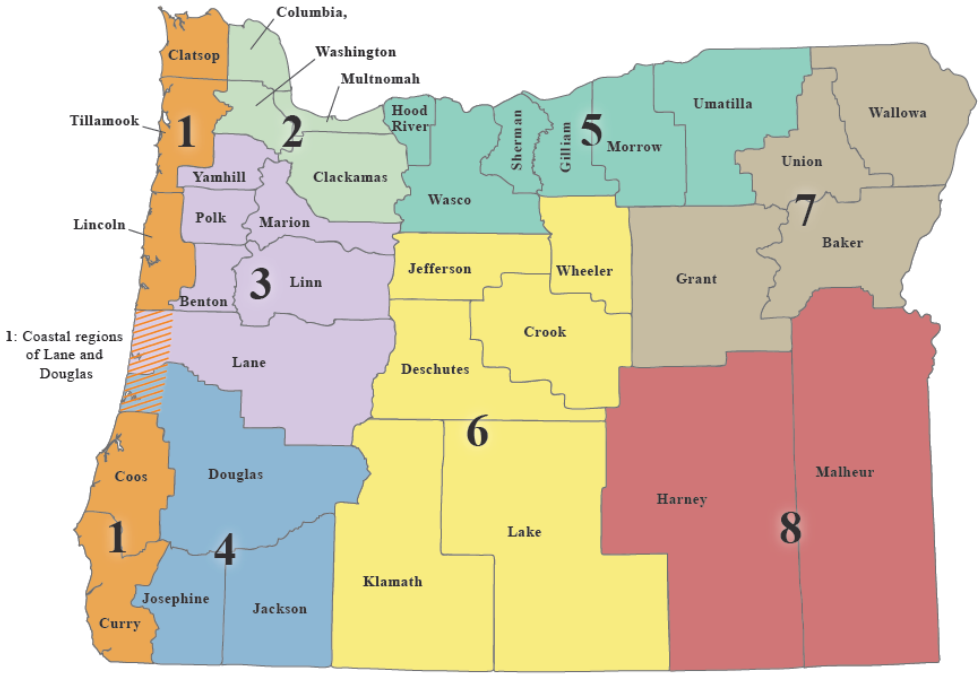
2.3 Regional Risk Assessments

The purpose of the Regional Risk Assessment is to assess risks at a regional scale by profiling the characteristics, natural hazards, and vulnerabilities within the eight Oregon NHMP Natural Hazard Regions (Figure 2-115). Each region has its own Risk Assessment. Together, the eight Regional Risk Assessments combine to describe the State's overall risk to natural hazards.

Figure 2-115. Oregon NHMP Natural Hazards Regions



Each Regional Risk Assessment includes three sections:

1. The **Summary** provides a general overview of (a) the Regional Profile, (b) the Regional Hazards and Vulnerability, and (c) how climate change models predict hazards in the region will be impacted based on statewide data.
2. The **Profile** section provides an overview of the region's unique characteristics including profiles of the natural environment, social and demographic situation, economic environment, infrastructure, and built environment.

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

prepare for, mitigate, and reduce vulnerability (Cutter, Boruff, & Shirley, 2003); (Cutter S. L., 2006).

Margin of Error (MOE)

The sociodemographic data in the regional profiles are primarily sourced from the U.S. Census Bureau's American Community Survey (ACS). The ACS's estimates are subject to sampling and nonsampling errors. Nonsampling errors are the product of survey design and measurement flaws, "while sampling error is when the characteristics of the survey group vary from those of the larger population of interest...causing the true value to fall within a range bounded by a margin of error" (Quinterno, 2014).

Through adding and subtracting the MOE from the estimate, users can calculate the 90% confidence interval for that estimate (U.S. Census Bureau, 2018). For example, in **Table 2-81. People with a Disability by Age Group in Region 1**, data from the 2017 ACS 5-year estimates indicate that 19.1% of all people in Clatsop County have a disability with a MOE of 1.4%. Through adding and subtracting the MOE from the estimate, the user can calculate the 90% confidence interval for that estimate (U.S. Census Bureau, 2018). Doing so indicates that we can be 90 percent confident that the true share of residents in Clatsop County with a disability in the 2013-2017 period falls between 17.7% and 20.5%.

Period Estimates

It should also be noted that the ACS estimates in the plan are period estimates, rather than point-in-time or cumulative counts. “A period estimate shows the average value of the variable over a specific reference period” (Quinterno, 2014). The ACS uses period estimates “to compensate for the fact [that] the sampling frame includes too few households to yield reliable annual estimates for small geographies and small population subgroups” (Quinterno, 2014). If the value presented in a table is a period estimate, the period is noted in the table’s source data.

Coefficient of Variation (CV)

In addition to a MOE, many of the estimates in the plan have a coefficient of variation (CV). “The CV is a relative measure of uncertainty and expresses uncertainty as a percentage of the census estimate” (Jurjevich, et al., 2018). Generally, the lower the CV, the more reliable the data. According to the U.S. Census Bureau, there are “no hard-and-fast rules for determining an acceptable range of error in ACS estimates. Instead, data users must evaluate each application to determine the level of precision that is needed for an ACS estimate to be useful” (U.S. Census Bureau, 2018). This plan adopts CV ranges and data reporting methods recommended by the Population Research Center at Portland State University (Jurjevich, et al., 2018).

Icons are used to indicate the reliability of each estimate using the CV. High reliability (CV <15%) is shown with a green check mark, medium reliability (CV 15–30% — be careful) is shown with a yellow exclamation point, and low reliability (CV >30% — use with extreme caution) is shown with a red cross. However, as mentioned above, there are no precise rules and users should consider the MOE and their need for precision (Jurjevich, et al., 2018).

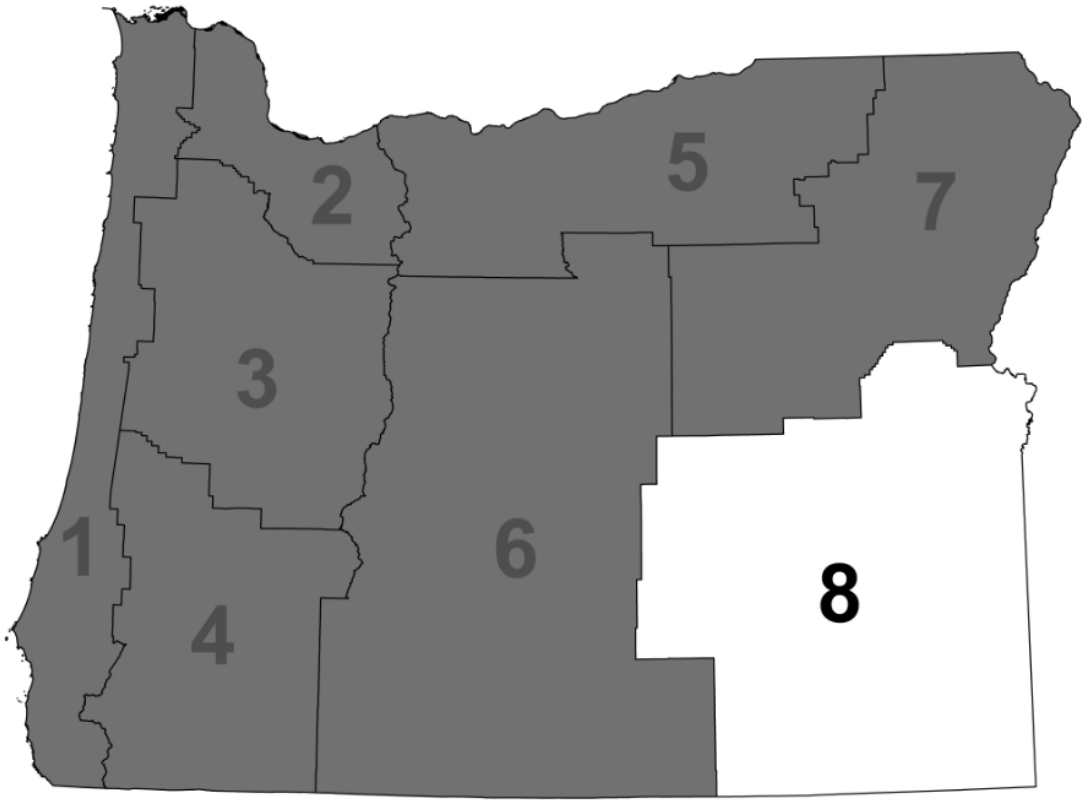
3. The **Hazards and Vulnerability** section first identifies each hazard and its characteristics in the region. Then, the historical events that have impacted the region are listed. Lastly, probabilities and vulnerabilities are discussed as identified by local and state risk assessments. Vulnerabilities

to and potential impacts from each hazard in the region are described including the identification and analysis of the region's State owned/leased facilities and critical/essential facilities located within hazard zones and seismic lifeline vulnerabilities.

Regional Risk Assessments add to the current body of literature and technical resource guides available to Oregon communities. The three levels of government — federal, state, and local — will find the Regional Risk Assessments useful when assessing natural hazards and vulnerabilities and when planning mitigation activities. Local governments can use the Regional Risk Assessments in the development of their jurisdiction's natural hazards mitigation plan. Information from these assessments is intended to be used as a springboard for more detailed community profiles. Likewise, information from local plans helps to inform the Oregon NHMP risk assessment overall.

2.3.8 Region 8: Southeast Oregon

Harney and Malheur Counties



2.3.8.1 Summary

Profile

Region 8's demographic, economic, infrastructure, and development patterns indicate that some populations, structures, and places may be more vulnerable to certain natural hazards than others. Mitigation efforts directed at these vulnerabilities may help boost the area's ability to bounce back after a natural disaster.

Social vulnerability in Region 8 is driven by a declining population, low median household incomes, and high levels of poverty. In Harney County there are also high percentages of seniors and people with disabilities. In Malheur County there are more tourists, higher percentages of people who do not speak English very well, a significant drop in already low incomes, and more family households with children.

This region is still recovering from the financial crisis that began in 2007 and the financial effects of the 2020 pandemic. There are few key industries and employment sectors in Region 8. Regional wages remain below the state average. Harney County continues to suffer from high unemployment. Damage or service interruption to roads, bridges, rail systems, and ports can have devastating effects the region's economy. Roads and railways are susceptible to winter storms and flooding.

Wells and rivers are primary sources of drinking water for the region. The quality of these water bodies can be threatened by regional agricultural practices that use pesticides and herbicides and by naturally occurring minerals in the soil. Malheur Lake is especially vulnerable to high mineral content.

Southeast Oregon has two power-generating facilities: one hydroelectric facility and one geothermal facility. Oil and natural gas pipelines and electrical transmission lines running through this region support the regional economy and are vulnerable to disruptions and damage from natural hazard events.

Region 8 is largely rural and is losing population. The region has high percentages of manufactured homes and homes built before floodplain management and seismic building standards. This coupled with the lack of modernized Flood Insurance Rate Maps (FIRMs) increases the vulnerability of development in Region 8.

Hazards and Vulnerability

Region 8 is affected by nine of the 11 natural hazards that affect Oregon communities. Coastal hazards and tsunamis do not directly impact this region.

Droughts: Droughts are common in Region 8 and have a significant economic impact on agricultural, livestock, and natural resources. The U.S. Department of Agriculture designated droughts in Malheur and Harney County as primary natural disasters from 2012 through 2016 and 2018 due to damages and losses caused by drought. Malheur County is considered one of the counties most vulnerable to drought in Oregon.

Earthquakes: Two types of earthquakes affect Region 8: (a) shallow crustal events and (b) earthquakes associated with volcanic activity. Region 8 is moderately vulnerable to earthquake-induced landslides, liquefaction, and ground shaking. In Region 8, a 2500-year probabilistic earthquake scenario could generate a potential loss of just under $1M in state building and critical facility assets, about 90% of it in Malheur County. The potential loss in local critical facilities is more than eight times that amount, almost $8M.

Extreme Heat: Extreme temperatures are common in Region 8 and the frequency of prolonged periods of high temperatures has increased. Owyhee, in Malheur County, has an average of about 55 days per year above 90°F. Both counties have a moderate vulnerability to extreme heat. High temperature and insufficient water stunt plant growth and cause areas of crops to wither. Some livestock, especially dairy cattle, are also sensitive to heat. Milk production decreases and susceptibility to death increases during and for some time after a heat wave. Like drought, impacts of drought on state-owned facilities related to agriculture may include impacts to research conducted in outdoor settings, such as at extension stations and research farms.

Floods: Floods affect Southeast Oregon in the form of riverine flooding often preceded by rapid snowmelt during unseasonably warm winters, ice jams, and closed basin playa flooding. Flash floods and associated summer thunderstorms are also possible. Both counties are considered to have a moderate to high vulnerability to the hazard of flooding. A large number (1,464 buildings) of Harney County's buildings representing 20% of the county's buildings were found to be within designated flood zones, 1,117 of which are located in the City of Burns. In Region 8, there is a potential loss from flooding of about $6M in state building and critical facility assets, 56% of it in Harney County and 44% in Malheur County. There is a much greater potential loss – about 3.5 times as much – due to flood in local critical facilities: over $22M.

Landslides: Landslides can occur throughout the region, though more tend to occur in areas with steeper slopes, weaker geology, and higher annual precipitation. In general, landslide vulnerability for Region 8 is low to moderate. About $239K in value of state assets is exposed to landslide hazards in Region 8, all of it in Malheur County. The total value of the Region's local critical facility assets, $15.8M, is also located in Malheur County.

Volcanoes: Though the volcanic Cascade Range is not in Region 8 and vulnerability to effects of volcanic eruptions is low, there is some threat of ashfall from Cascade volcanic eruptions. More locally, the region is also vulnerable to small eruptions of lava from the numerous youthful volcanic cones scattered across Harney and Malheur Counties. The communities in Southeast Oregon most vulnerable to volcanic activity are the Cities of Burns, Ontario, and Jordan Valley. No state buildings, state or local critical facilities are located in volcanic hazard areas.

Wildfires: The region's arid climate, frequent lightning strikes, large tracts of ponderosa pine forests (primarily in the northern part of Harney County), and grasslands all contribute to Region 8's vulnerability to wildfire. Past management practices that suppressed all wildfires and favored growth of a brushy understory and accumulation of dead or dying trees have led to devastating fires today. State and federal agencies seek to alleviate the problem through a controlled burning program. Areas of higher vulnerability are within wildland-urban interface communities. In Region 8, there is a potential loss to wildfire of almost $352M in state building and critical facility assets, 98% of it in Malheur County. There is a much lesser potential loss in local critical facilities: about $38M. Fifty-six percent of that value is also located in Malheur County.

Windstorms: Windstorms in Region 8 are commonly associated with thunderstorms. Windstorms can be especially problematic in burned areas, where dust becomes airborne reducing visibility and causing localized damage. Windstorms generally affect the region's buildings, utilities, tree-lined roads, transmission lines, residential parcels, and transportation systems along open areas such as grasslands and farmland. Small tornadoes also have the potential to impact this region. The value of state-owned and leased buildings and critical facilities in Region 8 is approximately $573,310,000 representing the total potential for loss of state assets due to windstorms. The value of locally owned critical facilities is $328,497,000.

Winter Storms: This region is known for winter storms that bring cold weather and 24 inches of snow annually. Moderate to heavy snowfall is expected in this region, and residents and tourists are usually prepared for them. The value of state-owned and leased buildings and critical facilities in Region 8 is approximately $573,310,000 representing the total potential for loss of state assets due to winter storms. The value of locally owned critical facilities is $328,497,000.

Climate Change

The hazards faced by Region 8 that are projected to be influenced by climate change include drought, wildfire, flooding, landslides, and extreme heat.

Climate models project warmer, drier summers for Oregon. Coupled with projected decreases in snowpack due to warmer winter temperatures, Region 8 is expected to be affected by an increased incidence of drought and wildfire. However, projected increases in spring precipitation may counteract some of the effects of warming and result in increases in summer soil moisture and runoff (*low confidence*). In Region 8, climate change would result in increased frequency of drought due to low spring snowpack (*very likely*, >90%). It is *very likely* (>90%) that Region 8 will experience increasing wildfire frequency and intensity due to warmer, drier summers coupled with warmer winters that facilitate greater cold-season growth.

It is *extremely likely* (>95%) that the frequency and severity of extreme heat events will increase over the next several decades across Oregon due to human-induced climate warming (*very high confidence*).

Furthermore, flooding and landslides are projected to occur more frequently throughout western Oregon. It is *very likely* (>90%) that Oregon will experience an increase in the frequency of extreme precipitation events and extreme river flows (*high confidence*) that is *more likely than not* (>50%) to lead to an increase in the incidence and magnitude of damaging floods (*low confidence*). Because landslide risk depends on a variety of site-specific factors, it is *more likely*

than not (>50%) that climate change, through increasing frequency of extreme precipitation events, will result in increased frequency of landslides.

While winter storms and windstorms affect Region 8, there is little research on how climate change influences these hazards in the Pacific Northwest. For more information on climate drivers and the projected impacts of climate change in Oregon, see Section 2.2.1.2, **Introduction to Climate Change**.

2.3.8.2 Profile

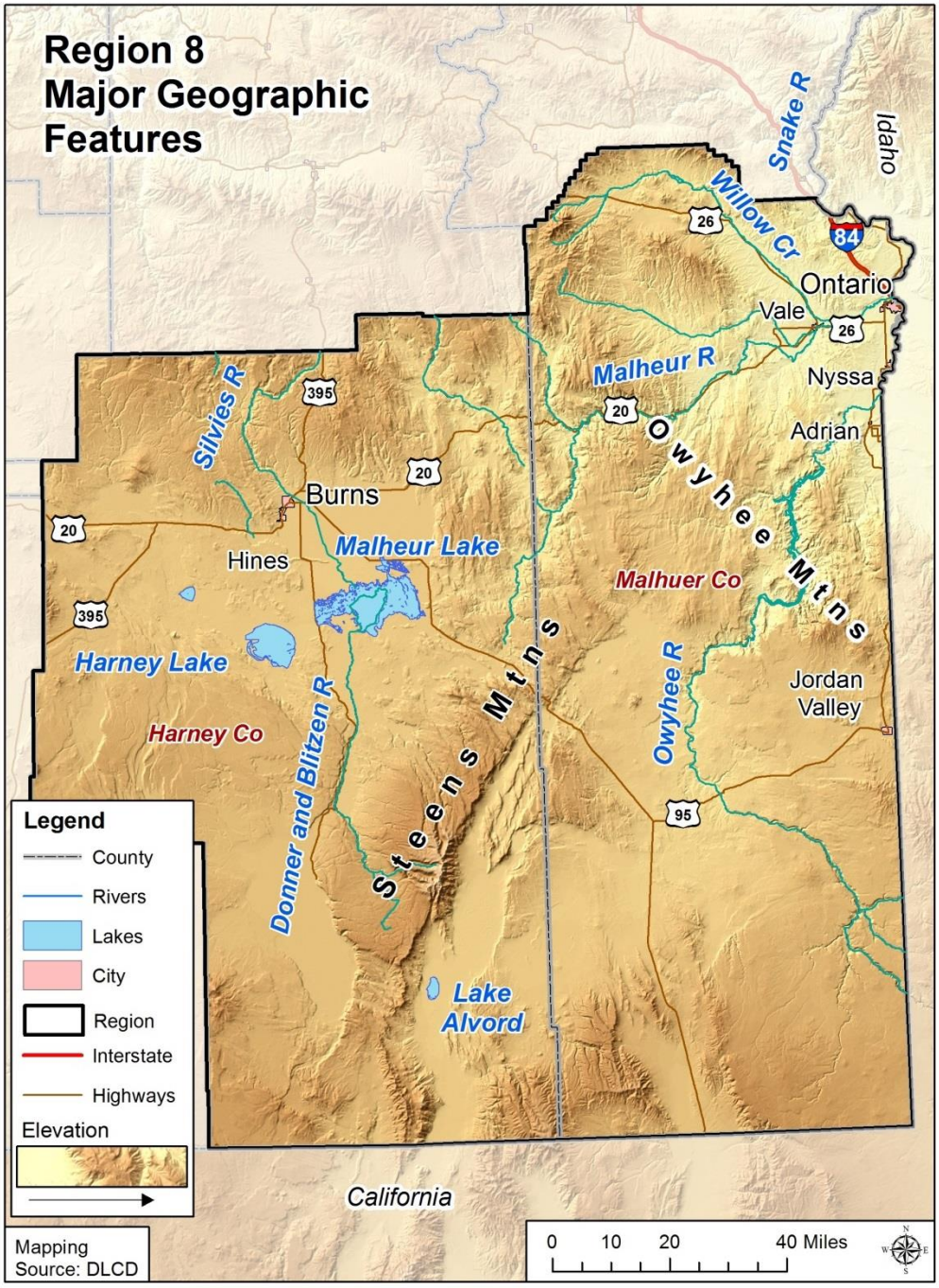
Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

Natural Environment

Geography

Region 8 is approximately 20,023 square miles in size and contains Harney and Malheur Counties. The region is bordered to the east by Idaho and to the south by Nevada and California. The Blue Mountains lie in the northern part of the region. Steens Mountain is a prominent landmass in the region and major rivers in the region include the Malheur and Owyhee.

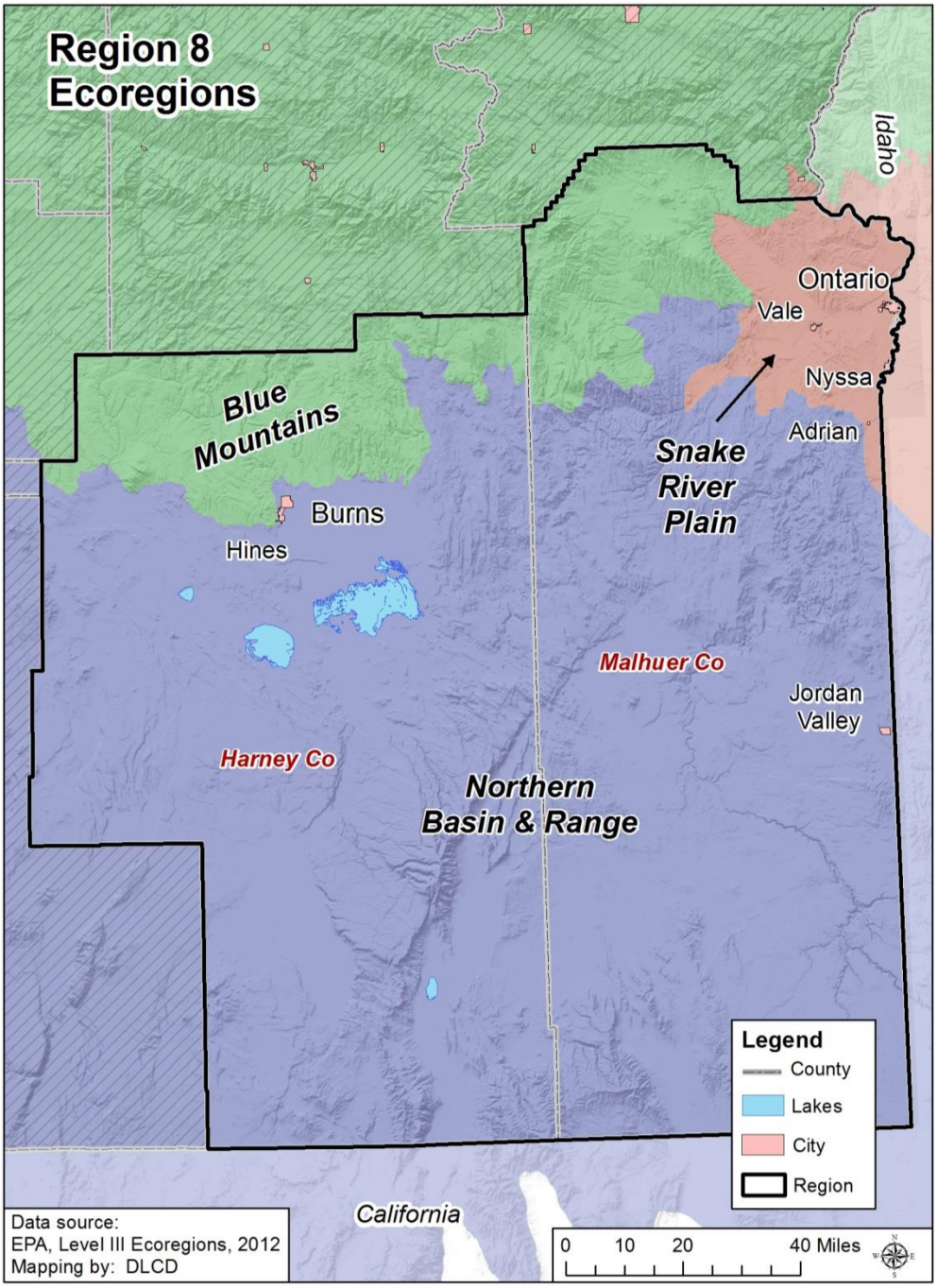
Figure 2-294. Region 8 Major Geographic Features



Source: Department of Land Conservation and Development, 2014

The U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Region 8 is composed of three ecoregions: Northern Basin and Range, Blue Mountains, and Snake River Plain (**Figure 2-295**).

