

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 OEM Hazard Mitigation Regions (Figure 78). Each Hazard Mitigation Region has its own Risk Assessment. Together, the eight Regional Risk Assessments combine to describe the State's overall risk to natural hazards.

Figure 78. || 2-CC-2: OEM Hazard Mitigation Regions



Each Regional Risk Assessment includes three sections:

- 1) The Summary provides a general overview of (1) the Regional Profile, (2) the Regional Hazards and Vulnerability, and (3) 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.

- 3) The Hazards and Vulnerability section first identifies each hazard and its characteristic in the region. Then, the historical events that have impacted the region are listed. Lastly, probabilities and

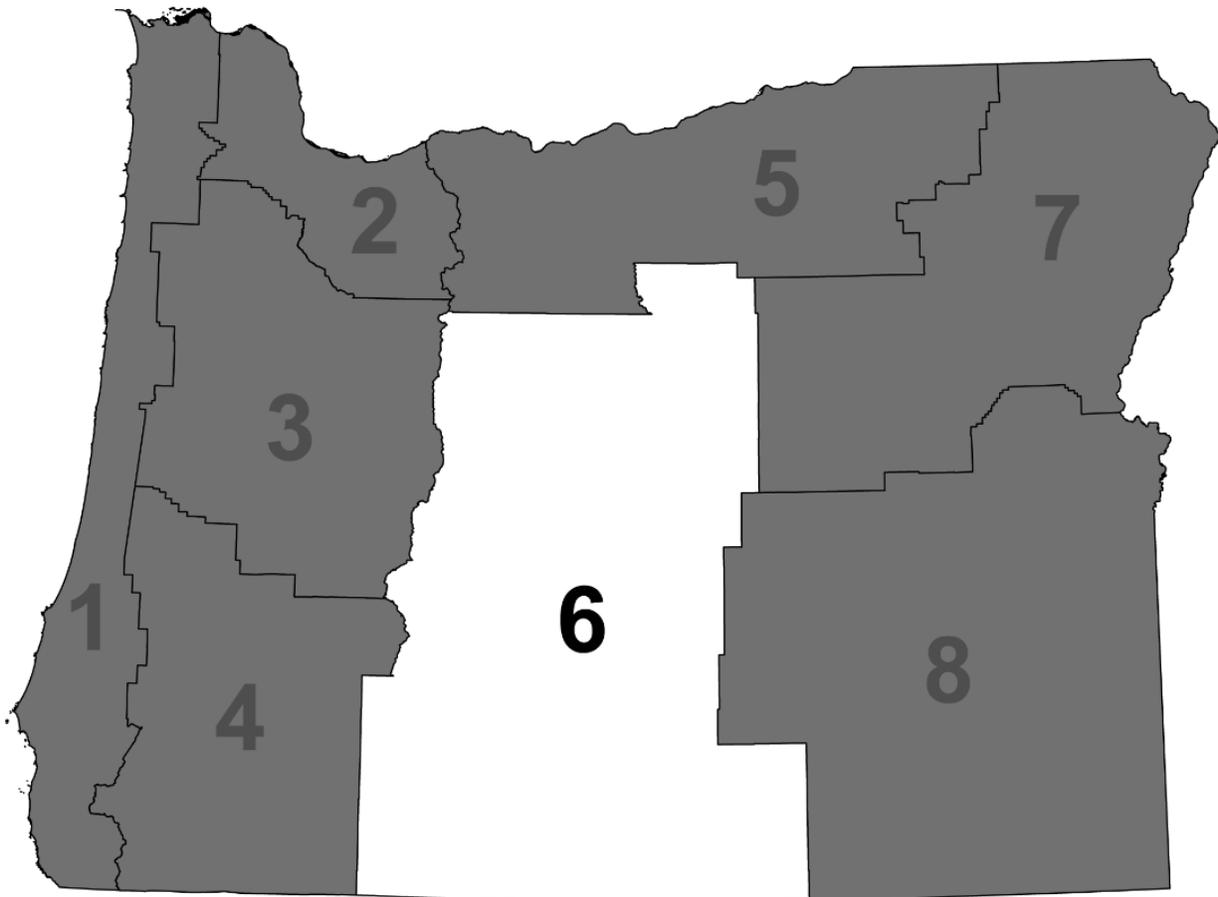
vulnerabilities are discussed as identified by local and state risk assessments. Vulnerabilities to and potential impacts from each hazard in the region are described including the identification and analysis of the region's state owned/leased facilities and critical/essential facilities located within 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.



2.3.6 Region 6: Central Oregon

Crook, Deschutes, Jefferson, Klamath, Lake and Wheeler Counties





2.3.6.1 Summary

Profile

The region's social, economic, infrastructure and development patterns indicate that some populations, structures and places may be more vulnerable to certain natural hazards than others. The Regional Profile for Region 6 indicates the following vulnerabilities for Central Oregon. Mitigation efforts directed at these vulnerabilities may help boost the area's ability to bounce back after a natural disaster.

Regionally, social vulnerability is driven high percentages of individuals with a disability and low median household incomes. At the county level vulnerability is driven by high numbers of seniors in Crook, Lake and Wheeler Counties; increases in child poverty Douglas and Deschutes Counties; vacant homes in Descutes, Lake and Klamath Counties; and single parent households in Klamath County.

Higher than average unemployment rates and low wages illustrate the region's slow recovery since the Great Recession. Average pay in Wheeler County is especially low, only 57% of the state average.

Road, bridge, rail and port) infrastructure across the state are vulnerable to damage and disruptions caused by icy conditions, floods, or seismic events. The Redmond Regional Airport is of particular importance in this region because it has been will identified as a primary airport for the state following a catastrophic Cascadia Subduction Zone (CSZ) earthquake event.

Water and energy systems in the region are at risk of being affected by natural hazards. Older centralized water infrastructure is vulnerable to pollution and flooding, which can have implications on human health and water quality. The region has a diverse energy portfolio that boosts its ability to withstand system disruptions due to natural hazard events. This includes hydroelectric, natural gas, biomass and solar voltaic power-generating facilities.

Region 6 is mostly rural, with the majority of development occurring in communities along I-97. . Mobile homes are inherently vulnerable to natural hazard events, and there is a significant number of mobile homes in Jefferson, Lake, and Wheeler Counties. Roughly half the homes in Klamath, Lake, and Wheeler Counties were built before 1970, and floodplain management and seismic building standards. With the exception of Crook and Deschutes Counties the region's FIRMs are not as up to date as other areas of the state.

Hazards and Vulnerability

Region 6 is affected by nine of the 11 natural hazards that affect Oregon communities. Ccoastal hazards and tsunami do not directly impact this region.

Droughts are common throughout Region 6. When droughts occur they can be problematic — impacting community water supplies, wildlife refuges, fisheris and recreation. Klamath and Lake Counties are especially vulnerable. The U.S. Department of Agriculture designated both counties “natural disaster areas” due to damages or losses caused by drought: Klamath in 2010 and 2013 and Lake in 2007 and 2013.



Dust Storms occur when strong winds carry fine silt, sand, and clay, particles into the air. These storms can travel hundreds of miles, over 10,000 feet, and at least 25 miles per hour. Dust Storms are most common over the areas of dry land that are prevalent within this region. Dust storms affect the region annually, during summer months and during periods of drought. In Central Oregon, Deschutes, Klamath, and Lake Counties have the most dust storms on record.

Earthquakes: Four types of earthquakes affect Region 6 —shallow crustal events, deep intra-plate events within the subducting Juan de Fuca plate, the offshore Cascadia Fault Zone (CSZ), and earthquakes associated with volcanic activity. Shallow crustal and intraplate earthquakes are the primary earthquake risks. In a CSZ event, most of the region’s impact will be secondary, due to disruptions to markets to the west. The region’s seismic lifelines have low vulnerability to a CSZ event, unless a Klamath Falls event is triggered. Region 6 is vulnerable to earthquake-induced landslides, liquefaction and strong ground shaking. Klamath County ranks among the top 15 in the state with the highest expected earthquake related damages and losses.

This region has 160 state-owned/ leased facilities in an earthquake hazard zone, valuing over \$366 million. Of these, 100 are critical/ essential facilities. An additional 721 non-state-owned/ leased critical/ essential facilities are also located within this hazard zone.

Floods affect Central Oregon in a variety of ways, including: (1) spring run-off from melting snow, (2) intense warm rain during the winter months, (3) ice-jam flooding (Deschutes County), (4) local flash flooding, (5) lake flooding associated with high winds (Klamath Lake), and (6) flooding associated with the breaching of natural debris dams (Deschutes County). East of the Cascades there have also been rain-on-snow floods associated with La Nina events.

All of the region’s counties are considered moderately vulnerable to the flood hazard. There are 66 state-owned/ leased facilities located in the region’s flood hazard zone valuing approximately \$9 million. Of these, nine are considered critical/ essential facilities. An additional 60 non-state-owned/ leased critical/ essential facilities are located in this hazard zone.

Landslides can occur throughout the region, though areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more. Rain-induced landslides can occur during winter months; and earthquakes can trigger landslides. The highest incidences of landslides in this region have taken place in the Klamath and Cascade Mountains, along the Highway 26 corridor near Prineville and Mitchell, and along Highway 97 just north of Klamath Falls. There are 785 state-owned/ leased facilities in this region, valued at over \$371 million. Of these, 103 are critical/ essential facilities. An additional 744 non-state-owned/ leased critical/ essential facilities are also located within this hazard zone.

Volcanic activity may occur within the western areas of the region’s counties that coincide with the crest of the Cascade mountain range. Most volcanic activity is considered local, however, some activity (lahars and ash fall) can travel many miles. Due to proximity to potential volcanic activity, small mountain communities, dams, reservoirs, energy-generating facilities, and highways merit special attention. Communities closer to the main volcanic edifices — Bend, Sisters, La Pine, and Klamath Falls — are at the greatest risk for inundation by lava flows, pyroclastic flows, lahars, or ash fall. Communities on the eastern side of the region may be subject to ash fall from Cascade volcanoes. There are 32 state-owned/ leased facilities located in a volcanic hazard zone within this region, a value of approximately \$11.6 million. Of these, none



are identified as critical/ essential facilities. There are 22 non-state-owned/ leased critical/ essential facilities located in this hazard zone.

Wildfire hazard risk throughout Central Oregon is high because homes are widely dispersed among ladder fuels and overstocked pine, sage, grassy areas and invasive weeds. The entire region is highly susceptible to wildfire, however, areas of higher vulnerability are within wildland-urban interface communities. Fire risk is highest in late summer and fall when fuel conditions are dry. There are 504 state-owned/ leased facilities located in a wildfire hazard zone with a value of approximately \$188 million. Of these, 59 are identified as critical/ essential facilities. An additional 350 non-state-owned/ leased critical/ essential facilities are also located in this hazard zone.

Windstorms are common in the inter-mountain areas of the region, and can reach speeds of 70-90 miles per hours. . Most vulnerable to windstorms are insufficiently anchored mobile homes and buildings needing roof repair. Overturned trees pose problems as they can block roads and emergency routes and can damage buildings and utility lines.

Winter Storms bring colder weather, higher precipitation, and occur annually. Communities are typically prepared for light to moderate storms, but are less prepared for severe winter storms that occur less frequently. The winter storm hazard has the potential to affect the entire region, particularly if it affects transportation along the Highway 97 corridor or over the mountain passes to the west.

Climate Change

The most reliable information on climate change to date is at the state level. The state information indicates that hazards projected to be impacted by climate change in Region 6 include drought and wildfire. Climate models project warmer drier summers and a decline in mean summer precipitation for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, all eight regions are expected to be affected by an increased incidence of drought and wildfire. An increase in drought could result in the increased incidence of dust storms; though no current research is available on the direct effects of future climate conditions on the incidence of dust storms. Areas that have historically been both hotter and drier than the statewide average— such as Central Oregon counties—are at somewhat higher risk of increased drought and wildfire than the state overall. While winter storms and windstorms affect Region 6, there is insufficient research available indicating any change in the incidence of either in Oregon due to changing climate conditions. For more information on climate drivers and the projected impacts of climate change in Oregon, see the section, [Introduction to Climate Change](#).



2.3.6.2 Profile

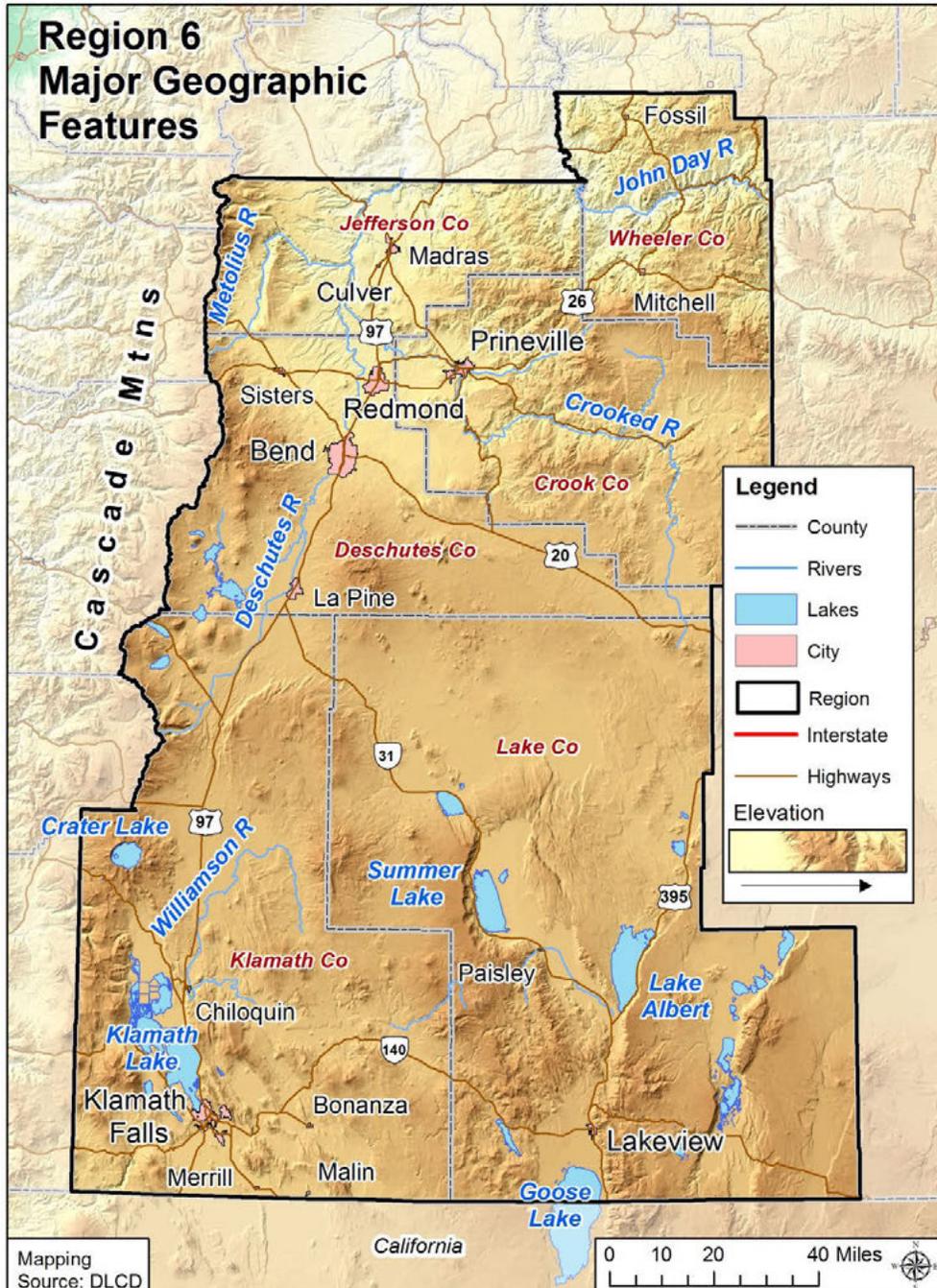
Natural Environment

Geography

Central Oregon is approximately 24,144 square miles in size, and includes Crook, Deschutes, Jefferson, Klamath, Lake, and Wheeler counties. The Cascades crest to the west, Blue Mountains in the north and the California border to the south define the territory of the region. Region 6 has a diverse variety of ecological zones and is not shaped by any particular watershed, although the Deschutes, John Day, and Crooked Rivers are major watersheds to the north. Large lakes are common in the southern portions of Region 6.



Figure 172. || Figure 2-R6-RP-1: Region 6 Major Geographic Features



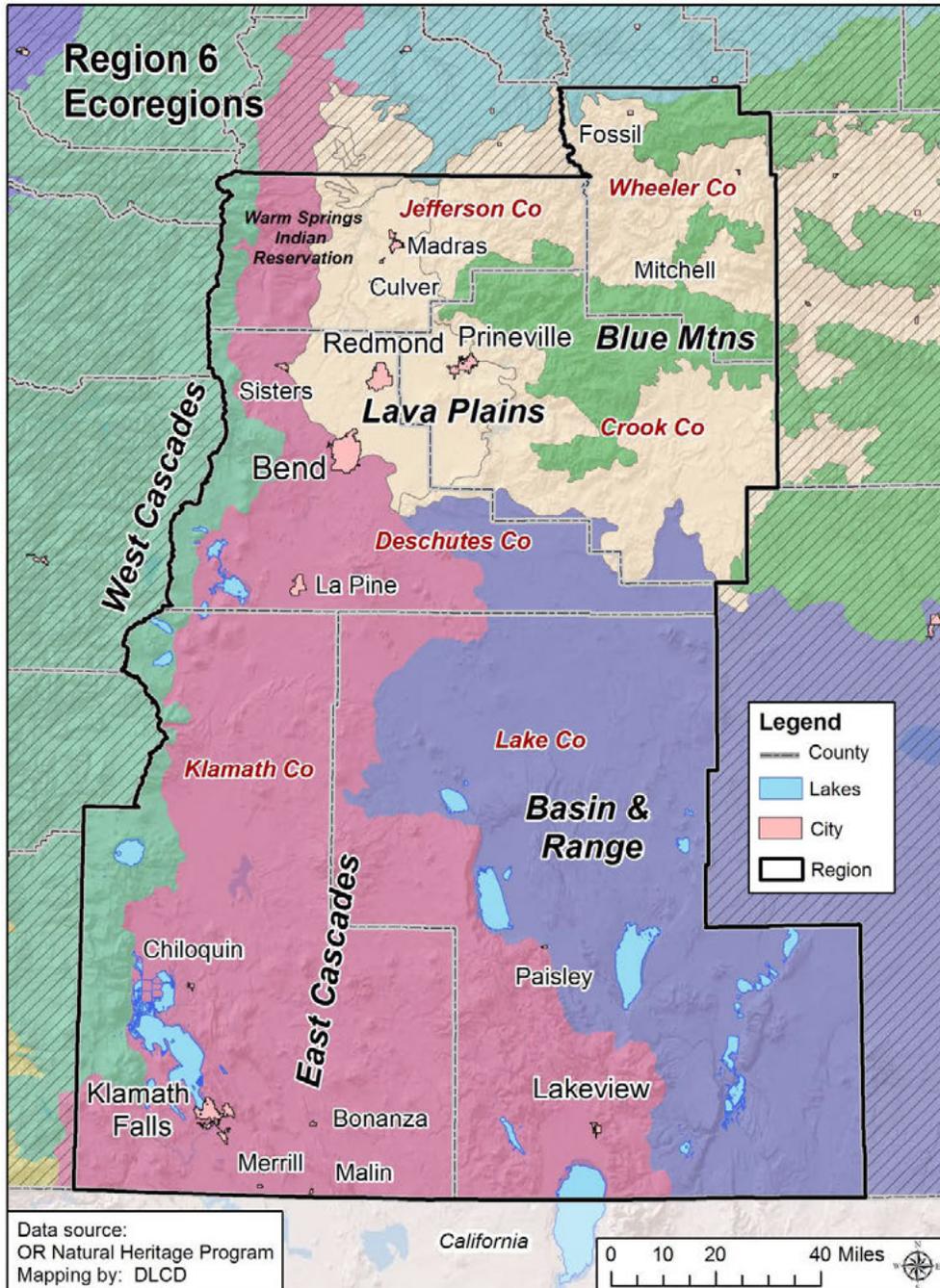
Source: Department of Land Conservation and Development



The U.S. EPA’s ecoregions are used to describe areas of ecosystem similarity. Region 6 is comprised of four ecoregions: the Blue Mountains, the Cascades, the Eastern Cascades Slopes and Foothills, and the Northern Basin and Range ([Figure 173](#)).



Figure 173. || Figure 2-R6-RP-2: Region 6 Ecoregions



Source: Integrated Water Resources Strategy Map Gallery, State of Oregon, 2010



Blue Mountains: This ecoregion is complex and diverse with many subcoregions with unique conditions. In general, the Blue Mountains areas of Region 6 have dry Continental climate with Marine intrusions because of proximity to the Columbia Gorge. While much of the Blue Mountains are flat with arid climates, the highly dissected John Day/Clarno Highlands contain the John Day and Crooked Rivers that provide more abundant water than other parts of the Blue Mountains ecoregion, which leads to higher levels of human settlement in proximity to the rivers. Grazing, logging, and fire suppression regimes have altered landcover throughout the region where Juniper woodlands have given way to sagebrush grasslands and grandfir forests have given way to spruce-fir forests. Other forests in the region predominantly have either a Douglas fir or Ponderosa pine canopy. Ponderosa forests tend towards sparsley vegetated understories the ecoregion’s Douglas fir forests tend towards dense shrub understories, making them more difficult to log. Some wet, high meadows also exist within Cold Basins of the Blue Mountains in Region 6 and unchannelized streams tend towards a meandering nature within wide floodplains, moving dynamically through the landscape. Riparian areas of the region have a diverse palette of understory shrubs with black cottonwoods, grand firs, and alders in the canopy layer.²⁸⁰

Cascades: This ecoregion is underlain by volcanic soils and naturally occurring mixed conifer forests have given way to predominantly Douglas Fir forests that are managed for commercial logging. Logging activities have put a strain on the ecological health of streams in the area.²⁸¹ 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.²⁸²

Eastern Cascades Slope and Foothills: The Region 6 section of this ecoregion is an ecological moasic. Wooded areas may be dominated by Ponderosa pines or mixed fir canopies while rangelands are dominated by sagebrush, bitterbrush and bunchgrasses. Most historically wet meadows have been drained to accommodate agricultural uses, however marshland wildlife refuges have been established to preserve biodiversity, particularly for avian populations. Because of its location in the rainshadow of the Cascades, the ecoregion often experiences dramatic temperature extremes and native plants are adapted to dry climates and frequent wildfires. Much of this ecoregion is underlain by highly permeable volcanic pumice soils, which contribute to the effects of drought in the ecoregion. Logging, livestock grazing, agriculture and recreation are common land uses throughout.²⁸³

²⁸⁰ Ibid.

²⁸¹ Ibid.

²⁸² Ibid.

²⁸³ Ibid.



Northern Basin and Range: The Region 6 section of this ecoregion contains seasonally wet lake basins, high desert wetlands, high shrub- and grass-covered plains, scattered hills, mountains and buttes, playas, and dunes. Lake levels and salinity in the region can fluctuate seasonally and yearly, with several years passing before some lake beds are filled with water. The majority of this ecoregion is dominated by shrub- and grass-covered rangeland, lending itself primarily to wildlife habitat, recreation, and limited cropland farming and livestock grazing.

Climate

Climate refers to the temperatures, weather patterns, and precipitation in the region. This section covers historic climate information. For estimated future climate conditions and possible impacts refer to the [State Risk Assessment](#) for statewide projections.

Region 6 has diverse ecoregions with varying climatic conditions with the majority of the region’s land divided almost equally between the four ecoregions. The region’s predominantly arid climate supports limited agricultural activities, primarily livestock grazing. The region is subject drought, floods, landslides and wildfires. When considering the climate, snowfall should also be taken into account. Flooding can be a direct result of rain-on-snow events. Likewise, the amount of snowpack in a region can also impact the ability of communities to cope with drought. [Table 2-353](#) shows mean annual precipitation and temperatures for the three ecoregions in Region 6.²⁸⁴ Variations in temperature and precipitation vary widely by subecoregion and microclimates. For more detailed and locally relevant climate data refer to the Oregon Climate Service.

Table 2-353. || Table 2-R6-RP-1: Average Rainfall and Temperatures in Region 6 Ecoregions

| Ecoregion | Mean Annual Rainfall Range (inches) | Mean Temperature Range (°F) January min/max | Mean Temperature Range (°F) July min/max |
|-------------------------------------|-------------------------------------|---|--|
| Cascades* | 45-140 | 16/43 | 38/74 |
| East Cascades Slopes and Foothills* | 12-40 | 12/40 | 38/85 |
| Blue Mountains * | 8-60 | 16/41 | 43/84 |
| Northern Basin and Range* | 6-26 | 17/42 | 42/86 |

Source: Thorson, Thor D. "Ecoregions of Oregon." Map. *Ecoregions of Oregon*. Reston, VA: U.S. Dept. of the Interior, U.S. Geological Survey, 2004. 1-2. Print.

Note: *Data has been aggregated from all subregions present in the ecoregion

²⁸⁴ Ibid.



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, 2003). If a population is forecasted to increase substantially, a community’s capacity to provide adequate housing stock, services, or resources for all populations post disaster may be stressed or compromised.²⁸⁵

Overall, from 2000-2013, 85% of the region’s growth occurred in Deschutes County, an increase of more than 47,000 people. Wheeler County was the only county to decline in population. By 2020, all counties in the region, except Deschutes and Jefferson, are projected to grow at a slower rate than the state overall. Population in Lake and Wheeler are expected to decline.

Table 2-354. || Table 2-R6-RP-2: Population Estimate and Forecast for Region 6

| | 2000 | 2013 | Percent Change (2000 to 2013) | 2020 Projected | Percent Change (2013 to 2020) |
|------------------|-----------|-----------|----------------------------------|-------------------|----------------------------------|
| Oregon | 3,421,399 | 3,919,020 | 14.5% | 4,252,100 | 8.5% |
| Region 6 | 226,302 | 281,435 | 24.4% | 306,608 | 8.9% |
| Crook | 19,182 | 20,690 | 7.9% | 21,933 | 6.0% |
| Deschutes | 115,367 | 162,525 | 40.9% | 182,455 | 12.3% |
| Jefferson | 19,009 | 22,040 | 15.9% | 24,054 | 9.1% |
| Klamath | 63,775 | 66,810 | 4.8% | 68,853 | 3.1% |
| Lake | 7,422 | 7,940 | 7.0% | 7,936 | -0.1% |
| Wheeler | 1,547 | 1,430 | -7.6% | 1,378 | -3.6% |

Source: Population Research Center, Portland State University, 2013; U.S. Census Bureau, 2010 Decennial Census. Table DP-1; Office of Economic Analysis, Long-Term Oregon State’s County Population Forecast, 2010-2050, 2013

Tourists

Tourists are not counted in population statistics; and are therefore considered separately in this analysis. Tourism activities in Region 6²⁸⁶ are largely centered on outdoor activities (hiking/ backpacking, visiting national/ state parks etc.), touring (traveling to experience scenic beauty,

²⁸⁵Cutter, Susan L., Bryan Boruff, W. Lynn Shirley. Social Vulnerability to Environmental Hazards. Social Science Quarterly. Volume 84, Number 2, June 2003.

²⁸⁶The Longwoods Travel Report includes Crook, Deschutes, Jefferson and Wheeler counties within the Central Region (which also includes parts of Gilliam, Sherman and Wasco counties). Klamath and Lake counties are included within the Southern region (which also includes Douglas, Jackson and Josephine counties); see Region 4 for the results of this study area.



history and culture), and special events (such as fairs, festivals or sporting events).²⁸⁷ Over 13% (3.6 million) of all overnight trips to Oregon spent time within Region 6. Three-fourths of all trips to the region occur between April and September and the average travel party contains 3.7 persons. The average trip length is over 4.4 nights.²⁸⁸ Visitors to the region are just as likely to lodge in hotels/ motels as in private homes and other accommodations.

Difficulty locating or accounting for travelers increases their vulnerability in the event of a natural disaster. Furthermore, tourists are often unfamiliar with evacuation routes, communication outlets, or even the type of hazard that may occur.²⁸⁹ Targeting natural hazard outreach efforts to places where tourist lodge can help increase awareness of hazards in the area and minimize the vulnerability of this population group.

