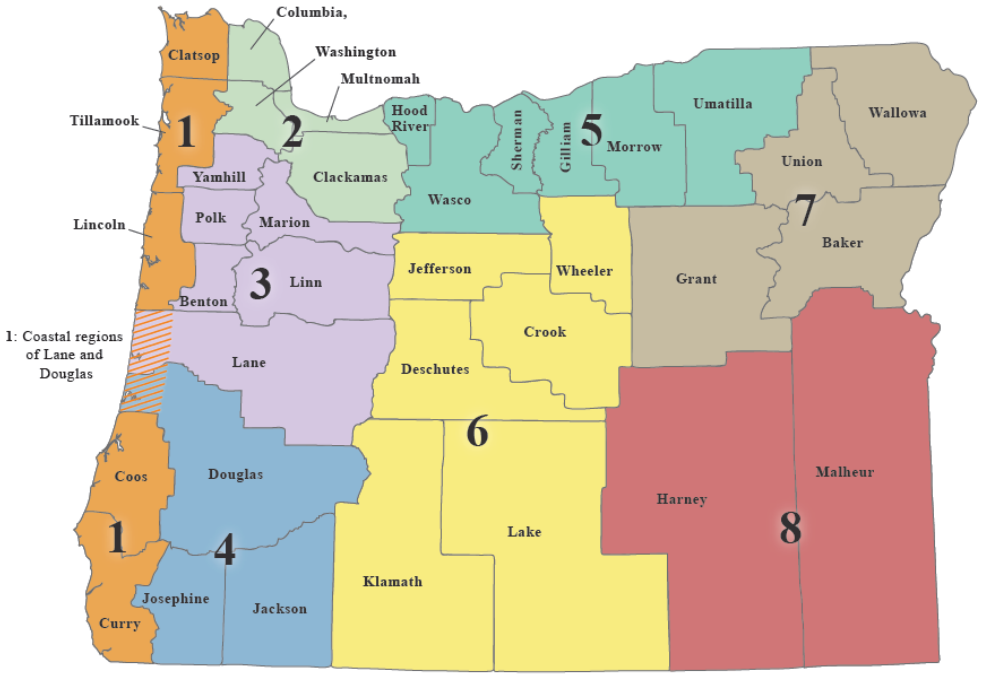
Figure 2-2. Oregon NHMP Natural Hazards Regions



2.3 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.

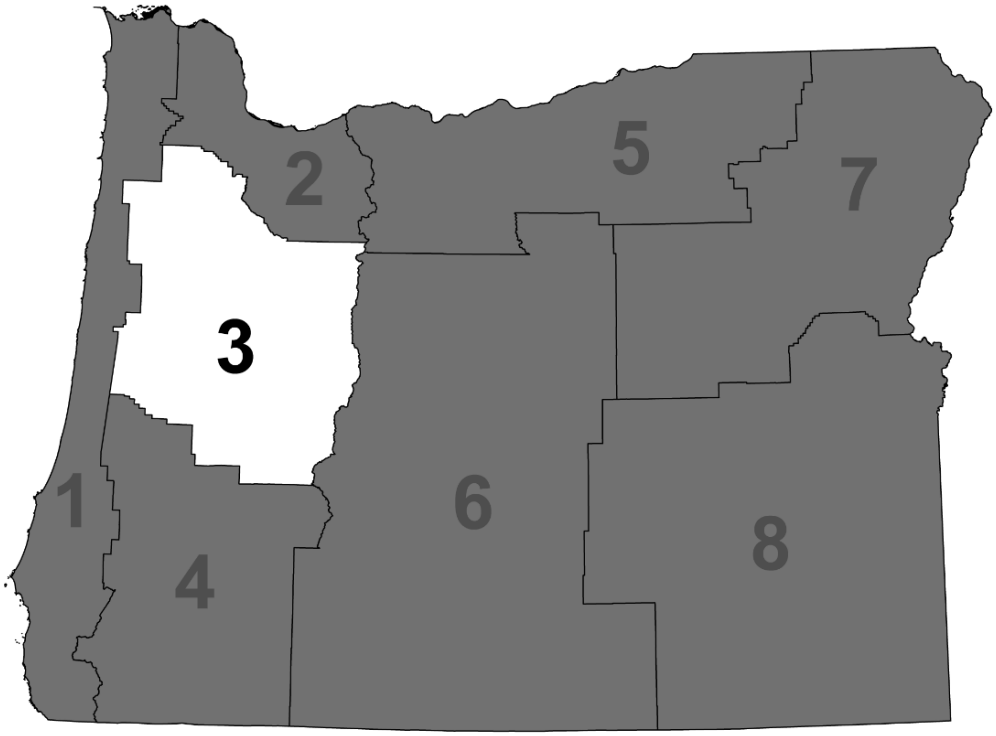
   The research of Susan Cutter, Professor of Geography at the University of South Carolina, Columbia, on vulnerability and environmental hazards provides the framework for discussion of vulnerability in the Regional Profile section. Cutter's framework helps to illustrate the geographic variability of vulnerability 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.

2.3.3 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

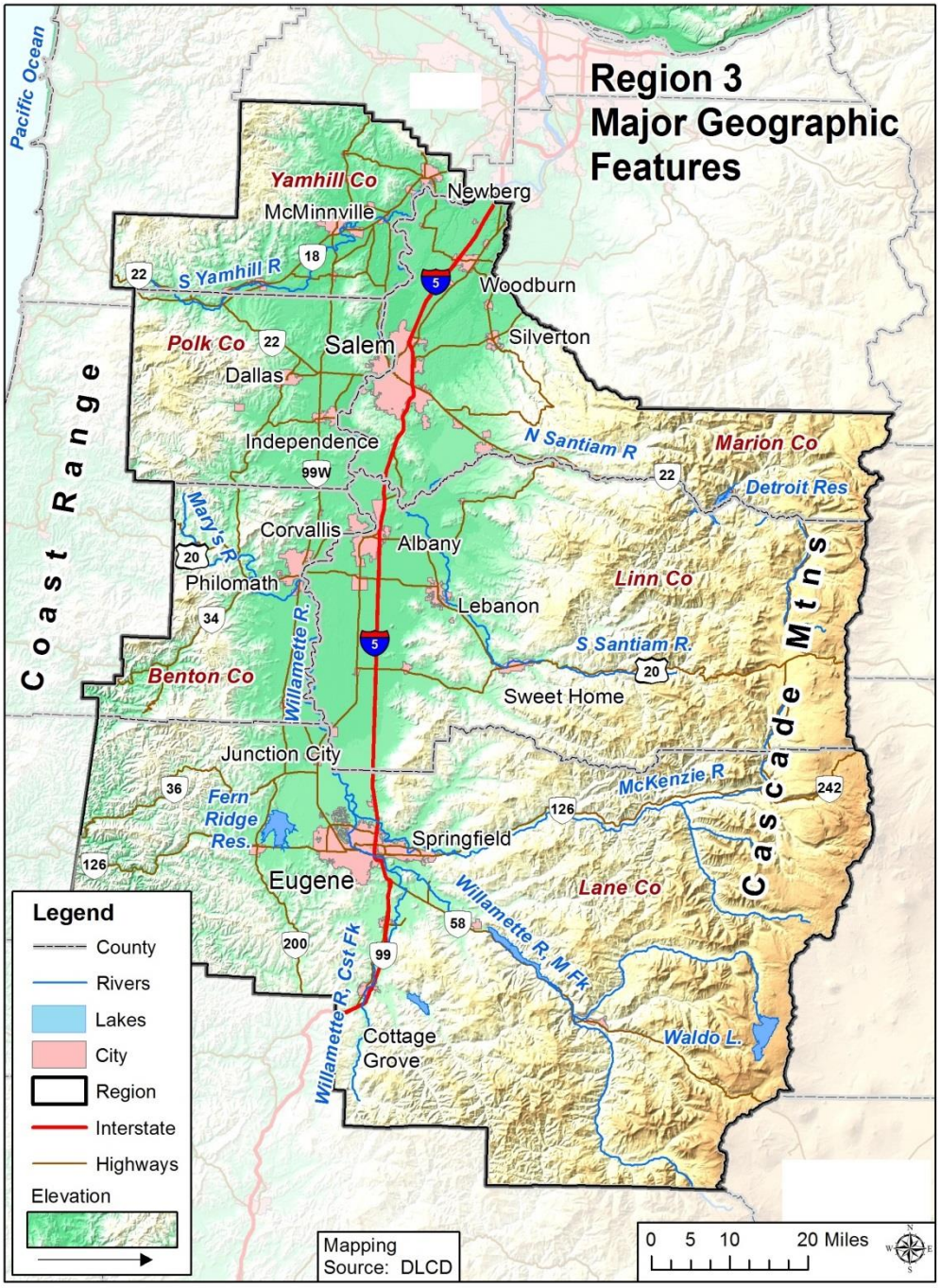
Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

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.