Figure 2-295. Region 8 Ecoregions



Blue Mountains: The Region 8 section of this ecoregion is complex and diverse having many sub-ecoregions with unique conditions. The landscape varies between steep sloped mountains of volcanic origin, scattered cinder cones, foothills, scattered buttes, and the Cold Basins, which contain cold, wet valleys, and basins. Forested areas may have ponderosa pine, mixed fir, or juniper canopies. Unforested areas are generally sagebrush steppes or wetlands with vegetation such as sedges and associated grasses. Land uses in the area are primarily livestock grazing and wildlife habitat (Thorson, et al., 2003).

Northern Basin and Range: This ecoregion dominates Region 8 with dissected lava plains, rolling hills, alluvial fans, valleys, deep river canyons, and scattered mountains. Because of the ecoregion's location in the rain shadow of the Cascades and Blue Mountains, most areas are arid or semi-arid. Basaltic rock, tuffaceous rock, or volcanic ash are dominant rock types, while soil generally varies between sediments, alluvial, colluvial and fluvial deposits, and rock outcrops. Land cover varies between sagebrush steppe, grasslands, rare wetlands, aspen stands in riparian meadows, and unvegetated deserts. Land uses in this ecoregion include recreation, wildlife habitat including federal wildlife refuges, and limited livestock grazing (Thorson, et al., 2003).

Snake River Plan: The Region 8 portion of the Snake River Plain ecoregion is classified as the "Unwooded Alkaline Foothills" and "Treasure Valley," which are underlain by volcanic and sedimentary rocks with alkaline lacustrine sediments and alluvium, loess, lacustrine and alluvial fan deposits at the surface. The landscape includes valleys, incised rivers, canals, rolling foothills, hills, benches, alluvial fans, and badlands. The land cover is dominated by sagebrush steppe with Wyoming big sagebrush, basin big sagebrush and associated grasses. Land uses in this ecoregion include croplands (potatoes, onions, beets, alfalfa, hay, wheat and sugar) as well as pastureland and wildlife habitat (Thorson, et al., 2003).

Climate

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

The climate of Southeast Oregon is semi-arid supporting primarily livestock grazing. The region is subject to droughts and wildfires, particularly during dry summers and years with low snowpack. Despite its relative dryness, the region is also subject to floods and landslides. Localized variations in temperature and precipitation exist across the region's microclimates. **Table 2-740** displays 1981–2010 average precipitation and temperature for counties and climate divisions within Region 8 based on data from the NOAA National Centers for Environmental Information.

Table 2-740. Average Precipitation and Temperature Ranges in Region 8 Ecoregions

Sub-Region	Annual Precipitation Mean & Range (1981–2010)	January & July Mean Precipitation (1981–2010)	Annual Mean Temperature (1981–2010)	January & July Average Min/Max Temperature (1981–2010)
Harney County	13.21" (7.58"–22.16")	Jan: 1.39" Jul: 0.42"	45.9°F	Jan: 19.9°F /37.4°F Jul: 50.4°F /84.1°F
Malheur County	13.13" (8.09"–21.78")	Jan: 1.41" Jul: 0.43"	48.0°F	Jan: 20.6°F /36.9°F Jul: 54.2°F /87.3°F
Climate Division 7 "South Central"	16.16" (10.02"–24.98")	Jan: 1.89" Jul: 0.49"	45.7°F	Jan: 21.5°F/38.4°F Jul: 48.6°F/82.6°F
Climate Division 9 "Southeast"	13.13" (8.09"–21.77")	Jan: 1.41" Jul: 0.43"	48.0°F	Jan: 20.6°F/36.9°F Jul: 54.2°F/87.3°F

Source: NOAA National Centers for Environmental Information, Climate at a Glance: County & Divisional Time Series, published August 2019, retrieved on August 22, 2019 from https://www.ncdc.noaa.gov/cag/.

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, Boruff, & Shirley, 2003). Population change includes two major components: natural increase (births minus deaths) and net migration (in-migrants minus out-migrants) (USDA, 2020). If a population is forecast to increase substantially, a community's capacity to provide adequate housing stock, services, or resources for all populations after a disaster may be stressed or compromised.

Between 2010 and 2018, the population in Region 8 grew slightly—approximately eight percentage points behind than the statewide rate. Harney County's population declined marginally during this period, driven by natural decrease and somewhat steady out-migration. Natural decrease is expected to overtake net in-migration over the next decade in Harney County, causing the population to continue to decline at a slow rate (Population Research Center, Portland State University, 2018 [Harney County]). Malheur County's population increased slowly from 2010 to 2018, with a waning natural increase outpacing fluctuating in/out-migration. Looking forward, net out-migration is expected to outpace natural increase, resulting in a slow population decline in the county through 2030 (Population Research Center, Portland State University, 2019 [Malheur County]).

Table 2-741. Population Estimate and Forecast for Region 8

	2010	2018	Percent Change (2010 to 2018)	2030 Projected	Percent Change (2018 to 2030)
Oregon	3,831,074	4,195,300	9.5%	4,694,000	11.9%
Region 8	38,735	39,305	1.5%	38,133	−3.0%
Harney	7,422	7,380	−0.6%	7,334	−0.6%
Malheur	31,313	31,925	2.0%	30,799	−3.5%

Source: Population Research Center, Portland State University (2018), Certified Population Estimates; Population Research Center, Portland State University (2019), Current Forecast Summaries for All Areas & Oregon Final Forecast Table by Age (2019); U.S. Census Bureau, 2010 Decennial Census. Table DP-1

Tourists

Tourists are not counted in population statistics and are therefore considered separately in this analysis. Tourism activities in Region 8 are largely centered on outdoor activities (hiking, vising state parks, etc.), touring (traveling to experience scenic beauty, history and culture), and special events (such as fairs, festivals or sporting events) (Longwoods International, 2017g). Note that the Longwoods Travel Report includes all of the Region 8 counties; Baker, Grant, Union, and Wallowa (Region 7); and Morrow, Umatilla, and parts of Gilliam Counties within the Eastern Region. Moreover, Longwoods notes that tourism data for Eastern Oregon should be used with caution due to the small sample size; to maximize reliability, the report combined samples from 2016 and 2017.

Approximately 43% of all trips to Eastern Oregon originate from other parts of Oregon (Longwoods International, 2017g). The average travel party contains between three to four

persons and the average number of nights spent in in the region between two and three (Longwoods International, 2017g). Annually there are more than twice as many tourists in Malheur County than Harney County.

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

Table 2-742. Annual Visitor Estimates in Person Nights (X1000) in Region 8

	2016		2017		2018	
	Number	Percent	Number	Percent	Number	Percent
Region 8	906	—	928	—	912	—
Harney	268	100%	271	100%	274	100%
Hotel/Motel	95	35.4%	99	36.5%	100	36.5%
Private Home	73	27.2%	74	27.3%	74	27.0%
Other	100	37.3%	99	36.5%	100	36.5%
Malheur	638	100%	657	100%	638	100%
Hotel/Motel	227	35.6%	243	37.0%	229	35.9%
Private Home	306	48.0%	310	47.2%	303	47.5%
Other	106	16.6%	104	15.8%	106	16.6%

Source: Oregon Travel Impacts: 1992–2018, March 2019. (Dean Runyan Associates, 2019), http://www.deanrunyan.com/doc_library/ORImp.pdf

Persons with Disabilities

Disabilities appear in many forms. While some disabilities may be easily identified, others may be less perceptible. Disabled populations are disproportionately affected during disasters and can be difficult to identify and measure (Cutter, Boruff, & Shirley, 2003). A higher percentage of residents in Region 8 have a disability compared to the statewide estimate. The share is also higher in both counties, even considering the margins of error.

The percentage of younger people (<18) in the region with a disability is higher; however, the estimates for “Under 18 years with a disability” should be used with caution due to sampling error.

The percentage of older adults with a disability is slightly higher than the statewide estimate. Harney County has a higher percentage than Malheur County; however, the margins of error should be noted.

Local natural hazard mitigation plans should specifically target outreach programs toward helping disabled residents better prepare for and recover from hazard events. Planning professionals might take a number of steps to mitigate risk for disabled community members. Inaccessible shelter facilities can pose challenges in a disaster event. Local officials should also strengthen partnerships with the disability community, and work with local media organizations to ensure emergency preparedness and response communications are accessible for all.

Table 2-743. People with a Disability by Age Group in Region 8

	With a Disability			Under 18 Years with a Disability			65 Years and Over with a Disability		
	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	14.6%	☑	0.1%	4.6%	☑	0.2%	37.1%	☑	0.4%
Region 8	17.1%	☑	1.4%	6.4%	⊙	1.9%	38.5%	☑	3.6%
Harney	19.2%	☑	2.0%	8.0%	⊗	4.3%	41.2%	☑	6.4%
Malheur	16.6%	☑	1.6%	6.0%	⊙	2.2%	37.5%	☑	4.1%

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau (2018). Table DP02: Selected Housing Characteristics, 2013-2017 American Community Survey 5-Year Estimates. Retrieved from https://data.census.gov/cedsci/. Total population does not include institutionalized population

Homeless Population

The U.S. Department of Housing and Urban Development requires Continuums of Care to conduct the Point-in-Time Count, a biennial count of sheltered and unsheltered people experiencing homelessness. These are rough estimates and can fluctuate with many factors. They should be understood as the absolute minimum number of people experiencing homelessness in the area (Oregon Housing & Community Services, 2019). Moreover, the PIT does not fully depict the extent of housing insecurity, as it excludes families or individuals that might be staying with friends or family due to economic hardship. The count also obscures the demographic composition of the houseless population, frequently undercounting people of color, for example (Oregon Housing & Community Services, 2019).

According to the PIT, between 2015 and 2019 the region experienced a decline in the total number of people experiencing homelessness; however, the volatility of the count between years suggests reliability issues. Malheur County reported a decline while the number of people counted in Harney County reportedly increased during the period.

People experiencing homelessness are typically more physically and psychologically vulnerable compared to the general population and natural hazard events exacerbate vulnerability conditions. Disasters that result in damage to the built environment can place additional stress on temporary shelters (Peacock, Dash, Zhang, & Van Zandt, 2017). Local emergency management professionals should take a trauma-informed approach to providing services and include people with expertise in providing support to people experiencing homelessness in planning for natural hazard events (U.S. Department of Housing and Urban Development, 2016). Additionally, it is important to plan for episodic natural hazards as well as chronic events. For example, year-around access to shelter is becoming increasingly important as wildfire smoke becomes more common across the state.

Table 2-744. Homeless Population Estimate for Region 8

	2015	2017	2019	Period Average
Oregon	13,077	13,953	15,800	14,277
Region 8	110	170	81	120
Harney	6	19	59	28
Malheur	104	151	22	92

Source: Oregon Housing and Community Services (n.d.). Oregon Point In Time Homeless Counts. Retrieved from https://public.tableau.com/profile/oregon.housing.and.community.services#!/vizhome/2019Point-in-TimeDashboard/Story1

Biological Sex and Gender

The concepts of sex and gender are often used interchangeably but are distinct; sex is based on biological attributes (chromosomes, anatomy, hormones) and gender is a social construction that may differ across time, cultures, and among people within a culture (U.S. Census Bureau, 2019, Apr. 3). Moreover, the two may or may not correspond (U.S. Census Bureau, 2019, Apr. 3).

The American Community Survey question was specifically designed to capture biological sex and there are no questions on the survey about gender (U.S. Census Bureau, 2019, Apr. 3). According to the survey, there are more men than women in the region (116.17 men to every 100 women) (U.S. Census Bureau, 2019, Mar. 31). Malheur County has the greatest imbalance (119.7 men to every 100 women), while the ratio in Harney is more even 102.4 men to every 100 women) (U.S. Census Bureau, 2019, Mar. 31).

Primarily empirical research has begun to emerge about the ways in which gender influences resilience to disasters. It indicates that gender influence is much more pervasive and expressed differently among men, women, LGBTQ+, and non-binary populations than has generally been recognized (Enarson, 2017). This is an area deserving of more attention as the field develops.

Age

Older adults, persons aged 65 and older, comprise a similar share of the population vis-à-vis the state. In Malheur County, conversely, the percentage is higher than the statewide estimate. Consequently, the regional share is also higher than the statewide estimate. Older adults require special consideration in the planning process. They are more likely to have a disability and require assistance from others to complete routine tasks. Family or neighbors who might ordinarily assist them might be unable to help during a disaster event (Flanagan, Gregory, Hallisey, Heitgerd, & Lewis, 2011). Moreover, an older population requires special consideration due to sensitivity to heat and cold, reliance upon transportation to obtain medication, and comparative difficulty in making home modifications that reduce risk to hazards. In addition, older people may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to all ages and abilities (Morrow, 1999).

Harney County has a similar percentage of children compared to the statewide estimate (approximately one-fifth). Malheur County, conversely, has a higher share of children and a larger population. Consequently, the percentage of children in the region is also higher than the state as a whole. 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 might lose time from work and money when their children's childcare facilities and schools are impacted by disasters (Cutter, Boruff, & Shirley, 2003).

Table 2-745. Population by Vulnerable Age Group, in Region 8

	Total Population	Under 18 Years Old			65 and Older		
	Estimate	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	4,025,127	21.5%	☑	0.1%	16.3%	☑	0.1%
Region 8	37,616	24.6%	☑	0.1%	17.2%	☑	0.1%
Harney	7,195	21.2%	☑	0.5%	22.2%	☑	0.4%
Malheur	30,421	25.4%	☑	*	16.0%	☑	0.1%

* Indicates that the estimate has been controlled to be equal to a fixed value and so it has no sampling error.

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau (2018). Table DP05: ACS Demographics and Housing Estimates, 2013-2017 American Community Survey 5-Year Estimates. Retrieved from https://data.census.gov/cedsci/

Language

Special consideration in hazard mitigation should be given to populations who do not speak English as their primary language. These populations are less likely to be prepared for a natural disaster if special attention is not given to language and culturally appropriate outreach materials. The region has a higher percentage of residents that do not speak English "very well" compared to the state as a whole. That population overwhelmingly lives in Malheur County. The number of people in Harney County who do not speak English "very well" is small and well below that statewide share, even considering the margins of error. Communities creating outreach materials used to communicate with and plan for populations who do not speak English very well should take into consideration the language needs of these populations.

Table 2-746. English Usage in Region 8

	Speak English Less Than "Very Well"				
	Estimate	CV **	MOE (+/−)	Percent	% MOE (+/−)
Oregon	222,428	☑	4,116	5.9%	0.1%
Region 8	2,507	☑	399	7.1%	1.1%
Harney	139	⊗	85	2.0%	1.3%
Malheur	2,368	☑	390	8.4%	1.4%

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

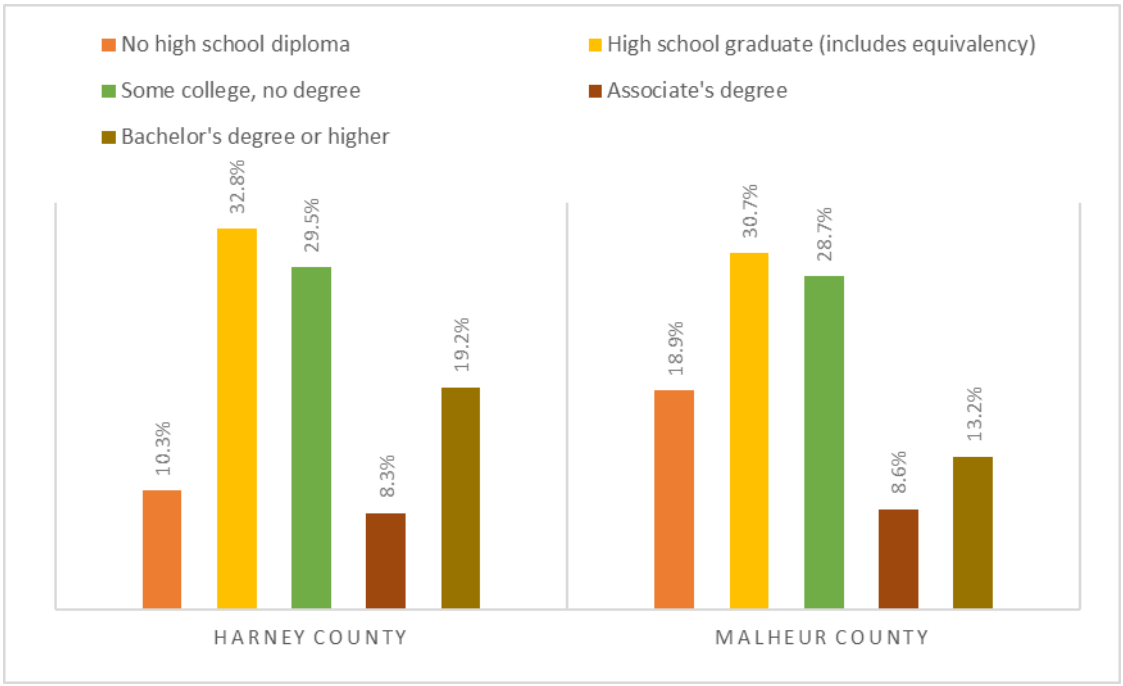
Source: U.S. Census Bureau (2018). Table DP02: Selected Housing Characteristics, 2013-2017 American Community Survey 5-Year Estimates. Retrieved from https://data.census.gov/cedsci/

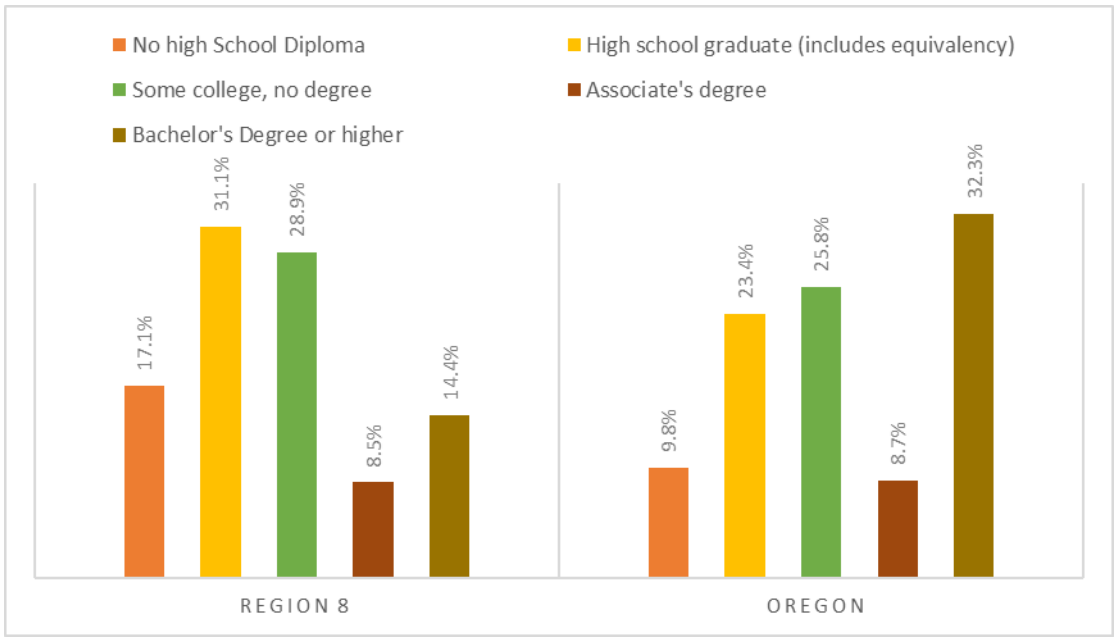
Education Level

Studies show that education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings (Cutter, Boruff, & Shirley, 2003). Furthermore, education can influence an individual's ability to understand and act on warning information, navigate bureaucratic systems, and to access resources before and after a natural disaster (Masozera, Bailey, & Kerchner, 2007).

The percentage of residents with a bachelor's degree is nearly eighteen percentage points smaller in Region 8 than in the state as a whole. Between the two counties, Harney County has a higher percentage of residents with a four-year degree. Malheur County has a greater percentage of residents without a high school diploma—approximately nine percentage points higher than the statewide estimate.

Figure 2-296. Educational Attainment in Region 8: (top) by County, (bottom) Regional vs. Statewide





Source: U.S. Census Bureau. Table DP03: Selected Economic Characteristics, American Community Survey, 2013-2017 American Community Survey 5-Year Estimates

Income and Poverty

The impact of a disaster in terms of loss and the ability to recover varies among population groups. “The causes of social vulnerability are explained by the underlying social conditions that

are often quite remote from the initiating hazard or disaster event" (Cutter S. L., 2006). Historically, 80% of the disaster burden falls on the public (Stahl, P., 2000). Of this number, a disproportionate burden is placed upon those living in poverty. People living in poverty are more likely to be isolated, are less likely to have the savings to rebuild after a disaster, and are less likely to have access to transportation and medical care.

Median household income in both counties is $16,000-$19,000 less than the statewide median. Harney County's estimate is slightly higher, however, the margins of error indicate median household income is similar in the two counties. Between 2012 and 2017, neither county experienced a statistically significant change in median household income.

Table 2-747. Median Household Income in Region 8

	2008-2012			2013-2017			Statistically Different*
	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	
Oregon	$53,427	☑	$338	$56,119	☑	$370	Yes
Region 8	—	—	—	—	—	—	—
Harney	$42,273	☑	$4,556	$39,504	☑	$4,691	No
Malheur	$39,872	☑	$2,028	$37,112	☑	$2,868	No

Note: 2012 dollars are adjusted for 2017 dollars. Data not aggregated at the regional level.

* Yes indicates that the 2013-2018 estimate is significantly different (at a 90% confidence level) than the estimate from 2008-2012. No indicates that the 2013-2017 estimate is not significantly different from the 2008-2012 estimate.

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: 2013-2017 American Community Survey 5-Year Estimates. Retrieved from: data.census.gov

Approximately 46% of all households in Region 8 earn less than $35,000 annually—fifteen percentage points higher than the statewide share. Malheur County has a higher percentage of earners in the bottom income brackets; however, the percentage earning less than $35,000 per year exceeds 40% in both counties. The higher proportion in the bottom means a smaller share at the top. Approximately 18% of residents in Region 8 earn more than 75,000 annually—roughly thirteen percentage points less than the share statewide. One-third of the region's households earn between $35,000 and $75,000 per year.