²⁸⁷ Longwoods Travel USA.(2011) *Regional Visitor Report 2011, The Central Region*. Retrieved April 29, 2014 from <http://industry.traveloregon.com/research/archive/>

²⁸⁸ Ibid.

²⁸⁹ MDC Consultants (n.d.). *When Disaster Strikes – Promising Practices*. Retrieved March 18, 2014, from <http://www.mdcinc.org/sites/default/files/resources/When%20Disaster%20Strikes%20-%20Promising%20Practices%20-%20Tourists.pdf>

Source: Oregon Travel Impacts: 1991-2013, April 2014. Dean Runyan Associates, http://www.deanrunyan.com/doc_library/ORImp.pdf



Table 2-355. || Table 2-R6-RP-3: Annual Visitor Estimates in Person Nights in Region 6

| | 2011 | | 2012 | | 2013 | |
|---------------------|--------|---------|--------|---------|--------|---------|
| | Number | Percent | Number | Percent | Number | Percent |
| Region 6 | 9,434 | - | 9,684 | - | 9,892 | - |
| Crook | 552 | 100% | 602 | 100% | 634 | 100% |
| Hotel/Motel | 107 | 19.4% | 144 | 23.9% | 176 | 27.8% |
| Private Home | 206 | 37.3% | 212 | 35.2% | 212 | 33.4% |
| Other | 239 | 43.3% | 246 | 40.9% | 246 | 38.8% |
| Deschutes | 5,649 | 100% | 5,895 | 100% | 6,058 | 100% |
| Hotel/Motel | 1,821 | 32.2% | 1,957 | 33.2% | 2,067 | 34.1% |
| Private Home | 2,040 | 36.1% | 2,104 | 35.7% | 2,148 | 35.5% |
| Other | 1,788 | 31.7% | 1,834 | 31.1% | 1,843 | 30.4% |
| Jefferson | 827 | 100% | 845 | 100% | 869 | 100% |
| Hotel/Motel | 101 | 12.2% | 114 | 13.5% | 122 | 14.0% |
| Private Home | 213 | 25.8% | 215 | 25.4% | 222 | 25.5% |
| Other | 513 | 62.0% | 516 | 61.1% | 525 | 60.4% |
| Klamath | 2,071 | 100% | 2,020 | 100% | 2,014 | 100% |
| Hotel/Motel | 685 | 33.1% | 646 | 32.0% | 626 | 31.1% |
| Private Home | 847 | 40.9% | 831 | 41.1% | 835 | 41.5% |
| Other | 539 | 26.0% | 543 | 26.9% | 553 | 27.5% |
| Lake | 262 | 100% | 252 | 100% | 248 | 100% |
| Hotel/Motel | 65 | 25% | 58 | 23% | 53 | 21% |
| Private Home | 78 | 30% | 76 | 30% | 76 | 31% |
| Other | 119 | 45% | 118 | 47% | 119 | 48% |
| Wheeler | 73 | 100% | 70 | 100% | 69 | 100% |
| Hotel/Motel | 13 | 17.8% | 10 | 14.3% | 8 | 11.6% |
| Private Home | 14 | 19.2% | 14 | 20.0% | 14 | 20.3% |
| Other | 46 | 63.0% | 46 | 65.7% | 47 | 68.1% |

Source: Oregon Travel Impacts: 1991-2013, April 2014. Dean Runyan Associates,
http://www.deanrunyan.com/doc_library/ORImp.pdf

Persons with Disabilities

Disabilities appear in many different forms. While some disabilities may be easily identified, others may be less perceptible. Some common disabilities include autism, diabetes, sensory impairments, spinal injuries, post-traumatic stress syndrome and mental disabilities.²⁹⁰ About

²⁹⁰ Kirshman, N. H., & Grandgenett II, R. L. (1997). *ADA: The 10 Most Common Disabilities and How to Accommodate* / *LegalBrief.com*. Retrieved March 2014, from <http://www.LegalBrief.com/kirshman.html>



the same percentage of the population in the region identify themselves as having a disability as statewide. All counties in Central Oregon, except Deschutes, have a higher share of their population with a disability compared to the state. Roughly 42% of seniors in Jefferson, Lake and Wheeler Counties have a disability.

Special needs populations are disproportionately affected during disasters. Because of their invisibility in communities, the affects of hazard events on this community are difficult to identify and measure. As a result, they are mostly ignored during recovery (Cutter, 2003). Local natural hazard mitigation plans should specifically target outreach programs to help these communities better prepare for and recover from hazard events.

Table 2-356. || Table 2-R6-RP-11 People with a Disability by Age Groups in Region 6, 2012

| | Total Population* | With a disability | | Under 18 years with a disability | | 65 years and over with a disability | |
|------------------|-------------------|-------------------|---------|----------------------------------|-----------|-------------------------------------|-----------|
| | Estimate | Estimate | Percent | Estimate | Percent** | Estimate | Percent** |
| Oregon | 3,796,881 | 511,297 | 13.5% | 39,439 | 4.6% | 200,374 | 37.8% |
| Region 6 | 274,535 | 39,778 | 14.5% | 3,558 | 5.7% | 15,570 | 34.9% |
| Crook | 20,932 | 3,825 | 18.3% | 214 | 4.8% | 1,628 | 38.2% |
| Deschutes | 158,076 | 19,066 | 12.1% | 2,111 | 5.8% | 7,369 | 31.0% |
| Jefferson | 20,941 | 3,540 | 16.9% | 351 | 6.4% | 1,345 | 41.4% |
| Klamath | 65,826 | 11,574 | 17.6% | 788 | 5.3% | 4,409 | 38.9% |
| Lake | 7,479 | 1,501 | 20.1% | 90 | 6.0% | 650 | 41.7% |
| Wheeler | 1,281 | 272 | 21.2% | 4 | 2.1% | 169 | 41.9% |

Note: *Total population does not include institutionalized population

Note: **Percent of age group

Source: U.S. Census Bureau, 2008-2012 American Community Survey 5-Year Estimates, Table DP02

Homeless Population

Population estimates of the homeless in Oregon are performed each January. These are rough estimates and can fluctuate with many factors, including the economy or season. The overwhelming majority of homeless are either single adult males or families with children. Communities located along major transportation corridors, such as Highway 97, tend to have higher concentrations of homeless populations.²⁹¹ This population has held steady in Region 6 from 2009 to 2011 at about 2,800 persons.

Extra attention is needed to care for and serve homeless communities. Many unhoused or homeless people choose to remain hidden or anonymous, while others are simply unnoticed. To

²⁹¹ Thomas, Y. F., Richardson, D., Cheung, I., & Association of American Geographers, N. (2008). *Geography and drug addiction*. Dordrecht: Springer.



serve these communities post-disaster, it is important to provide easy and accessible shelter and social services.

Table 2-357. || Table 2-R6-RP-12: Homeless Population Estimate for Region 6

| | 2009 | 2010 | 2011 | Three Year Average |
|------------------|--------|--------|--------|--------------------|
| Oregon | 17,122 | 19,208 | 22,116 | 19,482 |
| Region 6 | 2,837 | 2,811 | 2,756 | 2,801 |
| Crook | 282 | 244 | 229 | 252 |
| Deschutes | 1,867 | 1,688 | 1,775 | 1,777 |
| Jefferson | 89 | 329 | 271 | 230 |
| Klamath | 599 | 539 | 428 | 522 |
| Lake | 0 | 11 | 52 | 21 |
| Wheeler | 0 | 0 | 1 | 0 |

Source: Oregon Point in Time Homeless Count, Oregon Housing and Community Services.
http://www.oregon.gov/ohcs/pages/ra_point_in_time_homeless_count.aspx

Gender

The gender ratio in Region 6 is similar to that of the state, roughly 50:50.²⁹² 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.²⁹³

Age

Region 6 has a slightly higher percentage of seniors than the state. Between 20-30% of the population in Crook, Lake and Wheeler Counties are seniors. Senior citizens may require special consideration due to their sensitivities to heat and cold, their reliance upon transportation for medications, and their comparative difficulty in making home modifications that reduce risk to hazards. In addition, the elderly may be reluctant to leave their homes in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to the elderly populations.²⁹⁴

²⁹² U.S. Census Bureau; American Community Survey, 2010 Demographic Profile Data, Table DP-1; using American FactFinder (4 March 2014).

²⁹³ Cutter, S. L. (2003). Social Vulnerability to Environmental Hazards. *Social Science Quarterly*.

²⁹⁴ Morrow, B. H. (1999). Identifying and Mapping Community Vulnerability. *Disasters*. doi:10.1111/1467-7717.00102



The region’s percentage of children is similar to that of the state, except in Wheeler County where its 8% less of its population are children. Special considerations should be given to young children, schools and parents during the natural hazard mitigation process. Young children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities. Parents may lose time and money when their children’s childcare facilities and schools are impacted by disasters.²⁹⁵

Table 2-358. || Table 2-R6-RP-7: Population by Vulnerable Age Groups, in Region 6, 2012

| | Total Population | Under 18 years old | | 65 years and older | |
|------------------|------------------|--------------------|---------|--------------------|---------|
| | Estimate | Estimate | Percent | Estimate | Percent |
| Oregon | 3,836,628 | 864,243 | 22.5% | 540,527 | 14.1% |
| Region 6 | 277,255 | 62,920 | 22.7% | 45,080 | 16.3% |
| Crook | 21,102 | 4,583 | 21.7% | 4,303 | 20.4% |
| Deschutes | 158,884 | 36,349 | 22.9% | 23,965 | 15.1% |
| Jefferson | 21,746 | 5,467 | 25.1% | 3,333 | 15.3% |
| Klamath | 66,350 | 14,821 | 22.3% | 11,480 | 17.3% |
| Lake | 7,886 | 1,508 | 19.1% | 1,593 | 20.2% |
| Wheeler | 1,287 | 192 | 14.9% | 406 | 31.5% |

Source: U.S. Census Bureau; 2008-2012 American Community Survey 5-Year Estimates, Table DP05

Language

A greater percentage of the population in this region speak English “very well” compared to the state. Deschutes and Klamath) have the largest population who does not speak English “very well”. Outreach materials used to communicate with and plan for this community should take into consideration their language needs.

²⁹⁵ Cutter, S. L. (2003). Social Vulnerability to Environmental Hazards. *Social Science Quarterly*.



Table 2-359. || Table 2-R6-RP- 8: English Usage in Region 6, 2012

| | Speak English "Very Well" | | Speak English less than "very well" | |
|------------------|---------------------------|---------|-------------------------------------|---------|
| | Estimate | Percent | Estimate | Percent |
| Oregon | 3,376,744 | 93.8% | 224,905 | 6.2% |
| Region 6 | 252,787 | 96.9% | 8,096 | 3.1% |
| Crook | 19,623 | 98.0% | 400 | 2.0% |
| Deschutes | 145,397 | 97.3% | 3,989 | 2.7% |
| Jefferson | 18,845 | 93.4% | 1,338 | 6.6% |
| Klamath | 60,246 | 96.5% | 2,208 | 3.5% |
| Lake | 7,442 | 98.0% | 152 | 2.0% |
| Wheeler | 1,234 | 99.3% | 9 | 0.7% |

Source: U.S. Census Bureau; 2008-2012 American Community Survey 5-Year Estimates, Table DP02

Education Level

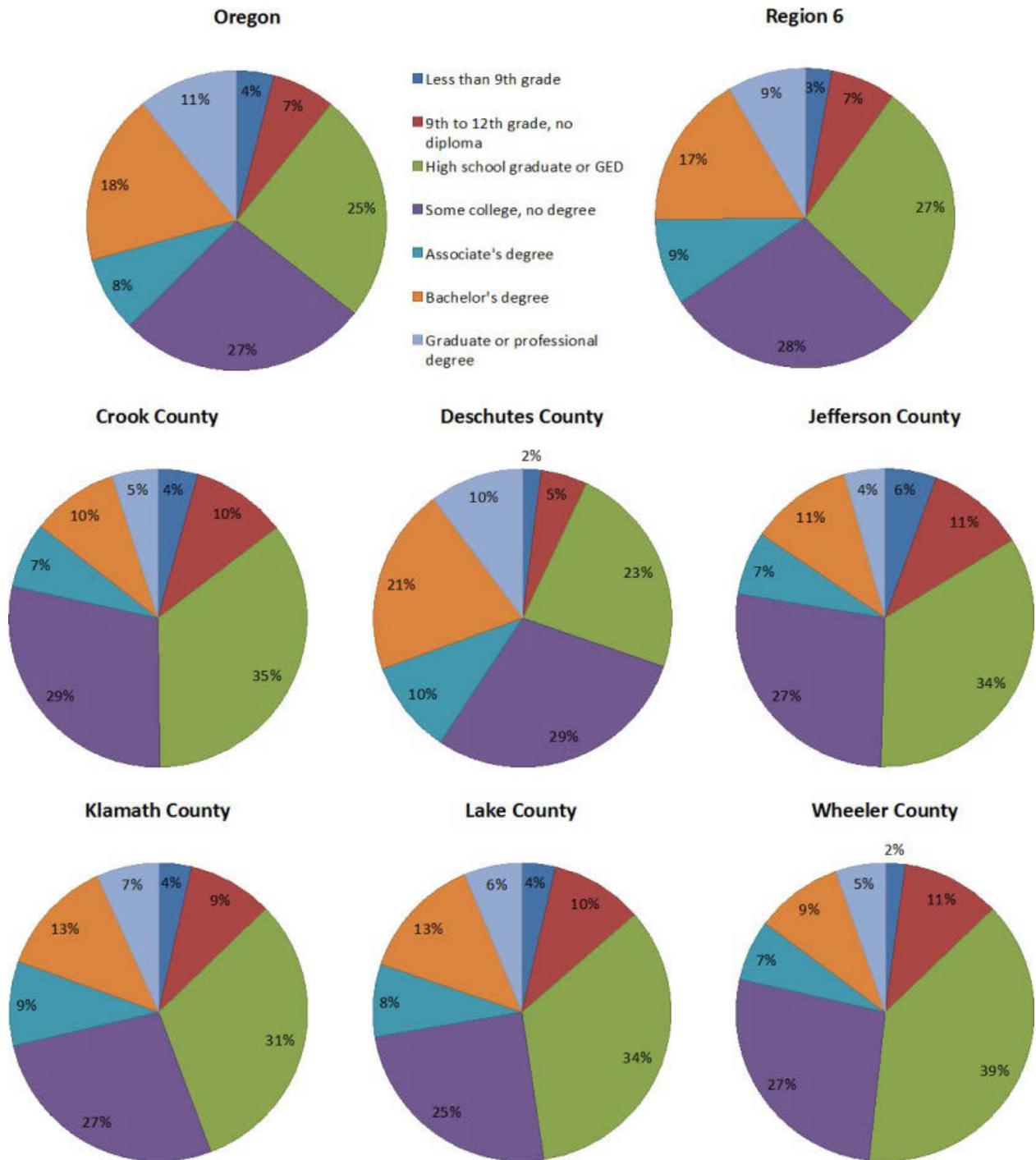
Studies show, education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings. The region has a 2% higher percentage of high school graduates (including GEDs) and a 4% lower share of bachelor’s degrees, compared to state percentages. Deschutes County has the largest percentage of its population with a bachelor’s degree or higher (41%), while Wheeler County has the lowest percentage (21%).

Education can influence the ability to access resources, while lack of resources may constrain the ability to understand warning information.²⁹⁶ Therefore, levels of education within the region should be considered when designing hazard outreach materials to local communities.

²⁹⁶ Ibid.



Figure 174. || Figure 2-R6-RP-4: Educational Attainment in Region 6, 2012



Source: U.S. Census Bureau; 2008-2012 American Community Survey 5-Year Estimates, Table DP02



Income

The impact of a disaster in terms of loss and the ability to recover varies among population groups. According to Susan Cutter’s research on vulnerability to environmental hazards, “the causes of social vulnerability are explained by the underlying social conditions that are often quite remote from the initiating hazard or disaster event”. (Cutter, 1996) Historically, 80% of the disaster burden falls on the public. Of this number, a disproportionate burden is placed upon those living in poverty. People living in poverty are more likely to be isolated in communities, are less likely to have the savings to rebuild after a disaster, and less likely to have access to transportation and medical care.

The recent Great Recession affected median household incomes in this region in diverse ways. Crook and Deschutes Counties experienced the greatest losses in median household incomes. Only Jefferson County experienced average household income increases. In 2012, with the exception of Deschutes County, median household incomes were \$6,700-\$13,700 below statewide numbers. Deschutes County was about \$1,400 above the state median income.

Table 2-360. || Table 2-R6-RP-4: Median Household Income in Region 6

| | 2009 | 2012 | Percent Change |
|------------------|----------|----------|----------------|
| Oregon | \$52,474 | \$50,036 | -4.6% |
| Region 6 | n/a | n/a | n/a |
| Crook | \$49,215 | \$40,263 | -18.2% |
| Deschutes | \$57,697 | \$51,468 | -10.8% |
| Jefferson | \$43,081 | \$43,330 | 0.6% |
| Klamath | \$43,920 | \$41,066 | -6.5% |
| Lake | \$40,132 | \$40,049 | -0.2% |
| Wheeler | \$34,609 | \$36,357 | 5.1% |

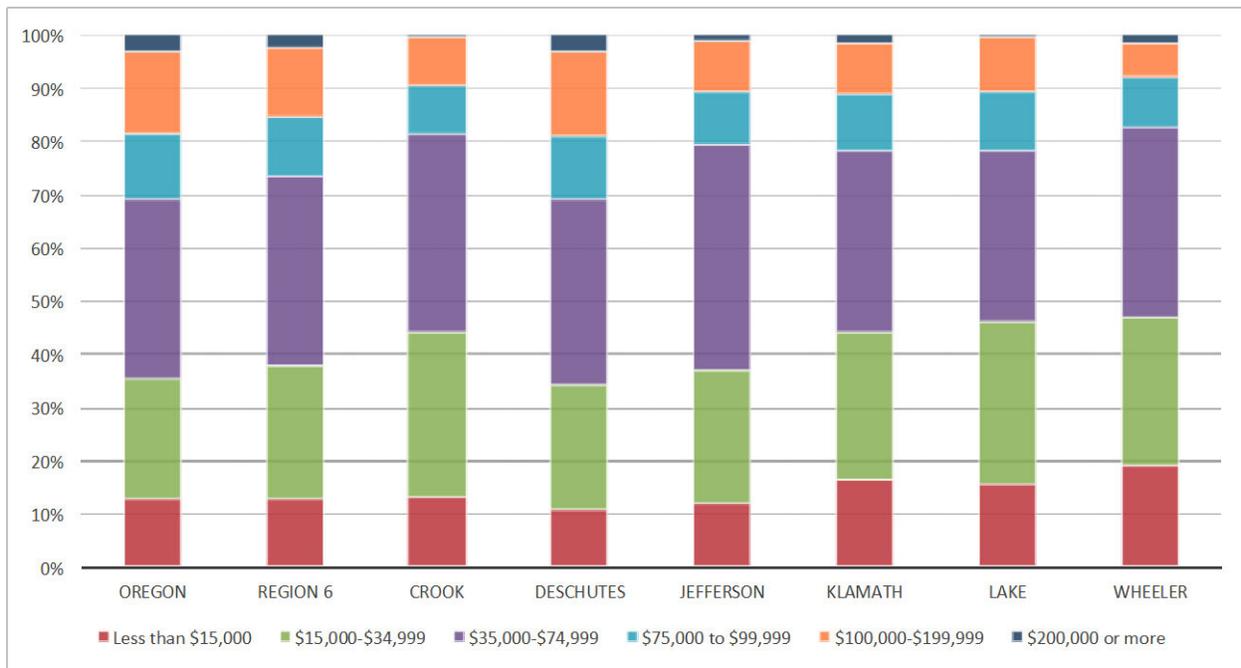
Note: 2009 dollars are adjusted for 2012 using Bureau of Labor Statistics’ Consumer Price Index Inflation Calculator.
n/a = data not aggregated at the regional level.

Source: U.S. Census Bureau. 2005-2009 and 2008-2012. American Community Survey – 5-Year Estimates. Table DP03.

Compared to statewide numbers, the region has a smaller percentage of households making more than \$75,000 per year. Just over one-third of the region’s households make between \$35,000-\$75,000 per year. Crook, Klamath, Lake and Wheeler Counties have the highest percentage of households making less than \$35,000 per year.



Figure 175. || Figure 2-R6-RP-3: Median Household Income Distribution in Region 6, 2012



Source: U.S. Census Bureau; 2008-2012 American Community Survey 5-Year Estimates, Table DP03

The region has about the same percentage of individuals and children living in poverty as the state overall. Overall, poverty is only declining in Wheeler County. Jefferson and Klamath counties have the highest total poverty rates, roughly 19%. Almost one third of all children in Jefferson County live in poverty. The largest increase in child poverty is in Deschutes County, with a dramatic increase of almost 61%.

Table 2-361. || Table 2-R6-RP-5: Poverty Rates in Region 6, 2012

| | Total Population in Poverty | | | Children Under 18 in Poverty | | |
|------------------|-----------------------------|---------|-----------------|------------------------------|---------|-----------------|
| | Number | Percent | Percent Change* | Number | Percent | Percent Change* |
| Oregon | 584,059 | 15.5% | 17.7% | 175,303 | 20.6% | 17.6% |
| Region 6 | 41,857 | 15.3% | 28.3% | 13,224 | 21.5% | 22.1% |
| Crook | 3,631 | 17.4% | 19.6% | 1,171 | 26.1% | -6.8% |
| Deschutes | 20,633 | 13.1% | 53.9% | 6,559 | 18.3% | 60.5% |
| Jefferson | 4,015 | 19.2% | 21.1% | 1,624 | 30.0% | 10.1% |
| Klamath | 12,143 | 18.7% | 6.0% | 3,493 | 24.6% | -1.6% |
| Lake | 1,284 | 17.2% | 7.4% | 354 | 23.7% | -15.1% |
| Wheeler | 151 | 12.0% | -26.0% | 23 | 12.0% | -53.1% |

Note: *Percent change since 2009

Source: U.S. Census Bureau. 2005-2009 and 2008-2012. American Community Survey – 5-Year Estimates, Table S1701



Low-income populations require special consideration when mitigating loss to a natural hazard. Often, those who make 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.²⁹⁷

Housing Tenure

Wealth can increase the ability to recover following a natural disaster (Cutter, 2003), and homeownership, versus renting, is often linked to having more wealth. Renters often do not have personal financial resources or insurance to help recover post-disaster. On the other hand, renters tend to be more mobile and have fewer assets at risk. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable due to natural disaster events.

A smaller percentage of housing units are rented than average— the highest . percentage of rental units being in Jefferson County. Lake County has the greatest percent vacant units, while Deschutes and Klamath Counties have the greatest total number of vacancies. In addition, the region has about 8% more seasonal, or recreational, homes than the state, and 70% of these homes are in Deschutes County.²⁹⁸

Table 2-362. || Table 2-R6-RP-6: Housing Tenure in Region 6, 2012

| | Occupied Units | Owner-occupied | | Renter-occupied | | Vacant [^] | |
|------------------|----------------|----------------|---------|-----------------|---------|---------------------|---------|
| | | Estimate | Percent | Estimate | Percent | Estimate | Percent |
| Oregon | 1,512,718 | 945,824 | 62.5% | 566,894 | 37.5% | 105,417 | 6.3% |
| Region 6 | 113,148 | 75,355 | 66.6% | 37,793 | 33.4% | 11,694 | 8.5% |
| Crook | 8,745 | 6,313 | 72.2% | 2,432 | 27.8% | 838 | 8.2% |
| Deschutes | 64,459 | 42,620 | 66.1% | 21,839 | 33.9% | 6,466 | 8.1% |
| Jefferson | 8,005 | 5,161 | 64.5% | 2,844 | 35.5% | 702 | 7.2% |
| Klamath | 27,747 | 18,395 | 66.3% | 9,352 | 33.7% | 3,112 | 9.5% |
| Lake | 3,566 | 2,405 | 67.4% | 1,161 | 32.6% | 576 | 13.1% |
| Wheeler | 626 | 461 | 73.6% | 165 | 26.4% | 66 | 7.5% |

Source: U.S. Census Bureau, 2008-2012 American Community Survey 5-Year Estimates, Table DP04 and Table B25004.

[^] = Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

²⁹⁷ Cutter, S. L. (2003). Social Vulnerability to Environmental Hazards. Social Science Quarterly.

²⁹⁸ U.S. Census Bureau, 2008-2012 American Community Survey, Table DP04 and Table B25004.



Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single parent households. Just over one-fourth of all households within the region are family households with children. Similar to statewide numbers, this region has about twice as many single parent households headed by females than by males. Jefferson County has the highest percentage of single parent households.

Table 2-363. || Table 2-R6-RP- 9: Family vs. Non-family Households in Region 6, 2012

| | Total Households | Family Households | | Nonfamily Households | | Householder Living Alone | |
|------------------|------------------|-------------------|---------|----------------------|---------|--------------------------|---------|
| | Estimate | Estimate | Percent | Estimate | Percent | Estimate | Percent |
| Oregon | 1,512,718 | 964,274 | 63.7% | 548,444 | 36.3% | 421,620 | 27.9% |
| Region 6 | 113,148 | 76,376 | 67.5% | 36,772 | 32.5% | 28,515 | 25.2% |
| Crook | 8,745 | 6,050 | 69.2% | 2,695 | 30.8% | 2,138 | 24.4% |
| Deschutes | 64,459 | 43,686 | 67.8% | 20,773 | 32.2% | 15,759 | 24.4% |
| Jefferson | 8,005 | 5,604 | 70.0% | 2,401 | 30.0% | 1,858 | 23.2% |
| Klamath | 27,747 | 18,411 | 66.4% | 9,336 | 33.6% | 7,451 | 26.9% |
| Lake | 3,566 | 2,228 | 62.5% | 1,338 | 37.5% | 1,088 | 30.5% |
| Wheeler | 626 | 397 | 63.4% | 229 | 36.6% | 221 | 35.3% |

Source: U.S. Census Bureau, 2008-2012 American Community Survey 5-Year Estimates, Table DP04

[Table 2-364](#) shows household structures for families with children in Region 6.

Table 2-364. || Table 2-R6-RP-10: Family Households with Children by Head of Household in Region 6, 2012

| | Family Households with Children | | Single Parent (male) | | Single Parent (female) | | Married Couple with Children | |
|------------------|---------------------------------|---------|----------------------|---------|------------------------|---------|------------------------------|---------|
| | Estimate | Percent | Estimate | Percent | Estimate | Percent | Estimate | Percent |
| Oregon | 415,538 | 27.5% | 35,855 | 2.4% | 93,575 | 6.2% | 286,108 | 18.9% |
| Region 6 | 31,005 | 27.4% | 3,373 | 3.0% | 6,349 | 5.6% | 21,283 | 18.8% |
| Crook | 2,266 | 25.9% | 205 | 2.3% | 434 | 5.0% | 1,627 | 18.6% |
| Deschutes | 18,223 | 28.3% | 1,805 | 2.8% | 3,273 | 5.1% | 13,145 | 20.4% |
| Jefferson | 2,208 | 27.6% | 370 | 4.6% | 527 | 6.6% | 1,311 | 16.4% |
| Klamath | 7,395 | 26.7% | 922 | 3.3% | 1,959 | 7.1% | 4,514 | 16.3% |
| Lake | 825 | 23.1% | 59 | 1.7% | 137 | 3.8% | 629 | 17.6% |
| Wheeler | 88 | 14.1% | 12 | 1.9% | 19 | 3.0% | 57 | 9.1% |

Source: U.S. Census Bureau; 2008-2012 American Community Survey 5-Year Estimates, Table DP04

Note: The table shows the percent of total households represented by each family household structure category.

Social and Demographic Trends

This analysis shows that Region 6 has a greater number of people than the state average who are predisposed to be particularly vulnerable during a hazard event, in the following categories:



- 85% of the region's growth is within Deschutes County;
- Higher percentages of its population has a disability than statewide, except in Deschutes County;
- High percentages of seniors in Crook, Lake and Wheeler Counties;
- Lower than average median household incomes in all counties except Deschutes;
- Increases in child poverty in Deschutes and Jefferson Counties;
- High numbers of vacant housing units in Deschutes, Lake and Klamath Counties; and
- Single-parent households in Klamath County.