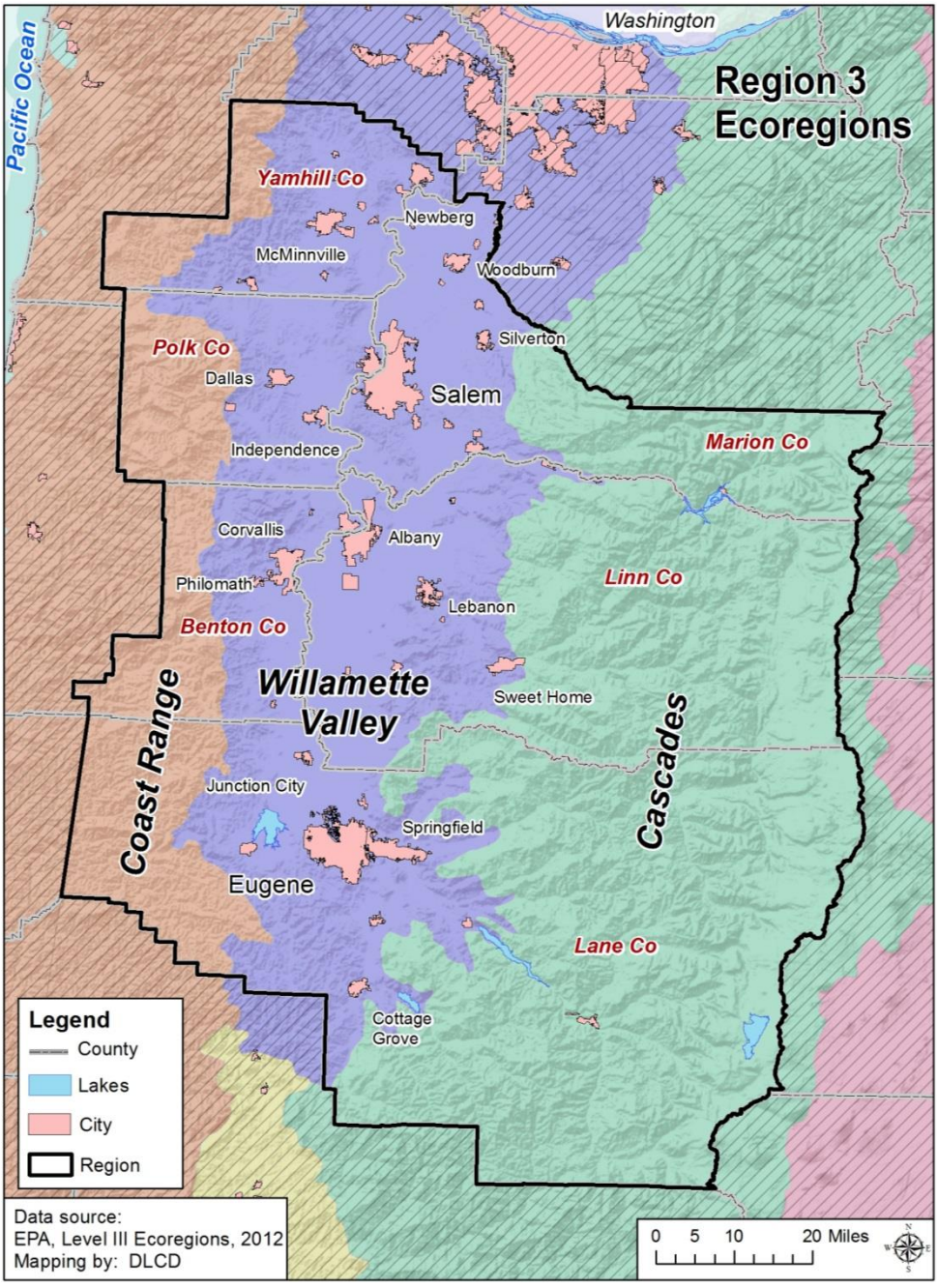
Figure 2-119. Region 3 Major Geographic Features



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

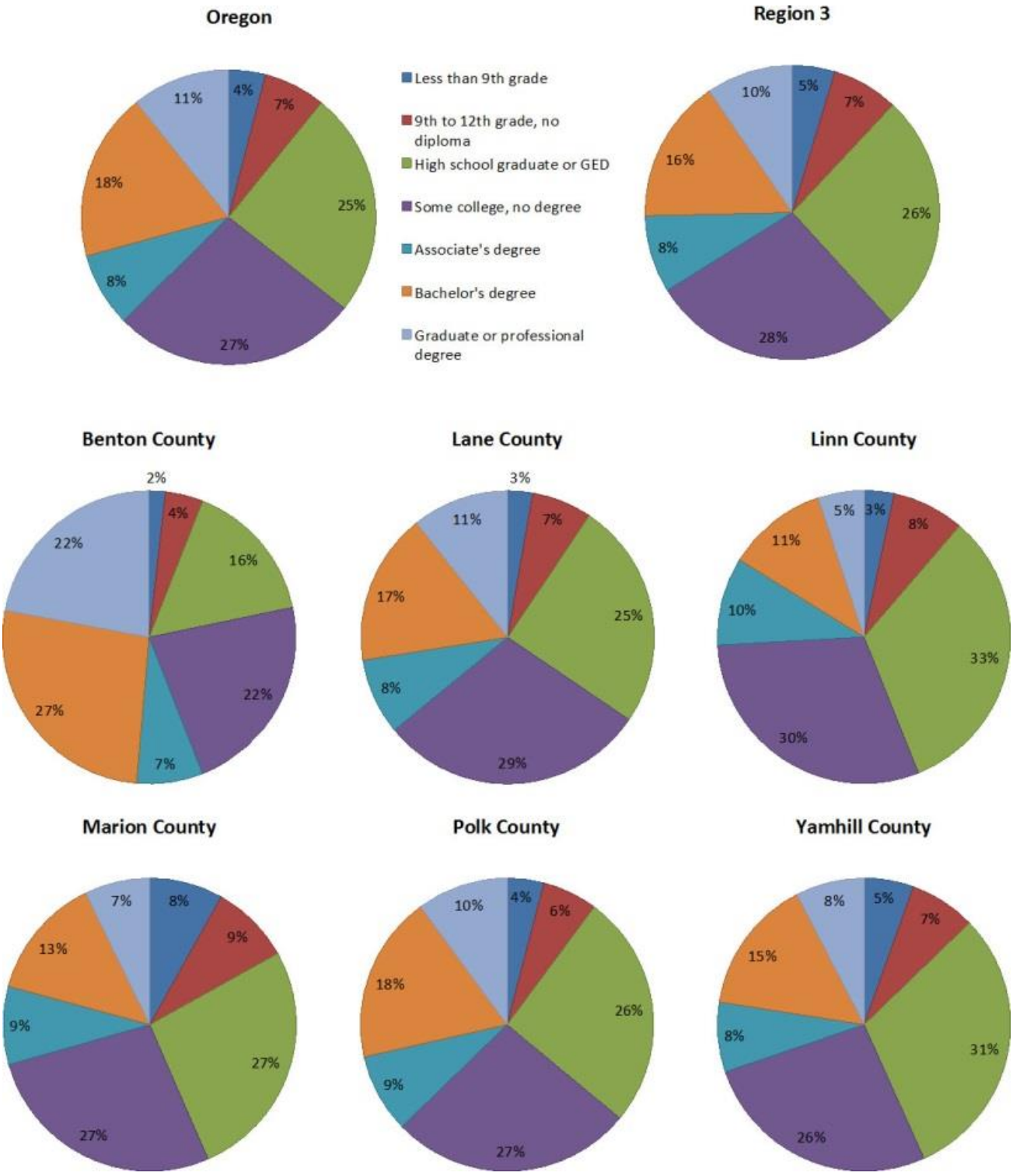
	Speak English "Very Well"		Speak English Less Than "Very Well"	
	Estimate	**Percent**	**Estimate**	**Percent**
Oregon	3,376,744	93.8%	224,905	6.2%
Region 3	922,262	94.1%	57,814	5.9%
Benton	78,954	96.6%	2,738	3.4%
Lane	323,424	96.9%	10,235	3.1%
Linn	106,495	97.5%	2,762	2.5%
Marion	259,286	88.8%	32,727	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%

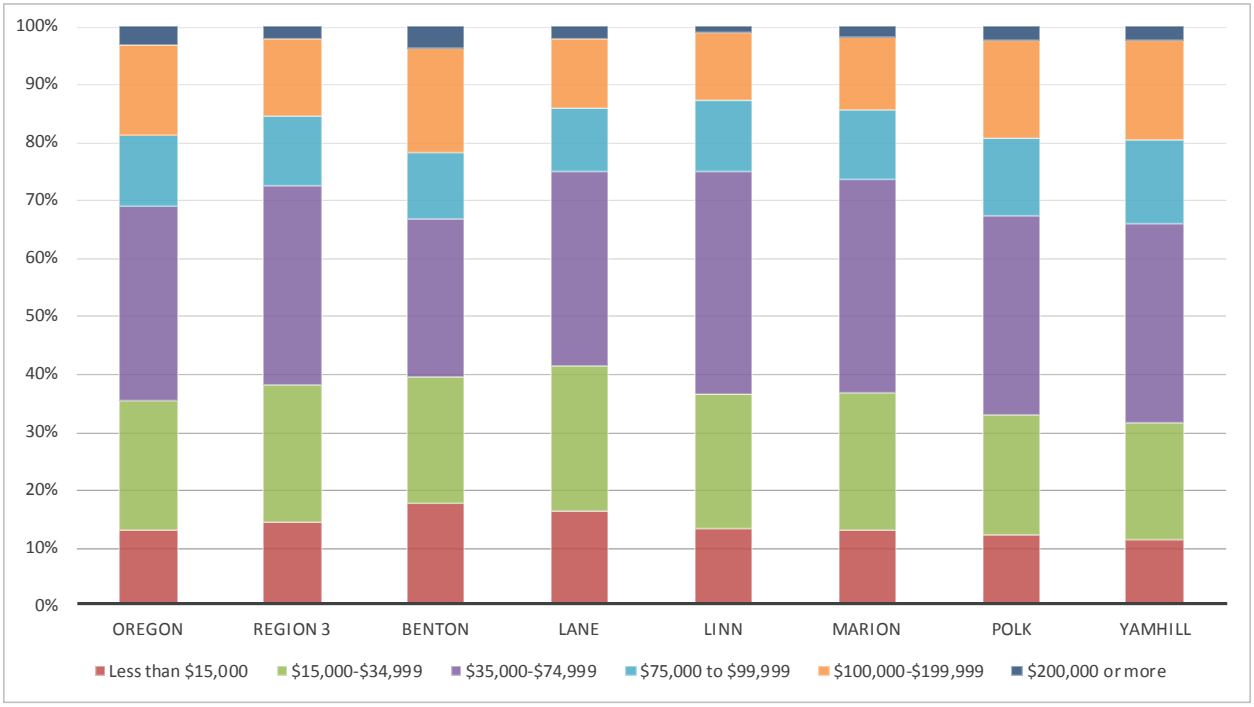
Note: 2009 dollars are adjusted for 2012 using Bureau of Labor Statistics' Consumer Price Index Inflation Calculator.