Figure 2-297. Median Household Income Distribution in Region 8

Source: U.S. Census Bureau. Table DP03: Selected Economic Characteristics, American Community Survey, 2013-2017 American Community Survey 5-Year Estimates

The American Community Survey uses a set of dollar value thresholds that vary by family size and composition to determine who is in poverty (U.S. Census Bureau, 2018). Moreover, poverty thresholds for people living in nonfamily households vary by age—under 65 years or 65 years and older (U.S. Census Bureau, 2018). A greater share of the regional population is living in poverty compared to the state as a whole. This is also true for both counties in the region as well. The percentage of people living in poverty is higher in Malheur County is higher than in Harney County; however, the margins of error indicate the estimates might be closer (or further apart).

A higher percentage of children in Region 5 are living in poverty compared to the statewide share; however, due to sampling error, estimates of child poverty for Harney County should be used with caution. Notably, over one-third of children in Malheur County live in poverty.

Low-income populations require special consideration when mitigating loss to a natural hazard. Often, those who earn less have little to no savings and other assets to withstand economic setbacks. When a natural disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the natural disaster. To reduce the compounded loss incurred by low-income populations post-disaster, mitigation actions need to be specially tailored to ensure safety nets are in place to provide further support to those with fewer personal resources (Cutter, Boruff, & Shirley, 2003).

Table 2-748. Poverty Rates in Region 8

	Total Population in Poverty						
	2008-2012			2013-2017			Statistical Difference?*
	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	
Oregon	15.5%	☑	0.3%	14.9%	☑	0.30	No
Region 8	23.8%	☑	2.2%	23.6%	☑	2.10	No
Harney	19.1%	⊙	4.7%	17.5%	☑	3.90	No
Malheur	25.0%	☑	2.5%	25.2%	☑	2.50	No

* Yes indicates that the 2013-2017 estimate is significantly different (at a 90% confidence level) than the estimate from 2008-2012. No indicates that the 2013-2017 estimate is not significantly different from the 2008-2012 estimate.

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau (2018). Table S1701: Poverty Status in Past 12 Months, 2013-2018 American Community Survey 5-Year Estimates. Retrieved from: data.census.gov

Table 2-749. Child Poverty in Region 8

	Children Under 18 in Poverty						
	2008-2012			2013-2017			Statistical Difference?*
	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	
Oregon	20.6%	☑	0.5%	19.0%	☑	0.6%	Yes
Region 8	32.3%	☑	5.1%	34.6%	☑	4.1%	No
Harney	29.0%	⊙	11.6%	23.3%	⊙	8.9%	No
Malheur	33.0%	☑	5.7%	36.8%	☑	4.6%	No

* Yes indicates that the 2013-2017 estimate is significantly different (at a 90% confidence level) than the estimate from 2008-2012. No indicates that the 2013-2017 estimate is not significantly different from the 2008-2012 estimate.

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau (2018). Table S1701: Poverty Status in Past 12 Months, 2013-2018 American Community Survey 5-Year Estimates. Retrieved from: data.census.gov

Low-income populations require special consideration when mitigating loss from a natural hazard. Often, those who earn less have little to no savings and other assets to withstand economic setbacks. When a natural disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the natural disaster. To reduce the compounded loss incurred by low-income populations post-disaster, mitigation actions need to be specially tailored to ensure safety nets are in place to provide further support to those with fewer personal resources (Cutter, Boruff, & Shirley, 2003).

Housing Tenure

Housing tenure, which captures whether someone owns or rents their home, has long been understood as a determinant of social vulnerability (Cutter, Boruff, & Shirley, 2003). Renters generally experience more housing challenges than homeowners; natural disasters frequently exacerbate those hardships (Lee & Van Zandt, 2019).

Homeownership is correlated with greater wealth, which can increase the ability to recover following a natural disaster (Cutter, Boruff, & Shirley, 2003). Renters often do not have personal financial resources or insurance to help recover post-disaster; they also frequently cannot access the same federal monies homeowners typically leverage following a disaster. They also might lack social resources, such as the ability to influence neighborhood decisions (Lee & Van Zandt, 2019).

Renters tend to be more mobile and have fewer assets at risk, however those assets might be more difficult to replace due to insufficient income. Renters typically have fewer options in terms of temporary shelter following a disaster and are less likely to stay with a relative or friend than in a public or mass shelter (Lee & Van Zandt, 2019).

The quality of construction for multi-family housing—more often rental—tends to be lower and is therefore more vulnerable to destruction during a disaster (Lee & Van Zandt, 2019). Moreover, renters have less ability to make improvements or alterations to their dwellings to enhance durability and structural safety (Lee & Van Zandt, 2019). Following a disaster, rental housing—especially affordable and subsidized housing—is frequently rebuilt more slowly, if at all (Lee & Van Zandt, 2019).

Harney County's estimate is approximately eight percentage points higher than the statewide estimate. Conversely, Malheur County's share is approximately three percentage points smaller than the statewide portion. As Malheur County has more than three times the number of households as Harney County, the percentage of owner-occupied households in Region 8 is slightly smaller than the share statewide.

Table 2-750. Housing Tenure in Region 8

	Total Occupied Units	Owner-Occupied			Renter-Occupied		
		Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	1,571,631	61.7%	☑	0.3%	38.3%	☑	0.3%
Region 8	13,341	60.8%	☑	2.3%	39.2%	☑	2.6%
Harney	3,079	69.9%	☑	4.2%	30.1%	☑	4.2%
Malheur	10,262	58.0%	☑	2.6%	42.0%	☑	2.6%

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau (2018). Table DP04: Selected Housing Characteristics, 2013-2017 American Community Survey 5-Year Estimates. Retrieved from: data.census.gov

Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households. Living alone can also be a risk factor—especially in poorer communities that lack adequate social infrastructure (Klinenberg, 2016). The American Community Survey defines a family household as one that contains a householder and one or more other people living in the same unit who are related by birth, marriage, or adoption. Conversely, a nonfamily household is one where someone is either living alone, or with nonrelatives only. Both counties in the region have a higher percentage of family households and a smaller share of single-person households compared to the state as a whole. Harney County has a smaller percentage of single-parent households than the statewide estimate. Conversely, Malheur County's share is approximately four percentage points higher than the statewide share.

Table 2-751. Family vs. Non-family Households in Region 8

	Total Households	Family Households			Nonfamily Households			Householder Living Alone		
	Estimate	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	1,571,631	63.3%	☑	0.2%	36.7%	☑	0.2%	27.7%	☑	0.2%
Region 8	13,341	67.6%	☑	2.6%	32.4%	☑	2.3%	26.3%	☑	2.2%
Harney	3,079	66.1%	☑	4.3%	33.9%	☑	4.3%	24.3%	☑	4.7%
Malheur	10,262	68.0%	☑	2.5%	32.0%	☑	2.5%	26.9%	☑	2.5%

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau (2018). Table DP02: Selected Housing Characteristics, 2013-2017 American Community Survey 5-Year Estimates. Retrieved from https://data.census.gov/cedsci/

Table 2-752. Family Households with Children by Head of Household in Region 8

	Family Households with Children			Single Parent (Male or Female)		
	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	26.2%	☑	0.2%	8.1%	☑	0.2%
Region 8	28.3%	☑	2.3%	11.1%	☑	1.9%
Harney	22.6%	☑	2.7%	6.5%	⊙	2.9%
Malheur	30.0%	☑	2.5%	12.5%	☑	2.4%

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau (2018). Table DP02: Selected Housing Characteristics, 2013-2017 American Community Survey 5-Year Estimates. Retrieved from https://data.census.gov/cedsci/

Social and Demographic Trends

This analysis shows that Region 8 has a greater number of people than the state average who are predisposed to be particularly vulnerable during a hazard event, because:

- The region has a higher percentage of residents with disabilities than the state as a whole. The share is also higher for older adults. The percentage of children living with a disability might also be higher, but the American Community Survey estimates are unreliable.
- Compared to the state as a whole, Region 8, and Malheur County, in particular, has a higher percentage of residents that do not speak English "very well".
- The share of residents with a bachelor's degree or more is considerably lower in the region compared to the state as a whole. Moreover, the percentage of residents without a high school diploma in Malheur County is significantly higher than the statewide share—approximately nine percentage points higher than the statewide estimate.
- Median household income in both counties is $16,000-$19,000 less than the statewide median. And approximately 46% of all households in Region 8 earn less than $35,000 annually—fifteen percentage points higher than the statewide share.
- A greater share of the regional population is living in poverty compared to the state as a whole, and over one-third of all children in Malheur County live in poverty.
- Malheur County's share of single-parent households is approximately four percentage points higher than the statewide share.

Economy

The impact of natural hazards on economic conditions depends on many variables. For example the vulnerability of businesses' labor, capital, suppliers, and customers are all relevant factors (Zhang, Lindell, & Prater, 2009). Some industries rebound quickly and even thrive following a disaster, manufacturing and construction, for example. Others, like wholesale and retail, rebound more slowly or never recover (Zhang, Lindell, & Prater, 2009). Economic resilience to natural disasters is far more complex than merely restoring employment or income in the local community. Building a resilient economy requires an understanding of how employment sectors, workforce participants, financial and natural resources, and critical infrastructure are interconnected and interdependent.

Employment

Natural disasters do not impact all labor market participants equally. Unemployed and underemployed populations are disproportionately affected by disaster events. Research shows that employment outcomes can be especially bad for people physically displaced by a disaster (Karoly & Zissimopoulos, 2010). Moreover, those who are unemployed and many employed in low-wage positions lack access to employee benefit plans that provide income and healthcare

supports (Flanagan, Gregory, Hallisey, Heitgerd, & Lewis, 2011). Income deprivation and inaccessible healthcare, ruinous in the best of times, are felt more severely following a disaster. It is important for local policy makers to understand existing labor force characteristics and existing market trends to build a resilient workforce and mitigate the scope and intensity of disruptions and economic pain.

Unemployment rates across Region 8 have been steadily declining since they peaked during the Great Recession. From 2014 to 2018, the unemployment rate in Harney County has always higher than in Malheur County; however, unemployment in both counties was consistently higher than the statewide rate.

Table 2-753. Civilian Labor Force in Region 8, 2018

	Civilian Labor Force	Employed Workers		Unemployed	
	Total	Total	Percent	Total	Percent
Oregon	2,104,516	2,017,155	95.8%	87,361	4.2%
Region 8	15,910	15,123	95.1%	787	4.9%
Harney	3,417	3,205	93.8%	212	6.2%
Malheur	12,493	11,918	95.4%	575	4.6%

Source: Oregon Employment Department, 2019

Table 2-754. Civilian Unemployment Rates in Region 8, 2014-2018

	2014	2015	2016	2017	2018	Change (2014–2018)
Oregon	6.8%	5.6%	4.8%	4.1%	4.2%	-2.6%
Region 8	8.3%	6.5%	5.7%	5.0%	4.9%	-3.3%
Harney	9.6%	7.2%	6.2%	6.3%	6.2%	-3.4%
Malheur	7.9%	6.4%	5.5%	4.6%	4.6%	-3.3%

Source: Oregon Employment Department, 2019

Supersectors and Subsectors

The North American Industry Classification System (NAICS) is a framework used by the United States, Canada, and Mexico to collect, analyze, and publish data about the North American economy. The classification system groups "economic units that have similar production processes" according to a six-digit hierarchical structure (Office of Management and Budget, n.d.). "The first two digits of the code designate the sector, the third digit designates the subsector, the fourth digit designates the industry group, the fifth digit designates the NAICS industry, and the sixth digit designates the national industry" (Office of Management and Budget, n.d.). The U.S. Bureau of Labor Statistics through its Quarterly Census of Employment and Wages program adds to the NAICS hierarchy by grouping NAICS sectors into supersectors (U.S. Bureau of Labor Statistics, 2019, Dec. 20). This plan looks at regional economic activity through these supersectors and then through three-digit NIAICS subsectors.

In 2018 the five major supersectors by share of employment in Region 8 were:

1. Trade, Transportation and Utilities
2. Local Government

3. Education and Health Services
4. Natural Resources and Mining
5. Leisure and Hospitality

Identifying supersectors with a large number of business establishments and targeting mitigation strategies to support them can help the region's resiliency. In Region 8, the following supersectors comprise a significant share of all business establishments.

- The Trade, Transportation, and Utilities supersector includes the highest number of establishments in Region 1, 17.8% of all businesses (QCEW, 2018).
- Other Services is second largest, with 16.0% of all business establishments (QCEW, 2018).
- The Natural Resources and Mining supersector is third, with 11.8% of the regional share (QCEW, 2018).
- Leisure and Hospitality is fourth largest with 9.2% of all establishments (QCEW, 2018).
- The Education and Health Services supersector is the fifth comprising 8.7% of all business establishments (QCEW, 2018).

While supersectors are useful abstractions, it's important to remember that within are many small businesses employing fewer than 20 employees (Valdovinos, 2020). Due to their small size, these businesses are particularly sensitive to disruptions that may occur following a natural hazard event.

Table 2-755. Covered Employment by Sector in Region 8, 2019

Industry	Region 8	Harney County		Malheur County	
	Percent	Employment	Percent	Employment	Percent
Total All Ownerships	100.0%	2,464	100.0%	12,875	100.0%
Total Private Coverage	73.0%	1,470	59.7%	9,725	75.5%
Natural Resources & Mining	10.1%	220	8.9%	1,332	10.3%
Construction	2.7%	105	4.3%	304	2.4%
Manufacturing	6.8%	(c)	(c)	1,044	8.1%
Trade, Transportation & Utilities	21.2%	420	17.0%	2,837	22.0%
Information	1.3%	(c)	(c)	194	1.5%
Financial Activities	2.2%	47	1.9%	290	2.3%
Professional & Business Services	3.2%	84	3.4%	412	3.2%
Education & Health Services	12.6%	222	9.0%	1,711	13.3%
Leisure & Hospitality	9.5%	268	10.9%	1,195	9.3%
Other Services	3.2%	84	3.4%	405	3.1%
Unclassified	0.0%	0	0.0%	(c)	(c)
Total All Government	27.0%	994	40.3%	3,149	24.5%
Total Federal Government	2.8%	229	9.3%	198	1.5%
Total State Government	8.2%	100	4.1%	1,156	9.0%
Total Local Government	16.0%	666	27.0%	1,795	13.9%

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

Source: Oregon Employment Department. (2019). Quarterly Census of Employment and Wages. Retrieved from Qualityinfo.org

Each supersector faces distinct vulnerabilities to natural hazards. Identifying a region's dominant supersectors and the underlying industries enables communities to target mitigation activities toward those industries' specific sensitivities. Each of the primary private employment supersectors has sensitivity to natural hazards, as follows.

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

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

Resources and Mining: The primary industries within this sector regionally are largely crop and animal production. These industries tend to fluctuate seasonally and are vulnerable to a variety of natural hazard (winter storms, floods, etc.). Further, to the loss of farm production, wages could be lost due to natural disasters. In addition, these industries are dependent upon transportation systems that are vulnerable to disasters.

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

Looking at industrial subsectors (three-digit NAICS) provides greater detail about the regional economy while maintaining a level of aggregation useful for analysis. The table below shows the top ten industries by share of employment within the region. Many of the top employment subsectors are similar across regions. For example, Food Services and Drinking Places and Educational Services are the two largest employment subsectors in Region 8. These subsectors also rank highly in other regions. Ambulatory Health Care Services—also known as outpatient services—and Hospitals are also major employers in Region 8 and across the state. Conversely, other subsectors, such as Crop Production and Food Manufacturing, are more unique to the region.

Table 2-756. Industries with Greatest Share of Employment in Region 8, 2018

Industry	Employment Share	Employment (2018)
Food Services and Drinking Places	8.9%	1,602
Educational Services	8.9%	1,589
Justice, Public Order, and Safety Activities	7.2%	1,298
Crop Production	6.2%	1,111
Food Manufacturing	6.1%	1,100
General Merchandise Stores	4.8%	869
Social Assistance	4.8%	855
Ambulatory Health Care Services	4.6%	831
Food and Beverage Stores	3.7%	665
Support Activities for Agriculture and Forestry	3.5%	637

Source: U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018); Calculations for employment share and average employment by DLCD

Industry Concentration and Employment Change

A location quotient (LQ) is a metric used to identify a region's area of industrial specialization. It is calculated by comparing an industry's share of regional employment with its share of employment in a reference economy (Quinterno, 2014). If a LQ is higher than 1.0, employment in that industry is more concentrated in that region than in the reference economy. In this case, the reference economy is the United States as a whole. Industries with a high LQ indicate the region might have a competitive advantage and that the industry is potentially—but not always—exporting goods and services. Understanding regional competitiveness and targeting mitigation strategies that make exporting industries less vulnerable can help the region's resiliency. Location quotients, however, require careful interpretation; analysis of employment data should be paired with local knowledge of regional business dynamics.

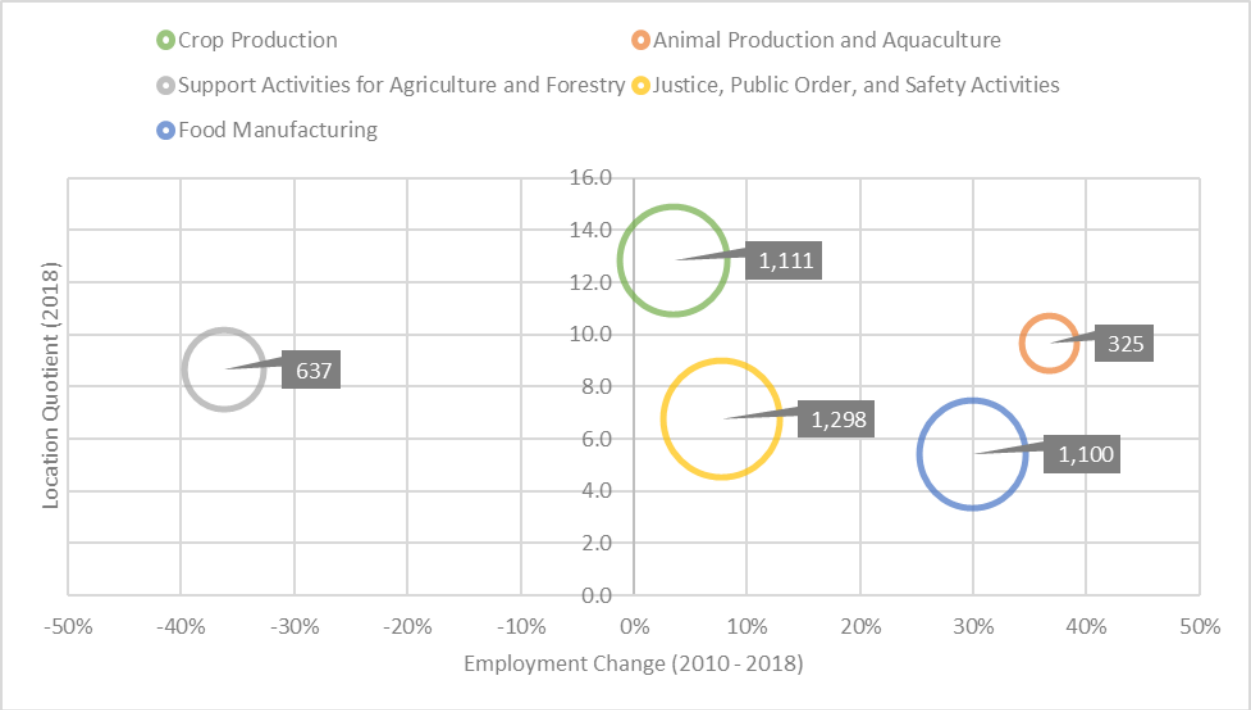
Table 2-757. Most Concentrated Industries and Employment Change in Region 8, 2018

Industry	Location Quotient	Employment (2018)	Employment Change (2010–2018)
Crop Production	12.9	1,111	3%
Animal Production and Aquaculture	9.7	325	37%
Support Activities for Agriculture and Forestry	8.7	637	−36%
Justice, Public Order, and Safety Activities	6.8	1,298	8%
Food Manufacturing	5.4	1,100	30%

Source: U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018), Retrieved from: https://ledextract.ces.census.gov/static/data.html; Calculations for location quotient, average employment, and employment change by DLCD

In addition to an industry's LQ value, it is important to consider the number of jobs and whether the industry is growing or declining. The scatter plot below presents this information for the five industries in Region 8 with the highest LQ values. It shows the percent change in employment over the last eight years, the total number of employees in the industry, and the LQ value.

Figure 2-298. Location Quotients, Employment Change, and Total Employment in Region 8, 2018



Source: U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018), Retrieved from: https://ledextract.ces.census.gov/static/data.html; Calculations for location quotient, average employment, and employment change by DLCD

Four of the region's most concentrated industries are either natural resource based or directly dependent on natural resource industries. Looking at these four subsectors as a whole, it's clear that the region has a competitive advantage in growing and processing food products. Three of the four also represent some of the largest subsectors by share of employment. The Food Manufacturing and Animal Production and Aquaculture subsectors experienced the most growth during the 2010-2018 period. Conversely, the Support Activities of Agriculture and Forestry subsector shed jobs during the period.

Fastest Growing and Declining Industries

Empirical analysis suggests that natural disasters can accelerate preexisting economic trends (Zhang, Lindell, & Prater, 2009). Therefore, it is important for local planners to understand their region's existing economic context, which industries are growing and which are declining.