Economy

Employment

Employment status and salary level may impact the resilience of individuals and families in the face of disasters as well as their ability to mitigate losses created by natural hazards (Cutter, 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, 2003). Though the accelerated growth in Deschutes County has contributed to a broad recovery for the region since the Great Recession; still less than half of the county's 11,000 job losses have been recovered since the recession's peak in 2009.²⁹⁹ Deschutes County has the largest labor force and one of the lowest unemployment rates in the region. Wheeler County's labor force has remained relatively stable through the recession due to the county's sparse population and high self-employment rates.³⁰⁰ Average salaries are lower than state average, ranging from 57% to 89% of that of the state. For example, the average salary in Crook County is \$40,118, and in Wheeler County is \$25,771.³⁰¹

²⁹⁹ Tauer, G. (2014, January). OLMIS - Regions 9 and 10: Economy. Retrieved July, 2014, from <http://www.qualityinfo.org/olmis/OlmisZine>

³⁰⁰ Fridley, Dallas. (2014, January). Wheeler County Economic Profile” July, 2014, from <http://www.qualityinfo.org/olmis/ArticleReader?itemid=00009006>

³⁰¹



Table 2-365. || Table 2-R6-RP-13: Unemployment Rates in Region 1, 2009-2013

| | 2009 | 2010 | 2011 | 2012 | 2013 | Change (2009-2013) |
|------------------|-------|-------|-------|-------|-------|-----------------------|
| Oregon | 11.1% | 10.8% | 9.7% | 8.8% | 7.7% | -3.4% |
| Region 6 | 14.7% | 14.2% | 12.8% | 11.8% | 10.1% | -4.6% |
| Crook | 17.9% | 17.1% | 15.3% | 14.2% | 12.3% | -5.7% |
| Deschutes | 14.7% | 14.3% | 12.7% | 11.4% | 9.5% | -5.2% |
| Jefferson | 14.8% | 14.4% | 13.4% | 12.3% | 10.7% | -4.1% |
| Klamath | 13.9% | 13.3% | 12.4% | 11.9% | 10.7% | -3.2% |
| Lake | 12.4% | 13.6% | 13.3% | 12.8% | 11.1% | -1.3% |
| Wheeler | 9.0% | 10.6% | 9.8% | 7.7% | 7.1% | -2.0% |

Source: Oregon Employment Department, 2014.

Table 2-366. || Table 2-R6-RP-14: Employment and Unemployment Rates in Region 6, 2013

| | Civilian Labor Force | Employed Workers | | Unemployed | |
|------------------|----------------------|------------------|---------|------------|---------|
| | Total | Total | Percent | Total | Percent |
| Oregon | 1,924,604 | 1,775,890 | 92.3% | 148,714 | 7.7% |
| Region 6 | 128,738 | 115,769 | 89.9% | 12,969 | 10.1% |
| Crook | 8,707 | 7,639 | 87.7% | 1,068 | 12.3% |
| Deschutes | 77,752 | 70,382 | 90.5% | 7,370 | 9.5% |
| Jefferson | 9,122 | 8,143 | 89.3% | 979 | 10.7% |
| Klamath | 28,905 | 25,798 | 89.3% | 3,107 | 10.7% |
| Lake | 3,573 | 3,176 | 88.9% | 397 | 11.1% |
| Wheeler | 679 | 631 | 92.9% | 48 | 7.1% |

Source: Oregon Employment Department, 2014.

Table 2-367. || Table 2-R6-RP-15: Employment and Payroll in Region 6, 2013

| | Employees | Average Pay | Percent State Average |
|------------------|-----------|-------------|--------------------------|
| Oregon | 1,679,364 | \$45,010 | 100% |
| Region 6 | 99,445 | \$36,865 | 81.9% |
| Crook | 5,833 | \$40,118 | 89.1% |
| Deschutes | 63,286 | \$37,749 | 83.9% |
| Jefferson | 6,172 | \$34,196 | 76.0% |
| Klamath | 21,513 | \$34,550 | 76.8% |
| Lake | 2,334 | \$34,621 | 76.9% |
| Wheeler | 307 | \$25,771 | 57.3% |

Source: Oregon Employment Department, 2014



Employment Sectors and Key Industries

In 2013, the five major employment sectors in Region 6 were: Trade Transportation and Utilities, Government, Education and Health Services, Leisure and Hospitality, and Professional and Business Services. Between 2012-2022, projected growth is expected to create a 18% increase in employment for Central Oregon, including Crook, Deschutes, Jefferson Counties; and a 14% increase in South Central Oregon, including Klamath and Lake Counties. For information on Wheeler County see the Region 5 Risk Assessment.³⁰²

Table 2-368. || Table 2-R6-RP-16a: Covered Employment by Sector in Region 6, 2013

| Industry | Region 6 | Crook County | | Deschutes County | | Jefferson County | |
|--|---------------|--------------|--------------|------------------|--------------|------------------|--------------|
| | | Employment | Percent | Employment | Percent | Employment | Percent |
| Total All Ownerships | 99,445 | 5,833 | 100% | 63,286 | 100% | 6,172 | 100% |
| Total Private Coverage | 82.0% | 4,618 | 79.2% | 54,792 | 86.6% | 3,780 | 61.2% |
| Natural Resources & Mining | 2.6% | 222 | 3.8% | 534 | 0.8% | 457 | 7.4% |
| Construction | 4.5% | 203 | 3.5% | 3,511 | 5.5% | 71 | 1.2% |
| Manufacturing | 7.9% | 731 | 12.5% | 4,209 | 6.7% | 907 | 14.7% |
| Trade, Transportation & Utilities | 19.3% | 1,630 | 27.9% | 12,339 | 19.5% | 793 | 12.8% |
| Information | 1.7% | 70 | 1.2% | 1,407 | 2.2% | 27 | 0.4% |
| Financial Activities | 4.1% | 117 | 2.0% | 3,208 | 5.1% | 111 | 1.8% |
| Professional & Business Services | 9.7% | 297 | 5.1% | 6,879 | 10.9% | 148 | 2.4% |
| Education & Health Services | 14.8% | 556 | 9.5% | 10,330 | 16.3% | 540 | 8.7% |
| Leisure & Hospitality | 13.6% | 553 | 9.5% | 9,901 | 15.6% | 544 | 8.8% |
| Other Services | 3.7% | 236 | 4.0% | 2,457 | 3.9% | 182 | 2.9% |
| Private Non-Classified | 0.0% | (c) | 0.0% | 18 | 0.0% | (c) | 0.0% |
| Total All Government | 18.0% | 1,216 | 20.8% | 8,494 | 13.4% | 2,392 | 38.8% |
| Federal Government | 2.4% | 304 | 5.2% | 864 | 1.4% | 132 | 2.1% |
| State Government | 3.0% | 203 | 3.5% | 1,245 | 2.0% | 311 | 5.0% |
| Local Government | 12.5% | 709 | 12.2% | 6,385 | 10.1% | 1,949 | 31.6% |

Source: Oregon Employment Department, 2013

Note: (c) = confidential, information not provided by Oregon Employment Department to prevent identifying specific businesses.

³⁰² "Long Term Projections Show Broad-Based Job Opportunities in Columbia Basin." *OLMIS*. N.p., n.d. Web. June 9, 2014. <http://www.qualityinfo.org>



Table 2-369. || Table 2-R6-RP-16b: Covered Employment by Sector in Region 6, 2013

| Industry | Region 6 | Klamath County | | Lake County | | Wheeler County | |
|-----------------------------------|----------|----------------|---------|-------------|---------|----------------|---------|
| | | Employment | Percent | Employment | Percent | Employment | Percent |
| Total All Ownerships | 99,445 | 21,513 | 100% | 2,334 | 100% | 307 | 100% |
| Total Private Coverage | 82.0% | 16,829 | 78.2% | 1,354 | 58.0% | 194 | 63.2% |
| Natural Resources & Mining | 2.6% | 999 | 4.6% | 326 | 14.0% | 48 | 15.6% |
| Construction | 4.5% | 667 | 3.1% | 50 | 2.1% | (c) | 0.0% |
| Manufacturing | 7.9% | 1,771 | 8.2% | 226 | 9.7% | (c) | 0.0% |
| Trade, Transportation & Utilities | 19.3% | 4,077 | 19.0% | 303 | 13.0% | 51 | 16.6% |
| Information | 1.7% | 179 | 0.8% | 18 | 0.8% | (c) | 0.0% |
| Financial Activities | 4.1% | 624 | 2.9% | 48 | 2.1% | (c) | 0.0% |
| Professional & Business Services | 9.7% | 2,220 | 10.3% | 61 | 2.6% | (c) | 0.0% |
| Education & Health Services | 14.8% | 3,172 | 14.7% | 94 | 4.0% | 55 | 17.9% |
| Leisure & Hospitality | 13.6% | 2,344 | 10.9% | 164 | 7.0% | 20 | 6.5% |
| Other Services | 3.7% | 776 | 3.6% | 60 | 2.6% | 9 | 2.9% |
| Private Non-Classified | 0.0% | (c) | 0.0% | (c) | 0.0% | (c) | 0.0% |
| Total All Government | 18.0% | 4,684 | 21.8% | 980 | 42.0% | 113 | 36.8% |
| Federal Government | 2.4% | 883 | 4.1% | 242 | 10.4% | 5 | 1.6% |
| State Government | 3.0% | 1,091 | 5.1% | 176 | 7.5% | 6 | 2.0% |
| Local Government | 12.5% | 2,710 | 12.6% | 562 | 24.1% | 102 | 33.2% |

Source: Oregon Employment Department, 2013

Note: (c) = confidential, information not provided by Oregon Employment Department to prevent identifying specific businesses.

Each industry faces distinct vulnerabilities to natural hazards. Identifying key industries in the region enables communities to target mitigation activities towards those industries’ specific sensitivities. Each of the primary private employment sectors has sensitivity to natural hazards, as follows.

Trade, Transportation and Utilities: Retail Trade is the largest employment subsector within the Trade, Transportation and Utilities sector. Retail Trade is vulnerable to disruptions in the disposable income of regional residents and to disruptions in the transportation system. Residents’ discretionary spending diminishes after natural disasters as spending priorities tend to focus on essential items. Disruption of the transportation system could sever connectivity of people and retail hubs. Retail businesses are concentrated in the larger cities of the region.

Education and Health Services: The industries in these sectors play important roles in emergency response in the event of a disaster. Health care is a relatively stable revenue sector regionally with an increasing distribution of businesses primarily serving a local and aging population.

The **Leisure and Hospitality** sector primarily serves regional residents with disposable income and tourists. The behavior of both of these social groups would be disrupted by a natural disaster. Regional residents may have less disposable income and tourists may choose not to visit a region with unstable infrastructure.

Professional and Business Services: This sector is comprised of professional service providing industries including scientific and technical, management professionals and administrative and



support services (e.g., engineering, law, headquarters, temp help, etc.). In general this sector has low vulnerability to natural disasters. Vulnerability is increased if suppliers are affected and/or physical infrastructure is damaged (buildings, roads, telecommunications, water systems, etc.). Mitigation efforts for this sector should include preparing business recovery plans.

Revenue by Sector

In 2007 Trade (Retail and Wholesale), Manufacturing, and Healthcare and Social Assistance were the highest revenue grossing industries in Region 6.³⁰³ Combined, these three industries generated over \$8.7 billion (92% of total revenue) for the region. Trade (Retail and Wholesale) is the largest grossing sector in all counties.

Note: Due to the small size and few industries in the region the collected data is withheld in several categories, especially for manufacturing, to avoid disclosing data for individual companies. Information is aggregated to the county level.

Table 2-370. || Table 2-R6-RP-17: Revenue of Top Industries (in Thousands of Dollars) in Region 6, 2007

| | Total Revenue (in Thousands) | Trade (Retail & Wholesale) | Manufacturing | Health Care and Social Assistance |
|------------------|---------------------------------|-------------------------------|---------------|--------------------------------------|
| Oregon | \$277,017,733 | 44.4% | 24.1% | 7.3% |
| Region 6 | \$10,277,989 | 53.7% | 18.4% | 12.9% |
| Crook | \$544,066 | 44.2% | 38.6% | 8.7% |
| Deschutes | \$7,069,183 | 57.0% | 12.7% | 13.8% |
| Jefferson | \$666,466 | 53.7% | 36.4% | D |
| Klamath | \$1,866,429 | 42.2% | 28.9% | 15.3% |
| Lake | \$120,934 | 76.3% | - | 15.2% |
| Wheeler | \$10,911 | 94.9% | - | D |

Source: U.S. Census, Economic Census. 2007, Table ECO700A1

Notes: D = Withheld to avoid disclosing data for individual companies; data are included in higher level totals, and “-“ = data not provided.

Sectors that are anticipated to be major employers in the future warrant special attention, especially in the hazard mitigation planning process so workforces and employers can be more prepared to respond and adapt to needs that arise after a natural hazard event. According to the Oregon Employment Department, between 2012 and 2022, the largest job growth in Region 6 is expected to occur in the following sectors: education and health services; leisure and

³⁰³ Revenue data from the 2012 Economic Census will not be released prior to the publication of this Plan.



hospitality; trade, transportation and utilities (including retail trade); professional and business services; and manufacturing.³⁰⁴

Identifying sectors with a large number of businesses, and targeting mitigation strategies to support those sectors, can help the region's resiliency. The Trade, Transportation and Utilities sector includes the most businesses in Region 6, 18.6% of all businesses. Professional and Business Services has the second most businesses. Other Services, Construction, Education and Health Services round out the top five sectors in the region.³⁰⁵ While many of these are small businesses, employing fewer than 20 employees, collectively they represent almost two-thirds of the businesses in the region. Due to their small size and large collective share of the economy, these businesses are particularly sensitive to temporary decreases in demand, such as may occur following a natural hazard event.

Economic Trends and Issues

Current and anticipated financial conditions of a community are strong determinants of community resilience, since a strong and diverse economic base increases the ability of individuals, families and communities to absorb impacts of a disaster and recover more quickly. The Economic analysis shows that Region 6 is particularly vulnerable during a hazard event due to the following characteristics:

- Less than half of the jobs lost at the peak of the Great Recession's in 2009 have been recovered; and
- Lower regional wages, particularly in Wheeler County.

The Central Oregon region has largely rebounded from the Great Recession, driven primarily by growth in Deschutes and Crook counties. The educational and health, professional and business services, leisure and hospitality, and manufacturing sectors, driven by the states fastest population growth rate and increasing tourism economy (both summer – bicycling and winter – skiing), drives the growth in employment within the region.³⁰⁶ Klamath, Lake and Wheeler counties have slower population growth rates, higher rates of unemployment and have not recovered as fully as the rest of the region. Supporting the growth of dominant industries and employment sectors, as well as emerging sectors identified in this analysis, can help the region become more resilient to economic downturns that often follow a hazard event.³⁰⁷

³⁰⁴ Oregon Employment Department (2014), *Employment Projections by Industry and Occupation: 2012-2022 Oregon and Regional Summary* Retrieved July 22, 2014, from <http://www.qualityinfo.org/olmisi/PubReader?itemid=00005720>

³⁰⁵ Oregon Employment Department, 2012.

³⁰⁶ "Regional Employment Expected to Grow Fast by 2022, but Only to Around 2007 Levels." *OLMIS*. Web. Mar. 31 2014. <http://www.qualityinfo.org>

³⁰⁷ Hazards Workshop Session Summary #16, Disasters, Diversity, and Equity. (July 2000). University of Colorado, Boulder.



Infrastructure

Transportation

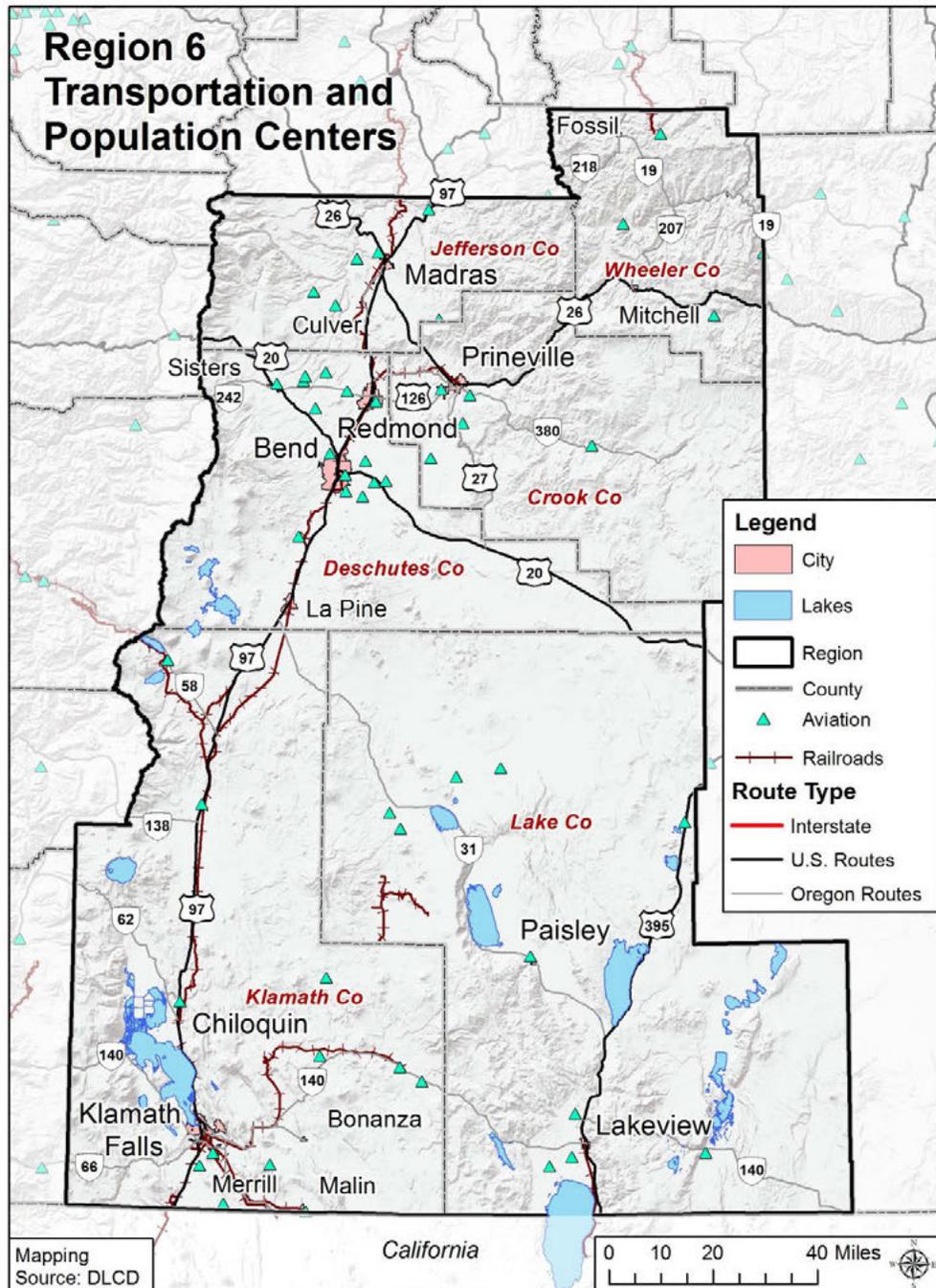
Roads

The largest population bases in Region 6 are located along the region's major highways. Growing population centers bring more workers, automobiles and trucks onto roads. A high percentage of workers driving alone to work coupled with interstate and international freight movement create additional stresses on transportation systems. Some of these 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.



Figure 176. || Figure 2-R6-RP-5: Region 6 Transportation and Population Centers



Source: Oregon Department of Transportation, 2014



Bridges

Because of earthquake risk in Region 6, the seismic vulnerability of the region’s bridges is an important issue. Non-functional bridges can disrupt emergency operations, sever lifelines, and disrupt local and freight traffic. These disruptions may exacerbate local economic losses if industries are unable to transport goods. The region’s bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or that are part of regional and local systems that are maintained by the region’s counties and cities. For information on ODOT’s Seismic Lifeline Report findings for Region 6, see [Seismic Lifelines](#).

Table 2-371 shows the structural condition of bridges in the region. A distressed bridge (Di) is a condition rating used by the Oregon Department of Transportation (ODOT) indicating that a bridge has been identified as having a structural or other deficiency, while a deficient bridge (De) is a federal performance measure used for non-ODOT bridges; the ratings do not imply that a bridge is unsafe.³⁰⁸ The table shows that the region has a lower percentage of bridges that are distressed and/ or deficient (13%), than does the state (21%). About 15% of the region’s ODOT bridges are distressed, compared to 22% for the state.

Table 2-371. || Table 2-R6-RP-18: Bridge Inventory for Region 6

| | State Owned | | | County Owned | | | City Owned | | | Other Owned | | | Area Total | | | Historic Covered |
|------------------|-------------|-------|-----|--------------|-------|-----|------------|-----|-----|-------------|-----|-----|------------|-------|-----|------------------|
| | Di | ST | %D* | De | ST | %D | De | ST | %D | De | ST | %D | D | T | %D | |
| Oregon | 610 | 2,718 | 22% | 633 | 3,420 | 19% | 160 | 614 | 26% | 40 | 115 | 35% | 1,443 | 6,769 | 21% | 334 |
| Region 6 | 21 | 144 | 15% | 27 | 240 | 11% | 8 | 57 | 14% | 4 | 9 | 44% | 60 | 449 | 13% | 12 |
| Crook | 7 | 28 | 22% | 5 | 24 | 21% | 1 | 7 | 14% | 0 | 0 | - | 13 | 63 | 21% | 3 |
| Deschutes | 5 | 48 | 11% | 8 | 47 | 17% | 5 | 35 | 14% | 1 | 4 | 25% | 19 | 132 | 14% | 2 |
| Jefferson | 1 | 13 | 7% | 9 | 34 | 26% | 0 | 4 | 0% | 0 | 1 | 0% | 10 | 53 | 19% | 4 |
| Klamath | 8 | 55 | 16% | 5 | 135 | 4% | 2 | 11 | 18% | 3 | 4 | 75% | 18 | 201 | 9% | 2 |
| Lake | 4 | 25 | 16% | 1 | 38 | 3% | 0 | 1 | 0% | 0 | 0 | - | 5 | 64 | 8% | 0 |
| Wheeler | 0 | 23 | 0% | 1 | 6 | 17% | 0 | 0 | - | 0 | 0 | - | 1 | 29 | 3% | 1 |

Source: Oregon Department of Transportation, 2014; Oregon Department of Transportation (2013), Oregon’s Historic Bridge Field Guide

Note: Di = ODOT bridges Identified as distressed with structural or other deficiencies; De = Non-ODOT bridge Identified with a structural deficiency or as functionally obsolete; D = Total od Di and De bridges; ST = Jurisdictional Subtotal; %D = Percent distressed (ODOT) and/or deficient bridges; * = ODOT bridge classifications overlap and total (ST) is not used to calculate percent distressed, calculation for ODOT distressed bridges accounts for this overlap.

Railroads

Railroads that run through Region 6 support cargo and trade flows. The region’s major (Class I) freight rail providers are the Union Pacific (UP) and the Burlington Northern-Santa Fe (BNSF) railroads. There is one major rail yard in the region (in Klamath Falls, Klamath County) operated

³⁰⁸ Oregon. Bridge Engineering Section (2012). 2012 Bridge Condition Report. Salem, Oregon: Bridge Section, Oregon Department. of Transportation.



by BNSF and UP.³⁰⁹ The Klamath Falls Yard, actually two adjacent yards, is used for switching, storing rail cars, and for locomotive repair.³¹⁰

Amtrak provides passenger rail service from the Willamette Valley south through Region 6 and southward to Los Angeles, California (with stops in Chemult and Klamath Falls) via the Coast Starlight line.

Rails are sensitive to icing from winter storms that can occur in Region 6. Disruptions in the rail system can result economic losses for the region. The potential for harm from rail accidents can also have serious implications for local communities, particularly if hazardous materials are involved.

Airports

The Redmond Regional Airport is the only commercial airport in the region.³¹¹ The airport serves four passenger airlines (American Airlines, Alaska Air, Delta Air, United/ United Express) providing direct service to Denver, Los Angeles, Portland, San Francisco, Salt Lake City, and Seattle.³¹² This airport has been identified to become a primary airport following a Cascadia Subduction Zone (CSZ) seismic event.

In the event of a natural disaster, public and private airports are important staging areas for emergency response activities. Public airport closures will impact the region's tourism industries, as well as the ability for people to leave the region by air. Businesses relying on airfreight may also be impacted by airport closures.

³⁰⁹ Oregon. Department of Transportation (2014). DRAFT Oregon State Rail Plan: Freight and Passenger Rail Inventory. Salem, Oregon. Oregon Department of Transportation.

³¹⁰ Ibid.

³¹¹ Redmond Airport Website, <http://www.flyrdm.com/>

³¹² Ibid.



Table 2-372. || Table 2-R6-RP-19: Public and Private Airports in Region 6

| | Number of Airports by FAA Designation | | | | Total |
|------------------|---------------------------------------|-----------------|----------------|-----------------|-------|
| | Public Airport | Private Airport | Public Helipad | Private Helipad | |
| Region 6 | 17 | 37 | 0 | 11 | 65 |
| Crook | 1 | 5 | 0 | 3 | 9 |
| Deschutes | 4 | 12 | 0 | 3 | 19 |
| Jefferson | 2 | 4 | 0 | 2 | 8 |
| Klamath | 5 | 7 | 0 | 2 | 14 |
| Lake | 5 | 5 | 0 | 1 | 11 |
| Wheeler | 0 | 4 | 0 | 0 | 4 |

Source: FAA Airport Master Record (Form 5010), 2014

Energy

Electricity

The region is served by several investor-owned, public, cooperative and municipal utilities. The Bonneville Power Administration is the areas wholesale electricity distributor. Pacific Power and Light (Pacific Power) is the primary investor-owned utility company serving portions of Crook, Deschutes, Jefferson, Klamath, and Lake counties. The regions electric cooperatives include: Central Electric Cooperative (Crook, Deschutes, Jefferson, Lake), Columbia Basin Cooperative (Wheeler), Columbia Power Cooperative (Wheeler), Harney Electric Cooperative (Crook, Deschutes, Harney, Lake), Midstate Electric Cooperative (Deschutes, Klamath, Lake), Surprise Valley Electric Cooperative (Klamath, Lake), and Wasco Electric Cooperative (Jefferson, Wheeler).

Table 2-373 lists electric power generating facilities that are within Region 6. The region has a total of 8 power-generating facilities: three are hydroelectric power facilities, two are natural gas power facilities, and three are categorized as “other” (biomass and solar voltaic). In total the power generating facilities have the ability to produce up to 1,109 megawatts (MW) of electricity. The region also includes one natural gas power facility (Klamath County) that is approved, but not constructed, that will have the capacity to generate up to 500 MW of electricity.³¹³

³¹³ Oregon Department of Energy, *Power Plants in Oregon*, Retrieved July 1, 2014, from <http://www.oregon.gov/energy/siting/pages/power.aspx>



Table 2-373. || Table 2-R6-RP-20: Power Plants in Region 6

| | Hydro- electric | Natural Gas | Wind | Coal | Other* | Total |
|-----------------------------------|--------------------|----------------|------|------|--------|-------|
| Region 6 | 3 | 2 | 0 | 0 | 3 | 8 |
| Crook | 0 | 0 | 0 | 0 | 0 | 0 |
| Deschutes | 0 | 0 | 0 | 0 | 0 | 0 |
| Jefferson | 2 | 0 | 0 | 0 | 1 | 3 |
| Klamath | 1 | 2 | 0 | 0 | 0 | 3 |
| Lake | 0 | 0 | 0 | 0 | 2 | 2 |
| Wheeler | 0 | 0 | 0 | 0 | 0 | 0 |
| Energy Production (MW) | 461 | 636 | 0 | 0 | 12 | 1,109 |

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), PacifiCorps; Form 10K Annual Report (2013), Portland General Electric; U.S. Geothermal, Inc.