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

Industry	Region 3	Benton County		Lane County		Linn County	
		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%

Industry	Region 3	Marion County		Polk County		Yamhill County	
		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

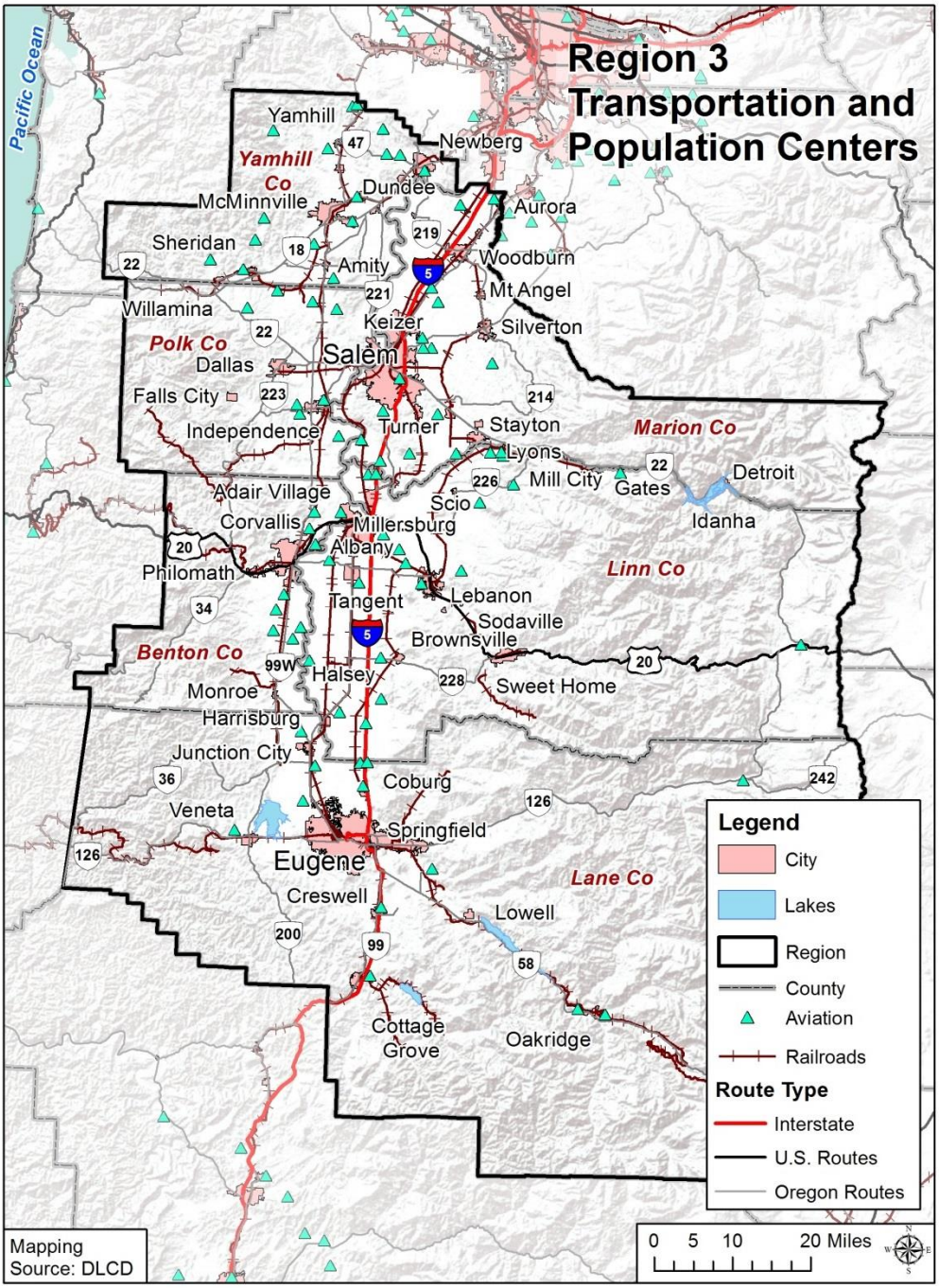
The highway system in the Region 3 centers on I-5 and the major east-west highways that intersect it. Recent population growth in the region has increased the number of vehicles on the roads. Many trips through the region originate outside the region in the Portland Metropolitan Area. Portland drivers 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).

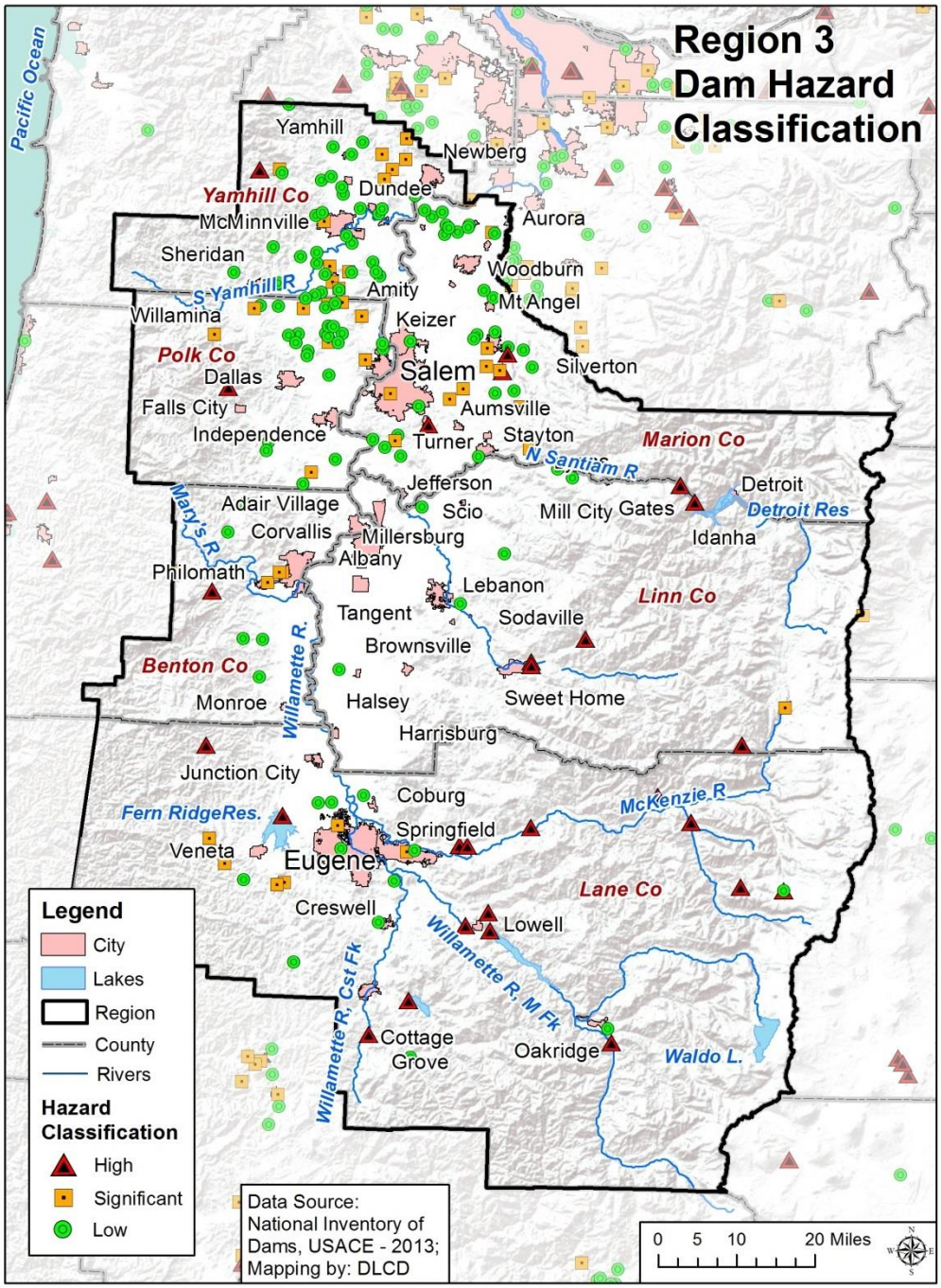
Minor dam failures can occur at any time. Most dam failures result in minor damage to structures and pose little or no risk to life safety. However, the potential for severe damage and fatalities does exist. For example, major dam failures occurred near Hermiston in 2005 and in Klamath Lake in 2006 (Association 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