Employment change can be caused by internal and external factors. The shift-share analysis helps us understand and separate regional and national influences on a local industry. There are three separate elements to the analysis that attempt to account for local and national forces. The national-share controls for the broad growth of the national economy; the industry-mix controls for broad national changes within an industry being analyzed; and the local-factor tries to explain what portion of employment change can be attributed to local factors. The bar chart below depicts a shift-share analysis for Region 8's fastest growing and declining industries

Table 2-758. Fastest Growing and Declining Industries in Region 8, 2010-2018

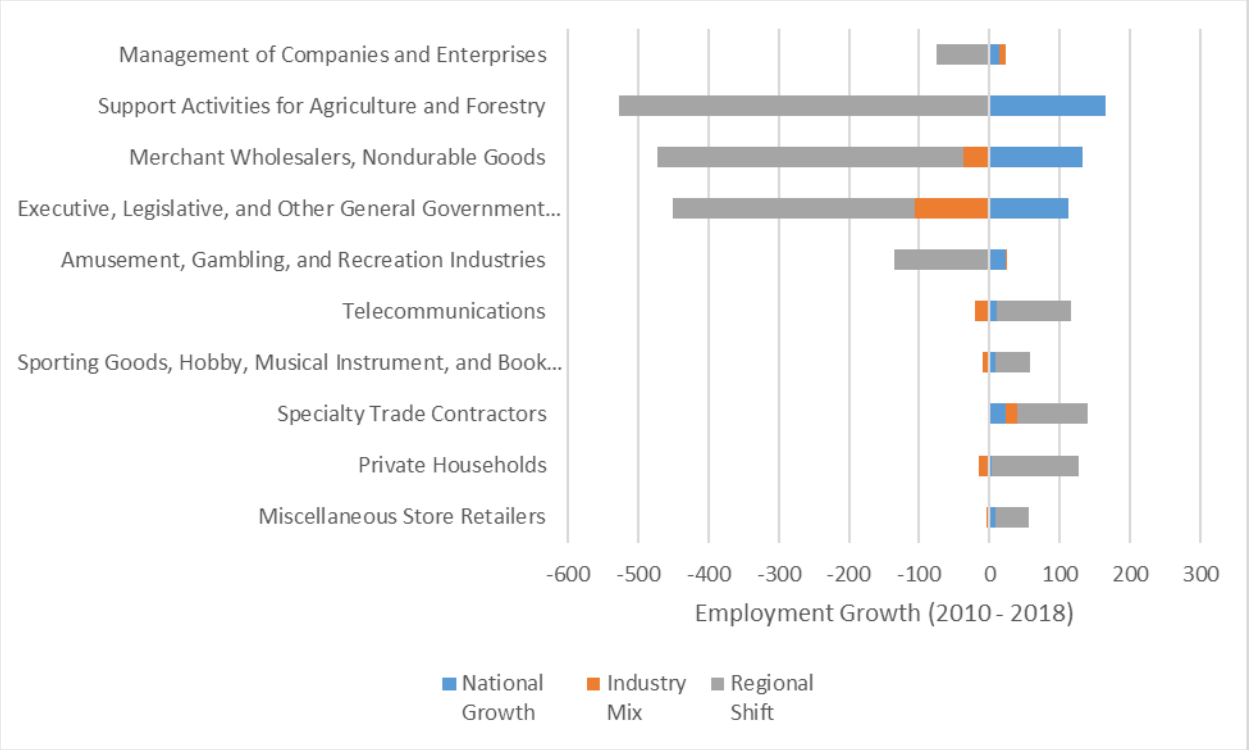
Industry	Employment Change	Employment (2010)	Employment (2018)
Fastest Growing			
Private Households	546%	21	133
Telecommunications	149%	63	158
Miscellaneous Store Retailers	104%	50	103
Sporting Goods, Hobby, Musical Instrument, and Book Stores	104%	47	97
Specialty Trade Contractors	102%	136	275
Fastest Declining			
Amusement, Gambling, and Recreation Industries	−80%	137	28
Management of Companies and Enterprises	−59%	90	37
Executive, Legislative, and Other General Government Support	−50%	672	333
Merchant Wholesalers, Nondurable Goods	−42%	801	462
Support Activities for Agriculture and Forestry	−36%	997	637

Source: U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018); Calculations for average annual employment, and employment change by DLCD

Due to a smaller regional population, the fastest growing industries started with meager employment in 2010—each under two-hundred. Consequently, small changes in absolute terms equate to significant percent increases. According to the shift share analysis, growth in all five subsectors was driven by largely by regional factors. However, it should be noted that with such small numbers, subsector growth potentially represents the opening of one or two establishments, rather than a larger industry trend.

Region 8 experienced notable declining employment in the Merchant Wholesalers, Nondurable Goods subsector; the Executive, Legislative, and other General Governmental Support subsector; and the Support Activities for Agriculture and Forestry subsector. Each shed over three-hundred jobs. While some of the jobs loss in the first two can be attributed to decline in the subsector at the national level, loss in all three was driven primarily by regional factors.

Figure 2-299. Shift-Share-Analysis of Fastest Growing and Declining Industries in Region 8, 2010-2018



Source: U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018); Calculations for shift share by DLCD

Table 2-759. Shift-Share-Analysis of Fastest Growing and Declining Industries in Region 8, 2010-2018

Industry	Employment Change	National Growth	Industry Mix	Regional Shift
Fastest Growing				
Miscellaneous Store Retailers	53	8	−4	48
Private Households	112	3	−15	124
Specialty Trade Contractors	139	23	17	99
Sporting Goods, Hobby, Musical Instrument, and Book Stores	49	8	−9	50
Telecommunications	95	11	−21	105
Fastest Declining				
Amusement, Gambling, and Recreation Industries	−109	23	3	−135
Executive, Legislative, and Other General Government Support	−339	112	−107	−344
Merchant Wholesalers, Nondurable Goods	−340	133	−37	−436
Support Activities for Agriculture and Forestry	−361	166	−3	−524
Management of Companies and Enterprises	−53	15	8	−76

U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018); Calculations for shift share by DLCD

Economic Trends and Issues

Because a strong and diverse economic base increases the ability of individuals, families, and communities to absorb impacts of a disaster and recover more quickly, current and anticipated financial conditions of a community are strong determinants of community resilience. The economic analysis of the region shows the following situations increase the region's level of vulnerability to natural hazard events:

- The region generally lacks a diversity of traded sector industries. Many of the region's most concentrated industries are natural resource-based or depend on natural resource industries. These sectors are especially vulnerable to the impacts of climate change;
- Unemployment rates across the region were higher than in the state as a whole From 2014 to 2018;
- The Support Activities for Agriculture and Forestry subsector, an area of competitive advantage for the region, shed jobs from 2010-2018.
- The regional economy has few opportunities for highly skilled employees, limiting the income potential of regional residents.

Supporting the growth of dominant industries and employment sectors, as well as emerging sectors identified in this analysis, can help the region become more resilient to economic downturns that often follow a hazard event (Stahl, et al., 2000).

Infrastructure

Transportation

Roads

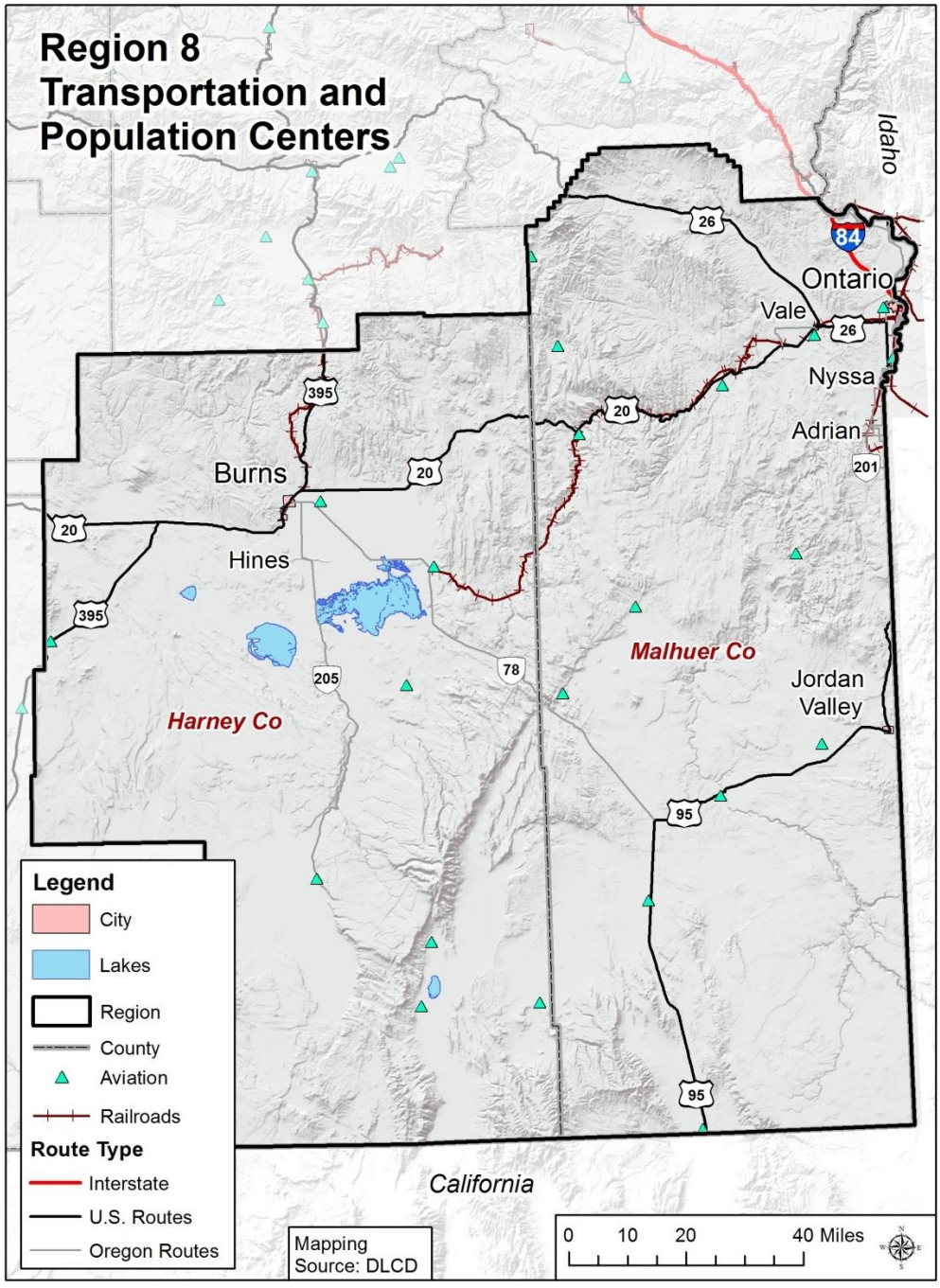
The largest population bases in Region 8 are located along the region's major highways: I-84, US-20, US-26, and US-95. I-84 runs north-south and is the main passage for automobiles and trucks traveling east of the Cascade Range between Portland and Idaho **Figure 2-300** shows Region 8's highways and population centers. US-20, US-26, and US-95 provide access east and west into Idaho and central Oregon counties. US-395 provides access into Lake County. Additional access is provided within Idaho to adjacent counties via US-30 and US-95.

Region 8's growing population centers bring more workers, automobiles, and trucks onto roads. A high percentage of workers driving alone to work coupled with interstate and international freight movement create additional stresses on transportation systems. Some of these include added maintenance, congestion, oversized loads, and traffic accidents.

Natural hazards and emergency events can further disrupt automobile traffic, create gridlock, and shut down local transit systems, making evacuations and other emergency operations difficult. Hazards such as localized flooding can render roads unusable. Likewise, a severe winter storm has the potential to disrupt the daily driving routine of thousands of people.

According to the Oregon Department of Transportation's (2014, October) Seismic Plus Report (Appendix **9.1.13**), the projected impacts of a CSZ event are considered negligible in this part of the state. However, economic disruption from major losses in the larger markets of the state will affect the economy in this region.

Figure 2-300. Region 8 Transportation and Population Centers



Source: Oregon Department of Transportation (2014, October)

Bridges

ODOT lists 287 bridges in the counties that comprise Region 8.

Non-functional bridges can disrupt emergency operations, sever lifelines, and disrupt local and freight traffic. These disruptions may exacerbate local economic losses if industries are unable to transport goods. The region's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or are part of regional and local systems that are maintained by the region's counties and cities.

A distressed bridge (Di) is a condition rating used by the Oregon Department of Transportation (ODOT) indicating that a bridge has been identified as having a structural or other deficiency, while a deficient bridge (De) is a federal performance measure used for non-ODOT bridges. The ratings do not imply that a bridge is unsafe (ODOT, 2020). The region has a lower percentage of bridges that are distressed and/or deficient (2%) than the state overall (5%).

Table 2-760. Bridge Inventory for Region 8

	State Owned			County Owned			City Owned			Other Owned			Area Total		
	Di	ST	%D*	De	ST	%D	De	ST	%D	De	ST	%D	D	T	%D
Oregon	42	2,760	2%	258	3,442	7%	30	643	5%	16	121	13%	346	6,966	5%
Region 8	0	111	0%	7	176	4%	0	0	N/A	0	0	N/A	7	287	2%
Harney	0	37	0%	2	71	3%	0	0	N/A	0	0	N/A	2	108	2%
Malheur	0	74	0%	5	105	5%	0	0	N/A	0	0	N/A	5	179	3%

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

Source: ODOT (2020)

Railroads

Railroads that run through Region 8 support cargo and trade flows. The region's major freight rail providers are the Union Pacific (UP) and the Burlington Northern-Santa Fe (BNSF) railroads. The rail line follows the I-84 corridor and another non-Class I rail line provides access to the City of Vale. There are no active rail lines in Harney County. There are two rail yards in the region — in Ontario and Nyssa — operated by UP (Cambridge Systematics, 2014). There is no passenger rail available in Region 8.

Oregon's rail system is critical to the state's economy, energy, and food systems. Rail systems export lumber and wood products, pulp and paper, and other goods produced in Oregon and products from other states that are shipped to and through Oregon by rail (Cambridge Systematics, 2014).

Rails are sensitive to icing from winter storms that can occur in Region 8. Disruptions in the rail system can result economic losses for the region. The potential for harm from rail accidents can also have serious implications for local communities, particularly if hazardous materials are involved.

Airports

There are no commercial airports in the region, however. There are several general aviation public airports including the Burns and Ontario Municipal airports.

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

Table 2-761. Public and Private Airports in Region 8

	Number of Airports by FAA Designation				
	Public Airport	Private Airport	Public Helipad	Private Helipad	Total
Region 8	6	17	0	1	24
Harney	1	8	0	0	9
Malheur	5	9	0	1	15

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

Energy

Electricity

The region is served by several investor-owned, public, cooperative, and municipal utilities. The Bonneville Power Administration is the area's wholesale electricity distributor. Idaho Power is the primary investor-owned utility company serving Harney and Malheur Counties. The region's electric cooperatives include the Harney Electric Cooperative (Harney, Malheur), and the Oregon Trail Electric Cooperative (Harney).

Table 2-762 lists electric power-generating facilities that are within Region 8. The region has two power-generating facilities: one hydroelectric power facility and one geothermal facility. There are no power-generating facilities in Harney County. In total, the power-generating facilities have the ability to produce up to 40 megawatts (MW) of electricity.

Table 2-762. Power Plants in Region 8

	Hydro-electric	Natural Gas	Wind	Coal	Other*	Total
Region 8	1	0	0	0	1	2
Harney	0	0	0	0	0	0
Malheur	1	0	0	0	1	2
Energy Production (MW)	35	0	0	0	5	40

*"Other" includes biomass, geothermal, landfill gas, solar, petroleum, and waste.

Source: Army Corps of Engineers; Biomass Power Association; Calpine Corporation; Eugene Water and Electric Board; Iberdola Renewables; Idaho Power Company; Klamath Energy LLC; Oregon Department of Energy; Owyhee Irrigation District; Form 10K Annual Report (2013), PacifiCorp; Form 10K Annual Report (2013), Portland General Electric; U.S. Geothermal, Inc.

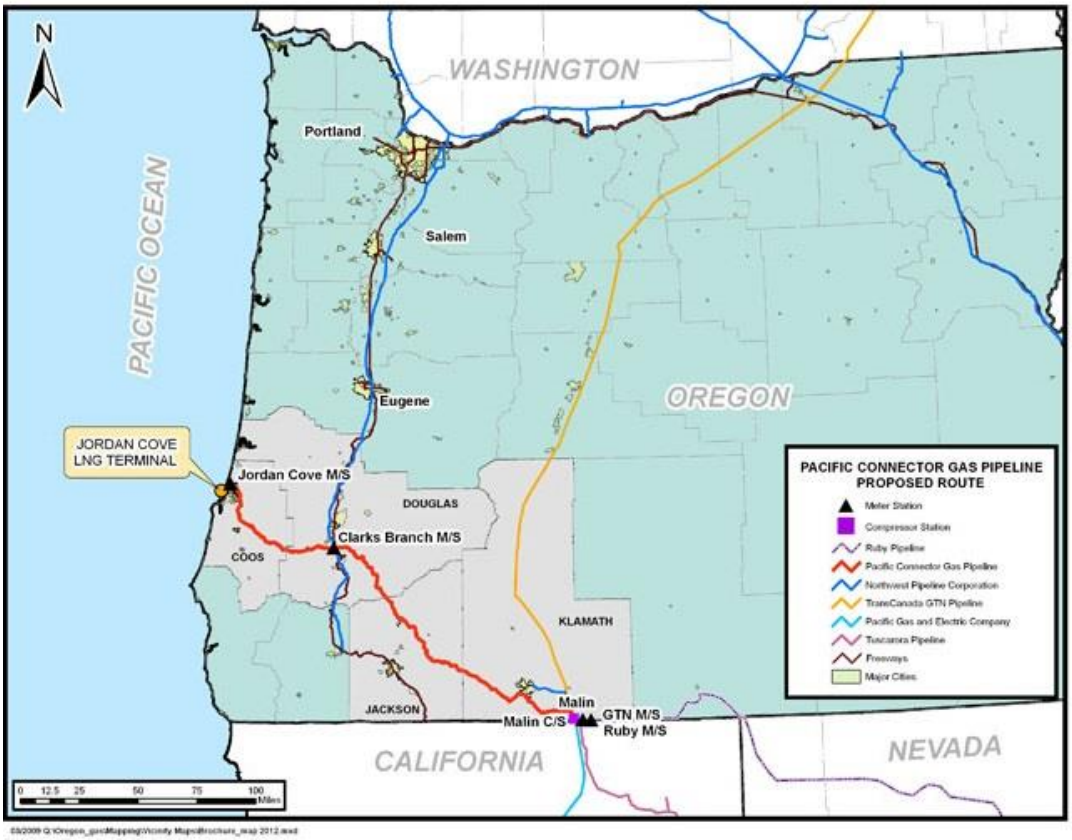
Hydropower

There are several major dams owned by Idaho Power along the Lower Snake River just north of Region 8 which produce a significant amount of hydropower.

Natural Gas

Although natural gas does not provide the most energy to the region, it does contribute a significant amount of energy to the region's energy portfolio. Liquefied natural gas (LNG) is transported via pipelines throughout the United States. **Figure 2-301** shows the Northwest Pipeline, which runs through Malheur County (near Ontario, shown in blue). (http://www.northwest.williams.com/NWP_Portal/extLoc.action?Loc=FilesNorthwestother&File=pipelineInfo.html). LNG pipelines, like other buried pipe infrastructure, are vulnerable to earthquakes and can cause danger to human life and safety, as well as environmental impacts in the case of a spill.

Figure 2-301. Liquefied Natural Gas Pipelines in Region 8



Source: Williams Corporation

Utility Lifelines

The northeast corner of Malheur County is an important throughway for oil and gas pipelines and electrical transmission lines. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy. These lines may be vulnerable to severe but infrequent natural hazards such as earthquakes.

Region 8 primarily receives oil and gas from Alaska by way of the Puget Sound through pipelines and tankers. The electric, oil, and gas lifelines that run through the region are both municipally and privately owned (Loy, Allan, & Patton, 1976).

The network of electrical transmission lines running through Region 8 is operated primarily by Idaho Power, Pacific Power, and regional electrical cooperatives (and supplied by the Idaho Power Company and Bonneville Power Administration) and primarily facilitates local energy production and distribution (Loy, Allan, & Patton, 1976). Most of the natural gas Oregon uses originates in Alberta, Canada. The Williams Company owns the main natural gas transmission pipeline in southeastern Oregon.

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio). Region 8 is part of the Lake-Harney Operational Area under The Oregon State Emergency Alert System Plan (Oregon OEM, 2013). There is a memorandum of understanding between these counties that facilitates the launching of emergency messages. Counties in these areas can launch emergency messages by contacting the Oregon Emergency Response System (OERS), which in turn creates emergency messages to communities statewide.

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

Television

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

Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband service providers serve Region 8. Broadband technology including mobile wireless is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless, and mobile wireless. Internet service is readily available throughout most parts the region with a smaller number of providers and service types available in the more remote parts of the region (NTIA, n.d.). Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

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

Radio

Radio is readily available to those who live within Region 8 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Radio transmitters for the Eastern Oregon Operational Area are:

Local Primary Station:

- KBHN-FM, 1230 KHZ (Burns); and

State Primary Station:

- KOBN-FM, 90.1 MHZ (Burns).

Ham Radio

Amateur radio, or ham radio, is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). ARES District 6 provides service to Region 8. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (Oregon Office of Emergency Management, n.d.)The official ham emergency station calls for Region 8 are (American Relay Radio League Oregon Chapter, www.arrloregon.org):

- Harney County: KF7CIS; and
- Malheur County: K&RHB.

Water

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

Drinking Water

In southeastern Oregon, the majority of municipal drinking water is supplied from groundwater wells, including in the cities of Burns and Hines. The City of Ontario primarily draws its drinking water from the Snake River. The City of Nyssa also has water rights for municipal water on the Snake River as a secondary water source. The City of Vale primarily relies on the Malheur River for drinking water and has groundwater wells as a backup water source. Rural areas in Malheur County draw drinking water from the Owyhee River, Beulah Reservoir, and Billy Creek. In Harney County, rural drinking water is drawn primarily from groundwater wells.

Irrigation water is generally pulled from surface sources and distributed through established irrigation districts in Malheur County. In Harney County, irrigation water is drawn from a combination of groundwater wells and surface sources including the Silvies, Donner und Blitzen River, and smaller tributary creeks.

There are several threats to the region's water quality and quantity. In Malheur County agricultural products such as pesticides and herbicides leech nitrates into ground and surface

water. DEQ, ODA, and ODF have programs in place to address water quality concerns caused by land management practices that are nonpoint sources of pollution. However, there continue to be on the 303d list and the Pesticide Stewardship Partnerships identified waterbodies that are not meeting water quality standards and pesticide benchmarks. More work is needed to address these. In general ODA's water quality rules and plans and its Confined Animal Feeding Operations (CAFO) program do provide some protection. However, the CAFO program is designed to provide water quality protection for up to a certain design storm, not for a major flood or other natural hazard event. In addition, the data defining the design storm need to be updated to provide the intended protection. Other concerns for water quality in Malheur County include naturally occurring arsenic and phosphorus in the soil and bacterial contaminants such as *Escherichia coli* (*E. coli*). Naturally occurring arsenic and other minerals threatens water quality in Harney County. Mineral concentrations become higher in proximity to Malheur Lake and during drought seasons, increasing water quality threats in Harney County.

Water shortages have become common in Region 8. 2011 was the last year with a predictable water supply. The region had drought declarations for three consecutive years, from 2012 to 2014.

Low levels of snowpack can lead to severe shortages in a region that is already subject to annual shortages. Low precipitation levels can lead to low levels of groundwater recharge, which could impact both agricultural and municipal supplies. Additionally, no new water rights are available for surface water, although groundwater rights are still available in Malheur County.

At the time of this writing, water supply in irrigation districts is not meeting demand to sustain local agricultural operations. In 2014, irrigation water supplies are expected to be unavailable two and a half months less than usual. This is compounded by the fact that Harney County currently has no above-ground reservoir for municipalities or rural residents.

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

Stormwater and Wastewater

In urbanized areas severe precipitation events may cause flooding that leads to stormwater runoff. A non-point source of water pollution, stormwater runoff can adversely impact drinking water quality. It can also lead to environmental issues such as increasing surface water temperatures that can adversely affect habitat health. Furthermore, large volumes of fast-moving stormwater that enter surface waterways can cause erosion issues.

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

urban areas and waterways. Underground stormwater and wastewater pipes are also vulnerable to damage by seismic events.

In Region 8, county and building codes (city and county) emphasize use of centralized storm sewer systems to manage stormwater. Low impact development (LID) mitigation strategies can alleviate or lighten the burden to a jurisdiction's storm sewer system by allowing water to percolate through soil onsite or detaining water so it enters the storm sewer system at lower volumes, at lower speed, and at lower temperatures. LID strategies are not required any community in Region 8. Promoting and requiring decentralized LID stormwater management strategies could help reduce the burden of new development on storm sewer systems, and increase a community's resilience to many types of hazard events.

Infrastructure Trends and Issues

Physical infrastructure is critical for everyday operations and is essential following a disaster. Lack or poor condition of infrastructure can negatively affect a community's ability to cope with, respond to, and recover from a hazard event. Diversity, redundancy, and consistent maintenance of infrastructure systems help create system resiliency (Meadows, 2008).

Damage or service interruption to roads, bridges, and rail systems can have devastating effects the region's economy. Hazards such as flooding and winter weather can close the highways that connect communities in Region 8 to the rest of the state and neighboring states. Eight percent of all bridges in Region 8 are distressed or deficient. In Malheur County there are two rail yards, and rails that support cargo and trade flows and are vulnerable to icy conditions.