Note: * “Other” includes biomass, geothermal, landfill gas, solar, petroleum, and waste.

Hydropower

Figure 177 shows the major dams operated by the Bonneville Power Administration (BPA), which provides hydro-generated electricity to the states consumer owned utilities. The major BPA dams in the region are located on the Deschutes River (Pelton and Round Butte).

Minor dam failures can occur at any time. Most dam failures result in minor damage to structures and pose little or not risk to life safety. However, the potential for severe damage and fatalities does exist (major dam failures have occurred most recently near Hermiston, 2005, and Klamath Lake, 2006).³¹⁴ The Oregon Water Resources Department maintains an inventory of all large dams located in Oregon (using the National Inventory of Dams (NID) threat potential methodology). **Table 2-374** lists the number of dams included in the inventory. The majority of dams in the region are located in Crook (53), Klamath (65), and Lake (79) counties. There are 19 High Threat Potential dams and 23 Significant Threat Potential dams in the region.

³¹⁴ Association of Dam Safety Officials. Dam Failures, Dam Incidents. Retrieved April 10, 2014, from http://www.damsafety.org/media/Documents/PDF/US_FailuresIncidents.pdf.



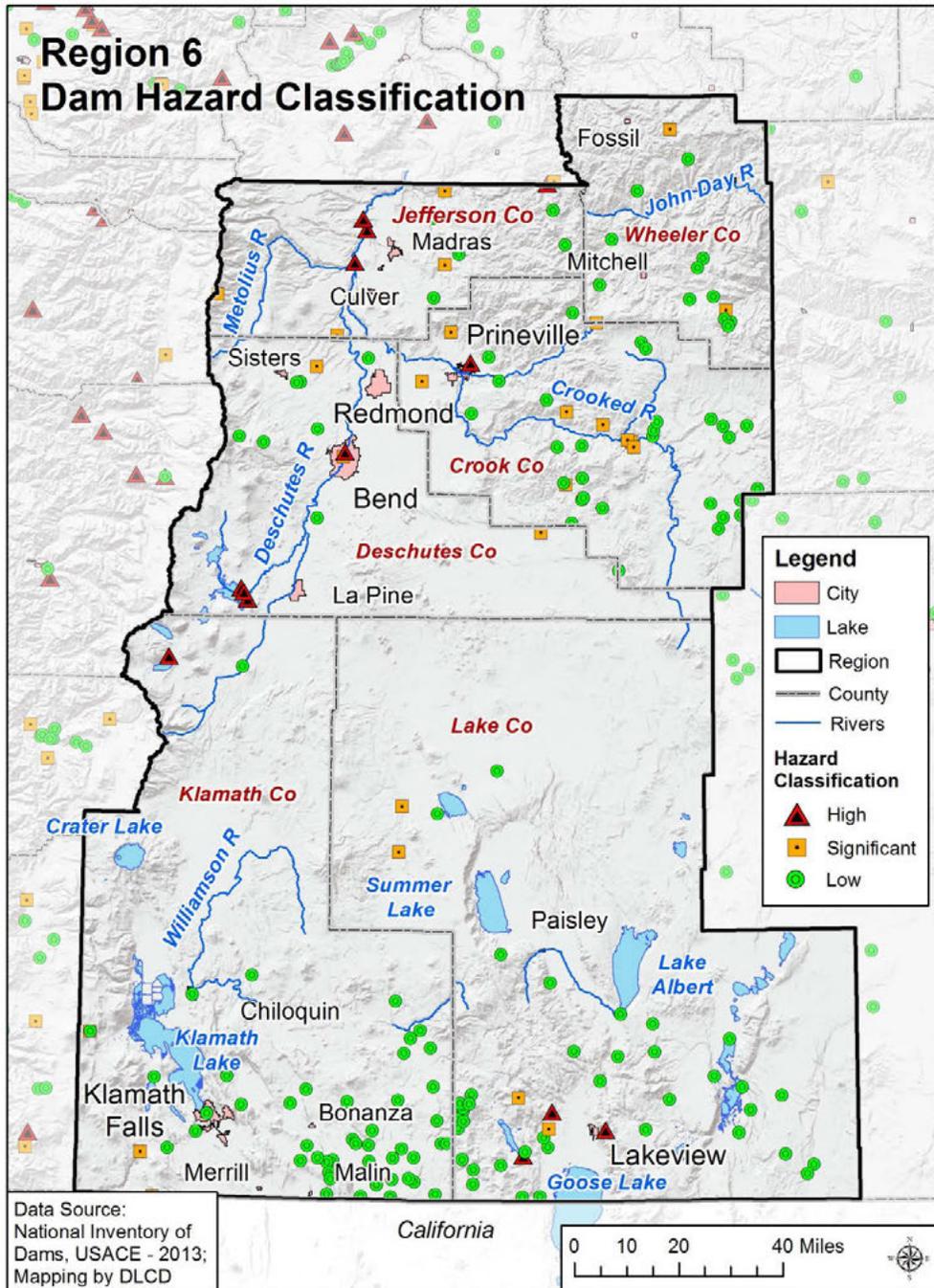
Table 2-374. || Table 2-R6-RP-21: Threat Potential of Dams in Region 6

| | Threat Potential | | | Total Dams |
|------------------|------------------|-------------|-----|------------|
| | High | Significant | Low | |
| Region 6 | 19 | 23 | 212 | 254 |
| Crook | 5 | 8 | 40 | 53 |
| Deschutes | 3 | 3 | 12 | 18 |
| Jefferson | 4 | 4 | 10 | 18 |
| Klamath | 4 | 3 | 58 | 65 |
| Lake | 3 | 5 | 71 | 79 |
| Wheeler | 0 | 0 | 21 | 21 |

Source: Oregon Water Resources Department, Dam Inventory Query, 2014



Figure 177. || Figure 2-R6-RP-9: Region 6 Dam Hazard Classification



Source: National Inventory of dams, USACE, 2013



Natural Gas

Although natural gas does not provide the most energy to the region, it does contribute a significant amount of energy to the region's energy portfolio. Liquefied Natural Gas (LNG) is transported via pipelines throughout the United States. The Gas Transmission Northwest (GTN) line runs through Klamath, Deschutes, Crook and Jefferson counties. A proposed Pacific Connector would connect into the GTN line in Klamath County.³¹⁵ 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. Cascade Natural Gas Corporation is the major supplier of natural gas in Central Oregon.

Utility Lifelines

Central Oregon is an important throughway for oil and gas pipelines and electricity transmission lines, connecting Oregon to California and Washington. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy. These lines may be vulnerable to severe, but infrequent natural hazards, such as earthquakes.

Region 6 primarily receives oil and gas from Alaska by way of the Puget Sound through pipelines and tankers. The region is at the southern end of this pipeline network. Oil and gas are supplied by Northern California from a separate network. The electric, oil, and gas lifelines that run through the County are both municipally and privately owned.³¹⁶

The network of electricity transmission lines running through Region 6 is operated primarily by Pacific Power and regional electrical cooperatives (and Bonneville Power Administration) and primarily facilitates local energy production and distribution.³¹⁷ Most of the natural gas Oregon uses originates in Alberta, Canada. Avista Utilities owns the main natural gas transmission pipeline in southern Oregon while Cascade Natural Gas supplies the greater part of Central Oregon.³¹⁸

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (Ham radio). Region 6 is part of the Central Oregon Operational Area (Crook, Deschutes, Jefferson, Wheeler), the Lake-Harney Operational Area (Lake), and the Southern Oregon Operational Area (Klamath) under The Oregon State Emergency Alert System Plan³¹⁹.

³¹⁵ *Pacific Connector and Jordon Cove clear approval hurdle — Pipelines International — The international pipeline magazine.* (n.d.). Retrieved from <http://pipelinesinternational.com/news/pacific-connector-and-jordon-cove-clear-approval-hurdle/009283/>

³¹⁶ Loy, W. G., Allan, S., & Patton, C. P. (1976). *Atlas of Oregon*. Eugene: University of Oregon and Economic Development for Central Oregon, retrieved from <http://www.edcoinfo.com/business-resources/utilities/natural-gas/default.aspx>

³¹⁷ Ibid.

³¹⁸ Ibid.

³¹⁹ Oregon Military Department's Office of Emergency Management (2013). *The 2013 Oregon State Emergency Alert System Plan* (12.0). Retrieved from State of Oregon website: http://www.oregon.gov/OMD/OEM/tech_resp/EAS/EAS_Plan.pdf



There is a memorandum of understanding between these counties that facilitates the launching of emergency messages. Counties in these areas can launch emergency messages by contacting the Oregon Emergency Response System (OERS), which in turn creates emergency messages to communities statewide.

Beyond day to day operations, maintaining communications capabilities during disaster events and other emergency situations helps to keep citizens safe by keeping them informed of the situation's status, areas to avoid, and other procedural information. Additionally, responders depend on telecommunications infrastructure to be routed to sites where they are needed.

Television

Television serves as a major provider for local, regional, and national news and weather information and can play a vital role in emergency communications. The Oregon State Emergency Alert System Plan does not identify a local primary station for emergency messages, however, messages are provided via the three state primary networks: Oregon Public Broadcasting (Portland), KOBI TV (Medford), and KWAX-FM (Eugene).

Telephone and Broadband

Landline telephone, mobile wireless telephone and broadband service providers serve Region 6. Broadband technology (including mobile wireless) is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless and mobile wireless. Internet service is readily available throughout most parts the region with a smaller number of providers and service types available in the more remote parts of the region.³²⁰ Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

Wireless providers sometimes offer free emergency mobile phones to those impacted by disasters, which can aid in communication when landlines and broadband service are unavailable.

Radio

Radio is readily available to those who live within Region 6 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Radio transmitters for The Central Oregon Operational Area include:

- KOAB-FM 91.3 MHZ, Bend
- KWRX-FM 88.5 MHZ, Redmond (KWAX-FM Network)

³²⁰ Oregon Broadband Mapping Project. Interactive Map. Accessed May 10, 2014.
<https://broadband.oregon.gov/StateMap/>



The radio transmitter for the Lake-Harney Operational Area is:

- KOAP-FM 88.7 MHZ, Lakeview

The radio transmitter for the Southern Oregon Operational Area is:

- KOTI-TV Ch. 13, Klamath Falls

Ham Radio

Amateur Radio, or Ham Radio, is a service provided by licensed Amateur Radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communications is a priority for the Amateur Radio Relay League (ARRL). ARES Districts 2 (Crook, Deschutes, Jefferson), 3 (Wheeler), and 4 (Klamath, Lake) provide service to Region 6. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters³²¹. The official Ham emergency station calls for Region 6 include³²²:

- Crook County: W7KFO
- Deschutes County: KE7TMU
- Jefferson County: K1GER
- Klamath County: WA7YPR
- Lake County: KE7QP
- Wheeler County: W7ILD

Water

Water infrastructure includes drinking water, stormwater, and wastewater systems. All of these systems possess some level of vulnerability to natural hazards that can have repercussions on human health, ecosystems, and industry.

Drinking Water

In Region 6 municipal drinking water supply is obtained from both surface and ground sources. In Crook, Deschutes, Jefferson, and Klamath counties rural areas draw water from surface water sources. In the upper basin of Klamath County rural drinking water is drawn from springs, while the lower basin draws water from Klamath Lake for drinking water and irrigation. In rural areas of Lake County drinking water is primarily drawn from wells. Rural drinking water and irrigation water is primarily drawn from surface water sources and may be delivered by localized irrigation districts or may be drawn directly by landowners with water rights. The region's cities primarily draw drinking water from groundwater wells with the exception of the City of Bend, which

³²¹ Oregon Office of Emergency Management (n.d.). *Amateur Radio Unit - W7OEM*. Retrieved March 15, 2014, from http://www.oregon.gov/OMD/OEM/Pages/tech_resp/amateur_radio.aspx

³²² The American Relay Radio League: Oregon Chapter. Retrieved June 6, 2014, from www.arrlregion.org/



draws water from Bridge Creek, a spring-fed waterway. A small portion of the City of Lakeview's drinking water is drawn from springs.

Region 6 is impacted by several threats to water quality and quantity. Low levels of snowpack and rain can lead to water shortages in a region that is often subject to annual shortages. Water rights in the region are fully appropriated in the summer season, which may impact opportunities for new development of urban and farm lands in the region. Above ground storage in reservoirs is a tool used throughout the region to help prepare for potential water shortages. Aging wells in the region may also contribute to shortages because of decreased efficiency in water delivery. However, the age and maintenance level of wells is mostly a concern because older equipment may not filter minerals and bacteria as effectively as well maintained infrastructure.

Water quality in Crook, Deschutes, and Jefferson Counties is generally high, partially due to the volcanic nature of the area's soil and bedrock, which lacks high levels of sedimentation. However, concerns regarding water quality do exist in regards to sedimentation that could be caused by river bank erosion caused by freeze-thaw cycles in the winter and also by weed growth along banks that leads to lowered channel capacity, which results in flooding in some areas. Throughout the region, complaints about hydrogen sulfide causing unpleasant odors to the water occasionally occur, however the unpleasant odor is not indicative of any health concerns. In Lake County, minerals including Arsenic and Boron are of concern and monitored regularly. In the area surrounding the City of Lakeview tailings and runoff from abandoned mines are a concern for the area's water quality. In Klamath County, the shallow, slow-moving nature of waterways causes high water temperatures, which is related to aquatic growth that can threaten water quality. Throughout the region, bacterial coliform levels are monitored to ensure that waterborne diseases do not threaten the quality of drinking water.

Surface sources for drinking water are vulnerable to pollutants caused by non-point sources and natural hazards. Non-point source pollution is a major threat to surface water quality, and may include storm water runoff from roadways, agricultural operations, timber harvest, erosion and sedimentation. Landslides, flood events, and earthquakes and resulting liquefaction can cause increased erosion and sedimentation in waterways

Underground water supplies and aging or outdated infrastructure —such as reservoirs, treatment facilities, and pump stations — can be severed during a seismic event. Rigid materials such as cast iron may snap under the pressure of liquefaction. More flexible materials such as polyvinyl chloride (PVC) and ductile iron may pull apart at joints under the same stresses. These types of infrastructure damages could result in a loss of water pressure in municipal water supply systems, thus limiting access to potable water. This can lead to unsanitary conditions that may threaten human health. Lack of water can also impact industry, such as the manufacturing sector. Moreover, if transportation infrastructure is impacted by a disaster event, repairs to water infrastructure will be delayed.

[Stormwater and Wastewater](#)

In urbanized areas severe precipitation events may cause urban flooding, leading to stormwater runoff— and this can become a serious issue. Stormwater is one non-point source of water pollution and may impact drinking water quality. Other environmental impacts of stormwater runoff include increased temperatures in surface water quality, adversely affecting habitat



health, flooding, and erosion due to the fast moving large volumes of water entering surface waterways from storm sewer systems.

Stormwater can also impact water infrastructure. Leaves and other debris can be carried into storm drains and pipes, which can clog storm water systems. In areas where stormwater systems are combined with wastewater systems, a.k.a. combined sewers, flooding events can lead to combined sewer overflows (CSOs). CSOs present a heightened health threat as sewage can flood urban areas and waterways. Underground stormwater and wastewater pipes are also vulnerable to damage by seismic events.

In Region 6, county and municipal building codes and stormwater management plans (city and county) emphasize use of centralized storm sewer systems to manage stormwater. Low impact development (LID) mitigation strategies can alleviate or lighten the burden 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. The largest municipalities in the region (Fossil, Madras, Prineville, Redmond, Bend, La Pine, Klamath Falls, and Lakeview) do not require use LID strategies in their building code. Promoting and requiring decentralized LID stormwater management strategies could help reduce the burden of new development on stormsewer systems, and increase a community's resilience to many types of hazard events.

Infrastructure trends/issues

Physical infrastructure is critical for every day operations and is essential following a disaster. Lack, or poor condition, of infrastructure can negatively affect a community's ability to cope, respond and recover from a hazard event. Diversity, redundancy and consistent maintenance in infrastructure systems help to create system resiliency.³²³

Damage or service interruption to roads, bridges, rail systems and ports can have devastating effects the region's economy. Railways supporting cargo and trade flows and Amtrak's passenger service that are subject to icy conditions. The Redmond Regional Airport will become a primary airport for the state following a catastrophic Cascadia Subduction Zone (CSZ) earthquake event.

The region has a diverse energy portfolio that boosts its ability to withstand system disruptions due to natural hazard events. This includes eight power-generating facilities: three hydroelectric, two natural gas, and three biomass and solar voltaic facilities. There is also a natural gas power plant proposed for Klamath County. The area has an emerging solar photovoltaic energy infrastructure and is also the location of two large dams and hydroelectric projects on the Deschutes River.

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

³²³ Meadows, D. H. (2008). *Thinking in Systems: A Primer*. White River Junction, VT: Chelsea Green Publishing.



that broadband and mobile telephone services may not cover rural areas of the region that are distant from Highway 97. This may present a communication challenge in the wake of a hazard event. Encouraging residents to keep AM/FM radios available for emergency situations could help increase the capacity for communicating important messages throughout the region.

Water systems in the region are particularly vulnerable to hazard events because they tend to be older, centralized, and lack system redundancies. Furthermore, because most drinking water is sourced from surface water or wells, the region is at risk of high levels of pollutants entering waterways through storm water runoff and Combined Sewer Overflows (CSOs) during high water events. The implementation of decentralized LID stormwater systems can increase the region's capacity to better manage high precipitation events.

Built Environment

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

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.³²⁴

Settlement Patterns

The region's percent urban growth between 2000 and 2010 is double that of the state. Deschutes County has the highest population in urban and rural areas; and has experienced roughly 57% urban growth. Overall, the region's urban areas are growing about four times faster than rural areas. Rural populations have grown significantly, between 10 and 18%, in all counties except Deschutes and Wheeler. Wheeler is the only county that does not have an urban population, based on U.S. Census definition; and is also the only county in the region that is losing rural population.

Urban housing is growing at twice the rate of rural housing in the region. Deschutes County gained the most urban housing units (approximately 21,150), growing by 69%. Lake County is

³²⁴ Department of Land Conservation and Development, website: <http://www.oregon.gov/>



the only county to decrease its share of rural homes. Notably, rural housing has increased by almost 30% in Crook and Klamath Counties.

The region’s population is clustered around the Highway 97 corridor and the cities of Bend, Klamath Falls, Madras, and Redmond.

Table 2-375. || Table 2-R6-RP-22: Urban and Rural Populations in Region 6

| | Urban | | | Rural | | |
|------------------|-----------|-----------|----------------|---------|---------|----------------|
| | 2000 | 2010 | Percent Change | 2000 | 2010 | Percent Change |
| Oregon | 2,694,144 | 3,104,382 | 15.2% | 727,255 | 726,692 | -0.1% |
| Region 6 | 134,438 | 177,374 | 31.9% | 91,864 | 98,773 | 7.5% |
| Crook | 10,290 | 10,905 | 6.0% | 8,892 | 10,073 | 13.3% |
| Deschutes | 72,554 | 114,130 | 57.3% | 42,813 | 43,603 | 1.8% |
| Jefferson | 7,252 | 8,010 | 10.5% | 11,757 | 13,710 | 16.6% |
| Klamath | 41,153 | 41,434 | 0.7% | 22,622 | 24,946 | 10.3% |
| Lake | 3,189 | 2,895 | -9.2% | 4,233 | 5,000 | 18.1% |
| Wheeler | 0 | 0 | - | 1,547 | 1,441 | -6.9% |

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

Note: The U.S. Census Bureau defines “urban” as either an “urbanized area” of 50,000 or more people, or an “urban cluster” of at least 2,500 people (but less than 50,000). Wheeler County do not meet either definition, therefore all of its population is considered rural even though the county has incorporated cities.

Table 2-376. || Table 2-R6-RP-23: Urban and Rural Housing Units in Region 6

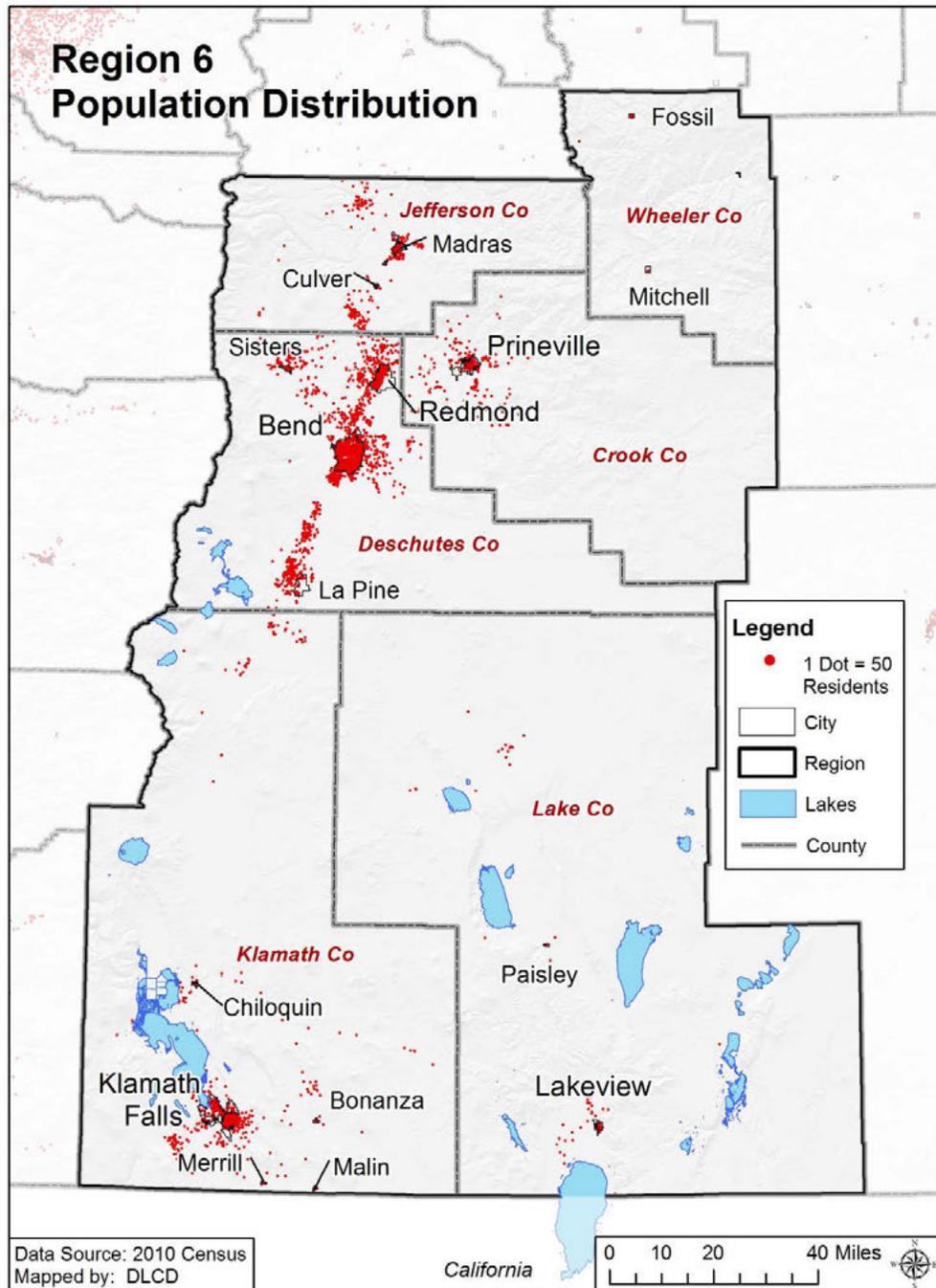
| | Urban | | | Rural | | |
|------------------|-----------|-----------|----------------|---------|---------|----------------|
| | 2000 | 2010 | Percent Change | 2000 | 2010 | Percent Change |
| Oregon | 1,131,574 | 1,328,268 | 17.4% | 321,135 | 347,294 | 8.1% |
| Region 6 | 57,098 | 80,325 | 40.7% | 47,792 | 57,939 | 21.2% |
| Crook | 4,190 | 4,884 | 16.6% | 4,074 | 5,318 | 30.5% |
| Deschutes | 30,684 | 51,844 | 69.0% | 23,899 | 28,295 | 18.4% |
| Jefferson | 2,735 | 3,382 | 23.7% | 5,584 | 6,433 | 15.2% |
| Klamath | 17,950 | 18,684 | 4.1% | 10,933 | 14,090 | 28.9% |
| Lake | 1,539 | 1,531 | -0.5% | 2,460 | 2,908 | 18.2% |
| Wheeler | 0 | 0 | - | 842 | 895 | 6.3% |

Source: U.S. Census Bureau. 2000 Decennial Census, Table H002 and 2010 Decennial Census, Table H2

Note: The U.S. Census Bureau defines “urban” as either an “urbanized area” of 50,000 or more people, or an “urban cluster” of at least 2,500 people (but less than 50,000). Wheeler County do not meet either definition, therefore all of it’s population is considered rural even though the county has incorporated cities.



Figure 178. || Figure 2-R6-RP-11: Region 6 Population Distribution



Source: US Census, 2012



Land Use and Development Patterns

Land ownership and geography tend to drive the land use patterns in Region 6. Federal ownership (61%) is made up primarily of the US Forest Service in the western portion ranging up the Cascade crest, and BLM has holdings generally ranging from southeast of Redmond and increasing until dominating the area of Lake County. The majority of land ownership is private holdings (36%) from the north Jefferson County and Madras area through the Prineville/ Redmond/ Sisters/ Bend areas. The Warm Springs Indian Reservation dominates the northeast portion.

Development pressure has been high in the Bend, Sisters, and Redmond areas in the past few decades. Between 1974 and 2009, the Bend area lost 13% of its land in resource land uses to more developed uses. However, since 1984 that rate has declined - annual average rates of conversion of land in resource land uses to low-density or urban uses in Deschutes County was 88% less in the 2005-2009 period when compared to the 1974-1984 period. Similar trends, although less pronounced, are seen in Klamath County.³²⁵

Responding to rapid growth and changing demographics, in 2011 Deschutes County completed a multi-year effort to establish the 2030 Comprehensive Plan update, namely the Plan 2030. This new plan incorporates updated goals and policies, community plans, and new projects like the South County Plan, destination resort remapping, a 2030 Transportation System Plan, and a South County Local Wetland Inventory.

Increasing Federal efforts to protect sage grouse habitat affect large portions of Deschutes, Crook, and Lake County's resource lands devoted to farm, ranch or forest uses. Land use threats to habitat have been identified as conversion to agriculture, energy development, mining, infrastructure and urbanization. Counties have been addressing some of these habitat fragmentation activities through their land use planning programs.