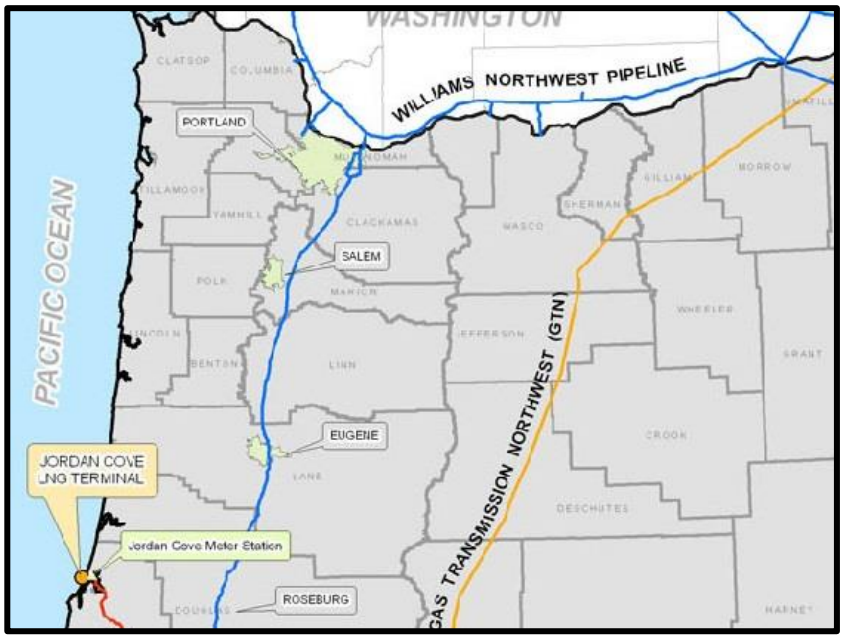


Source: National Inventory of Dams, USACE, 2013

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%

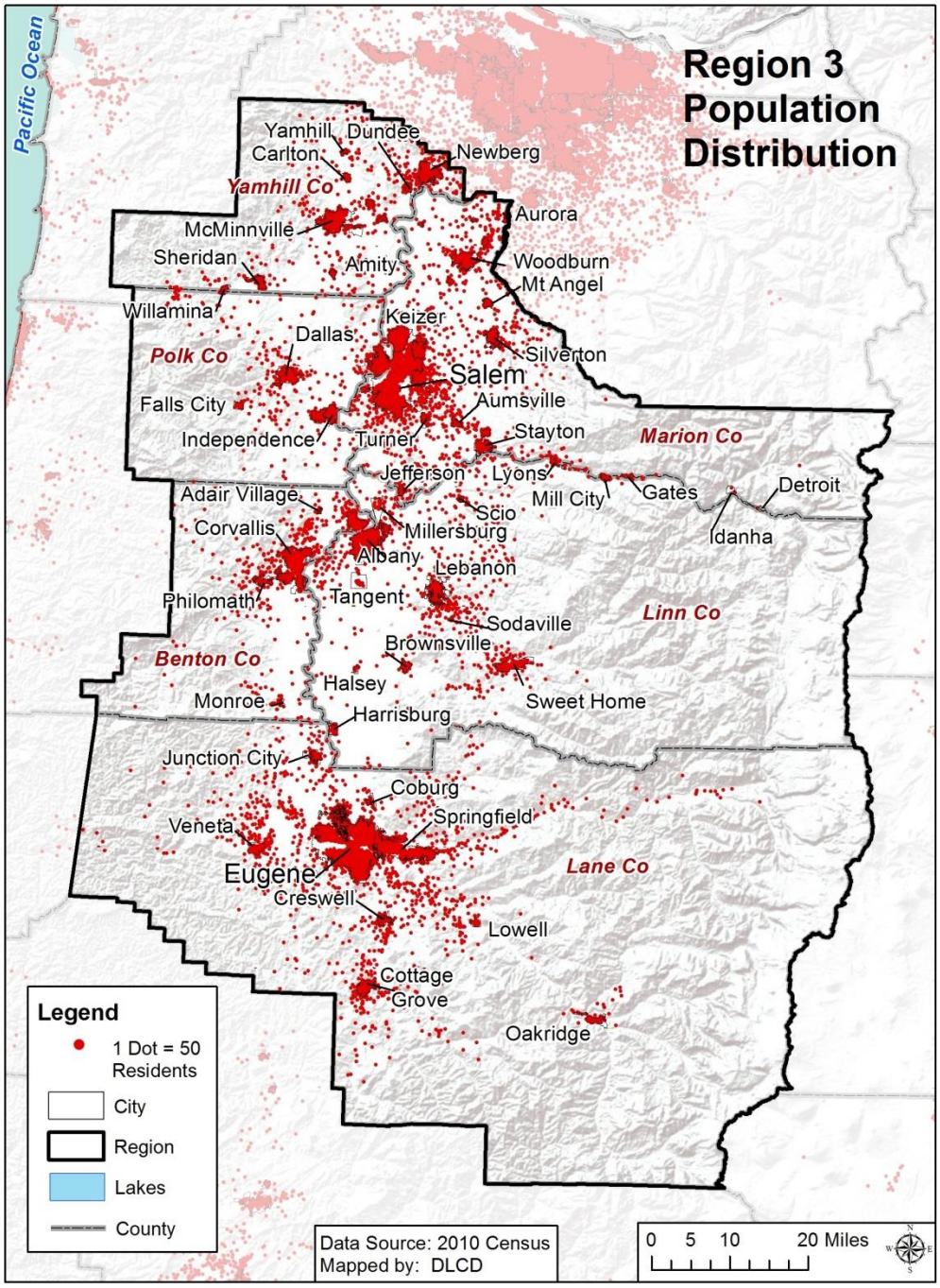
Source: U.S. Census Bureau. 2000 Decennial Census, Table P002 and 2010 Decennial Census, Table P2

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.

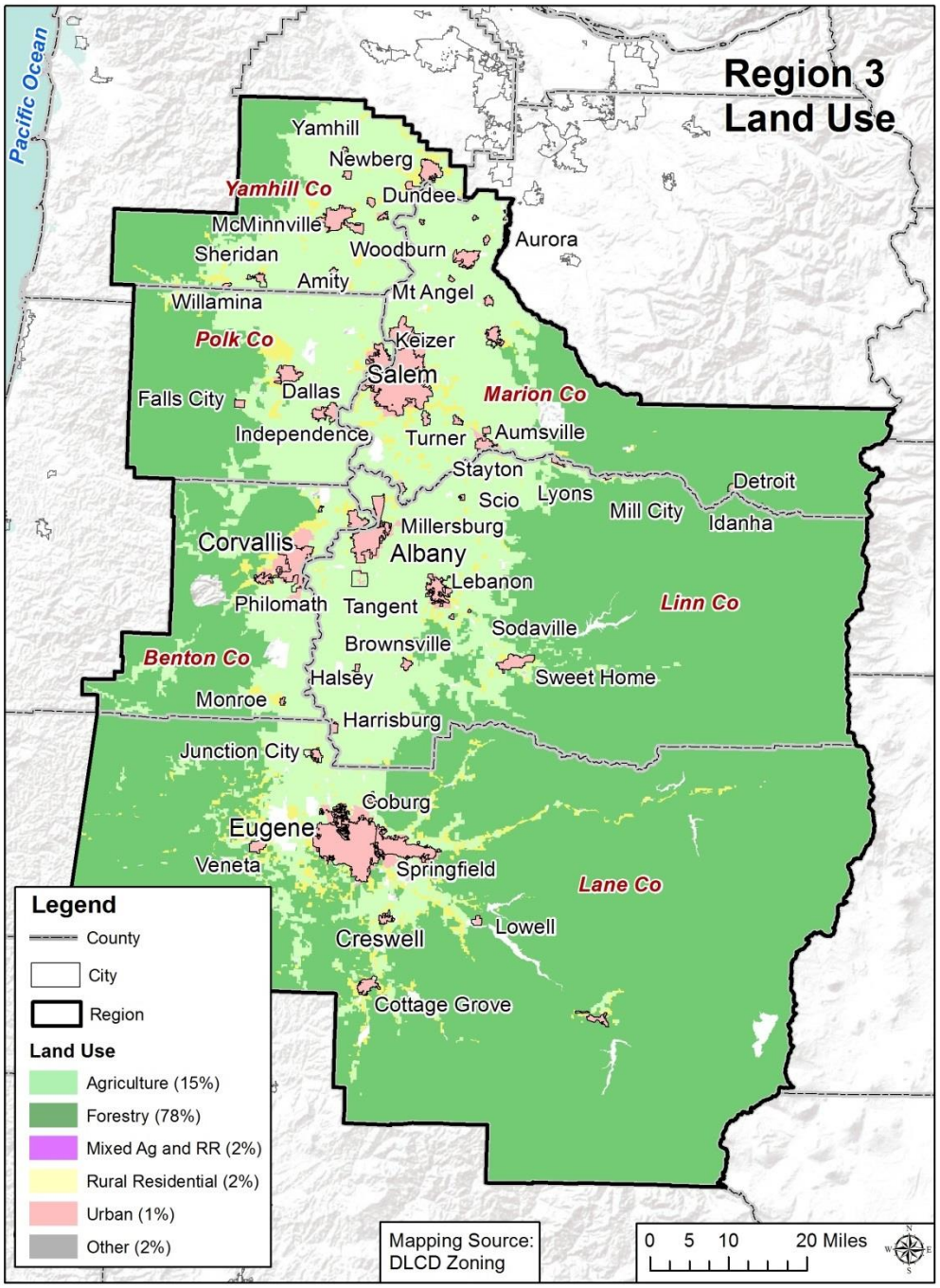
The South Willamette Region is a land of contrasts, with urban areas nestled within productive farmland, bordered by the Cascade and Coast Range timberlands. I-5 runs the length of the region, and this area's economy is shaped by the transportation system. With 61 incorporated communities in the region, 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.

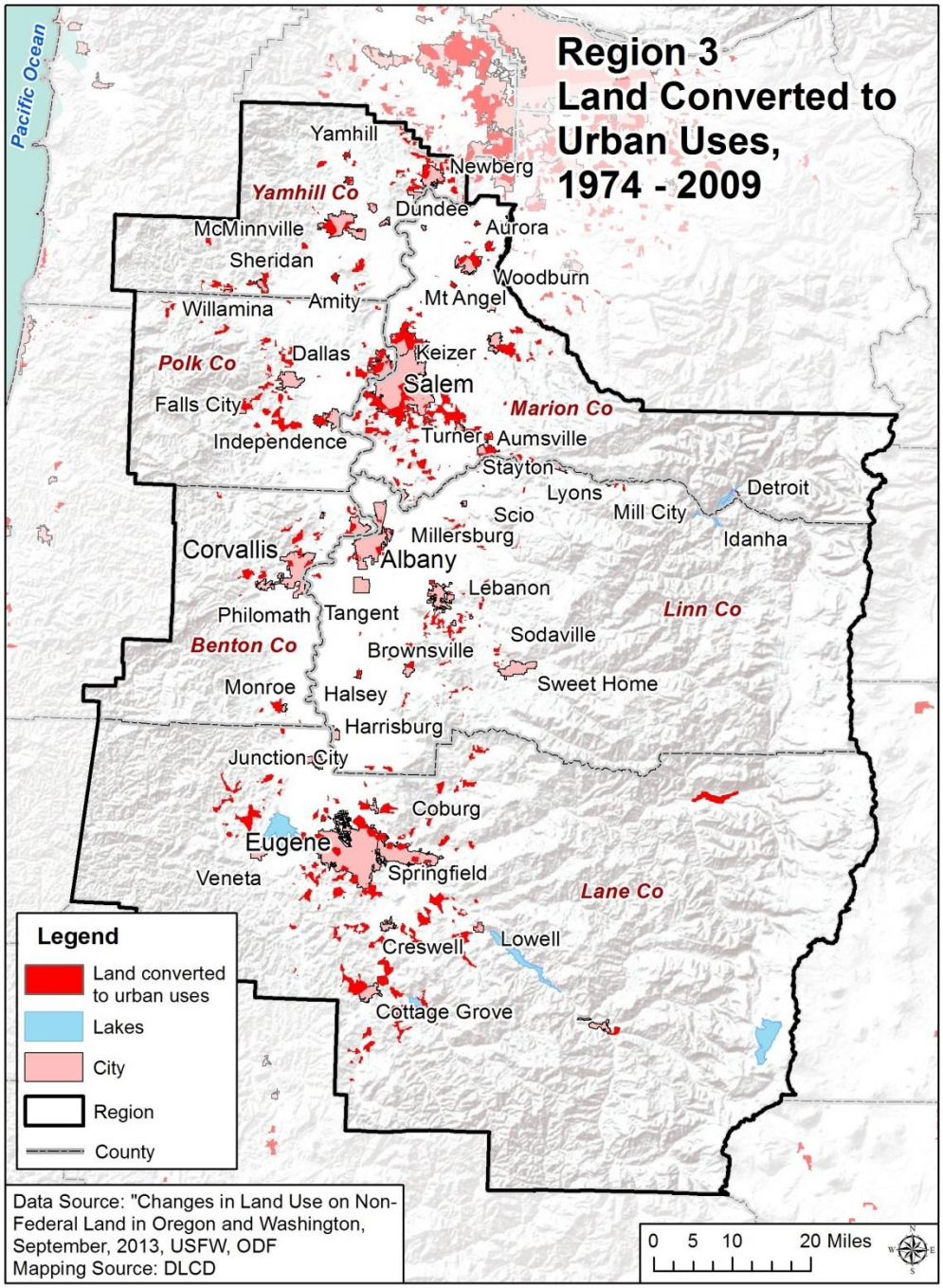
The Eugene-Springfield area is the second largest metropolitan area in Oregon, but expansion options are restricted by potential landslide and flood hazard areas. These communities are doing what they can to accommodate growth inside existing UGBs while minimizing encroachment into known hazard areas. 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