The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards. Two power-generating facilities are located here, a hydroelectric and a geothermal facility. The majority of the region's dams are located in Malheur County. Ten have High Threat Potential dams and 13 have Significant Threat Potential. The northeast corner of Malheur County is an important throughway for oil and gas pipelines and electrical transmission lines. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards.

Decentralization and redundancy in the region's telecommunication systems can help boost the area's ability to communicate before, during, and after a disaster event. It is important to note that broadband and mobile telephone services may not cover areas that are distant from major transportation routes. This may present a communication challenge in the wake of a hazard event. Encouraging residents to keep AM/FM radios available for emergency situations could help increase the capacity for communicating important messages throughout the region.

Drinking water is primarily sourced from groundwater wells, the Snake River, Malheur River Owyhee River, Beulah Reservoir, and Billy Creek. These water bodies are vulnerable to pollution from agricultural pesticides and herbicides. Naturally occurring mineral concentrations become higher in proximity to Malheur Lake and during drought seasons, increasing water quality vulnerability in Harney County. No communities in the region require low impact development (LID) regulations.

Built Environment

Settlement and Development Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's program is 19 land use goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards (DLCD, https://www.oregon.gov/lcd/OP/Pages/Goal-7.aspx).

Urbanization and Population Distribution

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). Jurisdictions are designated urban or rural after each decennial census. The 2020 Census is currently underway; therefore, the data in **Table 2-763** and **Table 2-764** remain from the 2010 Census.

Contrary to statewide patterns of urban growth and rural decline between 2000 and 2010, Region 8's urban populations shrank by about 13% and rural populations grew by roughly 15%. Harney County experienced a greater increase in housing units in both urban and rural communities.

The region's population is clustered around the I-84 corridor and the cities of Burns, Hines, Ontario, and Vale. The population distribution in Region 8 is presented in **Figure 2-302**.

Table 2-763. Urban and Rural Populations in Region 8, 2010

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	2,694,144	3,104,382	15.2%	727,255	726,692	-0.1%
Region 8	23,194	20,283	-12.6%	16,030	18,452	15.1%
Harney	4,330	4,131	-4.6%	3,279	3,291	0.4%
Malheur	18,864	16,152	-14.4%	12,751	15,161	18.9%

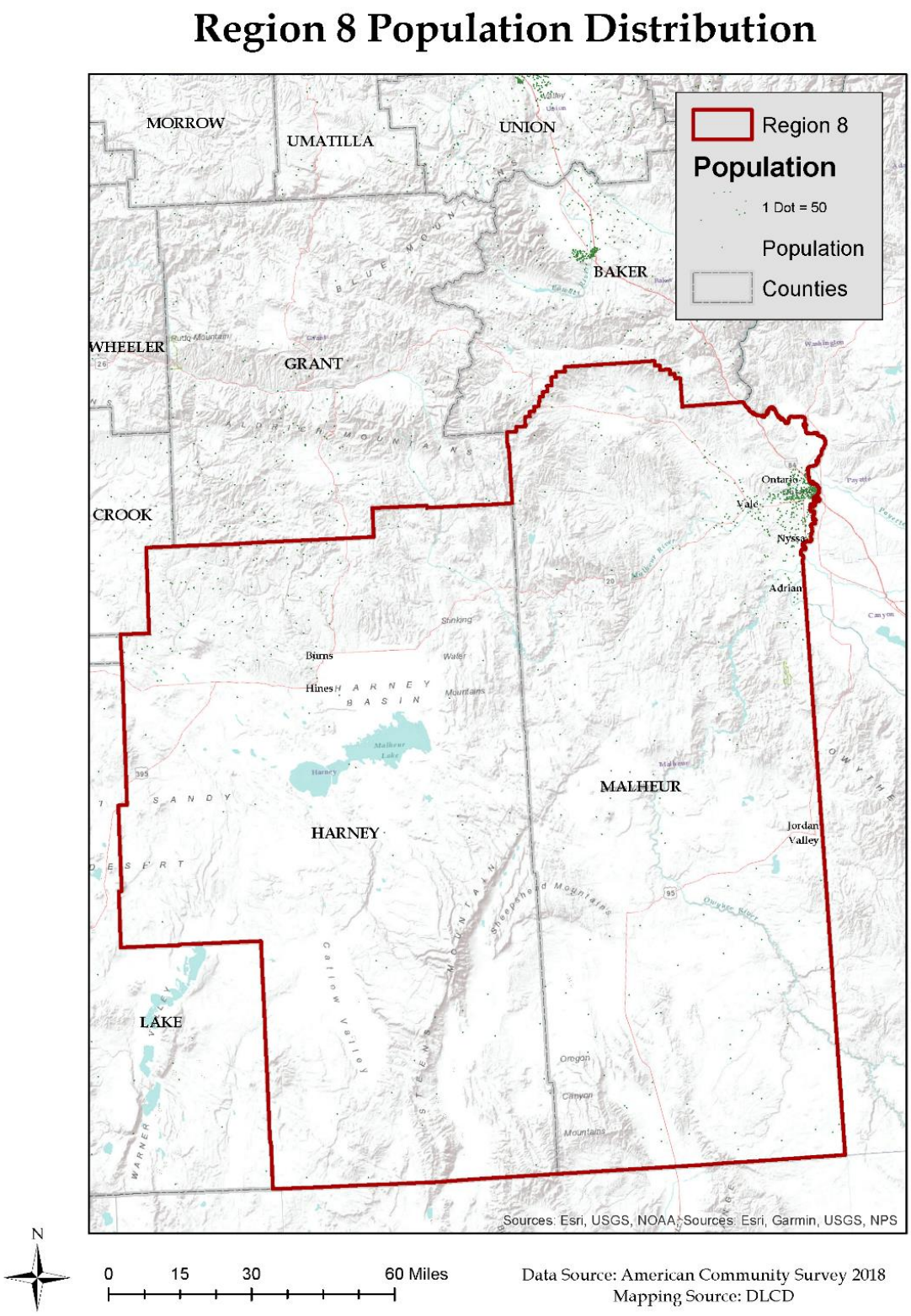
Source: U.S. Census Bureau (n.d.). 2010 Decennial Census, Table P2; U.S. Census Bureau (n.d.). 2000 Decennial Census, Table P002

Table 2-764. Urban and Rural Housing Units in Region 8, 2010

	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%
Region8	8,186	8,453	3.3%	6,580	7,074	7.5%
Harney	1,990	2,111	6.1%	1,543	1,724	11.7%
Malheur	6,196	6,342	2.4%	5,037	5,350	6.2%

Source: U.S. Census Bureau (n.d.). 2010 Decennial Census, Table H2; U.S. Census Bureau (n.d.). 2000 Decennial Census, Table H002

Figure 2-302. Region 8 Population Distribution



Source: U.S. Census Bureau, American Community Survey, 2014-2018 5YR

Housing Development

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. **Table 2-703** provides a breakdown by county of housing types: single-family, multi-family, and manufactured housing. Note: The total housing units value also includes boats, RVs, vans, etc. that are used as a residence. These homes are not included in the table as a separate category because they represent a small percentage of the overall housing profile. Consequently, adding the percentages horizontally for the state, region, and each county will not equal 100%.

Similar to the state, about two-thirds of the region's housing stock is single-family homes. In contrast, multi-family housing comprises a smaller share of the region's housing stock, approximately 15%. The share of manufactured homes is more than double the share statewide. Notably, more than a fifth of homes in Harney County are manufactured units. In natural hazard events such as earthquakes and floods, manufactured homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of Emergency Services, 1997).

Table 2-765. Housing Profile for Region 8

	Total Housing Units	Single Family			Multi-Family			Manufactured Homes		
		Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	1,733,041	68.1%	☑	0.3%	23.5%	☑	0.3%	8.2%	☑	0.1%
Region 8	15,676	65.9%	☑	2.3%	15.2%	☑	1.7%	18.8%	☑	1.6%
Harney	3,870	67.0%	☑	5.2%	8.8%	☑	0.8%	23.9%	☑	3.5%
Malheur	11,806	65.6%	☑	2.6%	17.2%	☑	2.3%	17.1%	☑	1.7%

Notes: **Green, orange, and red icons indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with green checkmark icon, medium reliability (CV 15–30% — be careful) is shown with orange dot icon, and low reliability (CV >30% — use with extreme caution) is shown with red "x" icon. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error (MOE) and the need for precision.

Source: U.S. Census Bureau (2018). Table B25024: Units in Structure, 2013-2017 American Community Survey 5-year estimates. Retrieved from https://data.census.gov/cedsci/

Aside from location and type of housing, the year structures were built (**Table 2-767**) has implications. Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for the Cascadia earthquake fault (Judson, 2012). Therefore, homes built before 1994 are more vulnerable to seismic events. Moreover, the Judson report did not include manufactured housing in its study, but more recent research concludes that manufactured homes installed prior to 2003 lack adequate anchoring and bracing, and are therefore more vulnerable to damage and loss caused by seismic events (Bauer, et al., 2020).

Also in the 1970s, FEMA began assisting communities with floodplain mapping as part of administering the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Upon receipt of floodplain maps, communities started to develop floodplain management ordinances to protect people and property from flood loss and damage. Regionally, about 45% of the housing stock was built prior to 1970, before the implementation of floodplain management ordinances. Over three-quarters of the housing stock was built before 1990 and

the codification of seismic building standards. Additionally, as shown in Table 2-768Table 2-582, many communities did not adopt their initial FIRM—and therefore did not adopt floodplain management ordinances—until the middle to late 1980s. This means that some structures built after 1970 could still be at increased risk.

Table 2-766. Housing Vacancy in Region 8

	Total Housing Units	Vacant^		
		Estimate	CV **	MOE (+/–)
Oregon	1,733,041	5.6%	☑	0.3%
Region 8	15,676	11.8%	☑	2.5%
Harney	3,870	17.1%	⊙	6.2%
Malheur	11,806	10.0%	⊙	2.6%

Notes: ^ Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

**Green, orange, and red icons indicate the reliability of each Green, orange, and red icons indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with green checkmark icon, medium reliability (CV 15–30% — be careful) is shown with orange dot icon, and low reliability (CV >30% — use with extreme caution) is shown with red "x" icon. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error (MOE) and the need for precision.

Source: U.S. Census Bureau (2018), 2013-2017 American Community Survey 5-Year Estimates. https://data.census.gov/cedsci/. Table B25004: Vacancy Status

Table 2-767. Age of Housing Stock in Region 8

	Total Housing Units	Pre 1970			1970 to 1989			1990 or Later		
		Estimate	CV **	MOE (+/–)	Estimate	CV **	MOE (+/–)	Estimate	CV **	MOE (+/–)
Oregon	1,733,041	34.6%	☑	0.3%	30.5%	☑	0.3%	34.9%	☑	0.3%
Region 8	15,676	45.6%	☑	2.9%	31.0%	☑	2.4%	23.4%	☑	2.2%
Harney	3,870	53.4%	☑	6.6%	23.3%	☑	4.7%	23.3%	☑	4.1%
Malheur	11,806	43.0%	☑	3.1%	33.6%	☑	2.8%	23.4%	☑	2.6%

Notes: **Green, orange, and red icons indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with green checkmark icon, medium reliability (CV 15–30% — be careful) is shown with orange dot icon, and low reliability (CV >30% — use with extreme caution) is shown with red "x" icon. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error (MOE) and the need for precision.

Source: U.S. Census Bureau (2018). Table B25034: Year Structure Built, 2013-2017 American Community Survey 5-Year Estimates. Retrieved from https://data.census.gov/cedsci/

The National Flood Insurance Program's (NFIP's) Flood Insurance Rate Maps (FIRMs) delineate flood-prone areas. They are used to assess flood insurance premiums and to regulate construction so that in the event of a flood, damage is minimized. **Table 2-768** shows the initial and current FIRM effective dates for Region 8 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, **Flood** section.

Table 2-768. Community Flood Map History in Region 8

	Initial FIRM	Current FIRM
Harney County	Apr. 17, 1984	Apr. 17, 1984
Burns	Aug. 15, 1984	Dec. 22, 1998
Hines	Sept. 28, 1984	Nov. 3, 1989
Burns-Paiute Reservation	Sept. 28, 1984	Sept. 28, 1984
Malheur County	Sept. 29, 1986	Sept. 29, 1986
Adrian	Sept. 19, 1984	Sept. 19, 1984
Jordan Valley	Sept. 19, 1984	Sept. 19, 1984
Nyssa	Dec. 14, 1982	Dec. 14, 1982 (M)
Ontario	Apr. 17, 1984	Apr. 17, 1984
Vale	Sept. 4, 1987	Sept. 4, 1987

(M) = no elevation determined; all Zone A, C and X.

Source: Federal Emergency Management Agency (2019), Community Status Book Report, https://www.fema.gov/cis/OR.pdf

State-Owned/Leased and Critical/Essential Facilities

In 2020 the Department of Geology and Mineral Industries updated the 2015 Oregon NHMP inventory and analysis of state-owned and –leased buildings, state-owned and –leased critical facilities, and local critical facilities. Results from this report relative to Region 8 can be found in **Table 2-769**. The region contains 2.7% of the total value of all local critical facilities and state-owned and –leased critical and non-critical facilities in the state. Cumulatively, these assets are valued just under one billion dollars.

Table 2-769. Value of State-Owned/Leased Critical and Essential Facilities in Region 8

	Value of Local and State-Owned/Leased Facilities				
	State Non-Critical	State Critical	Local Critical	State + Local Total	Percent of Total
Oregon	$2,630,306,288	$4,622,433,011	$ 26,285,277,425	$ 33,538,016,724	100%
Region 8	$ 16,722,870	$ 556,587,272	$ 328,497,252	$ 901,807,394	2.7%
Harney	$ 5,930,555	$ 17,086,378	$ 55,966,002	$ 78,982,935	0.2%
Malheur	$ 10,792,315	$ 539,500,894	$ 272,531,250	$ 822,824,459	2.5%

Source: DOGAMI, 2020

Land Use Patterns

Similar to Region 7, the past 40 years have seen a slower pace of development of private land in Region 8 than in western Oregon. In this time period very little loss of private land in forest, agriculture, and range uses occurred. Land use programs have limited rural residential and urban development and have maintained large parcel sizes. Demand for large-scale development has historically been very low. To the extent it has occurred, it has generally been located along existing transportation corridors (DLCD, internal communications, 2014).

Just over one fifth of all land in the region is privately owned, 23.3%. The federal government owns the vast majority of land, 71%, and the state owns approximately 4%. The remainder is owned by other public entities.

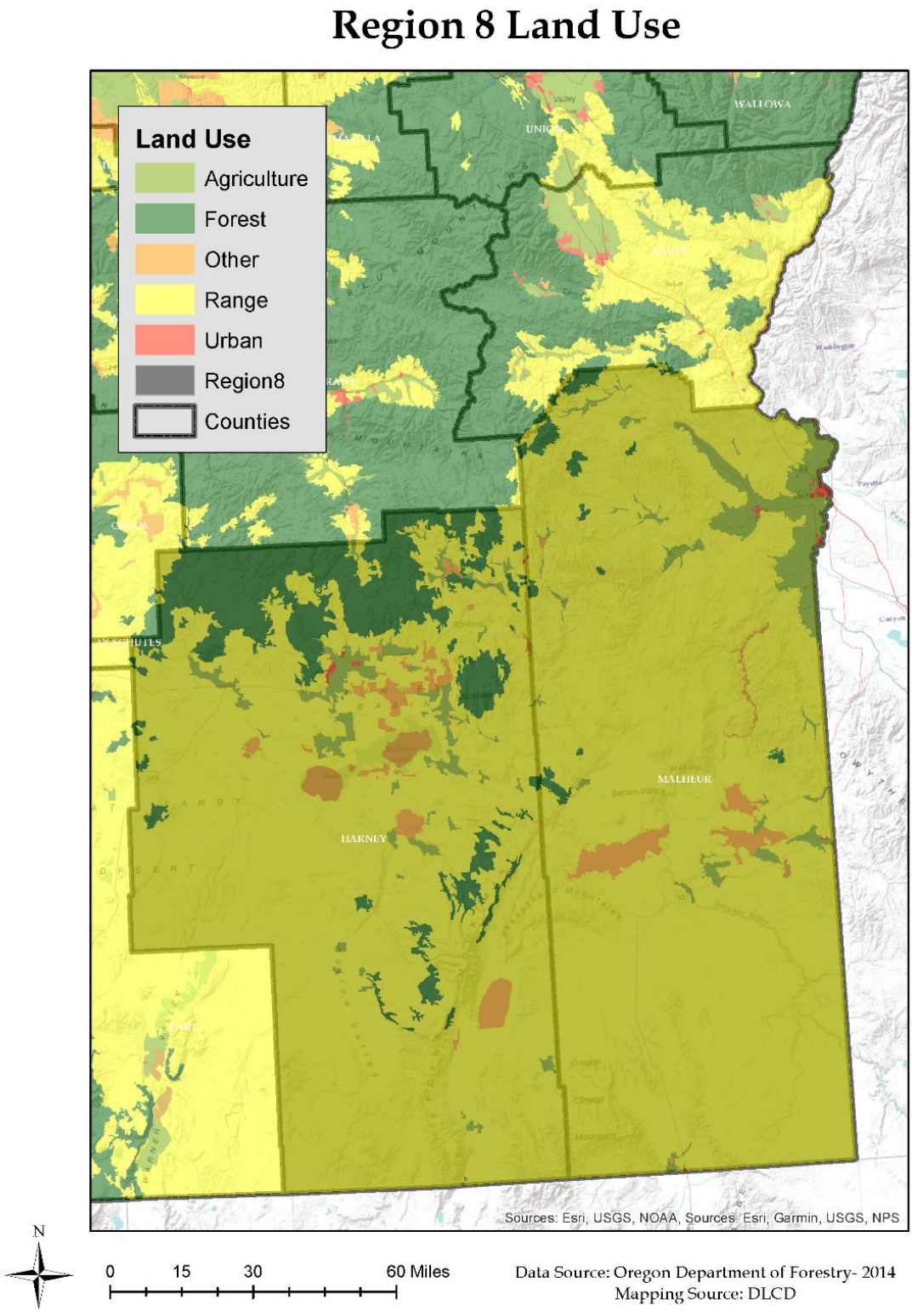
According to the Oregon Department of Forestry's most recent land-use study, "development of resource lands hit a record low between 2009 and 2014...with roughly 3,000 acres per year of Oregon's farms, forests, and rangeland shifted to low-density residential or urban uses" (Lettman G. J., Gray , Hubner , McKay, & Thompson , 2016). In Region 8, approximately 174 acres of resource lands were converted to more urban uses during the six-year period. **Table 2-770** shows that during the six-year period, the percentage of resource lands converted in Malheur and Harney Counties was less than one percent of the county's total resource acreage.

Overall, Region 8 is overwhelmingly rangeland, with the Bureau of Land Management (BLM) controlling much of the land. The land cover is largely grasslands and shrubs. Irrigated fields in the county's northeast corner, known as Western Treasure Valley, are the center of intensive and diversified farming.

The region's wide-open spaces have a total of only seven incorporated cities. Ontario, relatively close to the Boise, Idaho metropolitan area is economically active. Burns-Hines is an important center for commerce as well as tourism. Timber and logging remained important to that local economy until the 1990s, when the area's last lumber mill closed for lack of timber.

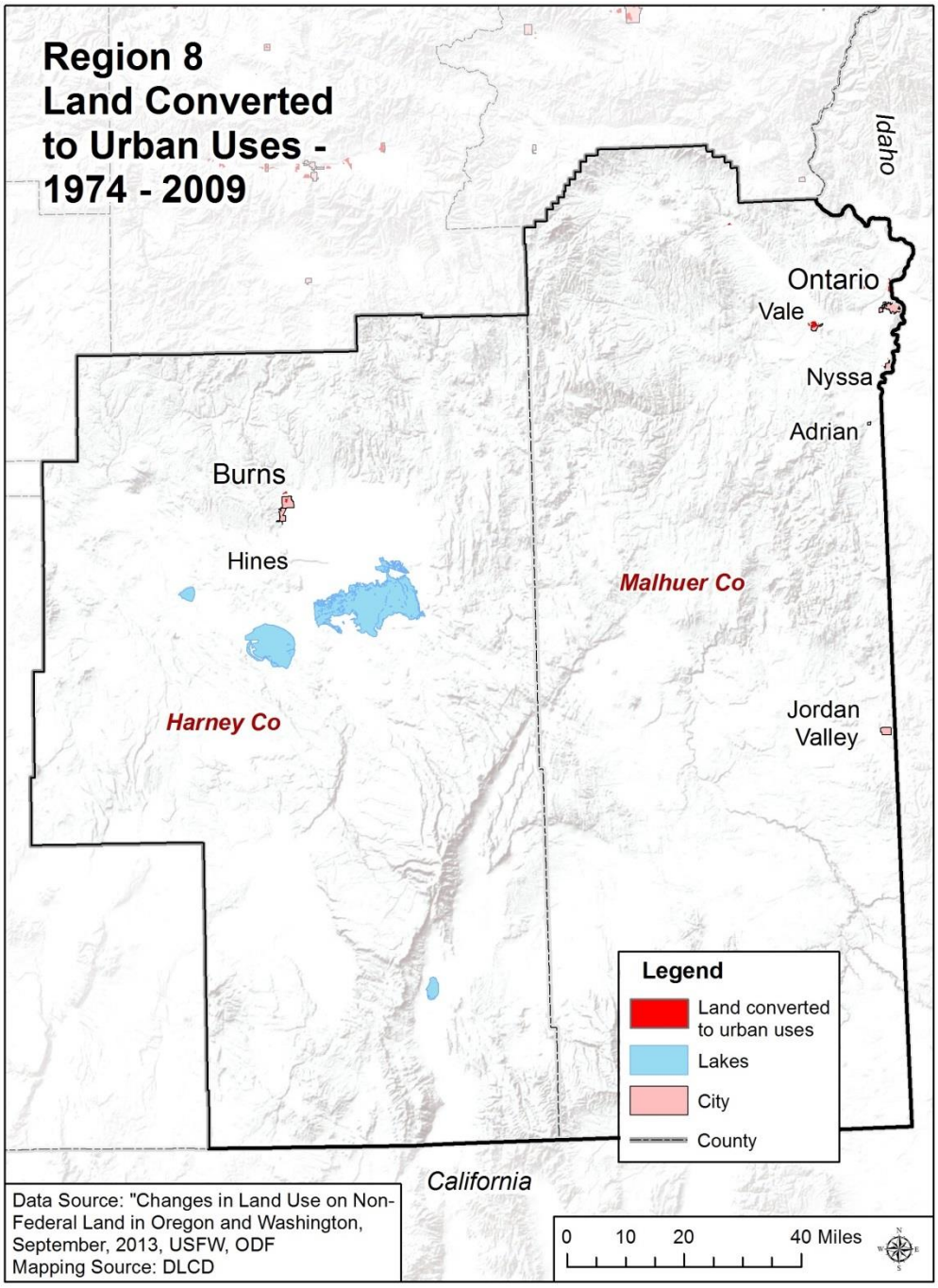
In July 2015, the Land Conservation and Development Commission adopted the "Sage Grouse Rule" to prevent listing of sage-grouse as under the Endangered Species Act. The rule protects sage-grouse habitat and limits the loss of core habitat from development. Counties review development applications for compliance with the rule and DLCD tracks development using an online tool. DLCD reports annually to the Commission on development in sage-grouse conservation areas. Very little development has occurred in these areas since August 2015 (https://www.oregon.gov/lcd/NRRE/Pages/Endangered-Species.aspx, August 2020).