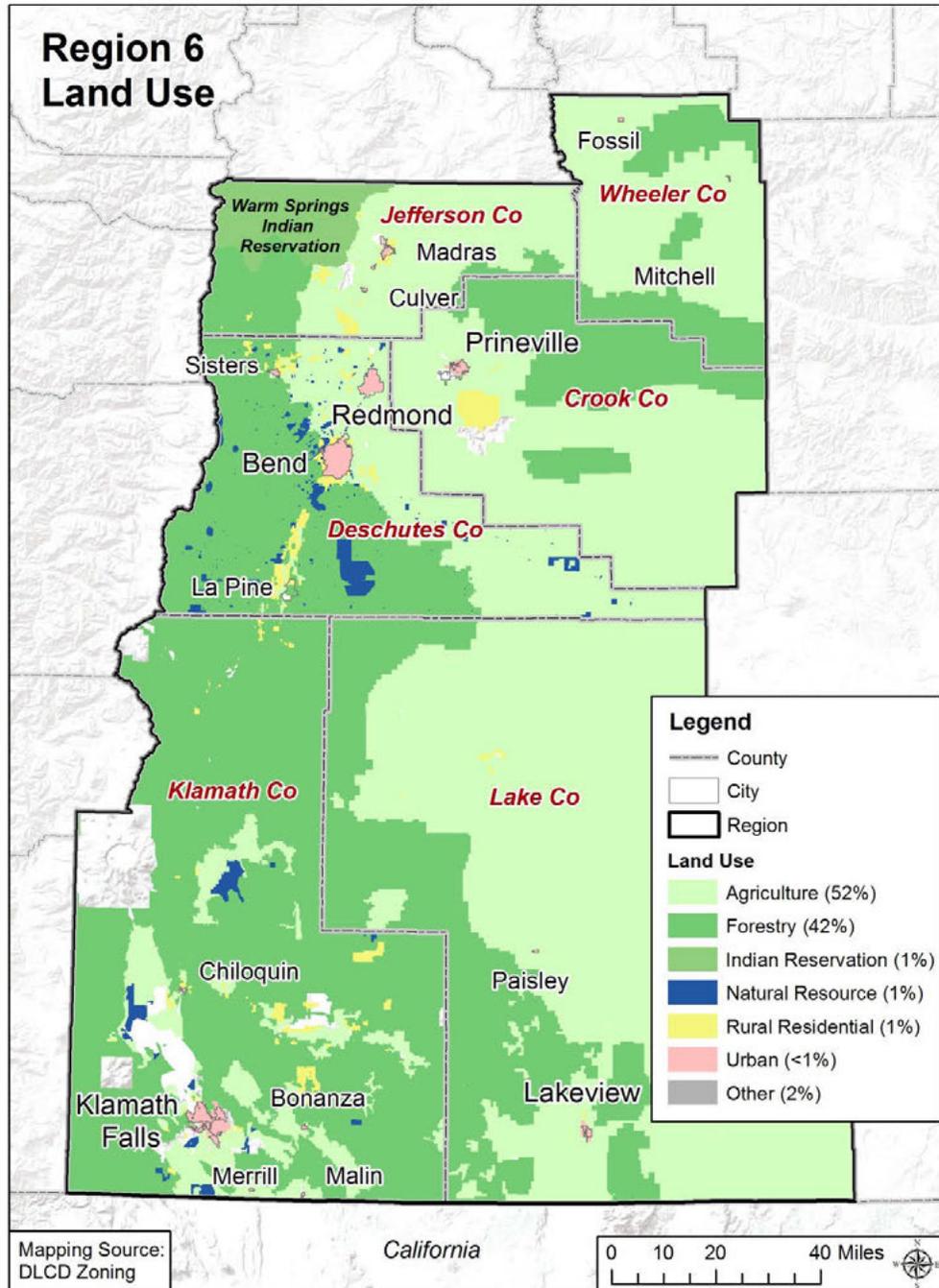
While periodic flooding is a challenge in the northern portion of the Region, the wildland-urban interface areas are a constant concern for community planners and emergency managers. The Oregon Forestland-Urban Interface Fire Protection Act – often referred to as Senate Bill 360 – enlists the aid of property owners toward the goal of turning fire-vulnerable urban and suburban properties into less volatile zones where firefighters may more safely and effectively defend homes from wildfires. All Region 6 counties implemented this in 2013.

The City of Madras in 2014 began working on integrating portions of its Comprehensive Plan with its Local Natural Hazard Mitigation Plan; this may prove to be a model for others.

³²⁵ Land Use Change on Non-Federal Land in Oregon 1974-2009, Oregon Department of Forestry and U.S. Forest Service, 2011



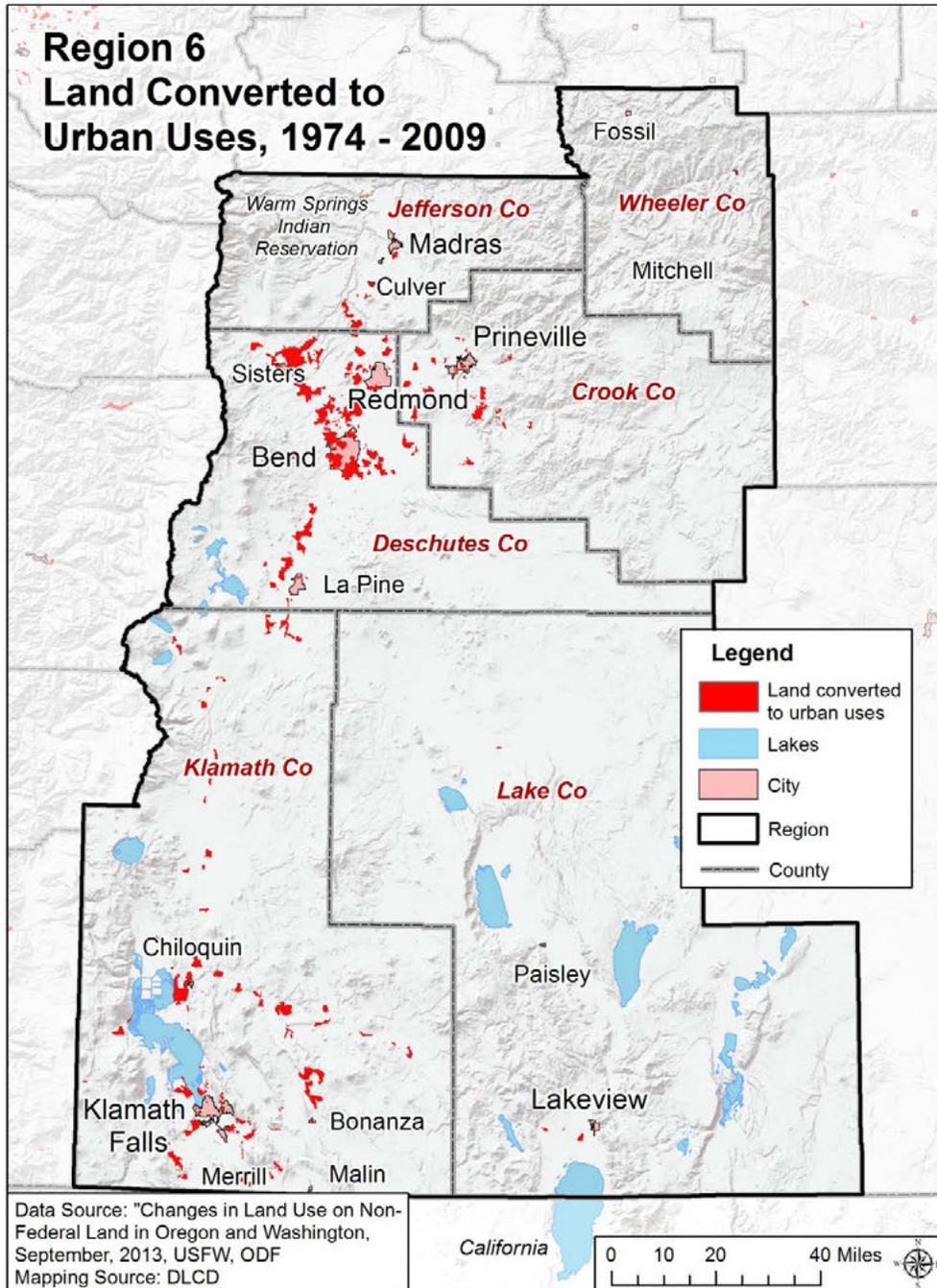
Figure 179. || Figure 2-R6-RP-12: Region 6 Land Use



Source: Department of Land Conservation and Development, 2014



Figure 180. || Figure 2-R6-RP-13: Region 6 Land Converted to Urban Uses, 1974-2009



Source: Land Use Change on Non-Federal Land in Oregon and Washington, September, 2013, USFS, ODF



Housing

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. Almost two thirds of the region’s housing stock is single-family homes. Mobile residences account for 13% of Region 6’s housing; and roughly 70% of all mobile homes reside in Deschutes and Klamath Counties. This is important because, in natural hazard events, such as earthquakes and floods, moveable structures like mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants.³²⁶

Table 2-377. || Table 2-R6-RP-24: Housing Profile for Region 6, 2012

| | Total Housing Units | Single Family | | Multi-Family | | Mobile Homes | |
|------------------|---------------------|------------------|------------------|----------------|------------------|----------------|------------------|
| | | Number | Percent of Total | Number | Percent of Total | Number | Percent of Total |
| Oregon | 1,673,593 | 1,140,319 | 68.1% | 460,852 | 27.5% | 139,768 | 8.4% |
| Region 6 | 138,082 | 102,288 | 74.1% | 17,474 | 12.7% | 18,017 | 13.0% |
| Crook | 10,204 | 7,763 | 76.1% | 663 | 6.5% | 1,669 | 16.4% |
| Deschutes | 80,039 | 61,145 | 76.4% | 11,557 | 14.4% | 7,308 | 9.1% |
| Jefferson | 9,807 | 6,409 | 65.4% | 1,009 | 10.3% | 2,337 | 23.8% |
| Klamath | 32,737 | 23,393 | 71.5% | 4,033 | 12.3% | 5,250 | 16.0% |
| Lake | 4,413 | 2,914 | 66.0% | 204 | 4.6% | 1,243 | 28.2% |
| Wheeler | 882 | 664 | 75.3% | 8 | 0.9% | 210 | 23.8% |

Source: U.S. Census Bureau. 2008-2012. American Community Survey 5-Year Estimates, Table B25024

Aside from location and type of housing, the year structures were built has implications. Seismic building standards were codified in Oregon building code starting in 1974; more rigorous building code standards were passed in 1993 that accounted for the Cascadia earthquake fault.³²⁷ Therefore, homes built before 1993 are more vulnerable to seismic events. Also in the 1970s, FEMA began assisting communities with floodplain mapping as a response to administer the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Upon receipt of floodplain maps, communities started to develop floodplain management ordinances to protect people and property from flood loss and damage (see tables below for more information on floodplain maps. Regionally, about one-quarter of the housing stock was built prior to 1970 – including roughly half of the residences in Lake and Wheeler Counties – before the implementation of floodplain management ordinances. Regionally, just under 54% of the housing stock was built before 1990 and the codification of seismic building standards.

³²⁶ Governor’s Office of Emergency Services, California (1997) *Emergency Plans for Mobile Home Parks*. Retrieved March 10, 2014 from [http://www.oes.ca.gov/Operational/OESHome.nsf/PDF/Emergency%20Plans%20for%20Mobilehome%20Parks/\\$file/Feat5.pdf](http://www.oes.ca.gov/Operational/OESHome.nsf/PDF/Emergency%20Plans%20for%20Mobilehome%20Parks/$file/Feat5.pdf)

³²⁷ State of Oregon Building Codes Division. *Earthquake Design History: A summary of Requirements in the State of Oregon*, February 7, 2012. http://www.oregon.gov/OMD/OEM/osspace/docs/history_seismic_codes_or.pdf



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.

Table 2-378. || Table 2-R6-RP-25: Age of Housing Stock in Region 6, 2012

| | Total Housing Units | Pre 1970 | | 1970 to 1989 | | 1990 or later | |
|------------------|---------------------|----------|------------------|--------------|------------------|---------------|------------------|
| | | Number | Percent of Total | Number | Percent of Total | Number | Percent of Total |
| Oregon | 1,673,593 | 609,062 | 36.4% | 518,569 | 31.0% | 545,962 | 32.6% |
| Region 6 | 138,082 | 32,008 | 23.2% | 42,128 | 30.5% | 63,946 | 46.3% |
| Crook | 10,204 | 2,840 | 27.8% | 2,624 | 25.7% | 4,740 | 46.5% |
| Deschutes | 80,039 | 10,166 | 12.7% | 24,414 | 30.5% | 45,459 | 56.8% |
| Jefferson | 9,807 | 2,325 | 23.7% | 2,952 | 30.1% | 4,530 | 46.2% |
| Klamath | 32,737 | 14,015 | 42.8% | 10,623 | 32.4% | 8,099 | 24.7% |
| Lake | 4,413 | 2,183 | 49.5% | 1,286 | 29.1% | 944 | 21.4% |
| Wheeler | 882 | 479 | 54.3% | 229 | 26.0% | 174 | 19.7% |

Source: U.S. Census Bureau. 2008-2012. American Community Survey 5-Year Estimates, Table B25034

The National Flood Insurance Program’s (NFIP’s) Flood Insurance Rate Maps (FIRMs) delineate flood-prone areas. They are used to assess flood insurance premiums and to regulate construction so that in the event of a flood, damage minimized. [Table 2-379](#) shows the initial and current FIRM effective dates for Region 6 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, [Flood](#) section.



Table 2-379. || Table 2-R6-RP-26: Community Flood Map History in Region 6

| | Initial FIRM | Current FIRM |
|----------------------|---------------------|---------------------|
| Crook | July 17, 1989 | February 12, 2012 |
| Prineville | July 17, 1989 | February 12, 2012 |
| Deschutes | August 16, 1988 | September 28, 2007 |
| Bend | September 4, 1987 | September 28, 2007 |
| La Pine | September 28, 2007 | September 28, 2007 |
| Sisters | September 29, 1986 | September 28, 2007 |
| Jefferson | July 17, 1989 | July 17, 1989 |
| Culver | September 4, 1987 | September 4, 1987 |
| Madras | July 17, 1989 | July 17, 1989 |
| Klamath | December 18, 1984 | December 18, 1984 |
| Bonanza | June 1, 1983 | June 1, 1983 (M) |
| Chiloquin | August 15, 1984 | August 15, 1984 |
| Klamath Falls | June 5, 1985 | June 5, 1985 |
| Lake | December 5, 1989 | December 5, 1989 |
| Lakeview | November 16, 1982 | September 5, 1990 |
| Paisley | September 15, 1989 | September 15, 1989 |
| Wheeler | July 17, 1989 | July 17, 1989 |
| Fossil | May 4, 1989 | May 4, 1989 |
| Mitchell | April 17, 1989 | April 17, 1989 |

Source: Federal Emergency Management Agency, Community Status Book Report;

(M) – No elevation determined, All Zone A, C and X

State-Owned/Leased and Critical and Essential Facilities

In 2014 the Department of Geology and Mineral Industries updated the 2012 Oregon NHMP inventory and analysis of state owned and leased facilities and critical and essential facilities. Results from this report relative to Region 6 can be found in [Table 2-380](#). The region contains 5.1% of the total value of state-owned or leased critical and essential facilities.



Table 2-380. || Table 2-R6-RP-27: Value of State-Owned/ Leased Critical and Essential Facilities

| | Total Property Value (state facilities) | Percent State Total |
|------------------|--|------------------------|
| Oregon | \$7,339,087,023 | 100% |
| Region 6 | \$371,339,811 | 5.1% |
| Crook | \$17,310,982 | 0.2% |
| Deschutes | \$105,581,675 | 1.4% |
| Jefferson | \$164,051,549 | 2.2% |
| Klamath | \$41,694,108 | 0.6% |
| Lake | \$38,521,237 | 0.5% |
| Wheeler | \$4,180,262 | 0.1% |

Source: The Department of Geology and Mineral Industries

Built Environment trends/issues

The trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. Region 6 is largely a rural county with urban development focused along Highway 97, around the population centers of Bend, Klamath Falls, Prineville, and Redmond. Deschutes County has the fastest growing urban population in the region while Wheeler County is entirely rural and is declining in population. The region’s housing stock is largely single-family homes; though in Jefferson, Lake, and Wheeler Counties the number of mobile homes equate to triple the state’s percentage. Roughly half the homes in Klamath, Lake, and Wheeler were built before 1970. With the exception of Crook and Deschutes Counties, none of the region’s FIRMs have been modernized or updated, as such the areas maps are not as up to date as other areas of the state.

2.3.6.3 Hazards and Vulnerability

Drought

Characteristics

Every county in Central Oregon has experienced drought conditions at some point during the past ten years, with Klamath County receiving the most Governor-declared declarations. A summary of Governor declared droughts since 1995 is listed in [Table 2-381](#). The U.S. Department of Agriculture can also designate a county as a “natural disaster area” due to damages or losses caused by a drought. In August 2013, Klamath and Lake Counties were declared natural disaster areas. In 2007, Lake County was declared a natural disaster area and Klamath County received the same designation in 2010.



Historic Drought Events

Table 2-381. || Table 1. Region 6 Historic Droughts

| Date | Location | Description |
|-----------|-----------------------|--|
| 1928-41 | Statewide | Prolonged statewide drought that caused major problems for agriculture. Statewide, the northern coast was the only area spared, with abundant rains in 1930-1933. The three Tillamook burns, the first in 1933, were the most significant impacts of this very dry period. |
| 1959-1964 | Eastern Oregon | Streamflows were low through eastern Oregon during this period. |
| 1985-94 | Statewide | Generally dry period, capped by statewide droughts in 1992 and 1994. Although not as severe as the 1976-1977 drought that affected the western Oregon region, ten consecutive years of dry conditions caused problems throughout the state, such as fires and insect outbreaks. In 1994, Governor declared Jefferson, Crook, Deschutes, and Klamath a drought emergency, along with 7 other counties in the state. |
| 2001 | Southern, Eastern OR | Jefferson, Wheeler, Crook, Deschutes, Klamath, and Lake Counties under a Governor-declared drought. In 2001, 18 counties were declared statewide. |
| 2002 | Southern, Eastern OR | Counties declared in 2001 remain in effect; Governor adds 5 additional counties in 2002, bringing the total to 23 counties. |
| 2003 | Southern, Eastern OR | Jefferson, Deschutes, and Lake Counties drought declarations expire June 23, 2003. Governor issues new drought declarations for Wheeler and Crook Counties, and extends Klamath drought order through December 2003. |
| 2004 | Eastern OR | Klamath County under a Governor drought declaration; 3 other counties declared in neighboring regions. |
| 2005 | Regions 5, 6, and 7 | Wheeler, Crook, Deschutes, Klamath, and Lake Counties received a Governor-drought declaration; All Region 5 counties declared, as well as 2 counties in Region 7. |
| 2007 | Regions 6, 7, and 8 | Governor-declared drought in Lake County, along with 5 other counties in Regions 6 and 7 |
| 2010 | Region 6 | Governor-declared drought for Klamath County and “contiguous counties.” |
| 2012 | Region 6 | Governor-declared drought for Lost River Basin only, located within Klamath and Lake Counties |
| 2013 | Regions 5-8 | Governor-declared drought for Klamath County, along with 4 other counties |
| 2014 | Regions 4, 6, 7 and 8 | Governor-declared drought in 9 counties, as of June 2014, including Crook, Klamath, Lake and Wheeler Counties in Region 6 |

* 2010 declaration also included contiguous counties; 2012 declaration affected the Lost River Basin only

Source: Taylor, George and Raymond R Hatton. (September 1999). The Oregon Weather Book: State of Extremes, and the Oregon Secretary of State’s Office, Archives Division

Historic drought information can also be obtained from the National Climatic Data Center, which provides historical climate data showing wet and dry conditions, using the Palmer Drought Severity Index (PDSI), that dates back to 1895. The Palmer Index is not the best indicator of water availability for Oregon as it does not account for snow or ice (delayed

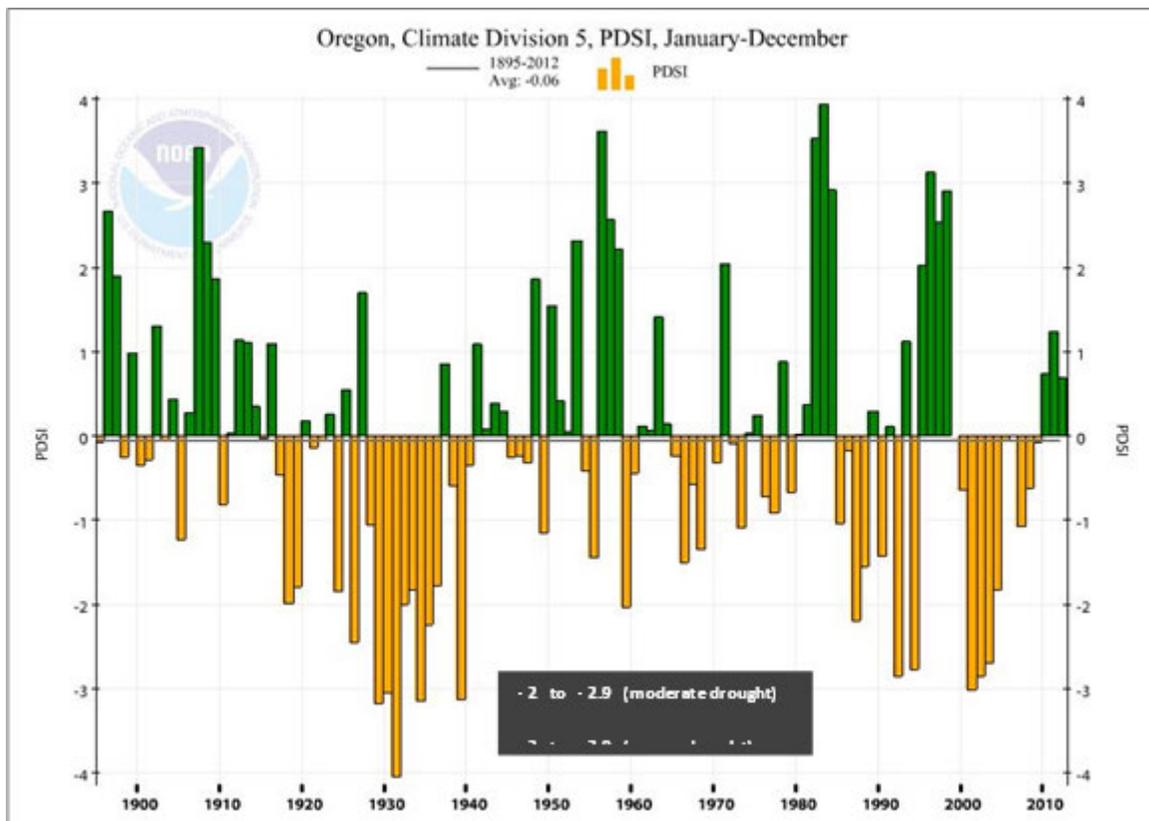
U.S Climate Divisions





runoff), but it has the advantage of providing the most complete, long-term record. The following PDSI graph shows years where drought or dry conditions affected the high plateau region of Oregon, which comprises much of Klamath County and parts of Lake and Deschutes Counties (Climate Division 5). Based on this index, 1931 was an extreme drought year for the high plateau region, while 1929, 1930, 1934, 1939, and 2001 were severe drought years. The PDSI for Climate Division 7, which includes Deschutes, Jefferson, Crook, Wheeler, and portions of Lake, and Klamath County, along with Harney County (a “Region 7” county for hazard planning), experienced similar years of severe drought, with 1934 being an extreme drought year for Region 7.

Figure 181. || Palmer Drought Severity Index



Probability and Vulnerability

As stated in the State Risk Assessment, 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 is 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. Following are the local and state probability and vulnerability descriptions as they stand, without analysis of similarities and differences.



Probability

Local Assessment

Based on the OEM Hazard Analysis conducted by county emergency program managers the probability (High, Moderate, Low) that Region 6 will experience drought is depicted in [Table 2-382](#). 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 2-382. || Table 2. Local Probability Assessment of Drought

| | Crook | Deschutes | Jefferson | Klamath | Lake | Wheeler |
|-------------|-------|-----------|-----------|---------|------|---------|
| Probability | M | H | H | H | H | - |

Source: Oregon Emergency Management, 2013 County Hazard Analysis Scores.

State Assessment

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

Oregon has yet to undertake a statewide comprehensive risk analysis for drought, to determine probability or vulnerability for a given community. Considering that several drought declarations have occurred during the last ten years, is it reasonable to assume that there is a high probability that Region 6 will experience drought in the near future.

Vulnerability

Local Assessment

Based on the OEM Hazard Analysis conducted by county emergency program managers, the region’s vulnerability (High, Moderate, Low) to drought is depicted in [Table 2-383](#). 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 2-383. || Table 3. Local Vulnerability Assessment of Drought

| | Crook | Deschutes | Jefferson | Klamath | Lake | Wheeler |
|---------------|-------|-----------|-----------|---------|------|---------|
| Vulnerability | H | L | H | M | H | - |

Source: Oregon Emergency Management, 2013 County Hazard Analysis Scores.

State Assessment

Oregon has not undertaken a comprehensive statewide analysis to identify which communities are most vulnerable to drought. However, based on a review of drought declarations issued by the Governor, Klamath County could be considered one of the most vulnerable communities to drought and its related impacts. Since 1992, Klamath County has been under a drought declaration during 11 of the past 22 years, more than any other county in the state.

In 2013, the Klamath Falls area experienced the second driest January through March period on record with precipitation measuring below average throughout the Klamath Basin. According to the U.S. Bureau of Reclamation, Klamath Basin Project irrigators have not received a full supply



of water in nine out of the last thirteen irrigation seasons. During dry or drought years, national wildlife refuges in the Klamath Basin received smaller water deliveries as well. These refuges are important nesting and feeding grounds for birds migrating along the Pacific Flyway. Reduced river flows, especially during the summer months, can negatively impact fisheries, recreation, and other uses as well.

Lake County could also be considered one of the most vulnerable communities to drought and its related impacts, based on Governor-declared drought declarations. Declarations have been issued in 1992, 2001 (which continued through June 2003), 2005, 2007, 2012, and most recently in February 2014.



Dust Storms

Characteristics

The characteristics of dust storms in Region 6 are well described in the State Risk Assessment, [Drought](#) section. There is little about the dust storms in this region that differs from the general description, except to note that agricultural practices generally don't play as big a role as they do in Region 5. That written, Central Oregon farmers, ranchers, homeowners, resort properties, and wildlife sometimes find themselves vying for limited water. This competition for scarce water can affect the locations and amounts of dust lifted into the atmosphere, and blown on the wind.

Examples of dust storms in this region are listed in [Table 2-384](#). One of the most recent significant storms occurred in April 2001: severely limited visibility was caused by high winds blowing dust from a recently plowed field.

Historic Dust Storms

Table 2-384. || Table XX: Historic Dust Storms

| Date | Location | Description |
|---------------------------|----------------|---|
| April 1931 ³²⁸ | Central Oregon | A heavy bank of clouds filled with dust reportedly worked their way over mountain passes into the Santiam Canyon. |
| Mar. 1935 | Central Oregon | "A dust storm which reduced visibility to a few hundred yards spread over several Central Oregon counties... slowing traffic on the Dallas (sic) – California highway and spreading a fine coating of dry dust over all adjacent wheat lands." ³²⁹ |

³²⁸ *Oregon Statesman*, "Dust, Wind, and Fire Cause Great Damage," April 23, 1931 and "Dust Storm Precedent on Record 88 Years Ago," April 26, 1931; information on this event, as well as the 1906 event, may also be found in the *Pacific Northwest Quarterly*, "The Pacific Northwest Dust Storm of 1931," Paul C. Pitzer, April 1988, pp. 50-55, as informed by the following sources used by Mr. Pitzer:

- Albany Democrat-Herald*, April 22, 1931
- Astoria Evening Budget*, April 24, 1931
- Coos Bay Times*, April 22, 23, 1931
- Corvallis Gazette-Times*, April 22, 24, 1931
- Pendleton East Oregonian*, April 22, 1931
- Portland Oregonian*, April 22, 25, 26 and May 1, 1931
- Portland Oregonian*, Lancaster Pollard, August 21, 1955 and November 25, 1962
- Roseburg News-Review*, April 22, 23, 1931
- Salem Oregon Journal*, April 22, 23, 24, 1931
- San Francisco Chronicle*, April 25, 1931
- The Dalles Optimist*, April 24, 1931
- Wenatchee Daily World*, April 22, 1931
- Beef Cattle Industry in Oregon: 1890-1938*, Dexter K. Strong, 1940
- Wind Erosion and Dust Storms in Oregon*, Arthur King, 1938.

³²⁹ *New York Times*, March 25, 1935, p. 17; "the Dallas" clearly should be "The Dalles." It may be that someone in New York believed that they were correcting a typographical error.



| | | |
|--------------------------|----------------------------------|---|
| April 2001 | Near Klamath Falls | Highway 97 about five miles north of Klamath Falls was closed for approximately six hours following three separate crashes; eleven cars were involved, sending nine people to the hospital; the accidents were due to severely limited visibility caused by high winds blowing dust from a recently plowed field across the highway. ³³⁰ |
| June 2004 ³³¹ | Lake County | Blowing dust from a dry lake bed filled the sky in and near Summer Lake. |
| March 2005 | Deschutes and Jefferson Counties | Visibilities of a half mile or less due to blowing dust were reported from this event. “Motorists on Highway 97 north of Madras reported visibilities down to near zero at times.” ³³² |
| Nov. 2009 ³³³ | Lake County | An alkaline dust storm blew into Lakeview. |

Probability and Vulnerability

As stated in the State Risk Assessment, 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 is 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. Following are the local and state probability and vulnerability descriptions as they stand, without analysis of similarities and differences.