	Initial FIRM	Current FIRM
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

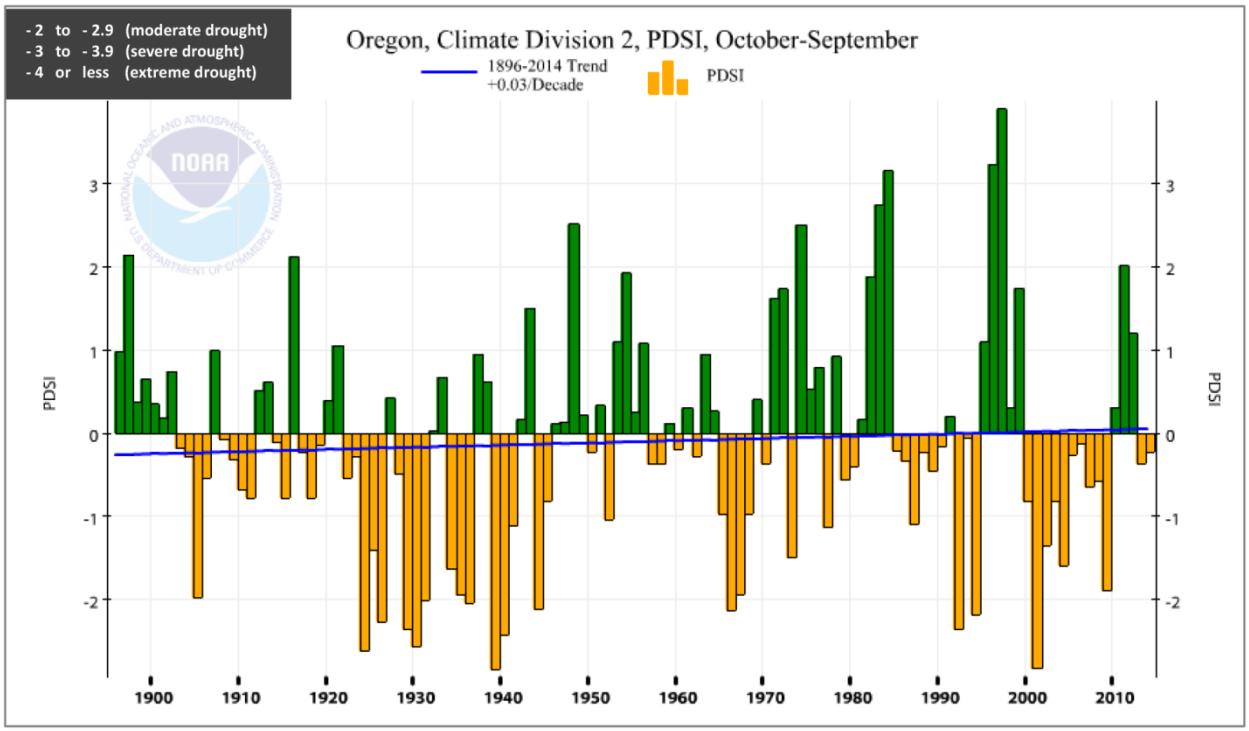
Table 2-203. Historic Droughts in Region 3

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

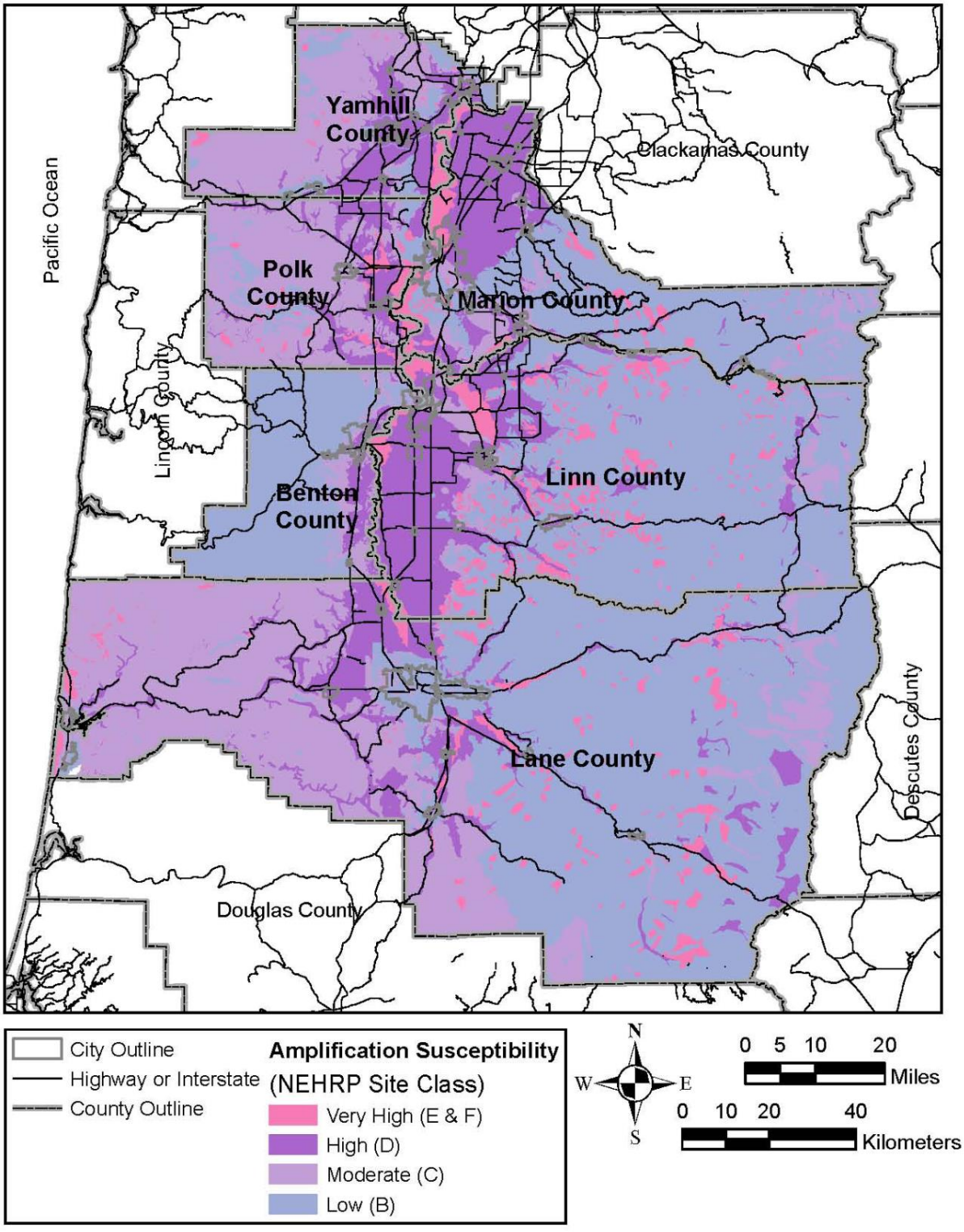
The geographic position of Region 3 makes it susceptible to earthquakes from four sources: (a) the off-shore Cascadia Fault Zone, (b) deep intra-plate events within the subducting Juan de Fuca plate, (c) shallow crustal events within the North America Plate, and (d) earthquakes associated with renewed 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.

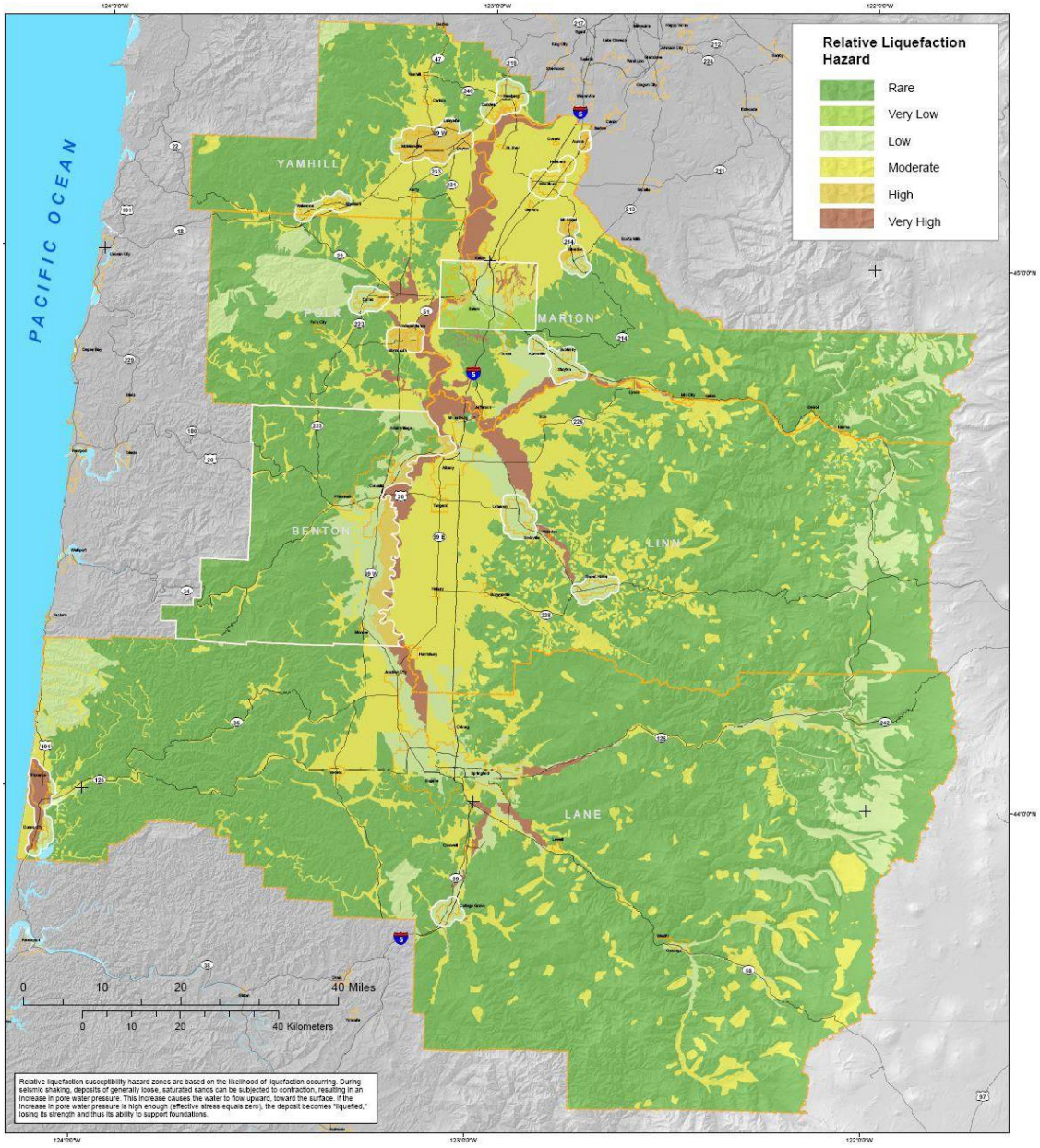
Figure 2-130. Amplification Susceptibility for Region 3