Figure 2-303. Region 8 Land Use



Source: Oregon Department of Forestry, 2014

Figure 2-304. Region 8 Land Converted to Urban Uses, 1974–2009



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

Table 2-770. Region 8 Resource Lands Converted to Urban Uses, 2009-2014

	Lost Resource Lands 2009-2014		
	Total Resource Acres (2009)	**Acres Converted to Urban Use**	**Percent Converted**
Region 8	3,500,340	174	0.00%
Harney	1,844,795	66	0.00%
Malheur	1,655,545	71	0.00%

Source: Oregon Department of Forestry, 2014; Oregon Department of Land Conservation and Development, 2020

Built Environment Trends and Issues

The trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. Region 8 is largely a rural county with urban development focused along I-84 and around the population centers of Burns, Hines, Ontario, and Vale. Population growth from 2010-2018 was stagnant and is projected to decline over the next decade. The results of the 2020 U.S. Census will better illustrate what has happened in the region over the last decade in terms of urbanization and population dispersion. Please refer to the Region 8 Risk Assessment **Demography** section for more information on population trends and forecast.

The region's housing stock is largely single-family homes. The region has more than double the state's percentage of manufactured homes. About 45% of the homes were built before 1970 and floodplain management standards; 76% were built before 1990 seismic standards. None of the region's FIRMs has been modernized or updated. Most of the region's share of state-owned and –leased, and local critical facilities are located in Malheur County

2.3.8.3 Hazards and Vulnerability

Droughts

Characteristics

Droughts are a common occurrence in Region 8 and can have a significant economic impact on agricultural, livestock, and natural resources. In 2013, for example, most irrigation reservoirs started the season at a third of capacity, with some irrigation districts running out of water by mid to late June. The Governor has declared a drought emergency in Region 8 numerous times since 1992. The U.S. Department of Agriculture designated Malheur and Harney Counties as primary natural disaster areas from 2012 through 2016 and 2018 due to damages and losses caused by drought. Malheur County is considered one of the counties most vulnerable to drought in Oregon.

Because of late winter 2014 reservoir storage levels and predicted streamflow forecasts, the Natural Resources Conservation Service predicted water shortages for the summer of 2014. Governor Kitzhaber issued drought emergencies for both Malheur and Harney Counties. Poor reservoir carryover and an almost non-existent snowpack during the 2014-15 winter resulted in very low reservoir levels for the 2015 water year. In part, prompting an almost statewide governor's declaration of drought. In 2018 low precipitation coupled with above-normal temperatures brought about another governor's declaration of drought in Harney and Malheur Counties.

High temperatures and low precipitation accompanying drought conditions reduce soil moisture, dry vegetation, and tend to enhance winds. These conditions can increase the amount of soil entrained by high winds, particularly in semi-arid regions where temperatures are increasing and precipitation is decreasing, and where areas of substantial land disturbance or development is occurring. Therefore, during extended dry and drought conditions, productive soils are vulnerable to loss, further impacting agriculture.

Historic Drought Events

Table 2-771. Historic Droughts in Region 8

Year	Location	Description
1930s	statewide	generally, a very dry period for much of Oregon; Malheur County experiences its most extreme drought years in 1931, 1934, and 1935
1988	Regions 7, 8	extreme drought for Malheur County (PDSI value of -4.14); this was also a severe drought year for northeast Oregon
1992	statewide	Governor declared drought emergency for all 36 counties in Oregon; 1992 was a severe drought year for Malheur County
1994	Regions 4–8	in 1994, Malheur County received a Governor drought declaration, along with 10 other counties located within regions 4, 5, 6, and 7
2001	eastern and southern Oregon	Governor-declared drought emergency for Harney County and 17 other counties throughout the state
2002	eastern and southern Oregon	Governor-declared drought emergency for Malheur and Harney Counties; total of 23 counties under a drought emergency during 2002
2003	eastern and southern Oregon	Governor-declared drought emergency issued for Malheur and Harney Counties; most counties remain under a drought emergency from the 2001 and 2002 declarations through June 2003
2004	Regions 5–8	Governor-declared drought emergency issued for Malheur County, along with three counties from neighboring regions
2007	Regions 6–8	Governor-declared drought emergency issued for Malheur and Harney County, along with four other counties in Region 6 and 7
2013	Region 5–8	Governor-declared drought emergency issued for Malheur County, along with four other counties in neighboring regions
2014	Regions 4, 6–8	Governor-declared drought emergency issued for Malheur and Harney Counties, along with eight other counties in other regions
2015	statewide	All 36 Oregon Counties receive federal drought declarations, including 25 under a Governor's drought declaration
2018	Regions 4, 6–8	Harney and Malheur County receive Governor's drought declarations along with 9 other counties in 5 other regions

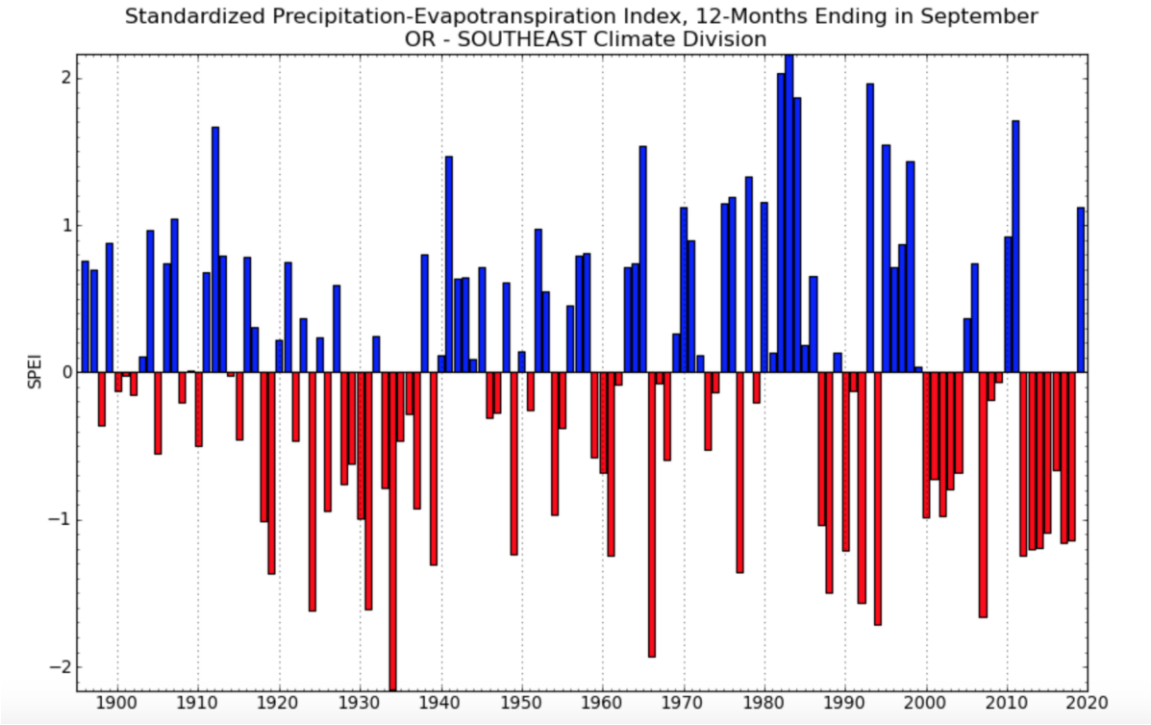
Sources: Taylor and Hatton (1999); and the Oregon Secretary of State's Archives Division. NOAA's Climate at a Glance. Western Regional Climate Center's Westwide Drought Tracker http://www.wrcc.dri.edu/wwdt. Personal Communication, Kathie Dello, Oregon Climate Service, Oregon State University

Historical drought information can also be obtained from the West Wide Drought Tracker, which provides historical climate data showing wet and dry conditions, using the Standard Precipitation-Evapotranspiration Index (SPEI) that dates back to 1895.

Figure 2-305 shows years where drought or dry conditions affected the south eastern area of Oregon, known as Climate Division 9, which encompasses Malheur County only.

Based on this index, 1934 was an extreme drought year for Malheur County. Water Years 1924, 1931, 1966, 1992, 1994, and 2007 were severe drought years. Malheur County has experienced more than a dozen moderate drought years, including the stretch from 2012–2018, with the exception of 2016.

Figure 2-305. Standard Precipitation-Evapotranspiration Index for Region 8



Drought Severity Scale: -1 to -1.49 = moderate drought; -1.5 to -1.99 = severe drought; -2.0 or less = extreme drought.

Source: West Wide Drought Tracker, https://wrcc.dri.edu/wwdt/time/

Table 2-772. Years with Moderate (<-1), Severe (<1.5), and Extreme (<-2) Drought in Oregon Climate Division 9 according to Standard Precipitation-Evapotranspiration Index

Moderate Drought (SPEI < -1.0)	Severe Drought (SPEI < -1.5)	Extreme Drought (SPEI < -2.0)
1988	1966	1934
1919	1994	
1977	2007	
1939	1924	
1961	1931	
2012	1992	
1949		
1990		
2013		
2014		
2017		
2018		
2015		
1987		
1918		

Note: Within columns, rankings are from more severe to less severe.

Source: West Wide Drought Tracker, https://wrcc.dri.edu/wwdt/time/

Probability

Table 2-773. Probability of Drought in Region 8

	Harney	Malheur
Probability	H	VH

Source: OWRD, DLCD

Despite impressive achievements in the science of climatology, estimating drought probability and frequency continues to be difficult. This is because of the many variables that contribute to weather behavior, climate change and the absence of long historic databases. Oregon has yet to undertake a comprehensive risk analysis for drought on a statewide basis to determine probability or vulnerability for a given community.

With that said, the likelihood that Malheur and Harney County will experience drought conditions in the near future is very likely. As mentioned, the Governor has declared drought in both counties on several occasions since 1992. During the period of 1896-2019, both counties experienced at least moderate drought conditions about 18% of the time. Harney County has received a drought declaration in 28% of the years since 1992, while Malheur has received a drought declaration in 34%. This accounts for the difference in their probability ratings.

Climate Change

Climate models project warmer, drier summers for Oregon as a whole though Region 8 may see slight increases in summer precipitation along with the Great Basin. Climate models also project decreases in mid-to-low elevation mountain snowpack due to warmer winter temperatures. In Region 8, climate change would result in increased frequency of drought due to low spring snowpack (very likely, >90%). With less confidence, climate models project increases in summer

runoff and summer soil moisture for lowland parts of eastern Oregon, including Region 8. Increases in summer soil moisture are the result of increased precipitation in the spring, which dominates the effects of warming temperatures (Gergel, et al., 2017). However, Region 8, like the rest of Oregon is projected to experience an increase in the frequency of summer drought conditions as summarized by the standard precipitation-evaporation index (SPEI) due largely to projected increases in potential evapotranspiration (Dalton, Dello, Hawkins, Mote, & Rupp, 2017).

Vulnerability

Table 2-774. Local Assessment of Vulnerability to Drought in Region 8

	Harney	Malheur
Vulnerability	H	H

Source: Most recent local hazard vulnerability analyses (Table 2-4)

Table 2-775. State Assessment of Vulnerability to Drought in Region 8

	Harney	Malheur
Vulnerability	H	VH

Source: OWRD, DLCD

Oregon has not undertaken a comprehensive statewide analysis to identify which communities are most vulnerable to drought. However, ranching, farming, and other agricultural activities greatly contribute to the economy of both counties. Malheur County ranks fourth in the state for agricultural sales, with $373 million in gross farm and ranch sales in 2012. Drought can have a significant impact on the agricultural community and associated businesses that rely on this industry.

Impacts of drought on state-owned facilities related to agriculture would include impacts to research conducted in outdoor settings, such as at extension stations and research farms. There is no single comprehensive source or other sources for information to assess economic impacts.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1–5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, Malheur County is the most socially vulnerable in the state. The county has the highest poverty rates, lowest per-capita income, and the highest share of people living in institutionalized group quarters. The county is also in the 90th percentile for the following variables: the share of residents without a high school diploma, the percentage of single-parent households, the share of people aged 17 and younger, the percentage of minorities, the percentage of occupied housing units with more people than rooms, and the share of households that lack access to a vehicle. Vulnerability in Harney County is moderate and driven by high unemployment and the percentage of manufactured homes.

Malheur County's social vulnerability rating is very high indicating that any natural hazard, including drought, would have significant impacts on its population. Harney County's social vulnerability rating is moderate. Its economic vulnerability has been taken into account in its high vulnerability rating. Both Harney and Malheur Counties are most vulnerable to drought in Region 8.

State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

The value of state-owned and leased buildings and critical facilities in Region 8 is approximately $573,310,000 representing the total potential for loss of state assets due to drought. The value of locally owned critical facilities is $328,497,000. Because drought could impact the entire region, these figures together represent the maximum potential loss to state assets and local critical facilities due to drought. Because the state is self-insured, FEMA funds are rarely used to cover damage to state assets from natural hazards. It is unclear from the Department of Administrative Services' records how many losses to state facilities were sustained in Region 8 since the beginning of 2015. Nevertheless, none of the recorded losses was due to drought.

Risk

Table 2-776. Risk of Drought in Region 8

	Harney	Malheur
Risk	H	VH

Source: OWRD, DLCD

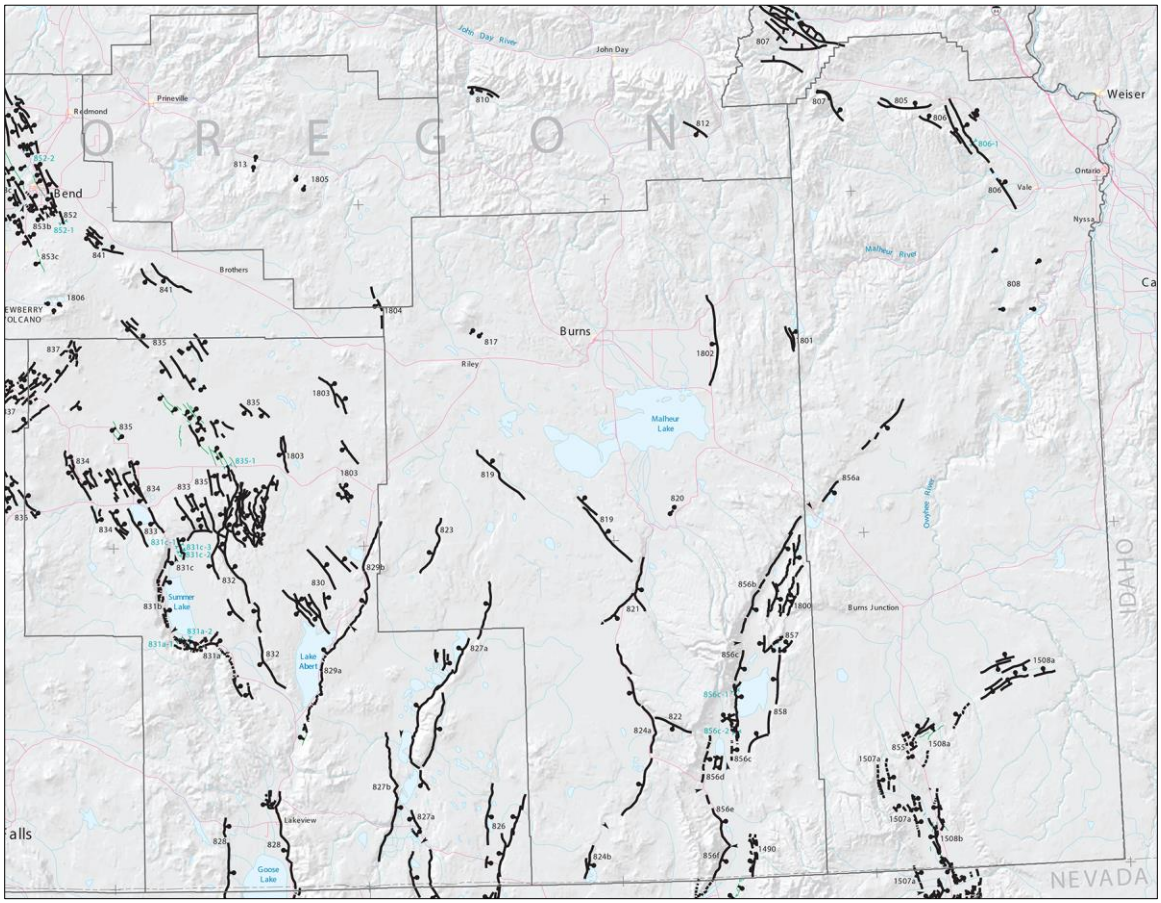
With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. Based on the very high probability of drought and vulnerability to it, risk of drought in Region 8 is considered very high.

Earthquakes

Characteristics

The geographic position of this region makes it susceptible to earthquakes from two sources: crustal events and volcanic-earthquakes. Generally, crustal faults can produce earthquakes with magnitudes up to roughly M7.0. Because only certain faults have been studied in detail and determined to be active, there may be many more crustal faults in the region capable of producing earthquakes which have not yet been identified. **Figure 2-306** shows the locations of faults in Region 8.

Figure 2-306. Quaternary Faults and Folds in Region 8

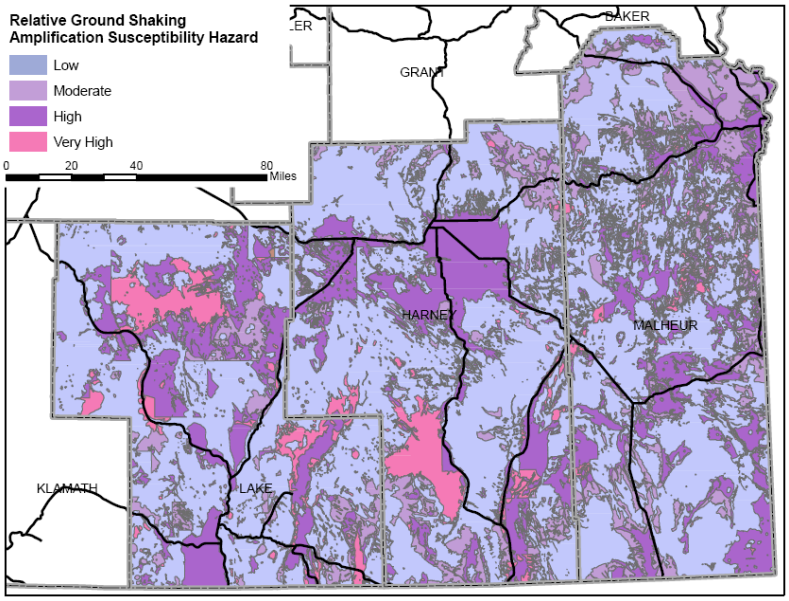


Source: Modified from Personius, et al. (2003)

When all of these earthquake sources are added together, the general earthquake hazard in the region can be displayed as a whole and is reflected in the USGS national seismic hazard maps. When compared to the rest of the United States, most of the region is within a relatively moderate seismicity area.

Figure 2-307 displays the relative ground shaking amplification hazard throughout Region 8.

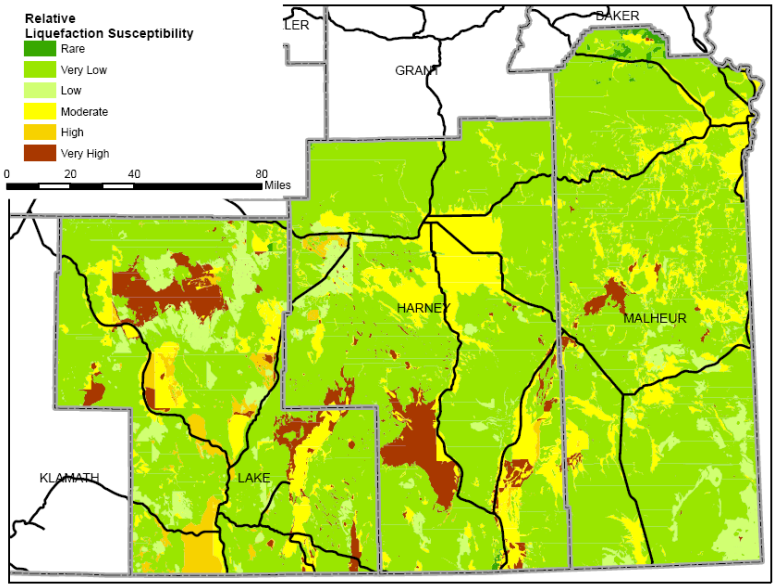
Figure 2-307. Relative Ground Shaking Amplification Hazard in Region 8



Source: Burns (2007)

During seismic shaking, deposits of loose saturated sands can be subjected to contraction resulting in an increase in pore water pressure. If the increase in pore water pressure is high enough, the deposit becomes "liquefied," losing its strength and its ability to support loads. Figure 2-308 displays the relative liquefaction hazard throughout Region 8.

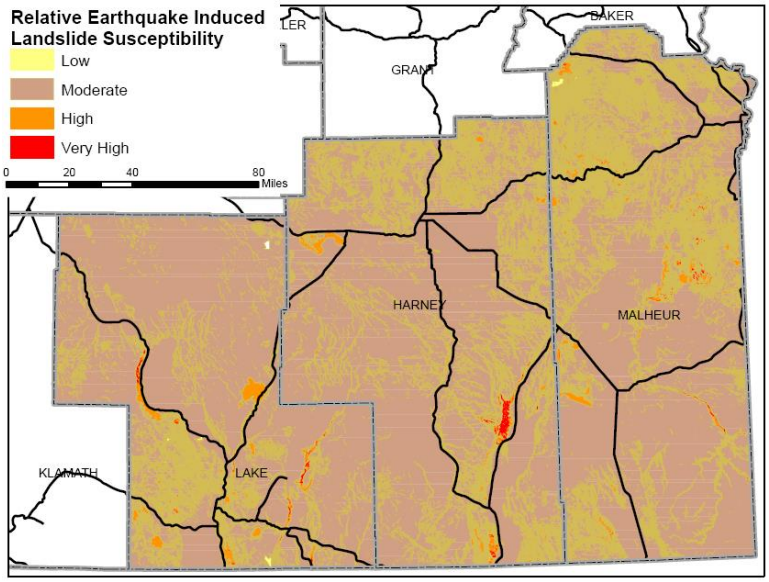
Figure 2-308. Relative Liquefaction Susceptibility Hazard in Region 8



Source: Burns (2007)

Strong ground shaking can also cause landslides and reactivate dormant landslides. Commonly, slopes that are marginally stable prior to an earthquake become unstable and fail. Some landslides result from liquefaction that causes lateral movement of soil, or lateral spread. **Figure 2-309** displays the relative earthquake induced landslide hazard throughout Region 8.

Figure 2-309. Relative Earthquake Induced Landslide Susceptibility Hazard in Region 8



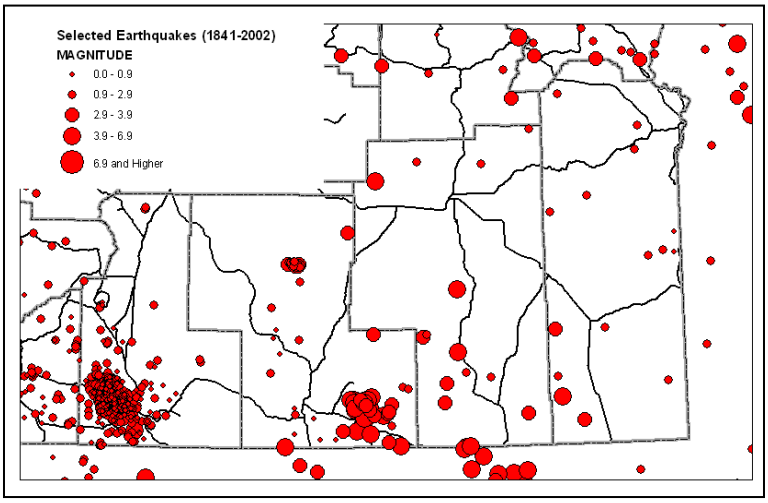
Source: Burns (2007)

Region 8 has experienced many earthquakes. Several earthquake sequences (swarms) have occurred in the region within the last 20 years. There are also identified faults in the region that have been active in the last 20,000 years. The region has also been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered outside the area. **Figure 2-310** maps earthquakes in the region from 1841 to 2002, and **Table 2-777** provides a general history of earthquakes in Oregon.