Probability

Local Assessment

Based on the OEM Hazard Analysis conducted by county emergency program managers the probability (High, Moderate, Low) that Region 6 will experience dust storms is depicted in [Table 2-385](#). 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.

³³⁰One of the sources for this is the Herald and News, April 17, 2001, though there are other sources.

³³¹The Oregonian (and Associated Press), June 21, 2004

³³²<https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5439654>

³³³[http://en.wikipedia.org/wiki/Goose_Lake_\(Oregon-California\)](http://en.wikipedia.org/wiki/Goose_Lake_(Oregon-California))



Table 2-385. || Table 2. Local Probability Assessment of Dust Storms

| | Crook | Deschutes | Jefferson | Klamath | Lake | Wheeler |
|-------------|-------|-----------|-----------|---------|------|---------|
| Probability | L | - | - | - | - | - |

Source: Oregon Emergency Management, 2013 County Hazard Analysis Scores.

State Assessment

Five significant storms in 75 years, indicates the history and probability of dust storms in Region 6 are both high.

Vulnerability

Local Assessment

Based on the OEM Hazard Analysis conducted by county emergency program managers, the region’s vulnerability (High, Moderate, Low) to dust storms is depicted in [Table 2-386](#). In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (-). See the [State Risk Assessment](#) for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-386. || Table 3. Local Vulnerability Assessment of Dust Storms

| | Crook | Deschutes | Jefferson | Klamath | Lake | Wheeler |
|---------------|-------|-----------|-----------|---------|------|---------|
| Vulnerability | L | - | - | - | - | - |

Source: Oregon Emergency Management, 2013 County Hazard Analysis Scores.

State Assessment

It is difficult to specifically identify the communities most vulnerable to dust storms in Region 6, but Deschutes, Klamath, and Lake Counties are the places with an identified history. Poor visibility leading to motor vehicle crashes is the worst potential impact of these storms; often these crashes result in fatalities and major injuries. Other impacts include poor air quality, including dust infiltration of equipment and engines, loss of productive soil, and an increase in fine sediment loading of creeks and rivers.

Earthquake

Characteristics

The geographical position of this region makes it susceptible to earthquakes from four sources. These four sources are: (1) the off-shore Cascadia Fault Zone, (2) deep intra-plate events within the subducting Juan de Fuca plate, (3) shallow crustal events within the North America Plate, and (4) earthquakes associated with volcanic activity.

Central Oregon includes portions of five physiographic provinces (High Cascades, Blue Mountains, Basin and Range, High Lava Plains, and Deschutes-Columbia Plateau). Consequently, its geology and earthquake susceptibility varies considerably. There have been several significant earthquakes that have been centered in the region, all in Klamath County: 1920 Crater Lake, and the 1993 Klamath County earthquakes (M5.9 and 6). There are also numerous identified faults in the region (mostly Klamath County) that have been active in the last 20,000 years. The region has also been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered outside the area. Earthquakes



produced through volcanic activity could possibly reach magnitudes of 5.5. The 1980 Mt. St. Helens eruption was preceded by a magnitude 5.1 earthquake. Despite the fact that the Cascade volcanoes are some distance away from major populated centers, earthquake shaking and secondary earthquake-related hazards, such as lahars, can cause major damage away from the volcano.

Most of the region is within a relative moderate seismicity area, except for portions of Klamath County which is within a relative high zone as shown in figure below.

There have been several significant earthquakes that have been centered in the region, all in Lake County: 1906 north of Lakeview, 1923 Lakeview area, 1958 Adel (M4.5), and 1968 Adel swarm (M4.7-5.1). There are also numerous identified faults in the region (mostly in Lake County) that have been active in the last 20,000 years. The region has also been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered outside the area. All considered, there is good reason to believe that the most devastating future earthquakes would probably originate along shallow crustal faults in the region.

Historic Earthquake Events

Table 2-387. || Table 4. Significant Earthquakes in Region 6

| Date | Location | Magnitude (M) | Remarks |
|---|--|----------------------|---|
| Approximate Years 1400 BCE* 1050 BCE 600 BCE 400 CE 750 CE 900 CE | Offshore, Cascadia Subduction Zone | Probably 8-9 | These are the mid-points of the age ranges for these six events. * BCE: Before the Common Era |
| January, 1700 | Offshore, Cascadia Subduction Zone | Approximately 9.0 | Generated a tsunami that struck Oregon, Washington, and Japan. Destroyed Native American villages along the coast |
| April, 1906 | North of Lakeview, OR | V | Three felt aftershocks. |
| April, 1920 | Crater Lake, OR | V | One of three shocks. |
| January, 1923 | Lakeview, OR | VI | |
| 1968 | Adel, OR | 5.1 | Swarm lasted May through July, decreasing in intensity; increased flow at a hot spring . |
| September, 1993 | Klamath Falls, OR | 5.9 and 6.0 | Series of earthquakes, largest: M 6.0. Damage: considerable (in and around Klamath Falls). Fatalities: Two (1 rock fall on highway and 1 heart attack). |
| April, 28 1999 | Christmas Valley, OR | 3.8 | Damage: unknown. |
| April, 1999 | Christmas Valley, OR | 1.9-3.0 | At least 6 earthquakes occurred in the area. |
| June 30, 2004 | SE of Lakeview, OR | 4.4 | Damage: unknown. |
| June, 2004 | SE of Lakeview, OR | 1.9-3.9 | At least 20 earthquakes occurred in the area. |



Source: Wong, Ivan and Bolt, Jacqueline, November 1995, A Look Back at Oregon’s Earthquake History, 1841-1994, *Oregon Geology*, p.125-139. Pacific Northwest Seismic Network

Probability and Vulnerability

As stated in the state risk assessment (pg. XX), 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 is 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. Following are the local and state probability and vulnerability descriptions as they stand, without analysis of similarities and differences.

Probability

Local Assessment

Based on the OEM Hazard Analysis conducted by county emergency program managers, the probability (High, Moderate, Low) that Region 6 will experience earthquakes is depicted in [Table 2-388](#). See the [State Risk Assessment](#) for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-388. || Local Probability Assessment of Earthquakes

| | Crook | Deschutes | Jefferson | Klamath | Lake | Wheeler |
|-------------|-------|-----------|-----------|---------|------|---------|
| Probability | L | M | L | M | M | L |

Source: Oregon Emergency Management, 2013 County Hazard Analysis Scores.

State Assessment

The probability of damaging earthquakes varies widely across the state. In Region 6, the hazard is dominated by local faults and background seismicity. We define the probability of earthquake hazards occurring in Oregon in the following two ways.

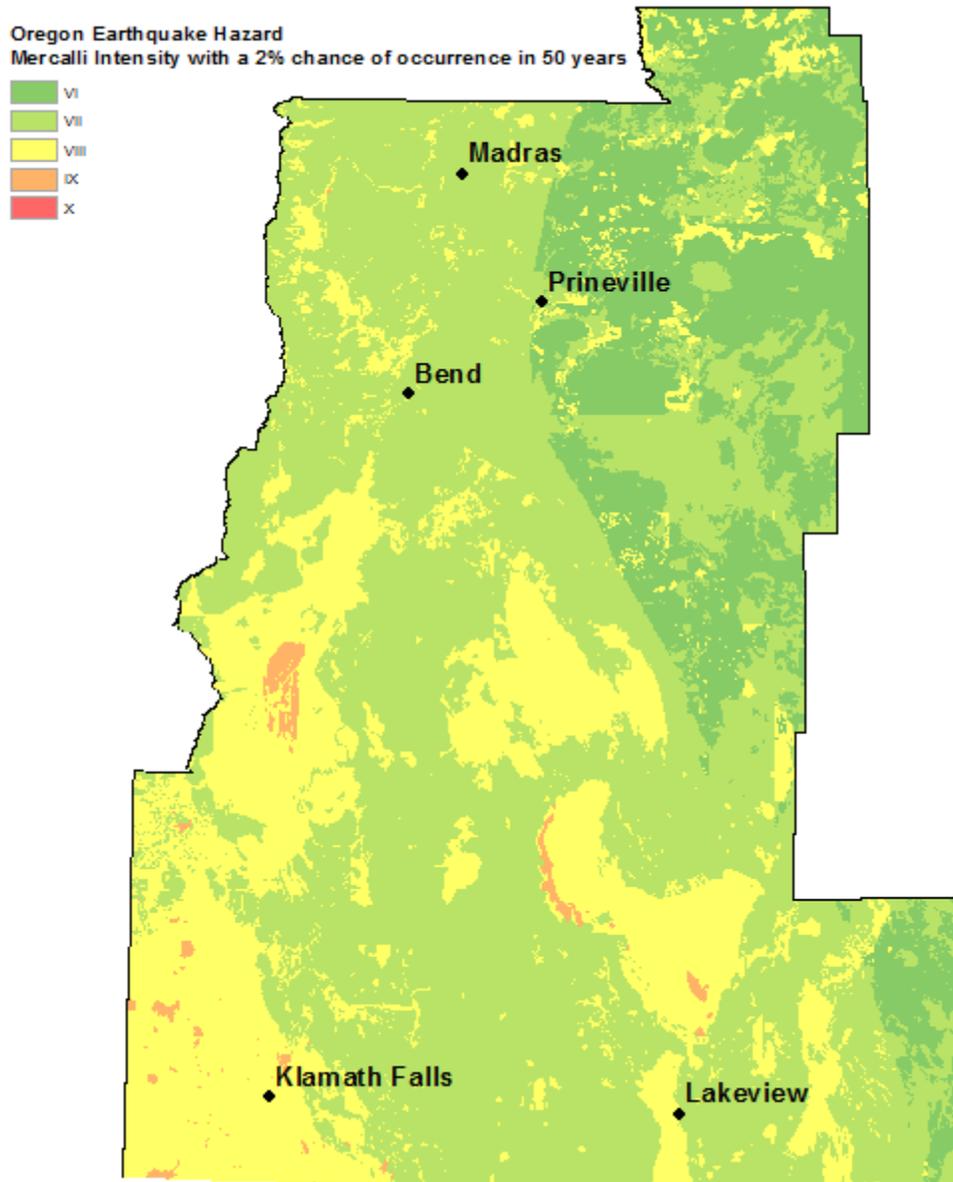
For Region 6, we show the probabilistic hazard in [Figure 182](#). This map shows the expected level of earthquake damage that has a 2 percent chance of occurring in the next 50 years. The map is based on the 2008 USGS National Seismic Hazard Map, and has been adjusted to account for the effects of soils following the methods of Madin and Burns, 2013. In this case, the strength of shaking, calculated as peak ground acceleration and peak ground velocity, have been expressed as Mercalli intensity, which describes the effects of shaking on people and structures, and is more readily understandable for a general audience. These maps incorporate all that is known about the probabilities of earthquake on all Oregon faults, including the Cascadia Subduction Zone.

For Oregon west of the crest of the Cascades, the Cascadia subduction zone is responsible for most of the hazard shown in [Figure 182](#). The paleoseismic record includes 18 M_w 8.8-M 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 7-12%. An additional 10-20 smaller M_w 8.3-8.5 earthquakes only affected 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 182. || Figure xx Region 6 Probabilistic Earthquake Hazard



Source: DOGAMI

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
- X Poorly built structures destroyed, heavy damage in well-built structures

Vulnerability

Based on the OEM Hazard Analysis conducted by county emergency program managers, the region’s vulnerability (High, Moderate, Low) to earthquakes is depicted in [Table 2-389](#). See the [State Risk Assessment](#) for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-389. || Table 3. Local Vulnerability Assessment of Earthquakes

| | Crook | Deschutes | Jefferson | Klamath | Lake | Wheeler |
|---------------|-------|-----------|-----------|---------|------|---------|
| Vulnerability | L | M | L | M | H | M |

Source: Oregon Emergency Management, 2013 County Hazard Analysis Scores.

State Assessment

Region 6 is vulnerable to earthquake-induced landslides, liquefaction and strong ground shaking. One county in Region 6 ranks among the top 15 in the state with the highest expected damages and losses, based on the 500 year model — Klamath.

The Oregon Department of Geology and Mineral Industries (DOGAMI) has also developed two earthquake loss models for Oregon based on the two most likely sources of seismic events: (1) the Cascadia Subduction Zone (CSZ), and (2) combined crustal events (500-year model) . Both models are based on HAZUS, a computerized program, currently used by the Federal Emergency Management Agency (FEMA) as a means of determining potential losses from earthquakes. The CSZ event is based on a potential 8.5 earthquake generated off the Oregon coast. The model does not take into account a tsunami, which probably would develop from the event. The 500-year crustal model does not look at a single earthquake (as in the CSZ model); it encompasses many faults, each with a 10% chance of producing an earthquake in the next 50 years. The model assumes that each fault will produce a single “average” earthquake during this time. Neither model takes unreinforced masonry buildings into consideration.

DOGAMI investigators caution that the models contain a high degree of uncertainty and should be used only for general planning purposes. Despite their limitations, the models do provide some approximate estimates of damage.

Region 6 is vulnerable to earthquake-induced landslides, liquefaction and strong ground shaking. Based on the 500 year model, Klamath County is one of the top 15 counties expected to have highest loss and damage. Results are found in [Table 2-390](#) and [Table 2-391](#).

Table 2-390. || Table 6. Building Collapse Potential in Region 6

| County | Level of Collapse Potential | | | |
|-----------|-----------------------------|----------------|-------------|-------------------|
| | Low (< 1%) | Moderate (>1%) | High (>10%) | Very High (100 %) |
| Crook | 7 | 7 | 3 | 13 |
| Deschutes | 55 | 35 | 41 | 9 |
| Jefferson | 11 | 1 | 12 | 11 |



| | | | | |
|---------|----|----|----|----|
| Klamath | 15 | 10 | 37 | 18 |
| Lake | 13 | 1 | 4 | 10 |
| Wheeler | 5 | 1 | 6 | 3 |

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

Table 2-391. || Table 7. Projected Dollar Losses in Region 6, based on a M8.5 Subduction Event and a 500-Year Model

| REGION 6 COUNTIES | ECONOMIC BASE IN THOUSANDS (1999) | GREATEST ABSOLUTE LOSS IN THOUSANDS (1999) FROM A M 8.5 CSZ EVENT | GREATEST ABSOLUTE LOSS IN THOUSANDS (1999) FROM A 500-YEAR EVENT |
|-------------------|-----------------------------------|---|--|
| CROOK | \$733,000 | Less than \$1,000 | \$6,000 |
| DESCHUTES | \$4,673,000 | \$5,000 | \$71,000 |
| JEFFERSON | \$707,000 | Less than \$1,000 | \$14,000 |
| KLAMATH | \$3,134,000 | \$41,000 | \$939,000 |

Source: DOGAMI, 1999, Special Paper 29: Earthquake Damage in Oregon.

Note: New HAZUS data was developed for Jefferson County using HAZUS-MH. That data is available through: Source: Burns, 2007. Unpublished Report. Geologic Hazards, Earthquake and Landslide Hazard Maps, and Future Earthquake Damage and Loss Estimates for Seven Counties in the Mid-Columbia River Gorge Region Including Hood River, Wasco, Sherman, Gilliam, Morrow, Umatilla, Jefferson, and Wheeler, DOGAMI Open File Report.

Table 2-392. || Table 8. Estimated Losses in Region 6 Associated with a M 8.5 Subduction Event

| | CROOK | DESCHUTES | JEFFERSON | KLAMATH |
|--------------------------------------|-----------|-----------|-----------|-----------|
| INJURIES | 0 | 1 | 0 | 14 |
| DEATHS | 0 | 0 | 0 | 0 |
| DISPLACED HOUSEHOLDS | 0 | 0 | 0 | 37 |
| ECONOMIC LOSSES FOR BUILDING | \$156,000 | \$5 mil | \$764,000 | \$41 mil |
| OPERATIONAL THE DAY AFTER THE EVENT | | | | |
| Fire stations | 96% | 100% | 100% | 99% |
| Police stations | 96% | 99% | 100% | 99% |
| Schools | 97% | 99% | 99% | 97% |
| Bridges | 100% | 100% | 100% | 98% |
| ECONOMIC LOSSES TO INFRASTRUCTURE | | | | |
| Highways | \$6,000 | \$17,000 | \$9,000 | \$339,000 |
| Airports | 0 | \$40,000 | 0 | \$642,000 |
| Communications | \$8,000 | \$2,000 | 0 | \$141,000 |
| DEBRIS GENERATED (thousands of tons) | 0 | 3 | 1 | 28 |

Source: DOGAMI, 1999, Special Paper 29: Earthquake Damage in Oregon.

Table 2-393. || Table 9. Estimated Losses in Region 6 Associated with a 500-Year Model

| REGION 6 COUNTIES | CROOK | DESCHUTES | JEFFERSON | KLAMATH |
|--|------------------|-----------|-----------|-----------|
| INJURIES | 1 | 17 | 7 | 630 |
| DEATHS | 0 | 0 | 0 | 12 |
| DISPLACED HOUSEHOLDS | 0 | 5 | 12 | 1,409 |
| ECONOMIC LOSSES FOR BUILDINGS ² | 5.5 mil | \$71 mil | \$14 mil | \$939 mil |
| OPERATIONAL THE DAY AFTER THE EVENT | | | | |
| Fire stations | | | | |
| Police stations | N/A ³ | N/A | N/A | N/A |



| | | | | |
|--|-----------|-----------|-----------|----------|
| Schools | N/A | N/A | N/A | N/A |
| Bridges | N/A | N/A | N/A | N/A |
| | N/a | N/A | N/A | N/A |
| ECONOMIC LOSSES TO INFRASTRUCTURE | | | | |
| Highways | \$879,000 | \$572,000 | \$698,000 | \$28 mil |
| Airports | \$316,000 | \$2 mil | \$395,000 | \$15 mil |
| Communications | \$18 mil | \$1 mil | \$104,000 | \$14 mil |
| DEBRIS GENERATED (thousands of tons) | 0 | 47 | 10 | 610 |

Source: DOGAMI, 1999, Special Paper 29: Earthquake Damage in Oregon.

Table 7 Notes:

¹Every part of Oregon is subject to earthquakes. The 500-year model is an attempt to quantify the risk across the state. The estimate does not represent a single earthquake. Instead, the 500-year model includes many faults. More and higher magnitude earthquakes than used in this model may occur (DOGAMI, 1999).

² “...there are numerous un-reinforced masonry structures (URMs) in Oregon, the currently available default building data does not include any URMs. Thus, the reported damage and loss estimates may seriously under-represent the actual threat” (page 126 – 1998, DOGAMI)

³NA - Because the 500-year model includes several earthquakes, the number of facilities operational the “day after” cannot be calculated

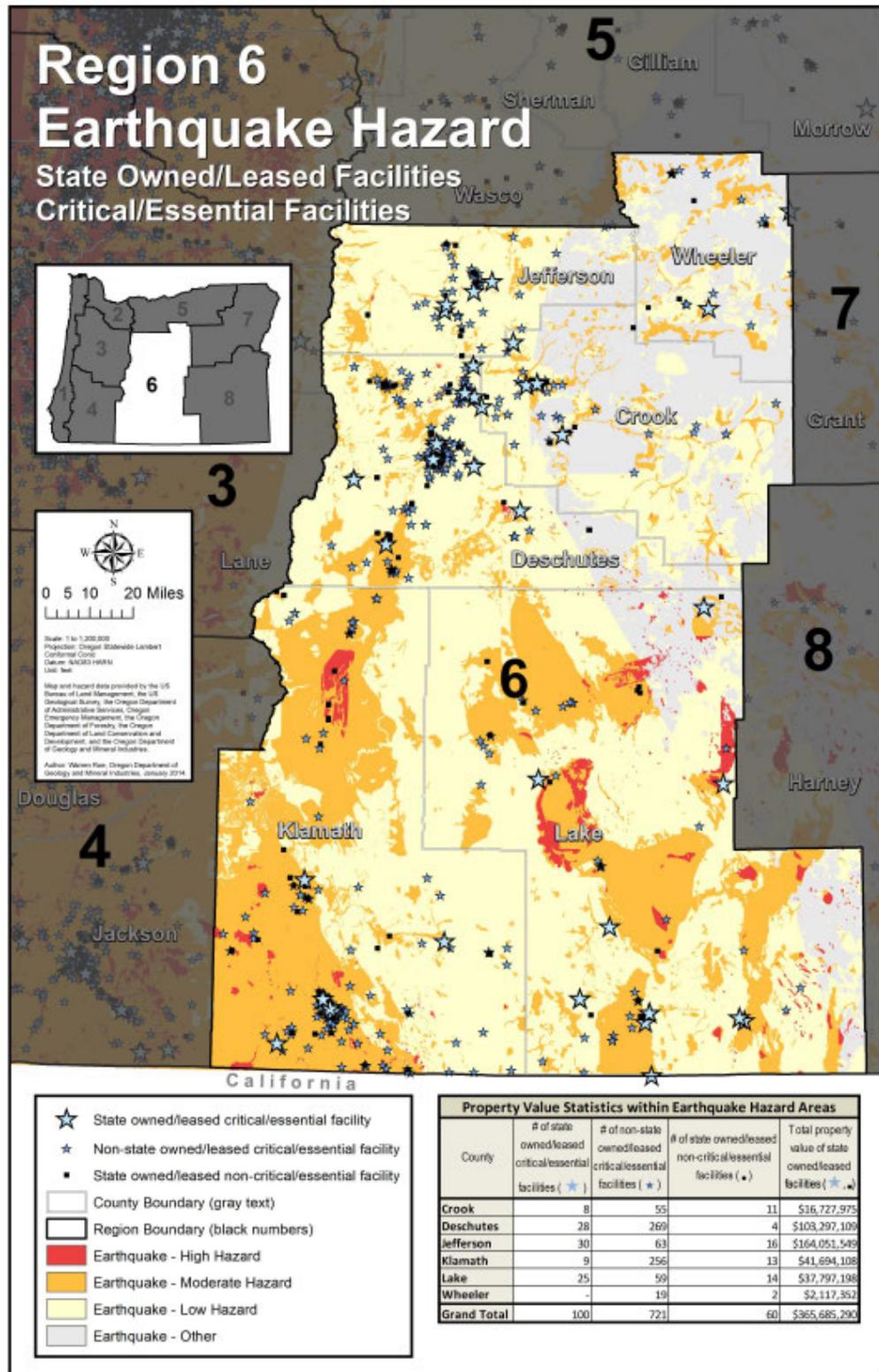
State Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical and essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, [Oregon Vulnerabilities](#) section for more information.

Of 5,693 state facilities evaluated, 160 totaling roughly \$366 million worth of property are located in an earthquake hazard zone in Region 6 ([Figure 183](#)). Among the 1,141 critical and essential state facilities, 100 are in an earthquake hazard zone in Region 6. Additionally, 721 non-state critical/essential facilities in Region 6 are located in an earthquake hazard zone.



Figure 183. || Figure 2-R6-EQ-2: State Owned/ Leased Facilities and Critical/ Essential Facilities in an Earthquake Zone in Region 6



Source: DOGAMI



Seismic Lifelines

According to the Oregon Department of Transportation’s (ODOT) Oregon Seismic Lifeline Report (OSLR), Region 6 has the following vulnerabilities to seismic lifelines. For a detailed description of the OSLR report and findings see [Section 2.2.3.6 Seismic Transportation Lifeline Vulnerabilities](#).

Regional delineations for this Plan and for the OSLR are slightly different. Regions in the OSLR that correspond to Region 6 include sections of the OSLR Cascades and Central Geographic Zones, as follows:

- *Cascades Geographic Zone:* The Cascades Geographic Zone consists of five crossings of the Cascades from western to central Oregon. These routes connect the highly seismically impacted western portion of the state to the central portion of the state that is expected to have less impact from a Cascadia Subduction Zone event. In addition, the southernmost route can serve as a connection from Medford to the Klamath Falls area in the event of a seismic event in the Klamath Falls area.

The Tier 1 system in the Cascades Geographic Zone consists of OR 58. The Tier 2 system in the Cascades Geographic Zone consists of: OR 22 from Salem to Santiam Junction and US 20 from Santiam Junction to Bend and OR 140 from Medford to Klamath Falls. There are no corridors designated as Tier 3 in this Region.

- *Central Geographic Zone:* Region 6 also includes the southerly portion of the Central Geographic zone. The Tier 1 system in this part of the Central Geographic Zone consists of US 97.

Regional Impact

Ground Shaking: In Region 6, ground shaking from a CSZ event is not expected to cause damage. However, a Klamath Falls event, either a local event or possibly one triggered by a CSZ event, can cause extensive damage. Unreinforced structures, roadbeds and bridges will be damaged to varying extents. Unreinforced bridges on lifeline corridors may be damaged and require clearing and/or temporary repairs to remain in service.

Landslides and Rockfall: The east/west routes in this Region are cut into or along landslide prone features in some areas where removal of slide and rockfall material is an ongoing responsibility of ODOT Maintenance crews. A major seismic event may increase landslide and rockfall activities and may reactivate ancient slides that are currently inactive.

Liquefaction: Structures in wetland, alluvial and other saturated areas will be subject to liquefaction damage; the total area of such impacts will vary with the extent of saturated soils at the time of the event. The Klamath Basin is the one area in this Region with extensive wetland and otherwise saturated soil areas.

Regional Loss Estimates

Economic losses caused by a CSZ event were not calculated for the specific zones of study or for specific highway facilities. The economic loss assessment statewide considered only the losses directly due to highway closures, so, for example, it does not include productivity losses due to business site damage. The highway related losses include disconnection from supplies and replacement inventory, and the loss of tourists and other customers who must travel to do business with affected businesses. Losses in this Region are expected to be low locally. Economic



disruption from major losses in the larger markets of the state will affect the economy in this Region.

Most Vulnerable Jurisdictions

Crook, Deschutes, Jefferson, Wheeler, Lake and Klamath have similar, relatively low vulnerability to ground shaking from a CSZ event and resulting landslides and rockfall. Relative to the western Regions of the state, fewer roadways in this Region are sited in landslide prone areas, especially in developed areas, but those that are may be minimally engineered so easily damaged.

Klamath County is the most vulnerable county to a local surface fault earthquake, with ground shaking for over 50 miles noted for relatively small earthquakes. A Klamath Falls earthquake could cause damage in Lake and Jackson Counties, as well.



Flood

Characteristics

Central Oregon is subject to a variety of flood conditions, including (1) spring run-off from melting snow, (2) intense warm rain during the winter months, (3) ice-jam flooding, (4) local flash flooding, (5) lake flooding associated with high winds (e.g., Klamath Lake), and (6) flooding associated with the breaching of natural debris dams. Although not as notable as flash floods, the most common flood condition in Central Oregon is associated with warm winter rain on snow.

Rain-on-snow floods, so common in western Oregon, also occur east of the Cascades. The weather pattern that produces these floods occurs during the winter months and has come to be associated with La Nina events, a three to seven year cycle of cool, wet weather. Brief, cool, moist weather conditions are followed by a system of warm, moist air from tropical latitudes. The intense warm rain associated with this system quickly melts foothill and mountain snow. Above-freezing temperatures may occur well above pass levels in the Cascade Mountains (4,000-5,000 feet). Some of Oregon's most devastating floods are associated with these events.³³⁴

Although flooding occurs throughout central Oregon, local geology and the relatively low population of the six-county area lessen its effects. Volcanic rocks, some of which have a large capacity for water storage, underlie much of the region. Consequently, the discharge rates for some streams (e.g., Deschutes River) are very low considering the size of their basins.³³⁵ In addition, there are some large reservoirs in the upper watersheds that can contain considerable quantities of runoff. Potential flood losses also are mitigated through land-use standards; all Region 6 communities participate in the National Flood Insurance Program.

The Flood Insurance Studies (FIS) for each of the Region 6 counties provide some insights associated with ice jam flooding (Deschutes County), lake level differentials produced by local wind conditions (Klamath County), and possible flooding caused by the failure of natural debris dams (Deschutes County). Although these phenomena have not and would not produce devastation like historical flash floods in Jefferson County, they certainly warrant the consideration of local emergency managers.

³³⁴ George Taylor, 1999.

³³⁵ June 8, 1998, Deschutes County Flood Insurance Study.