Source: Burns et al. (2008)

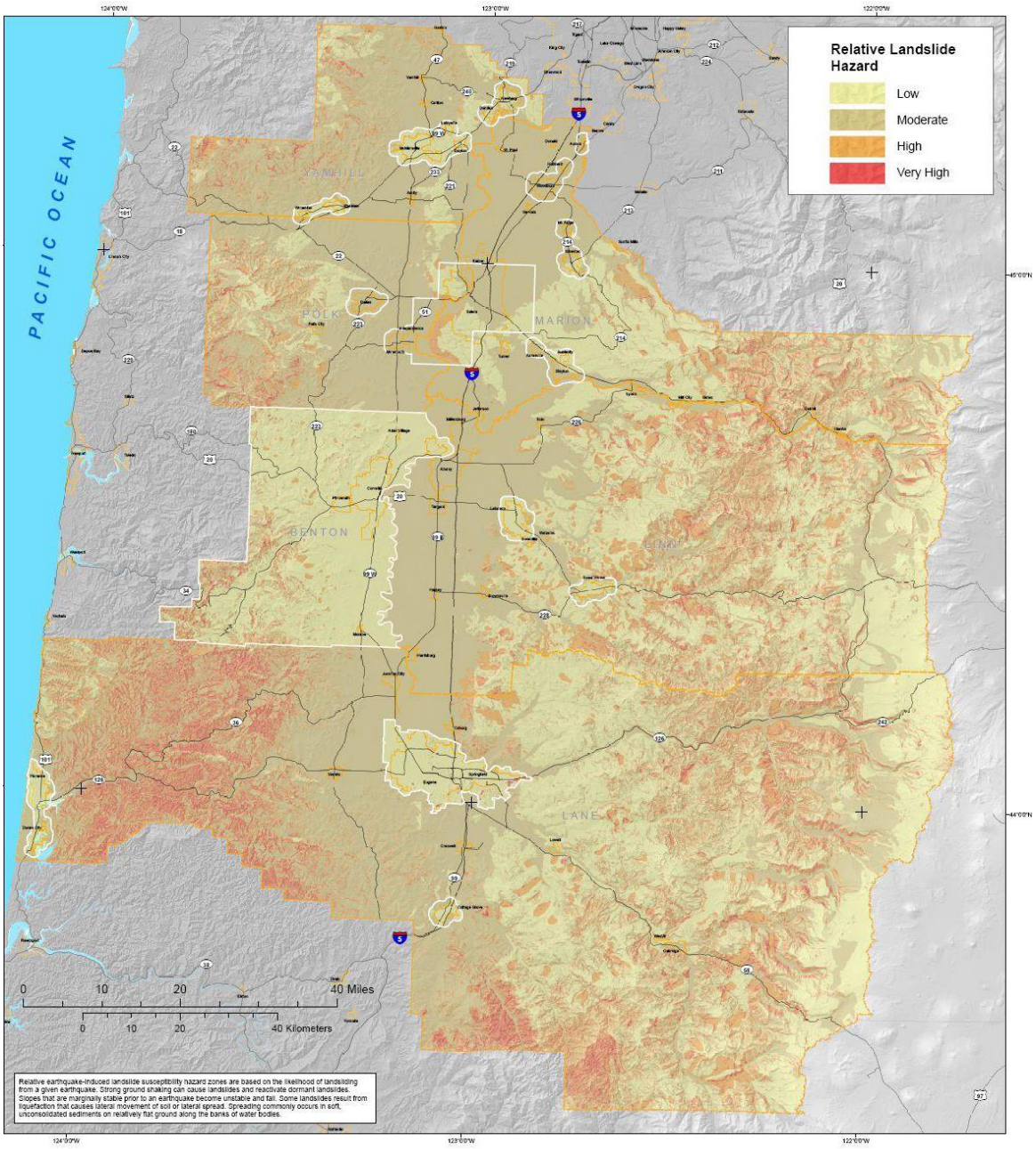
During seismic shaking, deposits of loose saturated sands can be subjected to contraction resulting in an increase in pore water pressure. If the increase in pore water pressure is high enough, the deposit becomes "liquefied," losing its strength and thus its ability to hold and support loads. **Figure 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

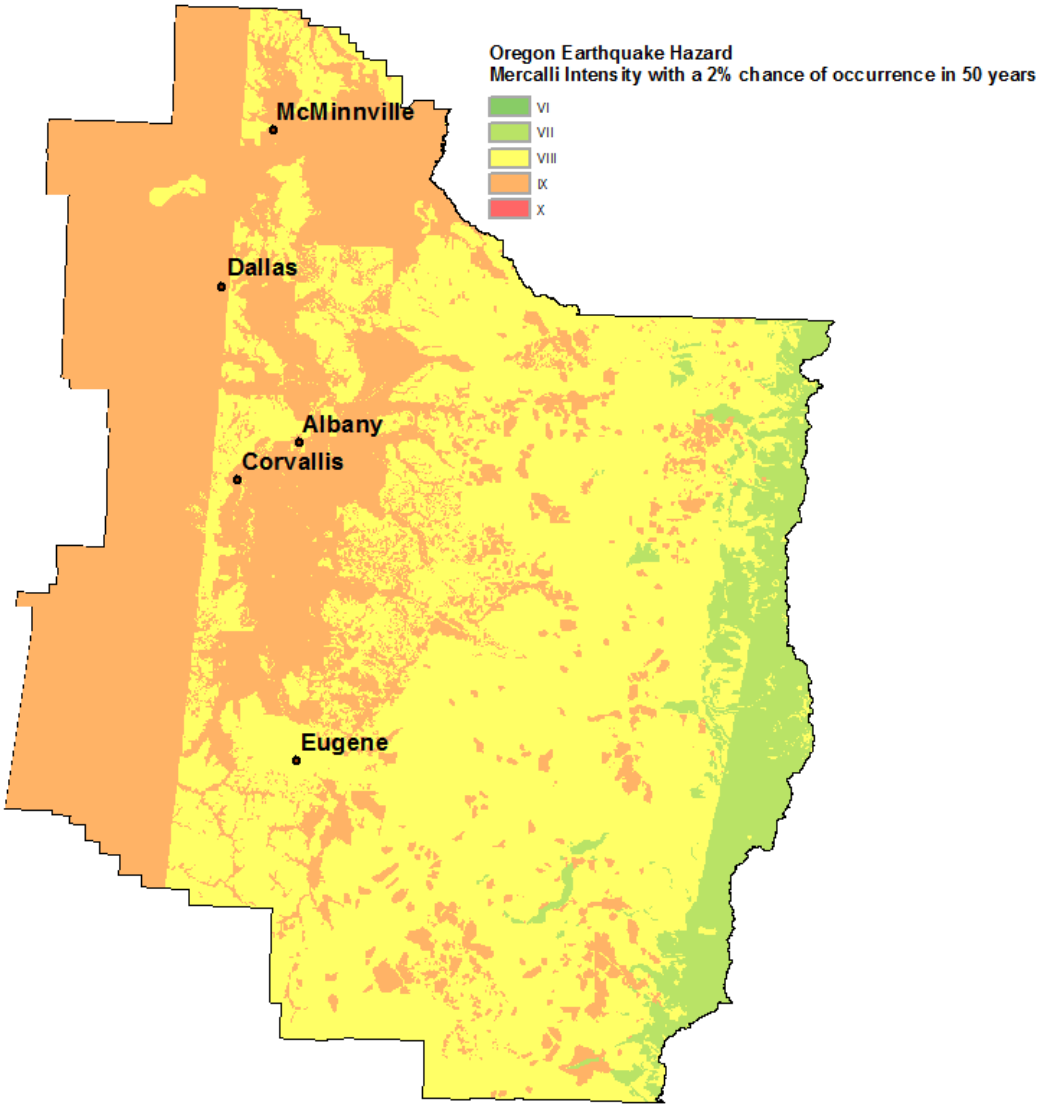
State Assessment

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

	Level of Collapse Potential			
County	**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	75%	100%	77%	61%	100%	50%
Police Station	75%	91%	40%	65%	100%	64%
Schools	91%	99%	70%	74%	100%	68%
Bridges	100%	97%	91%	86%	93%	89%
Economic losses to infrastructure:						
Highways	$18.7 m	$106 m	$129.70 m	$271.5 m	$35.7 m	$71.3 m
Airports	$19.3 m	$16 m	$38.3 m	$38 m	$11 m	$43.9 m
Communications	$ 0.24 m	$0.63 m	$0.11 m	$0.18 m	$0.05 m	$0.10 m
Debris generated (in thousands of tons)	0	1,000	0	1,000	0	0