When all of these earthquakes sources are added together, the general earthquake hazard in the region can be displayed as a whole and is reflected in the USGS national seismic hazard maps. When compared to the rest of the United States, most of the region is within a relative moderate seismicity area.

Figure 2-310 displays over 1,000 earthquakes that have been recorded in the region during the last century. Because the instrument network in the region was very sparse until the mid-2000s, it is likely that thousands of earthquakes have occurred in the region but were not recorded.

Figure 2-310. Selected Earthquakes in Region 8, 1841–2002



Source: Niewendorp & Neuhaus (2003)

Historic Earthquake Events

Table 2-777. Significant Earthquakes Affecting Region 8

Date	Location	Magnitude	Comments
Approximate years: 1400 BCE*, 1050 BCE, 600 BCE, 400, 750, 900	offshore, Cascadia Subduction Zone	probably 8-9	these are the midpoints of the age ranges for these six events
Jan. 26, 1700	offshore, Cascadia Subduction Zone	about 9	generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Nov. 23, 1873	near Brookings, Oregon at the Oregon-California border	6.8	may have been an intraplate event because of lack of aftershocks; felt as far away as Portland and San Francisco
Mar. 1893	Umatilla	VI-VII (Modified Mercalli Intensity)	damage: unknown
July 15, 1936	Milton-Freewater	6.4	damage: $100,000 damage (in 1936 dollars); two foreshocks and many aftershocks felt
Apr. 13, 1949	Olympia, Washington	7.1	fatalities: eight; damage: $25 million damage (in 1949 dollars); cracked plaster, other minor damage in northwest Oregon
Jan. 1951	Hermiston	V (Modified Mercalli Intensity)	damage: unknown
Nov. 5, 1962	Portland/ Vancouver	5.5	shaking up to 30 seconds; damage: chimneys cracked, windows broken, furniture moved
Apr. 12, 1976	near Maupin	4.8	sounds described as distant thunder, sonic booms, and strong wind
Apr. 25, 1992	Cape Mendocino, California	7.0	subduction earthquake at the triple-junction of the Cascadia Subduction Zone and the San Andreas and Mendocino faults
Mar. 25, 1993	Scotts Mill	5.6	center: Mount Angel-Gates Creek fault; damage: $30 million, including Molalla High School and Mount Angel church
Sep. 20, 1993	Klamath Falls	5.9 and 6.0	fatalities: two; damage: $10 million, including county courthouse; rockfalls
Jan. 4, 2015	NW Nevada	4.1	
Jan. 22, 2015	NW Nevada	4.5	
Jul. – Dec. 2015	NW Nevada	4.0-4.7	cluster of earthquakes

*BCE: Before Common Era.

Sources: Wong & Bott (1995); Pacific Northwest Seismic Network, https://pnsn.org/

Probability

Table 2-778. Assessment of Earthquake Probability in Region 8

	Harney	Malheur
Probability	M	L

Source: DOGAMI, 2020

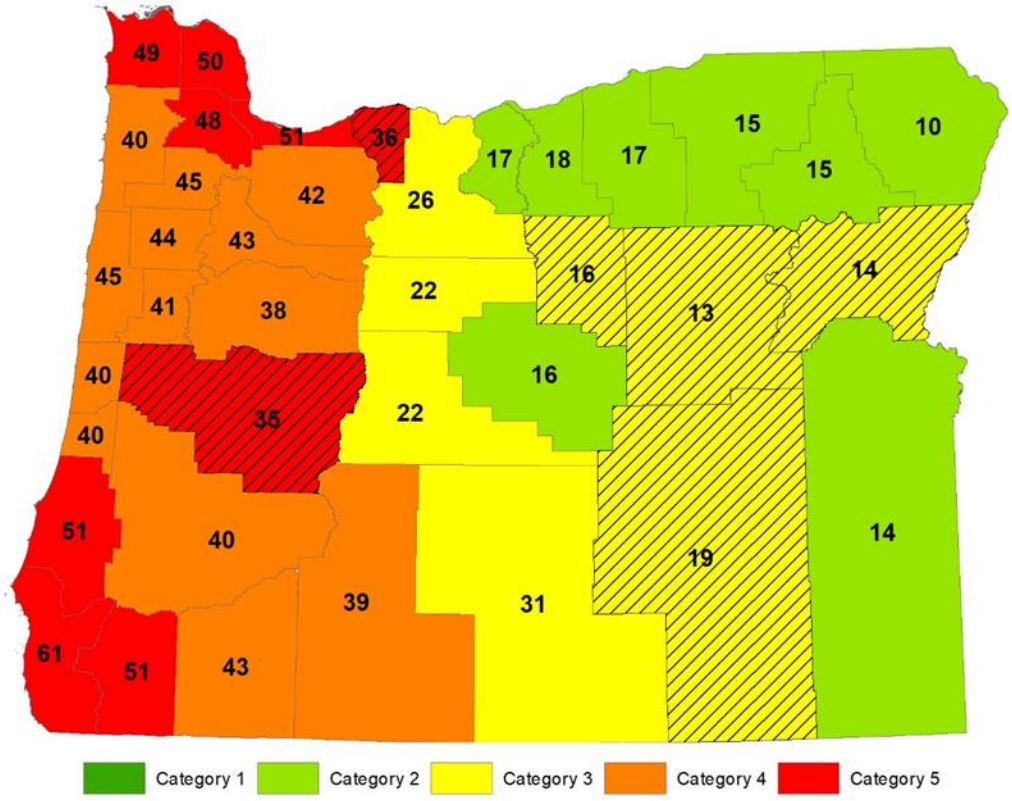
The probability of damaging earthquakes varies widely across the state. In Region 8, the hazard is dominated by local faults and background seismicity.

DOGAMI has developed a new probability ranking for Oregon counties that is based on the average probability of experiencing damaging shaking during the next 100 years, modified in some cases by the presence of newly discovered faults. If a county had newly discovered faults that were within 10-12 miles of a community, the category defined by the average probability of damaging shaking was increased one step.

- Category 1 100-year probability < 10%
- Category 2 100 year probability 10-20%
- Category 3 100 year probability 21-31%
- Category 4 100 year probability 32-45%
- Category 5 100 year probability > 45%

The probability levels for Baker, Grant, Harney, Hood River, and Wheeler Counties, and the non-coastal portion of Lane County were all increased in this way. The results of this ranking are shown in **Figure 2-311**.

Figure 2-311. 2020 Oregon Earthquake Probability Ranking Based on Mean County Value of the Probability of Damaging Shaking and Presence of Newly Discovered Faults



Note: Counties with hatching had their probability category increased one step due to newly discovered faults.

Source: DOGAMI, 2020

Vulnerability

Table 2-779. Local Assessment of Vulnerability to Earthquakes in Region 8

	Harney	Malheur
Vulnerability	L	L

Source: Most recent local hazard vulnerability analyses (Table 2-4)

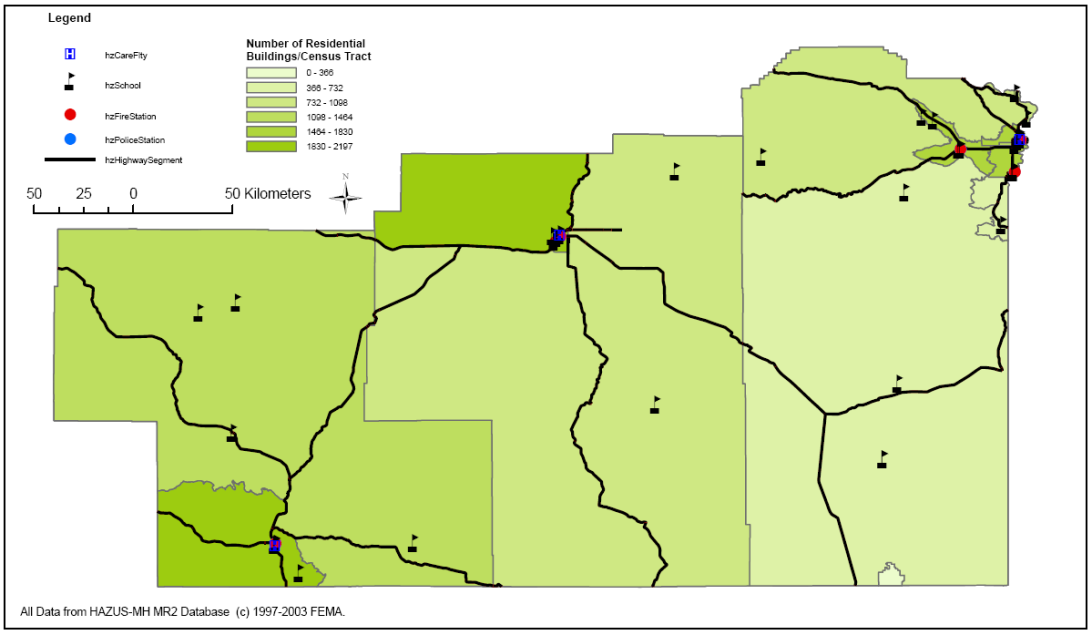
Table 2-780. Assessment of Vulnerability to Earthquakes in Region 8

	Harney	Malheur
Vulnerability	L	H

Source: DOGAMI and DLCD, 2020

Region 8 is moderately vulnerable to earthquake hazards from earthquake-induced landslides, liquefaction, and ground shaking. Most of the region's people and infrastructure are located in the major cities along I-84, US-20, and US-395. Figure 2-312 shows a map of the generalized exposure of buildings to earthquakes in Region 8.

Figure 2-312. Region 8 Generalized Earthquake Exposure



Source: Hazus-MH MR2 database, Burns, 2007.

The Oregon Department of Geology and Mineral Industries (DOGAMI) has developed two earthquake loss models for Oregon based on the two sources of seismic events: (a) a M6.9 arbitrary crustal event, and (b) 2,500 year probabilistic driving earthquake scenario. Both models are based on Hazus-MH, a computer program used by the Federal Emergency Management Agency (FEMA) as a means of determining potential losses from earthquakes. The arbitrary crustal event is based on a potential M6.9 earthquake generated from an arbitrarily chosen fault using the Hazus software, and assuming a worst-case scenario. The 2,500-year probabilistic driving earthquake does not look at a single earthquake; instead, it encompasses many faults and potential earthquake sources, each with a 2% chance of producing an earthquake in the next 50 years. The analysis assumes that each fault will produce a single "average" earthquake during this time.

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

Table 2-781. School and Emergency Response Buildings' Collapse Potential in Region 8

County	Level of Collapse Potential			
	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Harney	5	3	7	3
Malheur	16	6	5	23

Source: Lewis (2007)

Table 2-782. Building, Transportation, and Utility Exposure in Region 8

County	Building Exposure	Transportation Exposure	Utility Exposure	Total Exposure
Harney	$448,000,000	$2,281,900,000	$733,200,000	$3,463,100,000
Malheur	$1,441,000,000	$4,396,900,000	$810,300,000	$6,648,200,000
Region Total	$1,889,000,000	$6,678,800,000	$1,543,500,000	$10,111,300,000

Source: W. J. Burns (DOGAMI), 2007 (unpublished), Geologic hazards of the southeast Oregon region

Table 2-783. Building, Transportation, and Utility Losses in Region 8 Associated with a 2,500-Year Probable M6.5 Driving Earthquake Scenario

County	Building Losses	Transportation Losses	Utility Losses	Total Losses	Loss Percent of Total
Harney	$9,260,000	$21,600,000	$2,000,000	$32,860,000	0.9%
Malheur	$143,370,000	$47,000,000	$19,680,000	$210,050,000	3.2%
Region Total	$152,630,000	$68,600,000	$21,680,000	$264,590,000	2.6%

Source: W. J. Burns (DOGAMI), 2007 (unpublished), Geologic hazards of the southeast Oregon region

Table 2-784. Building, Transportation, and Utility Losses in Region 8 Associated with a (M) 6.9 Arbitrary Crustal Earthquake Event

County	Building Losses	Transportation Losses	Utility Losses	Total Losses	Loss Percent of Total
Harney	$1,600,000	$39,200,000	$390,000	$41,191,000	1.1%
Malheur	$453,470,000	$114,100,000	$36,820,000	$604,390,000	9.0%
Region Total	$455,070,000	$153,300,000	$37,210,000	$645,581,000	6.4%

Source: W. J. Burns (DOGAMI), 2007 (unpublished), Geologic hazards of the southeast Oregon

Table 2-785. Estimated Losses in Region 8 Associated with a M6.9 Arbitrary Crustal Earthquake Event

	Harney	Malheur
Injuries (5 pm time frame)	3	444
Death (5 pm time frame)	0	28
Displaced households	0	1,224
Economic losses from buildings	$1.6 mil	$453.47 mil
Operational day after quake:		
Fire stations	0%	25%
Police stations	0%	50%
Schools	29%	48%
Bridges	98%	93%
Economic losses to:		
Highways	$29.8 mil	$107.10 mil
Airports	$8.6 mil	$4.8 mil
Communications	$0.04 mil	$0.03 mil
Debris generated (million tons)	0	0

Source: W. J. Burns (DOGAMI), 2007 (unpublished), Geologic hazards of the southeast Oregon region

Table 2-786. Estimated Losses in Region 8 Associated with a 2,500-Year Probable M6.5 Driving Earthquake Scenario

	Harney	Malheur
Injuries (5 pm time frame)	3	106
Deaths (5 pm time frame)	0	5
Displaced Households	2	357
Economic losses from buildings	$9.26 m	$143.37 m
Operational the day after the quake		
Fire stations	100%	100%
Police stations	100%	100%
Schools	100%	100%
Bridges	100%	100%
Economic Losses to /for:		
Highways	$14.3 m	$34.3 m
Airports	$6.9 m	$11.8 m
Communication systems	$ 0.01 m	$0.01 m
Debris generated (million tons)	0	0

Source: W. J. Burns (DOGAMI), 2007 (unpublished), Geologic hazards of the southeast Oregon region

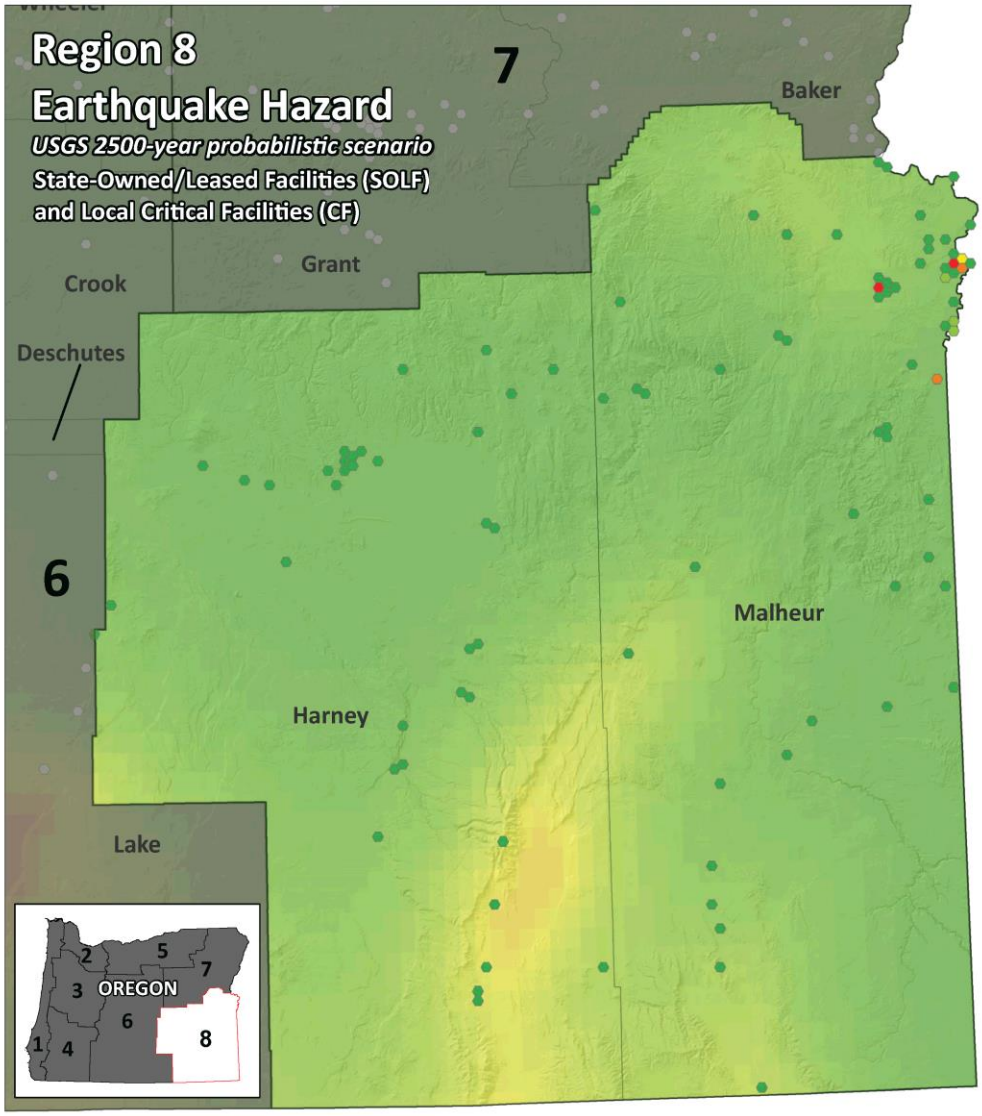
State-Owned/Leased Buildings And Critical Facilities And Local Critical Facilities

For the 2020 vulnerability assessment, DOGAMI used Hazus-MH to estimate potential loss from a 2500-year probabilistic earthquake scenario in Region 8. The analysis incorporated information about the earthquake scenario (such as coseismic liquefaction and landslide potential), as well as building characteristics (including the seismic building code and building material). The results of the analyses are provided as a loss estimation (the building damage in dollars) and as a loss ratio (the loss estimation divided by the total value of the building) reported as a percentage at the county level.

DOGAMI used the loss ratio to formulate a separate relative vulnerability score for the state buildings, state critical facilities, and local critical facilities data sets. The percentage of loss for each county was statistically distributed into 5 categories (Very Low, Low, Moderate, High, or Very High).

In Region 8, a 2500-year probabilistic earthquake scenario could generate a potential loss of just under $1M in state building and critical facility assets, about 90% of it in Malheur County. The potential loss in local critical facilities is more than eight times that amount, almost $8M. Again, 95% of that value is in Malheur County. **Figure 2-313** illustrates the potential loss to state buildings and critical facilities and local critical facilities from a 2500-year probabilistic earthquake scenario.

Figure 2-313. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in an Earthquake Hazard Zone in Region 8.High-resolution, full-size image linked from Appendix 9.1.26.



Estimated ($) losses to hazard per cell

- Outside of region
- 1 - 250,000
- 250,001 - 500,000
- 500,001 - 750,000
- 750,001 - 1,000,000
- 1,000,001 - 2,000,000

Earthquake peak ground acceleration
(Modified Mercalli Intensity Scale)
Strong — Very Strong

Administrative boundary
- Mitigation Planning Region
- County

Projection:
Oregon Statewide Lambert Conformal Conic, Unit: International Feet,
Horizontal datum: NAD83 HARN, Scale 1:1,000,000

Source Data:
Earthquake: Peak ground acceleration for 2500-year probabilistic earthquake, USGS, 2014
State-owned/lease buildings: Oregon Department of Administrative Services, 2019
Administrative boundaries: Oregon Emergency Management and the Oregon Department of Land Conservation and Development, 2015
Hillshade base map: DOGAMI, Statewide mosaic, 2018, from Oregon Lidar Consortium data

Author: Matt Williams, Oregon Department of Geology and Mineral Industries, January 2020.

REGION 8		Estimated Loss ($) from CSZ Earthquake					
		State-owned/leased facilities				Critical Facilities	
County	Total Value SOLF and Local CF	Loss SOLF CF	% Loss SOLF CF	Loss ($) SOLF Non-CF	Loss Total*	Loss Local CF	Total Loss SOLF CF and Local CF
Harney	78,983,000	57,000	0%	49,000	106,000	438,000	495,000
Malheur	822,824,000	632,000	0%	256,000	888,000	7,554,000	8,186,000
Total	901,807,000	689,000	0%	305,000	994,000	7,992,000	8,681,000

This study divided buildings into two major categories by ownership: state-owned or leased facilities (SOLF) and local critical facilities (CF). SOLF buildings were further subdivided into either CFs, such as police stations, or non-critical facilities (non-CF), such as administrative offices.
**Exposure totals for SOLF include the subset of SOLF CFs.*

0 12.5 25 50 Miles

N

Source: DOGAMI

Historic Resources

Of the 337 historic resources in Region 8, only 2 are in an area of high or very high liquefaction potential, both of them in Malheur County. However, 251 (74%) of Region 7's historic resources are located in areas of high or very high potential for ground shaking amplification. Of these, 194 (77%) are in Malheur County.

Archaeological Resources

Seven thousand five hundred ninety archaeological resources are located in earthquake hazard areas in Region 8. Of those, 138 are located in an area of high earthquake hazards. None are listed on the National Register of Historic Places and only one is eligible for listing. Nine have been determined not eligible and 128 have not been evaluated as to their potential for listing. Most (69%) of the archaeological resources in earthquake hazard areas in Region 8 are located in Harney County.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1–5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, Malheur County is the most socially vulnerable in the state. The county has the highest poverty rates, lowest per-capita income, and the highest share of people living in institutionalized group quarters. The county is also in the 90th percentile for the following variables: the share of residents without a high school diploma, the percentage of single-parent households, the share of people aged 17 and younger, the percentage of minorities, the percentage of occupied housing units with more people than rooms, and the share of households that lack access to a vehicle. Vulnerability in Harney County is moderate and driven by high unemployment and the percentage of manufactured homes.

For the 2020 vulnerability assessment, DLCD combined the social vulnerability scores with the vulnerability scores for state buildings, state critical facilities, and local critical facilities to calculate an overall vulnerability score for each county. According to this limited assessment, Harney County has low vulnerability to earthquake hazards and Malheur County is highly vulnerable.

Seismic Lifelines

Because the projected impacts of a CSZ event are considered negligible in this part of the state, this region was not part of the Oregon Department of Transportation's (ODOT) Oregon Seismic Lifeline Report (OSLR; Appendix **9.1.16**).

REGIONAL IMPACT. Within this region, significant adverse impacts from the CSZ event and secondary hazards (landslides, liquefaction etc.) are not anticipated.

REGIONAL LOSS ESTIMATES. Losses in this region are expected to be nonexistent to low. Economic disruption from major losses in the larger markets of the state will affect the economy in this region.

MOST VULNERABLE JURISDICTIONS. Vulnerability of this whole region to a CSZ event is low. Loss of life, property and business are not expected to be issues in this area. However, impacts to import and export infrastructure and basic supply lines could have short- to mid-term economic impacts. With an intact surface transportation system to the east, adaptation is expected to be relatively easy.