Historic Flood Events

Table 2-394. || Table 15. Significant Historic Floods

| Date | Location | Description | Type of Flood |
|----------------|--------------------------------|--|---------------|
| June, 1884 | Wheeler County (Painted Hills) | Mother and 3 children perished | Flash flood |
| June, 1900 | Wheeler County (Mitchell) | Large area of county devastated | Flash flood |
| December, 1964 | Entire state | Severe flooding in central Oregon | Rain on snow |
| August, 1976 | Jefferson County (Ashwood) | Severe flooding. Damaged buildings | Flash flood |
| February, 1986 | Entire state | Severe flooding | Rain on snow |
| August, 1991 | Crook County (Aspen Valley) | Severe flooding. 1 fatality | Flash flood |
| March, 1993 | Wheeler County | Severe flooding | ROS |
| May, 1998 | Crook County (Prineville) | Federal disaster declaration (FEMA-DR-1221-OR); Ochocho Dam threatened | Rain on snow |
| Dec., 2005 | Crook, Deschutes Counties | \$1,000,000 in property damage | |
| Dec., 2005 | Klamath and Lake Counties | \$500,000 in property damage | |
| June 2006 | Klamath County | A dike on Upper Klamath Lake failed, inundating agricultural fields, the Running Y Golf Resort, and State Highway 140. | Flash Flood |

Source: Taylor, George and Raymond Hatton, 1999, The Oregon Weather Book.

Source: Hazards & Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from <http://www.sheldus.org>

Source: U.S. Department of Commerce. National Climatic Data Center. Available from <http://www4.ncdc.noaa.gov/cgi-win/wwwcgi.dll?wwevent~storms>

Table 2-395. || Table 16. Principal Riverine Flood Sources

| Crook County | Deschutes County | Jefferson County | Klamath County | Lake County | Wheeler County |
|---------------|------------------------|--------------------------------|--------------------|---------------------|----------------|
| Crooked River | Deschutes River | Willow Creek | Sprague River | Chewaucan River | Bridge Creek |
| Ochocho River | Little Deschutes River | Unnamed stream north of Culver | Williamson River | N. Goose Lake Basin | Keyes Creek |
| | Squaw Creek | Muddy Creek | Klamath River | | |
| | Paulina Creek | | Williamson River | | |
| | Spring River | | Link River | | |
| | | | Four Mile Creek | | |
| | | | Varney Creek | | |
| | | | Upper Klamath Lake | | |

Sources: FEMA, Crook County Flood Insurance Study (FIS) 07/17/89; FEMA, Deschutes County FIS, 06/08/98; FEMA, Jefferson County FIS, 07/17/89; FEMA, Klamath County FIS, 06/18/84; FEMA.



Probability and Vulnerability

As stated in the state risk assessment (pg. XX), 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 is 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. Following are the local and state probability and vulnerability descriptions as they stand, without analysis of similarities and differences.

Probability

Local Assessment

Based on the OEM Hazard Analysis conducted by county emergency program managers, the probability (High, Moderate, Low) that Region 6 will experience flooding is depicted in [Table 2-396](#). See the [State Risk Assessment](#) for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-396. || Table 2. Local Probability Assessment of Floods

| | Crook | Deschutes | Jefferson | Klamath | Lake | Wheeler |
|-------------|-------|-----------|-----------|---------|------|---------|
| Probability | H | H | H | M | H | H |

Source: Oregon Emergency Management, 2013 County Hazard Analysis Scores.

State Assessment

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

All of the Region 6 counties have Flood Insurance Rate Maps (FIRM); however, some of the maps are old and could be outdated. The FIRM maps were issued at the following times:

- Crook, February 2012;
- Deschutes, September 2007;
- Jefferson, July 17, 1989;
- Klamath, December 18, 1984;
- Lake, December 5, 1989;
- Wheeler, July 17, 1989.

Significant flooding occurs at least once every 5-7 years.



Vulnerability

Local Assessment

Based on the OEM Hazard Analysis conducted by county emergency program managers the region’s vulnerability (High, Moderate, Low) to flooding is depicted in [Table 2-397](#). See the [State Risk Assessment](#) for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-397. || Table 3. Local Vulnerability Assessment of Floods

| | Crook | Deschutes | Jefferson | Klamath | Lake | Wheeler |
|---------------|-------|-----------|-----------|---------|------|---------|
| Vulnerability | H | L | M | M | M | M |

Source: Oregon Emergency Management, 2013 County Hazard Analysis Scores.

State Assessment

Each county in this region received a flood vulnerability score of five, except for Klamath County which received a score of six.

FEMA has identified no Repetitive Loss properties in Region 6.³³⁶

Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCDC encourages communities that adopt such standards to participate in FEMA’s Community Rating System (CRS), which results in reduced flood insurance costs. This region has no CRS communities

State Owned/Leased Facilities and Critical and Essential Facilities

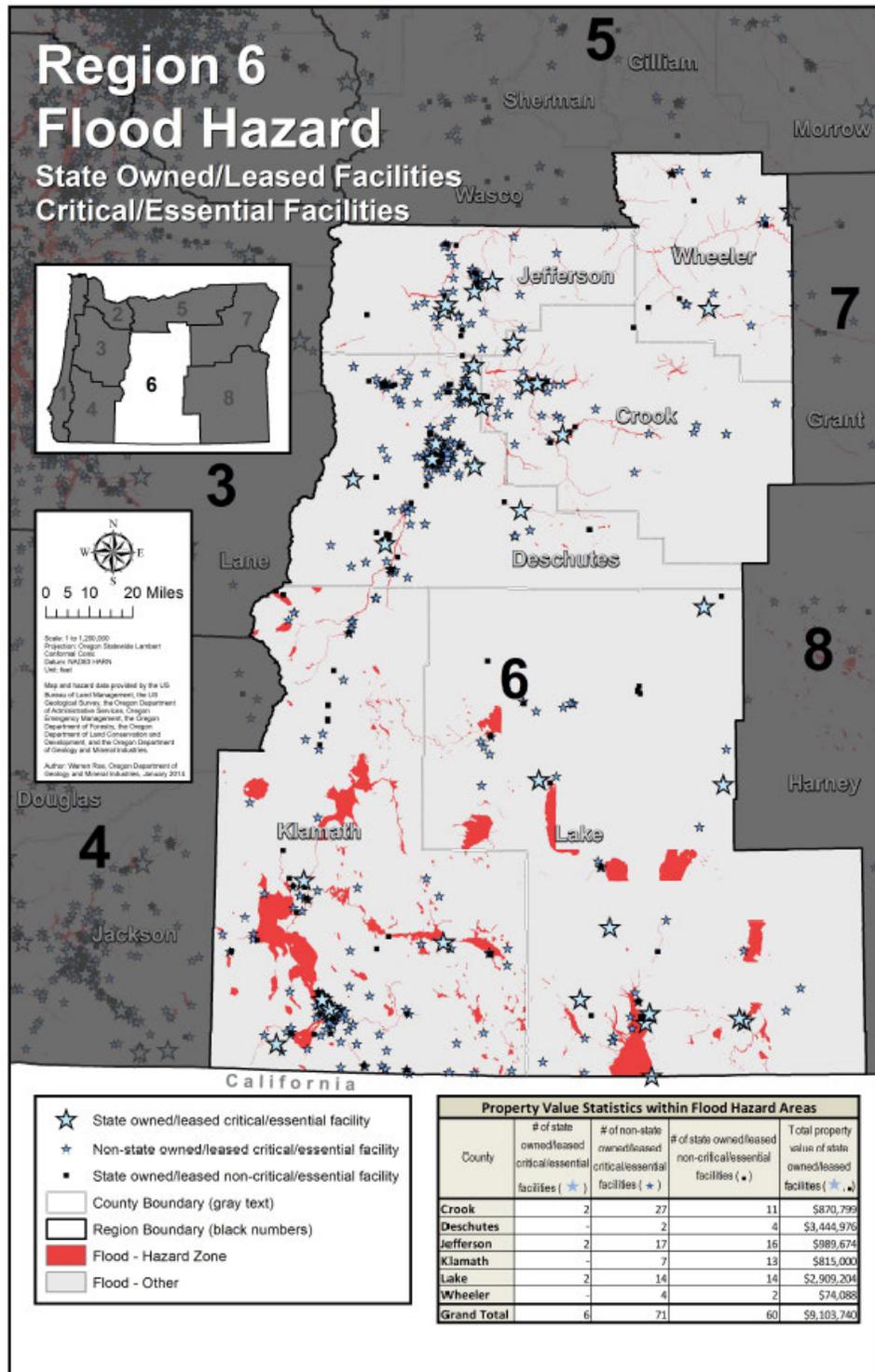
The following information is based on a state facility and critical and essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, [Oregon Vulnerabilities](#) section for more information.

Of the 5,693 state facilities evaluated, 66 are currently located within a flood hazard zone in Region 6 and have an estimated total value over \$9 million ([Figure 184](#)). Of these, 6 are identified as a critical or essential facility. An additional 60 non-state owned/leased critical/essential facilities are located in a flood hazard zone in Region 6.

³³⁶ FEMA BureauNet, accessed 12/1/2014



Figure 184. || Figure 2-R6-FL-1: State Owned/ Leased Facilities and Critical/ Essential Facilities in a Flood Hazard Zone in Region 6



Source: DOGAMI



Landslide

Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. In general, the Cascade Mountain Range and the Klamath Mountains have a high incidence of landslides. On occasion, major landslides occur on US or State Highways that sever these major transportation routes (including rail lines) causing temporary but significant economic damage.

Most landslides in Region 6 occur within the US Highway 26 corridor (Prineville-Mitchell). U.S. Highway 97 just north of Klamath Falls has a history of rock falls. One person was killed by a rockslide in this area during the 1993 Klamath Falls earthquake.

Historic Landslide Events

Table 2-398. || Table 19. Significant Landslides in Region 6

| Date | Location | Description |
|------------|----------------------|---|
| Dec., 2005 | Jefferson County, OR | Damage: \$11,666.67 * (includes Sherman and Wasco Counties) |

Source: Hazards & Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from <http://www.sheldus.org>

Probability and Vulnerability

As stated in the State Risk Assessment, 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 is 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. Following are the local and state probability and vulnerability descriptions as they stand, without analysis of similarities and differences.

Probability

Local Assessment

Based on the OEM Hazard Analysis conducted by county emergency program managers, the probability (High, Moderate, Low) that Region 6 will experience landslides is depicted in [Table 2-399](#). 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 2-399. || Table 2. Local Probability Assessment of Landslides

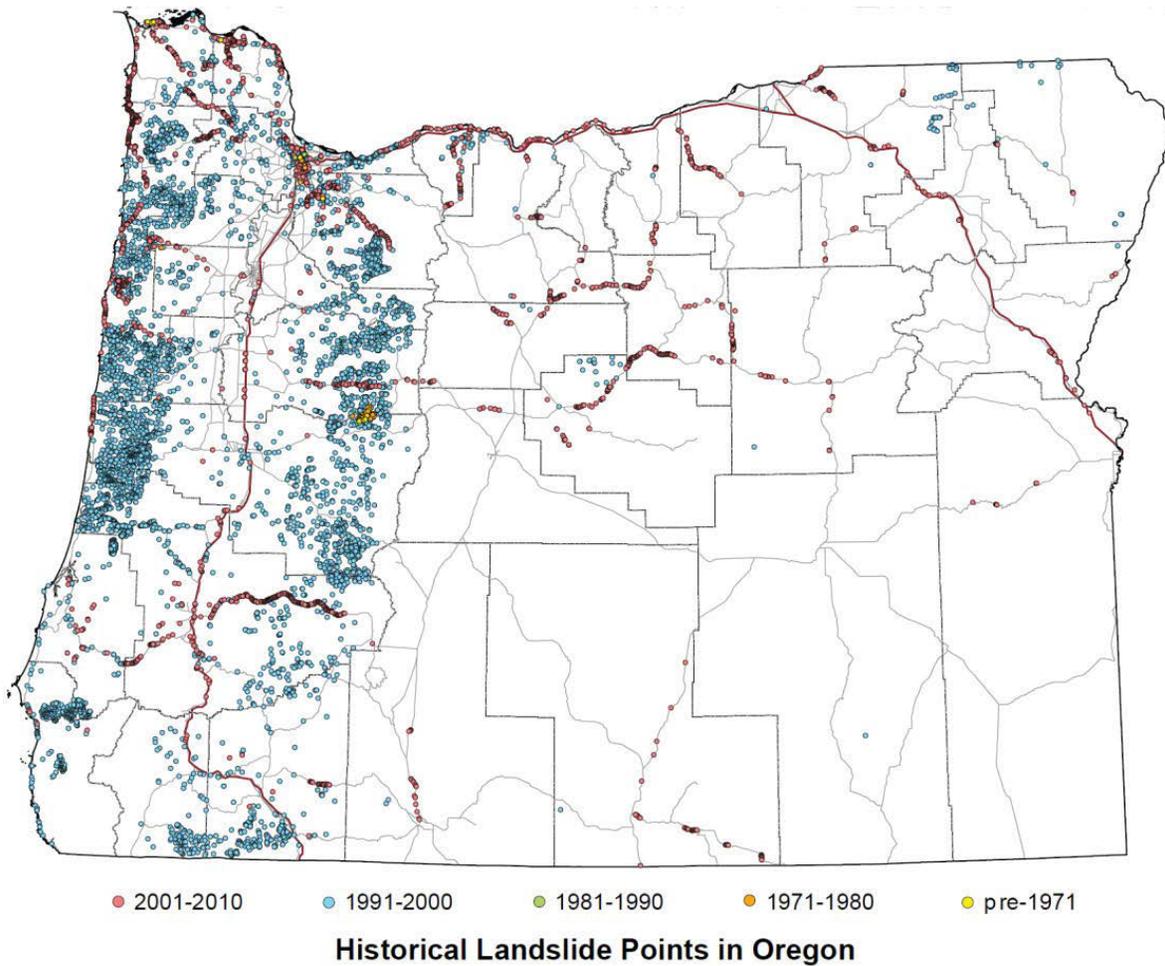
| | Crook | Deschutes | Jefferson | Klamath | Lake | Wheeler |
|-------------|-------|-----------|-----------|---------|------|---------|
| Probability | M | - | M | - | M | - |

Source: Oregon Emergency Management, 2013 County Hazard Analysis Scores.

State Assessment

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

Figure 185. || Figure X: Historic Landslides in Oregon



Source: Burns, W.J., Mickelson, K.A., Saint-Pierre, E.C., 2011. Statewide Landslide Information Database of Oregon Release-2, Oregon Department of Geology and Mineral Industries, SLIDO-2



Vulnerability

Local Assessment

Based on the OEM Hazard Analysis conducted by county emergency program managers, the region’s vulnerability (High, Moderate, Low) to landslides is depicted [Table 2-400](#). 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 2-400. || Table 3. Local Vulnerability Assessment of Landslides

| | Crook | Deschutes | Jefferson | Klamath | Lake | Wheeler |
|---------------|-------|-----------|-----------|---------|------|---------|
| Vulnerability | L | - | L | - | L | - |

Source: Oregon Emergency Management, 2013 County Hazard Analysis Scores.

State Assessment

Many of the historic landslides occur along the highways in this region and the areas along the Cascade Mountains (Burns et al., 2012).

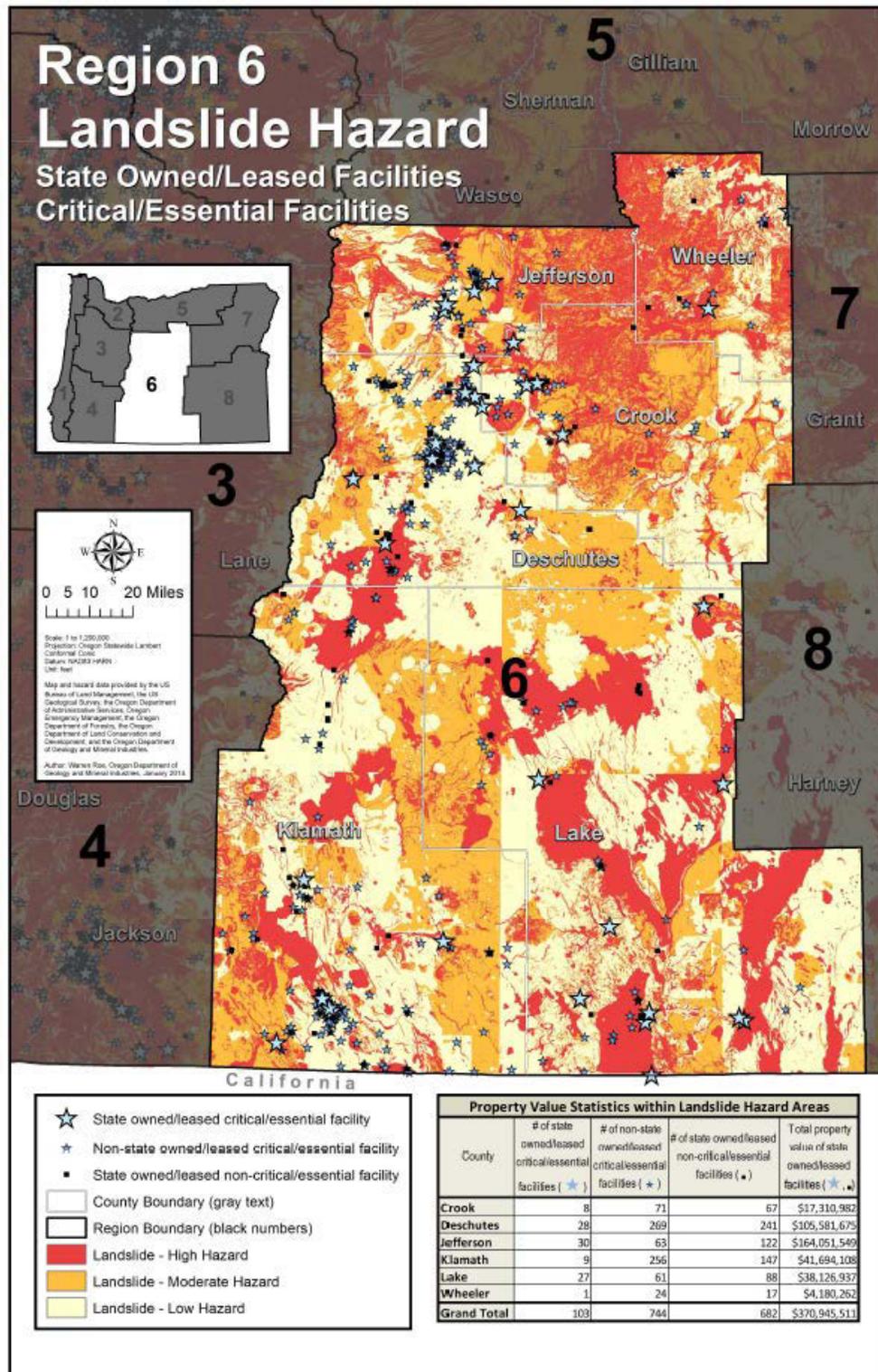
State Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical and essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, [Oregon Vulnerabilities](#) for more information.

Of the 5,693 state facilities evaluated, 785 are located within landslide hazard areas in Region 6, totaling roughly \$ 371 million ([Figure 186](#)). This includes 103 critical or essential facilities. 744 additional critical/essential facilities, not owned/leased by the state, also reside within a landslide hazard zone in Region 6.



Figure 186. || Figure 2-R6-LS-1: State Owned/ Leased Facilities and Critical/ Essential Facilities in a Landslide Hazard Zone in Region 6



Source: DOGAMI



Volcano

Characteristics

The western boundaries of Jefferson, Deschutes and Klamath counties coincide with the Cascade Mountains. Volcanic activity in the Cascades will continue, but questions regarding how, to what extent, and when, remain. Most volcano-associated hazards are local (e.g., explosions, debris, lava, and pyroclastic flows). However, lahars can travel considerable distances down stream valleys and wind-borne ash can blanket areas many miles from the source.

There is virtually no risk from lahars, debris or pyroclastic flows in Wheeler and Crook counties, although normal prevailing winds could carry ash into those areas. Jefferson, Deschutes, and Klamath counties are at risk, however, and should consider the impact of volcano-related activity on small mountain communities, natural debris dams (e.g., South Sister, Broken Top), dams creating reservoirs, tourist destinations (e.g., Crater Lake), highways and railroads. These counties also should consider probable impacts on the local economy (e.g., wood products and recreation) should a volcano-related hazard occur.

The history of volcanic activity in the Cascade Range is contained in its geologic record, and the age of the volcanoes vary considerably. Some lava flows on Washington’s Mt. Rainier are thought to be older than 840,000 years; Mt. Saint Helens erupted in May 1980, and continues to be active. In short, all of the Cascade volcanoes are characterized by long periods of quiescence and intermittent activity. And these characteristics make predictions, recurrence intervals, or probability very difficult to attain.

Several Region 6 communities are within a few miles of prominent volcanoes. Mt. Jefferson, the Three Sisters, Broken Top, and Mt. Bachelor dominate the skyline between Redmond and Bend (Deschutes County). A less imposing, but none-the-less important volcano, Newberry Crater, is within 15 miles of La Pine (Deschutes County) and less than 25 miles from the City of Bend. The string of volcanoes continues south with Mt. Thielsen, Mt. Scott (Crater Lake), and Mt. McLaughlin dominating the horizon. The composition, eruptive behavior and history of these volcanoes are not the same, which probably has a bearing on any future activity.

Historic Volcanic Events

Table 2-401. || Table V-10. Historic Volcanic Events in Region 6

| Date | Location | Description |
|-----------------------------|--|---|
| ~18,000 to 7700 YBP | Mount Bachelor, central Cascades | Cinder cones, lava flows |
| ~13,000 YBP | Lava Mountain, south-central Oregon | Lava Mountain field, lava flows |
| ~13,000 YBP | Devils Garden, south-central Oregon | Devils Garden field, lava flows |
| ~13,000 YBP | Four Craters, south-central Oregon | Four Craters field, lava flows |
| ~7700 YBP | Crater Lake Caldera | Formation of Crater Lake caldera, pyroclastic flows, widespread ash fall. |
| < 7700 YBP; 5300 – 5600 YBP | Davis Lake, southern Cascades | Lava flows and scoria cones in Davis Lake field. |
| ~10,000 - <7,700 YBP | Cones south of Mount Jefferson; Forked Butte and South Cinder Peak | Lava flows |



| | | |
|------------|------------------------------------|--------------------------------|
| ~ 2000 YBP | South Sister Volcano | Rhyolite lava flow. |
| ~1300 YBP | Newberry Volcano, central Oregon | Eruption of Big Obsidian flow. |
| ~1300 YBP | Blue Lake Crater, central Cascades | Spatter cones and tephra |

Sources: Source: Source: U.S. Geological Survey, Cascades Volcano Observatory: <http://volcanoes.usgs.gov/observatories/cvo/>
 Sherrod et al. (1997); Bacon et al. (1997); Walder et al. (2000); Scott et al. (2001)

Probability and Vulnerability

As stated in the State Risk Assessment, 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 is 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. Following are the local and state probability and vulnerability descriptions as they stand, without analysis of similarities and differences.

Probability

Local Assessment

Based on the OEM Hazard Analysis conducted by county emergency program managers, the probability (High, Moderate, Low) that Region 6 will experience volcanic hazards is depicted in **Table 2-402**. 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 2-402. || Table 2. Local Probability Assessment of Volcanic Activity

| | Crook | Deschutes | Jefferson | Klamath | Lake | Wheeler |
|-------------|-------|-----------|-----------|---------|------|---------|
| Probability | L | L | L | L | L | - |

Source: Oregon Emergency Management, 2013 County Hazard Analysis Scores.

State Assessment

The probability of volcanic activity can be very difficult to predict, unless there are obvious precursors. The precursors might include increased seismic activity, temperature and chemical changes in groundwater, etc. Probability is especially difficult when the volcano has been inactive for many thousands of years and lacks a clear geologic record of past events. Also, the knowledge of volcanoes is too limited to know how long a dormant period at any volcano can last,³³⁷ and this probably is the case for most Cascade volcanoes. Eruption probabilities

³³⁷ USGS OFR 99-24, p. 6.



generated by the U.S Geological Survey for the Oregon Cascades are largely based on the position of volcanic rocks in the geologic record. There is a considerable opportunity for error.

[Table 2-403](#) describes the probability of volcano-related hazards in Region 6.

Table 2-403. || Table V-11. Probability of Volcano-Related Hazards

| Volcano-Related Hazards | Jefferson | Deschutes | Klamath | Crook | Remarks |
|---|--------------------------|--|--|------------|--|
| Volcanic ash (annual probability of 1cm or more accumulation from eruptions throughout the Cascade Range) | 1 in 5,000 | 1 in 5,000 | 1 in 5,000 | 1 in 5,000 | Sherrod et al. (1997) |
| Lahar | Source: Mt. Jefferson | Source: Newberry Crater and Three Sisters | Source: Crater Lake | No Risk | If the Detroit Lake dam is breached, lahars could reach Mill City, Lyons, and Stayton in Marion County. Walder et al. (2000) (Maps) Lane County: Scott et al. (2001) (Map) |
| Lava flow | Source: Mt. Jefferson | Source: Newberry Crater and Three Sisters | Source: Crater Lake | No Risk | Mt. Jefferson: Walder et al. (2000) (Maps) Three Sisters: Scott et al. (2001) (Maps) |
| Debris flow / avalanche | Source: Mt. Jefferson | Source: Three Sisters | Source: Crater Lake | No Risk | Mt. Jefferson: Walder et al. (2000) (Maps) Three Sisters: OFR Scott et al. (2001) (Maps) |
| Pyroclastic flow | Source: Mt. Jefferson | Source: Newberry Crater and Three Sisters | Source: Crater Lake and Newberry Crater | No Risk | Mt. Jefferson: Walder et al. (2000) (Maps) Three Sisters: OFR Scott et al. (2001) (Maps) |

Source: USGS Open File Reports Sherrod et al. (1997), Walder et al. (2000), Scott et al. (2001)

Vulnerability

Local Assessment

Based on the OEM Hazard Analysis conducted by county emergency program managers, the region’s vulnerability (High, Moderate, Low) to volcanic hazards is depicted in [Table 2-404](#). In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (-). See the [State Risk Assessment](#) for background information on the OEM Hazard Analysis and scoring methodology.



Table 2-404. || Table 3. Local Vulnerability Assessment of Volcanic Activity

| | Crook | Deschutes | Jefferson | Klamath | Lake | Wheeler |
|---------------|-------|-----------|-----------|---------|------|---------|
| Vulnerability | H | H | H | L | H | - |

Source: Oregon Emergency Management, 2013 County Hazard Analysis Scores.

State Assessment

The U.S. Geological Survey has addressed volcanic hazards at Mount Jefferson (Walder et al., 2000), the Three Sisters (Scott et al., 2001), Newberry Volcano (Sherrod et al., 1997), and Crater Lake (Bacon et al., 1997). These reports include maps depicting the areas at greatest risk. Communities which are closer to the main volcanic edifices such as Bend, Sisters, La Pine, and Klamath Falls are at the greatest risk for inundation by lava flows, pyroclastic flows, lahars, or ash fall. Counties on the eastern side of region 6 may be subject to ash fall from Cascade volcanoes.