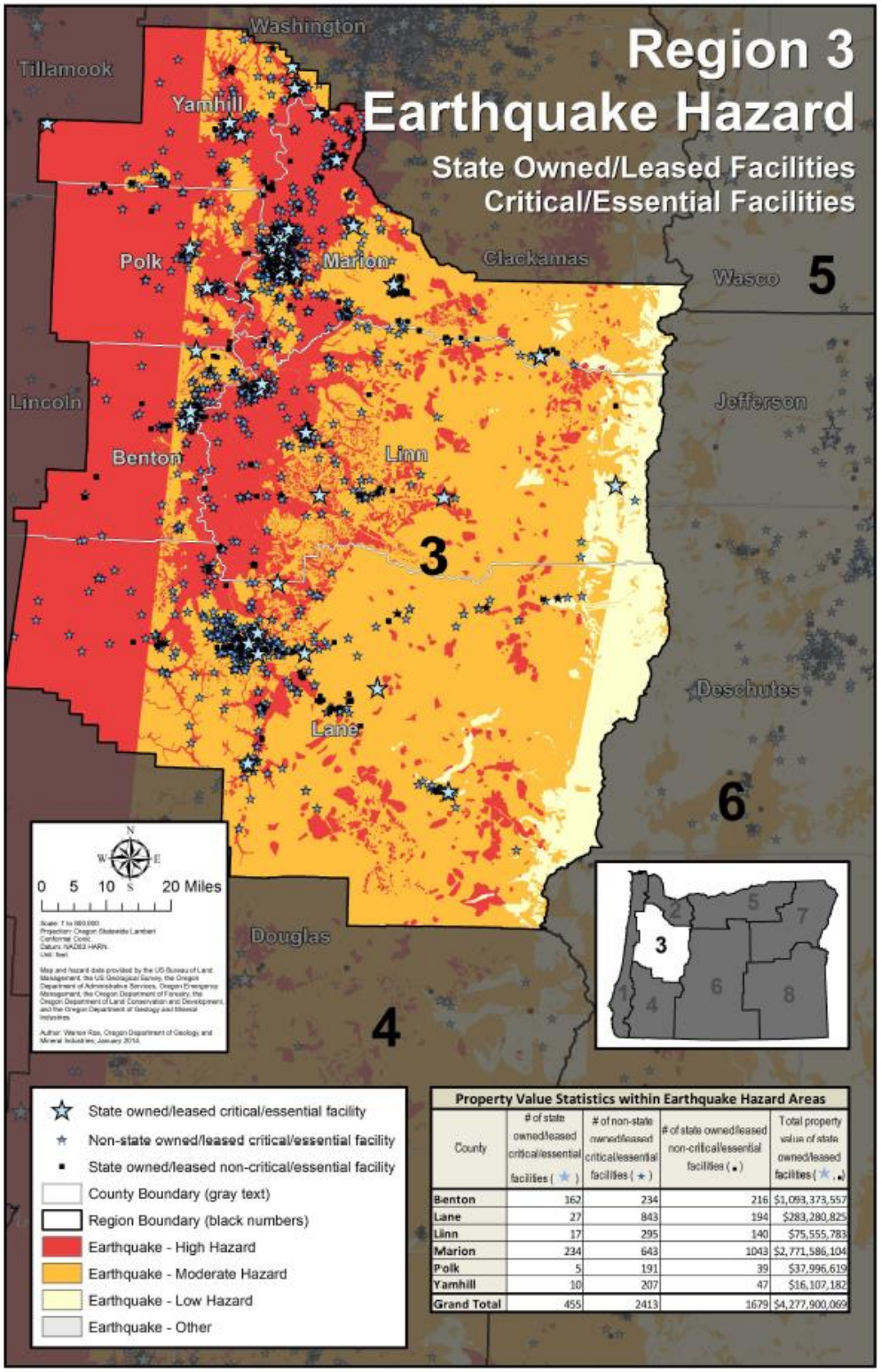
Source: Burns et al. (2008)

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: Marys River Newton Creek Mill Race Frazier Creek Soap Creek Oak Creek Jackson Creek	Willamette River and tributaries, especially: Amazon Creek Berkshire Slough Blue River Cedar Creek Coast Fork Dedrick Slough Fall Creek Long Tom River McKenzie River Mohawk River Oxley Slough Row River Salmon Creek Silk Creek	Willamette River and tributaries, especially: Calapooia River Santiam (N and S) Thomas Creek Ames Creek Oak Creek Peters Ditch Truax Creek	Willamette River and tributaries, especially: Santiam River Pudding River Battle Creek Butte Creek Beaver Creek Claggett Creek Croisan Creek Gibson Creek Lake Labish Creek Mill Creek Pringle Creek Senecal Creek Silver Creek Shelton Ditch	Willamette River and tributaries, especially: S. Yamhill River Ash Creek (all forks) Agency Creek Ellendale Creek Gibson Creek Rickreall Creek Rock Creek Rowell Creek	Willamette River and tributaries, especially: Yamhill River Yamhill Creek Baker Creek Chehalem Creek Cozine Creek Hess Creek Palmer Creek

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

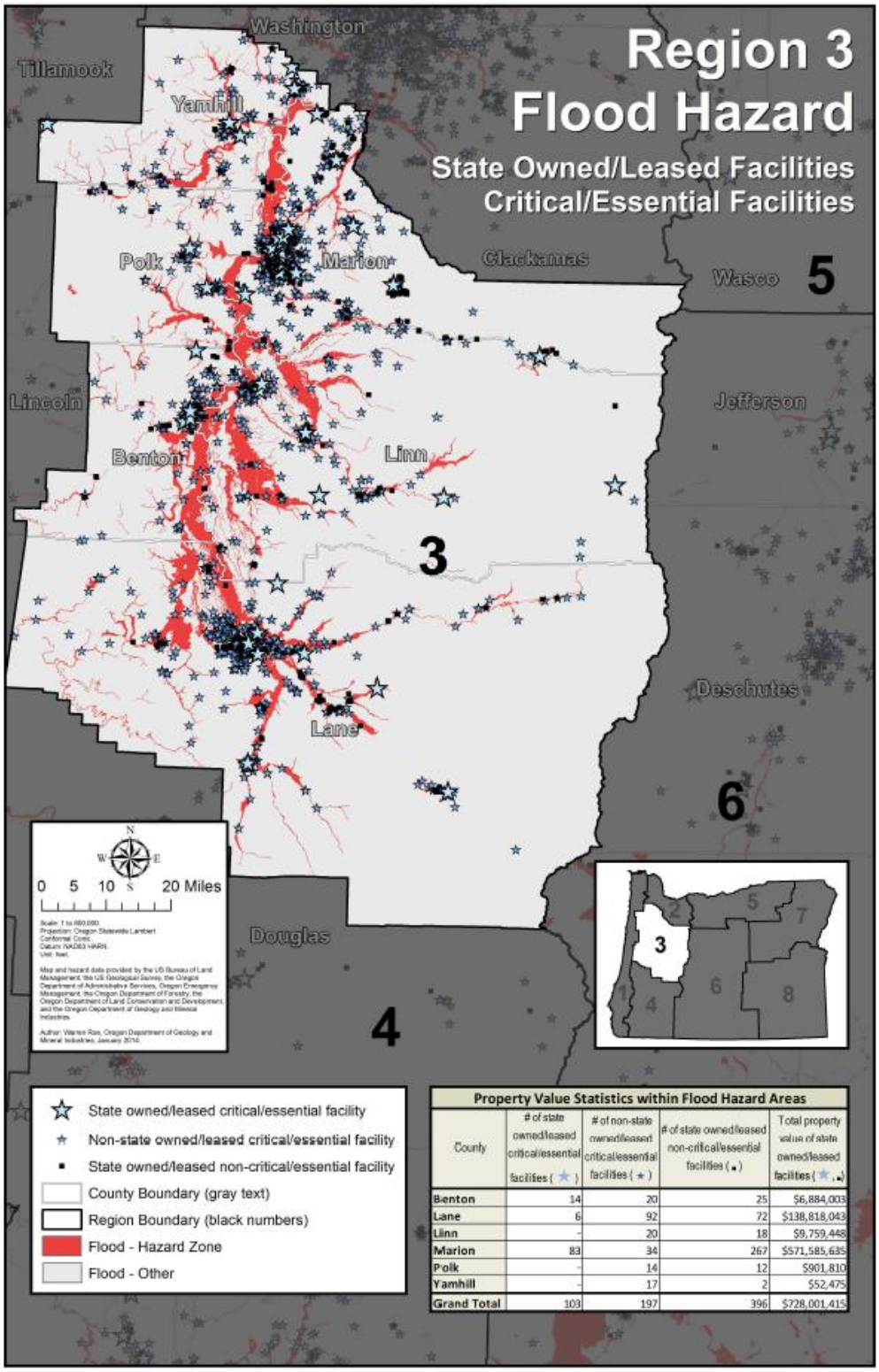
Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS), which results in reduced flood insurance costs. Benton, 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