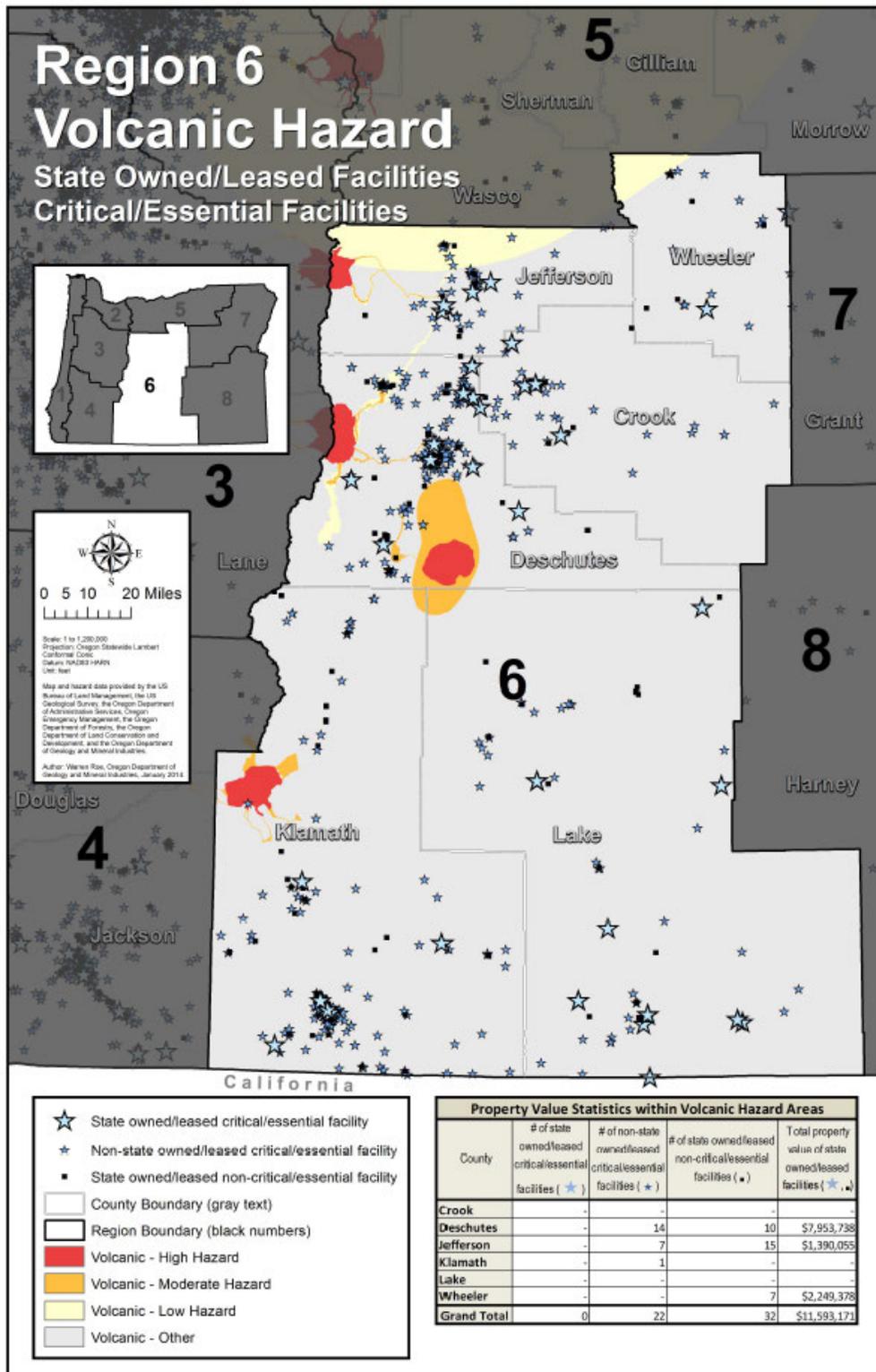
State Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical and essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, Oregon Vulnerabilities for more information.

Of the 5,693 state facilities evaluated, 32 are within a volcanic hazard zone in Region 6 and total about \$11.6 million in property value (**Figure 187**). None of these state facilities are critical or essential facilities. 22 non-state critical/essential facilities are also located in volcanic hazard zone in Region 6.



Figure 187. || Figure 2-R6-V-1: State-Owned or -Leased Facilities and Critical and Essential Facilities in a Volcanic Hazard Zone in Region 6



Source: DOGAMI



Wildfire

Characteristics

Oregon Senate Bill (SB) 360 Forestland / Urban Interface Protection Act has been implemented in all counties in Region 6. The growth of the wildland-urban interface occurs in areas dominated by juniper, sage, and grass. As populations increase, so do the number of wildland fires. Homes are widely dispersed in these pine-fringe areas, putting them at a greater risk of a high-intensity wildfire.

The hazard of wildland fire is high in region 6 due to ladder fuels and overstocked ponderosa pine stands, juniper invasion into sagebrush and grasslands, and the pervasiveness of invasive weeds such as cheat grass and Medusahead grass. Fire risk is extreme during the late summer and fall months when grasses and weeds are dry. These flashy fuels are easily ignited, burn rapidly and resist suppression. Many structures are at risk because owners do not follow Firewise guidelines for protection.

Historic Wildfire Events

Table 2-405. || Table 11. Significant Wildfires

| Year | Name of Fire | Location | Acres Burned | Remarks |
|------|---------------------|----------------|--|---|
| 1981 | Redmond | | | State Conflagration Act Fire |
| 1984 | Crooked River Ranch | | | State Conflagration Act Fire |
| 1985 | Crooked River Ranch | | | State Conflagration Act Fire |
| 1990 | Delicious | Deschutes | 1704 | |
| 1990 | Awbrey Hall | Deschutes | 3,400 | This fire was an act of arson that affected the western fringe of Bend. |
| 1992 | Hanes Butte | Deschutes | 348 | |
| 1992 | Sage Flat | Deschutes | 995 | |
| 1992 | Round Lake | Klamath | 490 | |
| 1992 | Lone Pine | Klamath | 30,320 | |
| 1994 | LaClair | Jefferson | | |
| 1995 | Day Road | Deschutes | | |
| 1996 | Little Cabin | Jefferson | 2,438 | |
| 1996 | Smith Rock | Deschutes | 500 | 1 structure was destroyed in this fire. |
| 1996 | Simnasho | Jefferson | | |
| 1996 | Skeleton | Deschutes | 17,700 | 19 structures were destroyed in this fire impacting the eastern fringe of Bend. |
| 1996 | Ashwood/Donnybrook | Central Oregon | 118,000 | This fire burned in areas of the state not protected from fire. |
| 1996 | Wheeler Point | Wheeler | 21,980 | |
| 1999 | McCain Road | Deschutes | 99 | Prineville |
| 2002 | Eyerly | Jefferson | 23,573 | 37 structures destroyed. |
| 2002 | Winter | Lake County | 35,779 | |
| 2002 | Cache Mountain | Deschutes | 4,200 | 2 structures destroyed. |
| 2003 | Booth | Crook | 90,800 (acreage also includes B&B fire) | 13 structures were destroyed *excerpted from the State Plan, 2006 |
| 2003 | Davis | Deschutes | 16,000 | |



| | | | | |
|------|------------------------|-----------|-------|--|
| 2005 | | Jefferson | | \$333.33 in property damage *Damage estimate includes Sherman and Wasco Counties for a total of \$1000 in damages. |
| 2007 | | Klamath | | \$100,000 in property damage. |
| 2007 | GW | Deschutes | 7,357 | |
| 2008 | Summer Springs Complex | Deschutes | 1,973 | |

Source: Oregon Department of Forestry, 2013

Probability and Vulnerability

As stated in the State Risk Assessment, 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 is 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. Following are the local and state probability and vulnerability descriptions as they stand, without analysis of similarities and differences.

Probability

Local Assessment

Based on the OEM Hazard Analysis conducted by county emergency program managers, the probability (High, Moderate, Low) that Region 6 will experience wildfire is depicted in [Table 2-406](#). See the [State Risk Assessment](#) for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-406. || Table 2-R6-WF-2: Local Probability Assessment of Wildfire

| | Crook | Deschutes | Jefferson | Klamath | Lake | Wheeler |
|-------------|-------|-----------|-----------|---------|------|---------|
| Probability | H | H | H | H | H | H |

Source: Oregon Emergency Management, 2013 County Hazard Analysis Scores.

State Assessment

The lightning potential in Region 6 is very high. For example, in Lake County approximately five percent of the fires were human-ignited, while 95 percent were lightning-caused. There is very little that can be done in terms of ignition prevention, as fire starts from lightning are predicted to continue.

Due to many years of fire suppression, logging, and other human activities, the forests and rangelands of this region have changed significantly. High wildfire occurrence is common in this region. Areas that historically experienced frequent, low-severity wildfires now burn with much greater intensity due to the build-up of understory brush and trees. This region’s fires are larger and more severe, killing the trees and vegetation at all levels. The combination of steep slope, canyons, open rangeland, and fuel type have a history and potential for fast moving and fast



spreading wildfires. The area is highly vulnerable to a wind-driven fires, whose embers could ignite grasses and weeds, and cause spot fires in more populated areas. Typical summer conditions could prove to be problematic due to a fire moving uphill from a structure fire on a lower slope, or from a wildland fire pushing upslope through the trees on a windy day, endangering multiple homes simultaneously in a very short period of time. Residences would have very short notice of an approaching fire.

Fire protection districts are created and staffed to deal with the fire emergency needs of the property within the district. Wildland fires that threaten multiple homes simultaneously can quickly overwhelm the available fire resources. The areas protected by these fire districts are typically large, with few stations, which causes longer response time for additional fire forces. This could prove to be a negative factor for early fire control. When a wildland fire is threatening structures, additional resources are ordered, but may be several hours away. A wildland fire can easily travel into and through a WUI community before additional responding resources can arrive. There simply is not enough fire engines to protect all threatened homes. Ultimately, the homes that are less vulnerable to ignition are most likely to survive. A home that is extremely vulnerable may not be able to be protected regardless of protection resources on scene. Under dry, windy conditions, an advanced house fire could extend within the area, or a rapidly approaching wildland fire could have the potential to overwhelm local firefighters, before additional outside resources could arrive.

In more populated areas like Klamath County, the historic wildfire occurrence shows that most of the large and damaging wildfires that threatened communities or other improvements were human caused.

Recreation is a main attraction for people currently living in and moving to Central Oregon. There are popular recreation destinations for hunting, fishing, camping and water sports, such as Lake Billy Chinook, the Middle Deschutes River, Lake of the Woods, Crescent, Odele, and Crater Lakes, and Haystack Reservoir. This area swells with visitors on any given weekend in the summer during fire season. Higher numbers of fires are concentrated near recreation areas and reservoirs. Concerns in this region not only include potential evacuation needs in the event of an emergency, but also the potential for recreationists to inadvertently start wildfires through improper campfire use, smoking or ATV use.

Vulnerability

Local Assessment

Based on the OEM Hazard Analysis conducted by county emergency program managers, the region’s vulnerability (High, Moderate, Low) to wildfire is depicted in [Table 2-407](#). See the [State Risk Assessment](#) for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-407. || Table 3. Local Vulnerability Assessment of Wildfire

| | Crook | Deschutes | Jefferson | Klamath | Lake | Wheeler |
|---------------|-------|-----------|-----------|---------|------|---------|
| Vulnerability | M | M | M | L | M | H |

Source: Oregon Emergency Management, 2013 County Hazard Analysis Scores.

State Assessment

All counties in Region 6 are extremely vulnerable to wildfire.



The checkerboard pattern of land ownership means that many residences are dispersed on small, scattered private parcels of land. Narrow roads, dead end roads, and long steep driveways are prevalent. Access and egress could be cumbersome with evacuees and fire forces operating in the area at the same time. Evacuation and fire suppression could be problematic due to bottle necking.

Many people chose to live in Central Oregon for the cultural interest and historical values, therefore, there is a strong need to protect key homesteads and Native American and historical sites.

The Northwest corner of Region 6 belongs to the Confederated Tribes of the Warm Springs Reservation. The Warm Springs community is an historic community with heavy home densities and infrastructure, and is protected by a structural fire department. The distribution of the communities is all within Trust and restricted title lands of the Confederated Tribes of Warm Springs.

Economic values at risk include businesses, private forests, farmland, rangeland, grazing land, hunting and other recreational land. Wildfires have the potential to change the vegetative landscape, which would have a significant effect on the natural resources industries that are the economic staple of this region. Critical infrastructure including communication sites, electrical transmission lines and substations, gas lines, water sources, highways, bridges, and railroad lines are also vulnerable to wildfires. Many of the communities that depend on this infrastructure are very remote and rural, so this critical infrastructure could be out of service for extended periods of time.

There are extensive areas of private land within the county that receive no wildland or structural fire protection. Rural areas have general issues including, but not limited to, the absence of formal fire protection and extended response times, dense vegetation capable of causing flame lengths greater than four feet, insufficient water supply, insufficient ingress/egress, and combustible structures.

Table 2-408. || Table 13. Wildland-Urban Interface Communities

| Crook | Deschutes | Jefferson | Klamath | Lake | Wheeler |
|---------------------|--------------------|---------------------|-----------------------|-------------------------|----------------|
| Jasper Point Resort | Bend | Ashwood | Beaty | Adel | Fossil |
| Paulina | Black Butte | Camp Sherman | Beaver Marsh | Christmas Valley | Mitchell |
| Post | Brothers | Crooked River Ranch | Bly | Drew’s Gap | Richmond |
| Prineville | Elk Lake | Culver | Bly Mountain | Lakeview Basin | Spray |
| | Hampton | Gateway | Bonanza | New Pine Creek | Twickenham |
| | LaPine | Madrass | Chemult | Paisley | Winlock |
| | Redmond | Metolius | Chiloquin | Plush | |
| | Sisters-Cloverdale | Warm Springs | Crater Lake | Silver Lake | |
| | Sunriver | | Crescent | South Drews | |
| | Terrebonne | | Crescent Lake | Summer Lake | |
| | Tumalo | | Dairy | Valley Falls / Chandler | |
| | | | Diamond Lake Junction | | |



| | | | | | |
|--|--|--|----------------------|--|--|
| | | | Gilchrist | | |
| | | | Harriman | | |
| | | | Keno | | |
| | | | Klamath Falls | | |
| | | | Little River | | |
| | | | Malin | | |
| | | | Merrill | | |
| | | | Odell Lake | | |
| | | | Rocky Point | | |
| | | | Rosedale | | |
| | | | Running Y | | |
| | | | Sand Creek | | |
| | | | Klamath | | |
| | | | Sprague River Valley | | |
| | | | Sycan Estates | | |

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

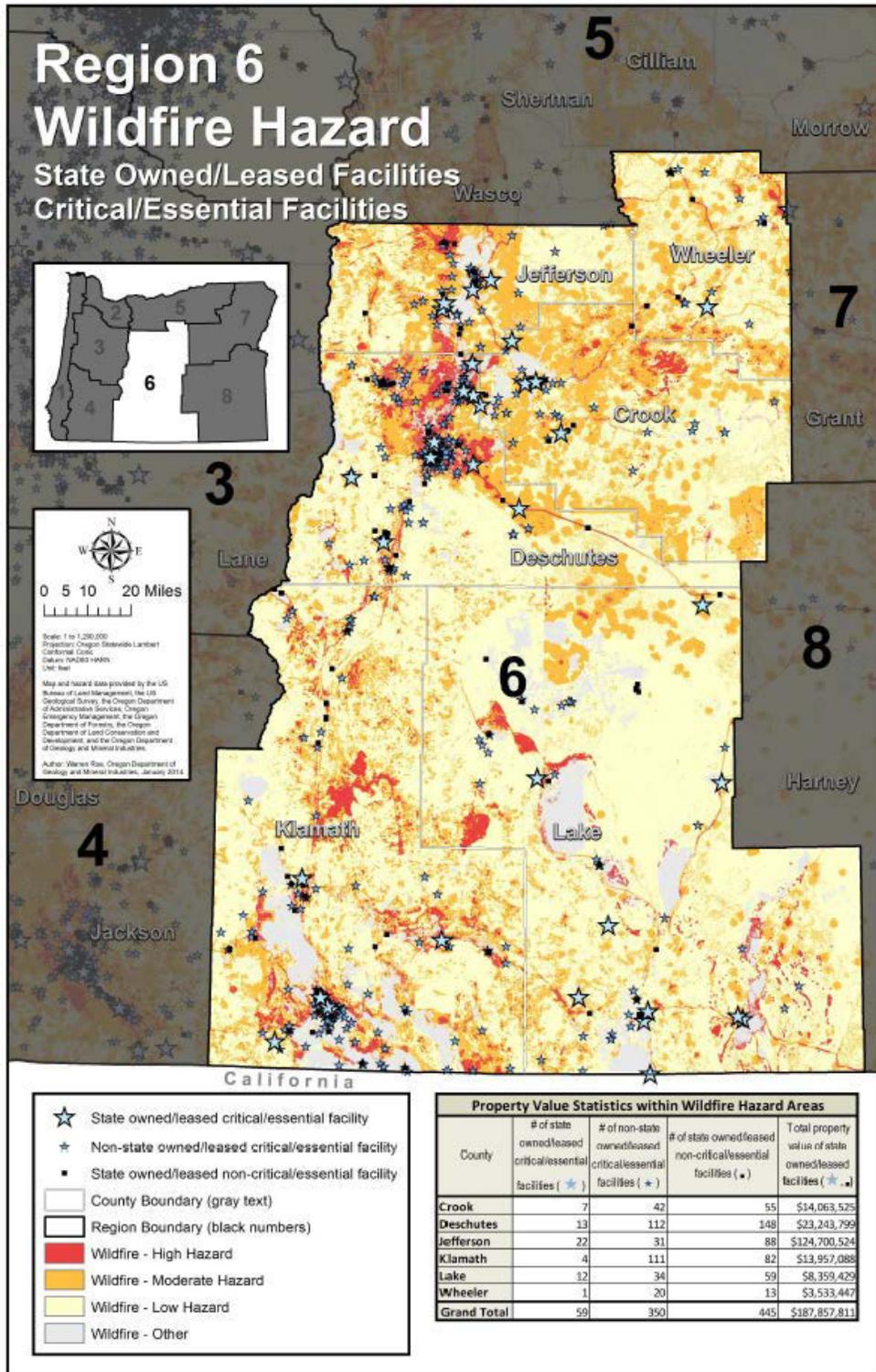
State Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical and essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, [Oregon Vulnerabilities](#) for more information.

Of the 5,693 state facilities evaluated, 504 are within a wildfire hazard zone in Region 6 and total roughly \$188 million in value ([Figure 188](#)). Among those, 59 are state critical/essential facilities. An additional 350 non-state critical/essential facilities are also located in Region 6.



Figure 188. || Figure 2-R6-WF-1: State Owned/ Leased Facilities and Critical/ Essential Facilities in a Wildfire Hazard Zone in Region 6



Source: DOGAMI



Windstorm

Characteristics

High winds in inter-mountain areas in Central Oregon are not uncommon. For example, stiff winds from the Ochoco Mountains often occur in the City of Prineville (Crook County). These areas experience thunderstorms, which are sometimes accompanied by strong outflow and surface winds. Fallen trees and structural damage from windstorms are not uncommon in these areas. The prominent Cascade Range can act as a buffer to strong storms that mostly affect western Oregon. However, the interior counties in this region may experience strong down sloping winds off the lee side of the mountains.

Historic Windstorm Events

Table 2-409. || Table 26. Historic Windstorms in Region 6

| Date | Affected Area | Characteristics |
|------------------|------------------------------|--|
| Apr., 1931 | N. Central OR | 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 Co. |
| Nov., 1981 | Statewide | Severe wind storm |
| Dec., 1991 | N. Central OR | Severe wind storm; Blowing dust. Damage reported in Bend (Deschutes County) |
| Dec., 1995 | Statewide | Severe wind storm |
| April, 2003 | Deschutes County | \$10,000 in property damage |
| Aug., 2003 | Wheeler County | \$1,000 |
| Nov., 2003 | Deschutes County | \$2,000 in property damage |
| Jan., 2004 | Jefferson County | \$3,000 in property damage |
| June, 2004 | Crook and Jefferson Counties | \$1,000 in property damage |
| Aug., 2004 | Crook Count | \$100 in property damage |
| Dec., 2004 | Jefferson County | \$3,333.33 in property damage *damage estimate includes Sherman and Wasco Counties |
| March, 2005 | Jefferson County | \$2,000 in property damage *damage estimate includes Sherman and Wasco Counties |



| | | |
|-------------|--------------------------------------|---|
| March, 2005 | Crook, Deschutes Counties | \$9,000 in property damage |
| August 2005 | Klamath County | Hail storm causes \$1000 in damage. |
| Oct., 2005 | Crook, Deschutes Counties | \$50,000 in property damage |
| Nov., 2005 | Crook, Deschutes Counties | \$40,000 in property damage |
| June 2006 | Jefferson, Deschutes, Crook Counties | Strong winds and hail caused \$10,000 in damages to grass and alfalfa crops in Jefferson County, \$7 million in insurance claims for damage to automobiles and homes in Deschutes County, \$20 million in insurance claims for damage to automobiles and homes in Crook County. |
| July 2006 | Deschutes County | Lightening from a severe storm hit an electrical transmission line, knocking out power to 31,500 people. |
| August 2006 | Klamath County | Severe windstorm with winds up to 66 mph downed several trees and power lines between Klamath Falls and Chiloquin. |
| July 2007 | Klamath County | Extensive wind, rain, and hail damage to Malin and Yonna valleys, and several power lines downed due to falling trees. |
| Oct. 2007 | Crook, Deschutes Counties | \$1000 in total damage from high wind storm. |
| Oct. 2007 | Crook, Deschutes Counties | \$50,000 in total damage from high wind storm |
| August 2009 | Jefferson County | High winds broke boat docks off the shore at Pelton Park Reservoir. \$50,000 in total damages |

Source: Taylor, George H., and Ray Hatton. (1999), The Oregon Weather Book. p.151-157; and FEMA-1405-DR-OR, February 7, 2002, Hazard Mitigation Team Survey Report, Severe Windstorm in Western Oregon.

Hazards & 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/wwwcgi.dll?wwevent~storms>

Table 2-410. || Table 27. Tornadoes Recorded in Region 7

| County | Date | Location | Damage |
|--------|---------|----------------------|--------------------|
| Lake | 09/1973 | County | No reported damage |
| Lake | 08/2005 | Christmas Valley, OR | No reported damage |

Source: Taylor and Hatton, 1999, pp. 123-137.

Probability and Vulnerability

As stated in the State Risk Assessment, 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 is 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. Following are the local and state probability and vulnerability descriptions as they stand, without analysis of similarities and differences.

Probability

Local Assessment

Based on the OEM Hazard Analysis conducted by county emergency program managers, the probability (High, Moderate, Low) that Region 6 will experience windstorms is depicted in [Table 2-411](#). 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 2-411. || Table 2. Local Probability Assessment of Windstorms

| | Crook | Deschutes | Jefferson | Klamath | Lake | Wheeler |
|-------------|-------|-----------|-----------|---------|------|---------|
| Probability | H | H | - | - | H | - |

Source: Oregon Emergency Management, 2013 County Hazard Analysis Scores.

State Assessment

In this region, a 100-year event is considered to have one-minute average winds of 90 mph. A 50-year event has average winds of 80 mph. A 25-year event has average winds 70 mph.

Vulnerability

Local Assessment

Based on the OEM Hazard Analysis conducted by county emergency program managers, the region’s vulnerability (High, Moderate, Low) to windstorm is depicted in [Table 2-412](#). 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 2-412. || Table 3. Local Vulnerability Assessment of Windstorms

| | Crook | Deschutes | Jefferson | Klamath | Lake | Wheeler |
|---------------|-------|-----------|-----------|---------|------|---------|
| Vulnerability | M | L | - | - | M | - |

Source: Oregon Emergency Management, 2013 County Hazard Analysis Scores.

State Assessment

Many buildings, utilities, and transportation systems within Region 6 are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It also is true in forested areas, along tree-lined roads and electrical transmission lines, and on residential parcels where trees have been planted or left for aesthetic purposes. Structures most vulnerable to high winds include insufficiently anchored manufactured homes and older buildings in need of roof repair.

Fallen trees are especially troublesome. They can block roads and rails for long periods of time, impacting emergency operations. In addition, up-rooted or shattered trees can down power



and/or utility lines and effectively bring local economic activity and other essential facilities to a standstill. Much of the problem may be attributed to a shallow or weakened root system in saturated ground. Many roofs have been destroyed by uprooted trees felled by high winds. In some situations, strategic pruning may be the answer. Prudent counties will work with utility companies in identifying problem areas and establishing a tree maintenance and removal program.



Winter Storm

Characteristics

Severe winter weather in Region 6 can be characterized by extreme cold, snow, ice, and sleet. While there are annual winter storm events in Region 6 with an average of 24 inches of snow annually most communities are prepared for them. Severe winter storms are considered to be unusual. Light to moderate snow fall is prepared for and expected on an annual basis in this central region. Heavier snow fall is expected and planned for in the areas on the west side of the region into the Cascade mountain range as the elevation gets higher.

Historic Winter Storm Events

Table 2-413. || Table XX. Significant Winter Storms in Region 6

| Date | Location | Remarks |
|-----------------------|--------------------------|--|
| Dec., 1861 | Entire state | Storm produced between 1 and 3 feet of snow. |
| Dec., 1892 | Northern counties, OR | Between 15 and 30 inches of snow fell throughout the northern counties. |
| Jan., 1916 | Entire state | Two storms. Heavy snowfall, especially in mt. areas. |
| Jan., Feb., 1937 | Entire state | Deep snow drifts. |
| Jan., 1950 | Entire state | Record snow falls; Property damage throughout state. |
| Mar., 1960 | Entire state | Many automobile accidents; Two fatalities. |
| Jan., 1969 | Entire state | Heavy snow throughout state. |
| Jan., 1980 | Entire state | Series of string storms across state. Many injuries and power outages. |
| Feb., 1985 | Entire state | Two feet of snow in northeast mountains; Downed power lines. Fatalities. |
| Feb., 1986 | Central / Eastern Oregon | Heavy snow in Deschutes Basin. Traffic accidents; Broken power lines. |
| Mar., 1988 | Entire state | Strong winds; Heavy snow. |
| Feb., 1990 | Entire state | Heavy snow throughout state. |
| Nov., 1993 | Cascade Mountains, OR | Heavy snow throughout region. |
| Mar., 1994 | Cascade Mountains, OR | Heavy snow throughout region. |
| Winter 1998-99 | Entire state | One of the snowiest winters in Oregon history (Snowfall at Crater Lake: 586 inches). |
| Dec. 2003 – Jan. 2004 | Entire state | The most significant winter storm in several years brought snowfall to most of Oregon in late December 2003. According to the state climatologist, a combination of cold air near the surface and overrunning moist air from a Pacific weather system was responsible for the storm. |

Source: Taylor, George and Ray Hatton, 1999, *The Oregon Weather Book* p.118-122, and unknown sources.

Probability and Vulnerability

As stated in the State Risk Assessment, 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 is 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. Following are the local and state probability and vulnerability descriptions as they stand, without analysis of similarities and differences.

Probability

Local Assessment

Based on the OEM Hazard Analysis conducted by county emergency program managers, the probability (High, Moderate, Low) that Region 6 will experience winter storms is depicted in [Table 2-414](#). See the [State Risk Assessment](#) for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-414. || Table 2. Local Probability Assessment of Winter Storms

| | Crook | Deschutes | Jefferson | Klamath | Lake | Wheeler |
|-------------|-------|-----------|-----------|---------|------|---------|
| Probability | M | H | H | H | H | H |

Source: Oregon Emergency Management, 2013 County Hazard Analysis Scores.

State Assessment

Winter storms occur annually in Region 6. Based on historical events severe winter storms may impact the region approximately every four years. We can expect to have continued annual storm events in this region however there is no statistical data available other than the historical events that have occurred to base these judgments on. There is no statewide program to study the past, present and potential future 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 (High, Moderate, Low) to winter storms is depicted in [Table 2-415](#). See the [State Risk Assessment](#) for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-415. || Table 3. Local Vulnerability Assessment of Winter Storms

| | Crook | Deschutes | Jefferson | Klamath | Lake | Wheeler |
|---------------|-------|-----------|-----------|---------|------|---------|
| Vulnerability | M | H | H | M | H | H |

Source: Oregon Emergency Management, 2013 County Hazard Analysis Scores.

State Assessment

Region 6 communities are known for cold, snowy winters. This is advantageous in at least one respect: in general, the region is prepared, and those visiting the region during the winter usually come prepared. However, there are occasions when preparation cannot meet the challenge. Drifting, blowing snow has often brought highway traffic to a standstill. Also, windy, icy conditions have often closed mountain passes and canyons to certain classes of truck traffic. In these situations, travelers must seek accommodations, sometimes in communities where



lodging is very limited. And local residents also experience problems. During the winter, heating, food, and the care of livestock and farm animals are everyday concerns. Access to farms and ranches can be extremely difficult and present a serious challenge to local emergency managers.