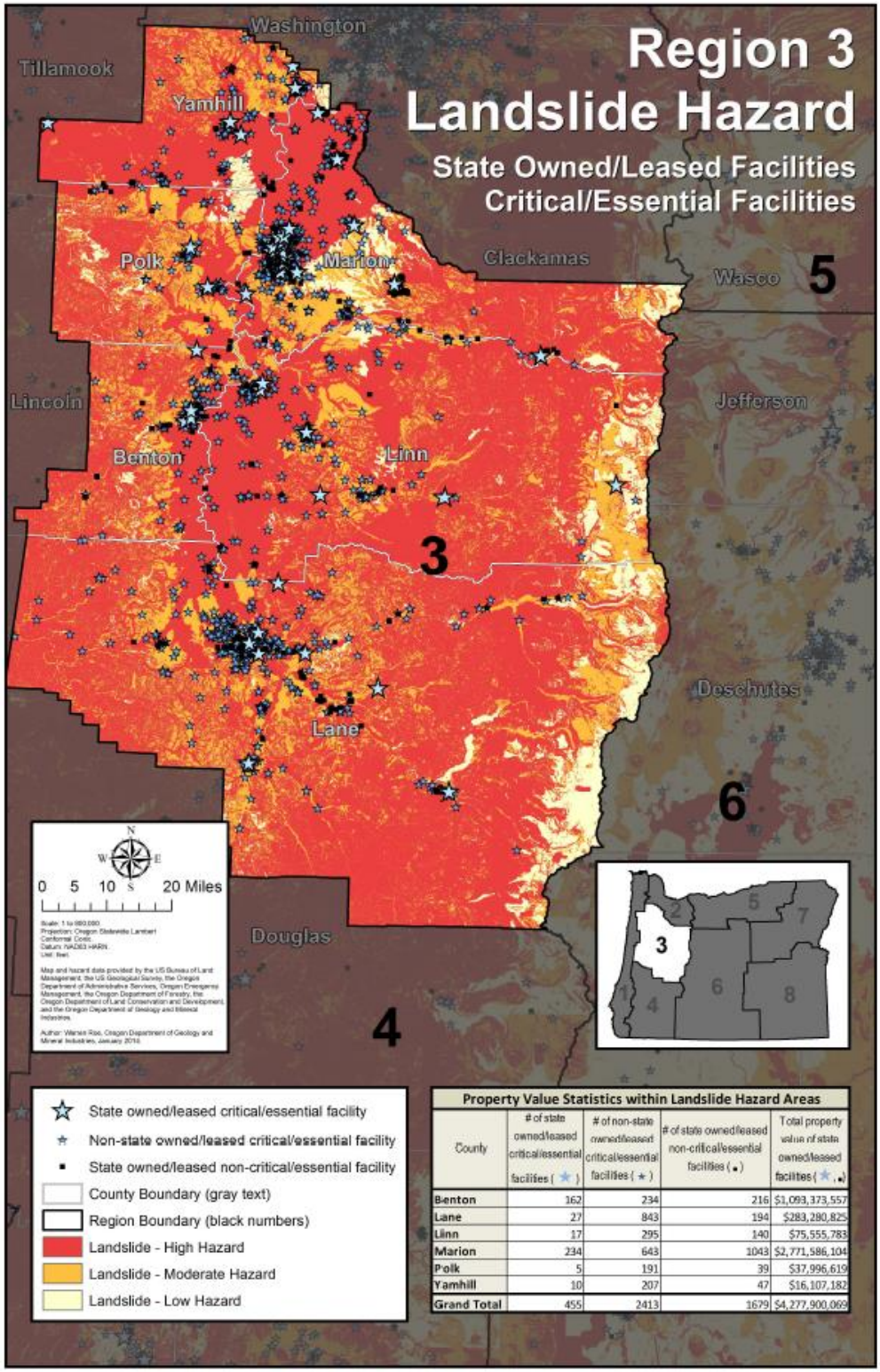
Many of the communities in this region are vulnerable to landslides; for example, the cities of Salem, Corvallis, and Eugene all have moderate exposure to landslides. As previously mentioned, the Vineyard Mountain area near Corvallis had landslides during the January 2009 storm. Many of these landslides 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

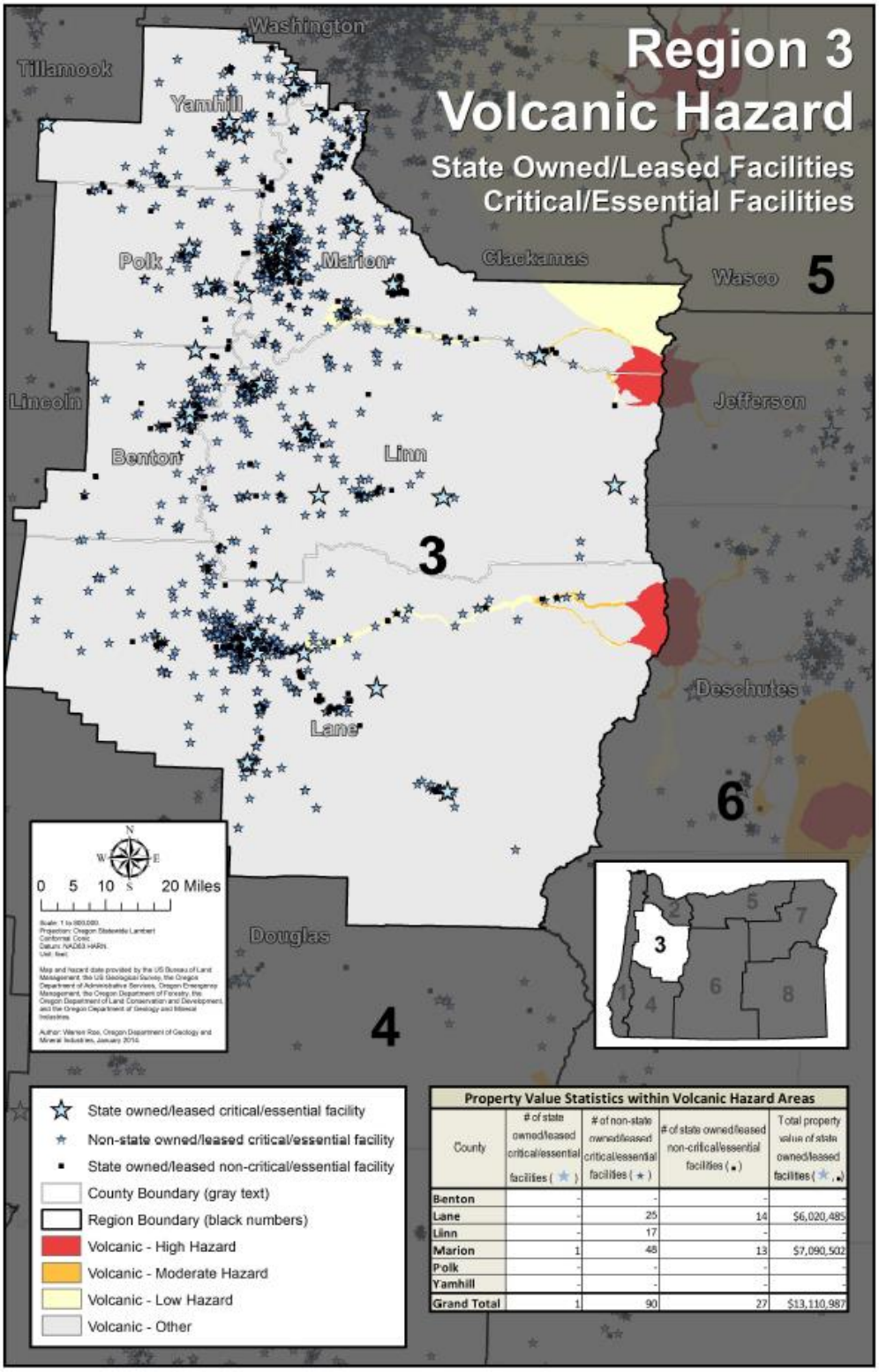
The U.S. Geological Survey has addressed volcanic hazards at Mount Jefferson (Walder et al., 1999) and the Three Sisters (Scott et al., 2001). These reports include maps depicting the areas at greatest risk. Lane, Linn, and Marion Counties are at risk and should consider the impact of volcano-related 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 facilities (★ , ▪)
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				

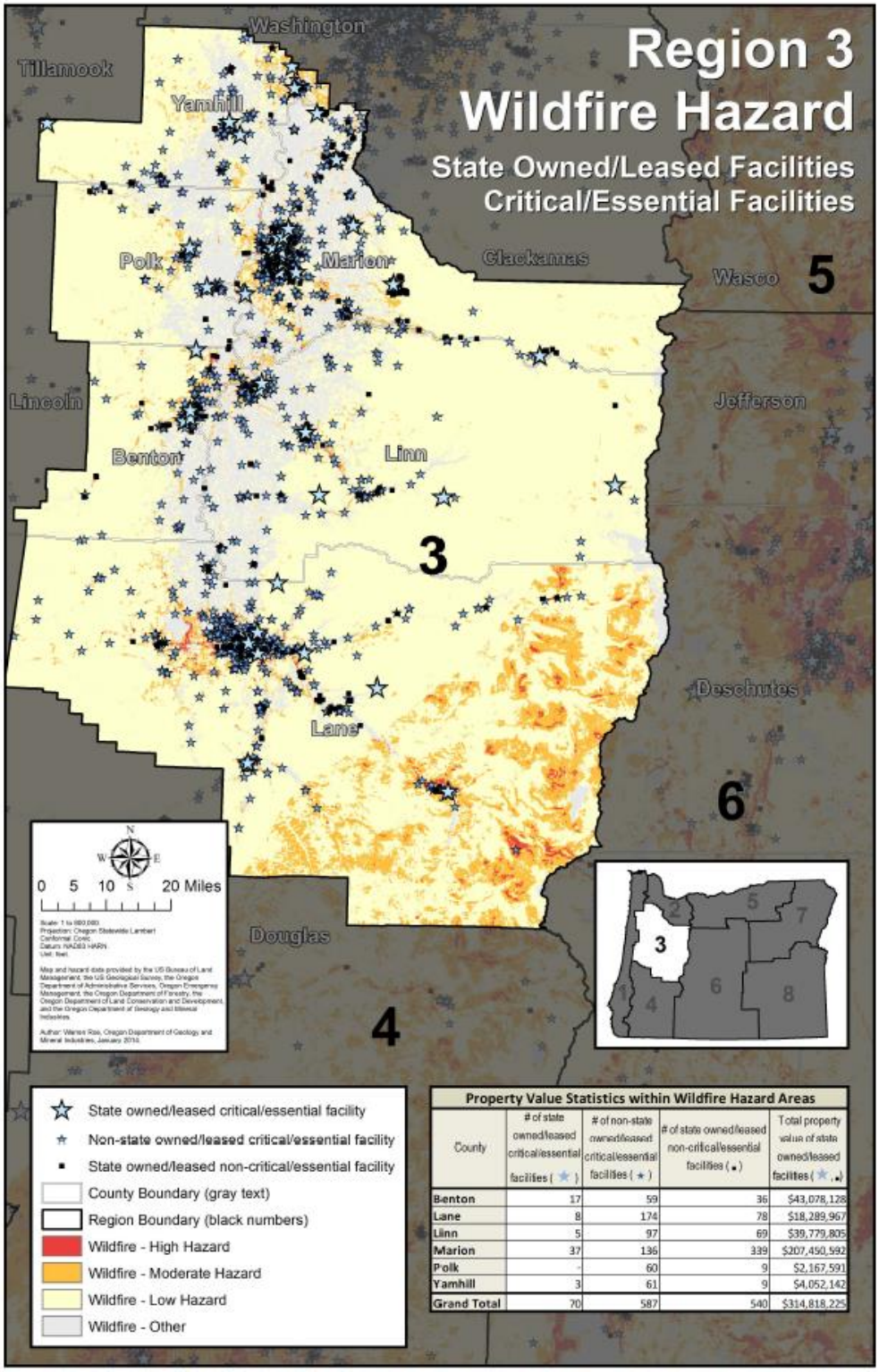
Source: Oregon Dept. of Forestry Statewide Forest Assessment, September 2006

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.