Risk

Table 2-787. Assessment of Earthquake Risk in Region 8

	Harney	Malheur
Risk	M	M

Source: DOGAMI and DLCD, 2020

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. The 2020 risk assessment combined the earthquake probability with the vulnerability assessment to arrive at a composite risk score. According to the 2020 risk assessment, both Harney and Malheur Counties are at moderate risk of earthquake hazards.

Extreme Heat

Characteristics

Extreme temperatures are common in Region 8 and the frequency of prolonged periods of high temperatures has increased. Owyhee, in Malheur County, has an average of about 55 days per year above 90°F.

Historic Extreme Heat Events

The NOAA Storm Events Database does not record any excessive heat or heat events in Harney or Malheur Counties; however, region-wide heat events do impact Region 8. Excessive heat events may not have been declared by the National Weather Service for these counties.

Probability

The relative probability of extreme heat was determined by dividing the counties by quintiles based on historic and projected future frequency of days with heat index above 90°F (as shown in **Figure 2-62**). Counties in the bottom quintile had the lowest frequency of days with heat index above 90°F relative to the rest of the state and were given a score of 1 meaning "very low." Region 8's relative probability rankings are shown in **Table 2-788**.

Table 2-788. Probability of Extreme Heat in Region 8

	Harney	Malheur
Probability	H	VH

Source: Oregon Climate Change Research Institute, https://climatetoolbox.org/

Climate Change

It is *extremely likely* (>95%) that the frequency and severity of extreme heat events will increase over the next several decades across Oregon due to human-induced climate warming (*very high confidence*). Region 8 experiences some of the hottest temperatures in the state and is projected to experience greater frequency of extreme temperatures under future climate change. **Table 2-789** lists the number of days exceeding the heat index of 90°F in the historical baseline and future mid-21st century period under RCP 8.5 for counties in Region 8.

Table 2-789. Annual Number of Days Exceeding Heat Index ≥ 90°F for Region 8 Counties

County	Historic Baseline	2050s Future
Harney	4	30
Malheur	12	45

Note: Numbers represent the multi-model mean from 18 CMIP5 climate models

Source: Oregon Climate Change Research Institute using data from the Northwest Climate Toolbox, https://climatetoolbox.org/.

Vulnerability

Vulnerability of Oregon counties to extreme heat is discussed in Section 2.2.1.3, Extreme Heat. Vulnerability is defined as the combination of sensitivity to extreme heat and level of adaptive capacity in response to extreme heat.

For this assessment, sensitivity to extreme heat events was defined using the Center for Disease Control and Prevention (CDC) 2016 Social Vulnerability Index, https://svi.cdc.gov/data-and-tools-download.html.

According to the CDC Social Vulnerability Index, Malheur County is the most socially vulnerable in the state. The county has the highest poverty rates, lowest per-capita income, and the highest share of people living in institutionalized group quarters. The county is also in the 90th percentile for the following variables: the share of residents without a high school diploma, the percentage of single-parent households, the share of people aged 17 and younger, the percentage of minorities, the percentage of occupied housing units with more people than rooms, and the share of households that lack access to a vehicle. Vulnerability in Harney County is moderate and driven by high unemployment and the percentage of manufactured homes.

Adaptive capacity to extreme heat is defined here as percent of homes with air conditioning; however, the authors note that this measure has its flaws. First, it assumes that people who have access to cooling systems are able to afford to use them. Second, the data only includes single-family homes, which omits populations living in multi-family housing or who are house-less.

Because extreme heat is common in Region 8 (“very high” probability), many people are accustomed or prepared in terms of air conditioning when an extreme heat event occurs (“high” adaptive capacity). In Cooling Zone 3, which includes Malheur County, 91% of single-family homes have air conditioning. In Cooling Zone 1, which includes Harney County, just over half of single-family homes have air-conditioning (https://neea.org/img/uploads/Residential-Building-Stock-Assessment-II-Single-Family-Homes-Report-2016-2017.pdf).

The relative vulnerability of Oregon counties to extreme heat was determined by adding the rankings for sensitivity (social vulnerability) and adaptive capacity (air conditioning). The sum of the two components ranged from 1 to 10. Rankings were determined as follows: total vulnerability scores of 1–2 earned a ranking of 1 (very low); scores of 3–4 earned a ranking of 2 (low); scores of 5–6 earned a ranking of 3 (moderate); scores of 7–8 earned a ranking of 4 (high); and scores of 9–10 earned a ranking of 5 (very high). Rankings for NHMP regions are averages of the counties within a region and rounded to the nearest whole number.

Table 2-790 displays the total vulnerability rankings as well as ranking for sensitivity and adaptive capacity for each county in NHMP Region 8. Table 2-791 provides the summary descriptors of Region 8's vulnerability.

Combining sensitivity and adaptive capacity, Region 8's total relative vulnerability to extreme heat is "Moderate." Neither of the counties in Region 8 is most vulnerable to extreme heat.

Table 2-790. Relative Vulnerability Rankings for Region 8 Counties

County	Sensitivity	Adaptive Capacity	Vulnerability
Region 8	**4**	**2**	**3**
Harney	3	3	3
Malheur	5	1	3

Source: Oregon Climate Change Research Institute

Table 2-791. Vulnerability to Extreme Heat in Region 8

	Harney	Malheur
Vulnerability	M	M

Source: Oregon Climate Change Research Institute

Region 8 counties did not rank vulnerability to extreme heat.

As with drought, prolonged elevated temperatures pose risks to agriculture, involving the health and welfare of farmers and other farm workers, crops and livestock. In hotter conditions, crops, livestock and humans require more water. For example, on average, for each degree Fahrenheit increase in temperature, plants use 2.5% - 5% more water. High temperature and insufficient water stunt plant growth and cause areas of crops to wither. Some livestock, especially dairy cattle, are also sensitive to heat. Milk production decreases and susceptibility to death increases during and for some time after a heat wave. Since risks to human health and welfare are also elevated during heat waves, Oregon and the federal government have regulations and guidelines to help prevent injury to those who work on farms.

Like drought, impacts of drought on state-owned facilities related to agriculture may include impacts to research conducted in outdoor settings, such as at extension stations and research farms. However, the appropriate data are not available to assess impacts of heat waves on agriculture and subsequent effects on the state economy.

State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

The value of state-owned and leased buildings and critical facilities in Region 8 is approximately $573,310,000 representing the total potential for loss of state assets due to extreme heat. The value of locally owned critical facilities is $328,497,000. Because extreme heat could impact the entire region, these figures together represent the maximum potential loss to state assets and local critical facilities due to extreme heat. Because the state is self-insured, FEMA funds are rarely used to cover damage to state assets from natural hazards. It is unclear from the Department of Administrative Services' records how many losses to state facilities were

sustained in Region 8 since the beginning of 2015. Nevertheless, none of the recorded losses was due to extreme heat.

Risk

With respect to extreme heat, risk is defined as the combination of the probability of extreme heat events, sensitivity to extreme heat, and level of adaptive capacity in response to extreme heat.

The total relative risk of Oregon counties to extreme heat was determined by adding the rankings for probability and vulnerability (sensitivity and adaptive capacity). The sum of the two components ranged from 1 to 10. Rankings were determined as follows: total risk scores of 1-2 earned a ranking of 1 ("very low"); scores of 3-4 earned a ranking of 2 ("low"); scores of 5-6 earned a ranking of 3 ("moderate"); scores of 7-8 earned a ranking of 4 ("high"); and scores of 9-10 earned a ranking of 5 ("very high"). Rankings for NHMP regions are averages of the counties within a region and rounded to the nearest whole number.

Table 2-792 displays the relative risk ranking as well as rankings for probability and vulnerability for each county in NHMP Region 8. Table 2-793 provides the summary descriptors of Region 8's risk to extreme heat.

Table 2-792. Risk Rankings for Region 8 Counties

County	Probability	Vulnerability	Risk
Region 8	**5**	**3**	**4**
Harney	4	3	4
Malheur	5	3	4

Source: Oregon Climate Change Research Institute

Table 2-793. Risk of Extreme Heat in Region 8

	Harney	Malheur
Risk	H	H

Source: Oregon Climate Change Research Institute

Floods

Characteristics

Although flooding occurs throughout Oregon, the climate, local geology and the relatively low population of Region 8 lessen its effects. Region 8 contains a variable landscape that greatly influences flood conditions. The region is subject to a variety of flood conditions including:

- Spring runoff from rain and melting snow;
- Warming and rain during the winter months;
- Ice-jam flooding;
- Local flash flooding; and
- Closed basin playa flooding.

Most flooding throughout the region is linked to the spring cycle of melting snow. Rain-on-snow events, particularly those associated with La Niña years are associated with some of Oregon's most devastating floods in this region. Spring melting may also result in ice jams on the Snake and Malheur rivers creating flood conditions in the region.

Ice jams on the Snake and Malheur rivers have created flood conditions in the past. Ice jams happen during the winter and early spring, while the river is still frozen. Sudden warming of higher altitude snow and ice results in increased runoff and break-up of river ice. On the way downstream, floating ice can "jam" in a narrow reach of the drainage or against a road crossing, causing a dam. Subsequent breach of the dam releases a torrent of water.

Summer thunderstorms are common throughout the region. During these events, normally dry gulches quickly become raging torrents, a flash flood. Although flash flooding occurs throughout Oregon, local geology in the region can increase this hazard. Bedrock, composed mostly of igneous rocks, is exposed at the surface throughout much of the region. Consequently, runoff is increased significantly.

Many parts of Harney and Malheur Counties are characterized by interior drainage or closed basins called playas. Some playas contain lakes that grow and diminish with the seasons and from year to year. Harney and Malheur lakes are good examples. At times, they are almost dry, but conditions change with prolonged periods of rainfall or snowmelt. Since the water has nowhere to go except into the lakes, the lakes just keep filling up until they overflow. Evaporation is the primary way the water levels recede and it can take years to significantly reduce swollen lake levels through this slow process.

Flooding may follow winters with deep snow accumulation. Such was the case in 1982 and subsequent years, when high lake levels caused economic damage within the region (especially in Harney County). Farms, ranches, homesteads, utilities, highways, and a railroad branch line are at risk from this type of flooding.

In Malheur County, the Owyhee uplands and the Snake River plains give rise to streams that flow into the Snake River, a tributary of the Columbia. Several reaches of the Snake River have flood control structures. Consequently, flooding is less of a problem on these rivers than on other rivers in the region.

All of the Region 8 counties have Flood Insurance Rate Maps (FIRM); however, the maps are old and not available in digital format. The FIRM maps were issued on the following dates:

- Harney: April 17, 1984, and
- Malheur: September 29, 1986.

A remapping initiative is underway in Harney County employing updated LiDAR in the Silvies River watershed.

Notable floods affecting Region 8 are shown in **Table 2-794**.

Historic Flood Events

Table 2-794. Significant Flood Events in Region 8

Date	Location	Description	Remarks
1897	Harney County	severe flooding on Silvies River	flood of record on the Silvies River (300-year flood)
1904	Harney and Malheur Counties	severe flooding on Silvies and Malheur Rivers	
1910	Malheur County	severe Malheur River flooding	flood of record on the Malheur River
1921	Harney County	severe flooding on Silvies River	
1943	Harney County	severe flooding on Silvies River	
1952	Harney and Malheur Counties	severe flooding on Jordan Creek, the Silvies and Malheur rivers	
Feb. 1957	Harney and Malheur Counties	severe flooding on Jordan Creek, the Silvies and Malheur rivers	warm rain on snow / frozen ground
Dec. 1964	entire state	severe flooding throughout region	warm rain on snow / frozen ground
1982	Harney County	severe flooding from Harney and Malheur lakes	Long history: not the first lake floods; other floods followed
Dec. 1985	Malheur County	ice jam flooding	40 miles of ice on Snake River between Farewell
June 1989	Malheur County	flash flood; crops damaged; high winds	vicinity of Nyssa
Mar. 1993	Malheur and Harney Counties	widespread flooding in rural areas; highways closed	warm rain on heavy snowpack; flood of record on
Owyhee River			
May 1998	Malheur and Harney Counties	widespread flooding. Mudslides in Malheur County	persistent rain on mountain snowpack

Date	Location	Description	Remarks
May 2005	Harney County	$10,000 in property damage	
Apr. 2011	Harney County	widespread basin flooding	Oregon DOT closed and breached U.S. 20 at milepost 132.6 on April 8, 2011, for flood relief; the breach was done at the request of Harney County Emergency Operations Center to avoid damage to nearby residences; larger culverts were later installed
Feb. 2017	Harney and Malheur Counties	Flooding due to ice jams	Flows on the John Day river reached flood levels downstream of Monument due to the breaking up of an ice jam. Rainfall and snow melt combined to increase the flow on the Silvies River to minor flood stage. Flooding occurred along the Silvies River around the Burns, Oregon area and surrounding fields and roads.
March 2017	Malheur County	Rain on snow flooding	Flooding occurred along the Snake River around the Ontario, Oregon area and surrounding fields and roads.

Sources: FEMA, Malheur County Flood Insurance Study (FIS), 09/29/86; Harney County FIS, 12/22/98; Taylor and Hatton (1999), The Oregon Weather Book, p. 96-103; Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org; NOAA National Centers for Environmental Information, Storm Events database, https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=697190

Table 2-795 lists flood sources for each of the counties in the region.

Table 2-795. Principal Flood Sources in Region 8

Harney County	Malheur County
Silvies River	Snake River
Silver Creek	Malheur River
Silver Lake	Bully Creek
Cow Creek	Willow Creek
Donner und Blitzen River	Jordan Creek
McCoy Creek	Indian Creek
Trout Creek	Clover Creek
Whitehorse Creek	Owyhee River
Harney Lake	Cottonwood Creek
Malheur Lake	

Sources: FEMA, Malheur County Flood Insurance Study (FIS), 09/29/86; FEMA, Harney County FIS, 12/22/98

Probability, Vulnerability, and Risk

Different methods are used to assess probability and vulnerability at local and state levels. These methods employ history, probability, and vulnerability data to determine probability and

vulnerability scores for each hazard. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. A description of the "OEM Hazard Analysis Methodology" used by local governments is provided in Section 2.1, **Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in Appendix **9.1.19**.

The purpose of the probability and vulnerability scores is to identify high-priority areas to which local and state governments can target mitigation actions.

Probability

Local Assessment

Participants in each county's Natural Hazard Mitigation Plan update process used the OEM hazard analysis methodology to analyze the probability that Region 8 will experience flooding. The resulting estimates of probability are shown in **Table 2-796**.

Table 2-796. Local Assessment of Flood Probability in Region 8

	Harney	Malheur
Probability	H	H

Source: Oregon Office of Emergency Management, 2019 County Hazard Analysis Scores

State Assessment

Using the methodology described in the Section 2.2.7.1, Floods/Probability, the state assessed the probability of flooding in the counties that comprise Region 8. The results are shown in **Table 2-797**.

Table 2-797. State Assessment of Flood Probability in Region 88

	Harney	Malheur
Probability	M	M

Source: DOGAMI

Climate Change

It is very likely (>90%) that Oregon will experience an increase in the frequency of extreme precipitation events and extreme river flows (high confidence). The likelihood of increase in extreme precipitation events is greater east of Cascades than west. Extreme river flow, while affected by extreme precipitation, is also driven by antecedent conditions (soil moisture, water table height), snowmelt, river network morphology, and spatial variability in precipitation and snowmelt. Most projections of extreme river flows show increases in flow magnitude at most locations across Oregon. Overall, it is more likely than not (>50%) that increases in extreme river flows will lead to an increase in the incidence and magnitude of damaging floods (low confidence), although this depends on local conditions (site-dependent river channel and floodplain hydraulics). Increases in extreme river flows leading to damaging floods will be less

likely where storm water management (urban) and/or reservoir operations (river) have capacity to offset increases in flood peak.

Vulnerability

Table 2-798. Local Assessment of Vulnerability to Flood in Region 8

	Harney	Malheur
Vulnerability	M	M

Source: Oregon Office of Emergency Management, 2019 County Hazard Analysis Scores

Table 2-799. State Assessment of Vulnerability to Flood in Region 8

	Harney	Malheur
Vulnerability	H	H

Source: DOGAMI, DLCD

DOGAMI performed an exposure analysis for Harney County by overlaying building locations on the 100-year flood extent. A large number (1,464 buildings) of Harney County's buildings representing 20% of the county's buildings were found to be within designated flood zones, 1,117 of which are located in the City of Burns. By comparing the number of non-damaged buildings from Hazus-MH with exposed buildings in the flood zone, DOGAMI estimated the number of buildings that could be elevated above the level of flooding. This evaluation can also shed some light on the number of residents that might have mobility or access issues due to surrounding water.

The DOGAMI Risk Assessment and exposure analysis found that three of Harney County's critical facilities are at risk to flood hazard (Burns Municipal Airport, Burns Fire and Police Department, and Harney County Roads Department buildings).

The exposure of critical infrastructure and facilities was analyzed in Malheur County by the Steering Committee members who participated in the development of the 2019 Malheur County NHMP. A comprehensive list of the 84 facilities is listed in this plan, only 7 of which were not considered by the SC members to be at risk from flooding. Although this analysis of vulnerability is not as rigorous as the exposure analysis performed by DOGAMI, it does indicate a high level of concern by the SC members about the impact of flooding on critical infrastructure and facilities.

Repetitive Losses

FEMA has identified one Repetitive Loss property in Region 8 (FEMA NFIP Community Information System, https://isource.fema.gov/cis/ accessed 02/11/2020).

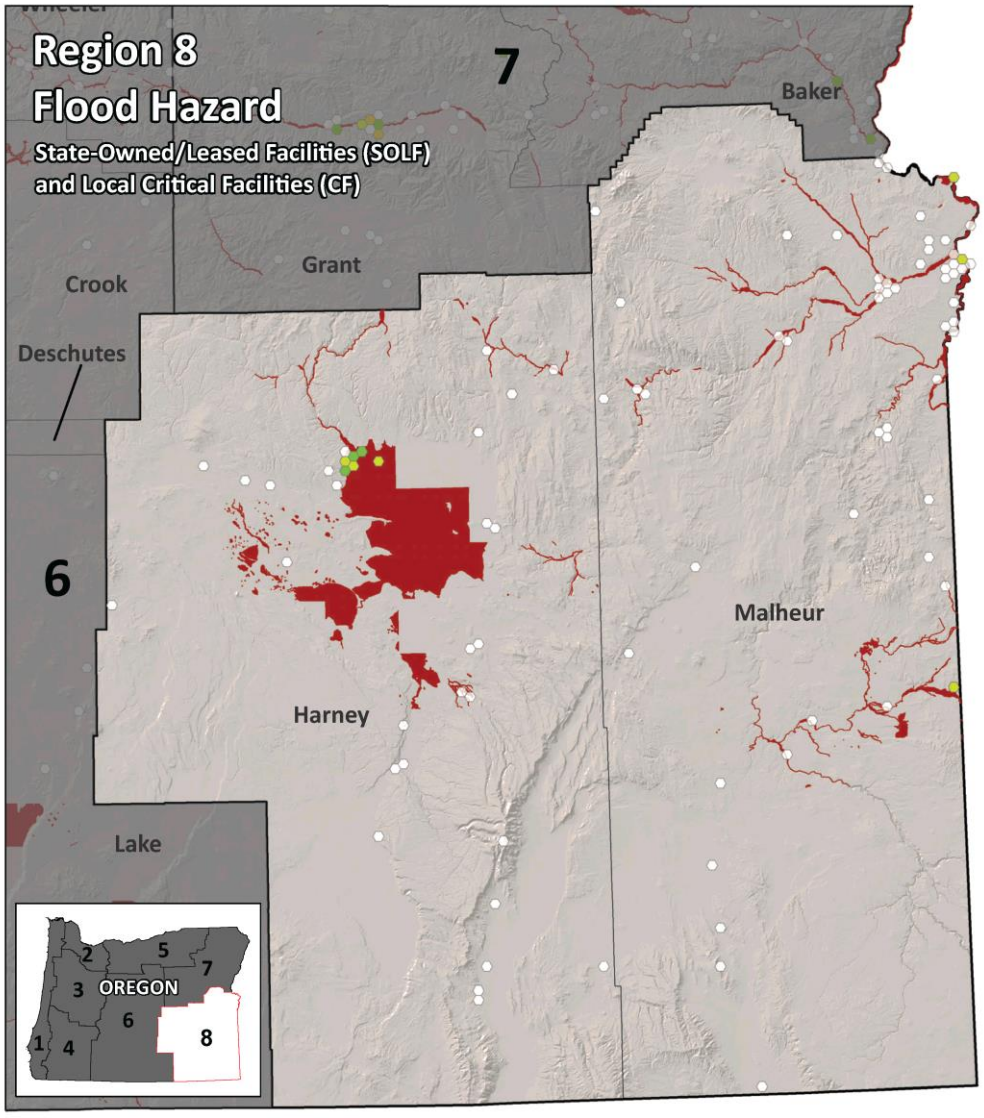
Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS) Program, which results in reduced flood insurance costs. No Region 8 communities participate in the CRS Program

State-Owned/Leased Facilities and Critical/Essential Facilities

For the 2020 Risk Assessment, DOGAMI used a combination of FEMA effective and preliminary flood zone data (FEMA National Flood Hazard Layer, 2019) and FEMA Q3 data (an unpublished digital dataset of paper flood insurance rate maps). All FEMA data that DOGAMI used was current as of 2019. The flood hazard was not divided in to High, Moderate, or Low categories due to the wide variety of flood data, its variable absolute and relative accuracy, and its variable geographic coverage and completeness. Rather, when a building was located within a floodway, 100-year floodplain, or 500-year floodplain, a "High" flood hazard was designated. When there was insufficient information to determine whether a flood hazard exists for a given site, the flood hazard was designated "Other." Sites with "Other" designations could conceivably face relatively high flood hazards or no flood hazard at all.

In Region 8, there is a potential loss from flooding of about $6M in state building and critical facility assets, 56% of it in Harney County and 44% in Malheur County. There is a much greater potential loss – about 3.5 times as much – due to flood in local critical facilities: over $22M. About 52% of that value is in Malheur County, 48% in Harney County. **Figure 2-314** illustrates the potential loss to state buildings and critical facilities and local critical facilities from flooding.

Figure 2-314. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in a Flood Hazard Zone in Region 8.High-resolution, full-size image linked from Appendix 9.1.26.



Building value ($) exposed to hazard per cell

- No exposure to hazard
- 1 - 2,500,000
- 2,500,001 - 10,000,000
- 10,000,001- 25,000,000
- 25,000,001 - 50,000,000
- 50,000,001 - 477,000,000

Hazard area

- Flood - high hazard

Administrative boundary

- Mitigation Planning Region
- County

Projection:
Oregon Statewide Lambert Conformal Conic, Unit: International Feet, Horizontal datum: NAD83 HARN, Scale 1:1,000,000

Source Data:
Flood: various studies from Federal Emergency Management Agency, National Flood Insurance Program
State-owned/lease buildings: Oregon Department of Administrative Services, 2019
Administrative boundaries: Oregon Emergency Management and the Oregon Department of Land Conservation and Development, 2015
Hillshade base map: DOGAMI, Statewide mosaic, 2018, from Oregon Lidar Consortium data

Author: Matt Williams, Oregon Department of Geology and Mineral Industries, January 2020.

REGION 8		Exposure ($) to Flood Hazard Areas					
		State-owned/leased facilities				Critical Facilities	
County	Total Value SOLF and Local CF	Value Exposed SOLF CF	% Value Exposed SOLF CF	Value Exposed SOLF Non-CF	Value Exposed Total*	Value Exposed Local CF	Total Value Exposed SOLF CF and Local CF
Harney	78,983,000	3,364,000	21%	84,000	3,448,000	10,652,000	14,016,000
Malheur	822,824,000	2,725,000	0%	0	2,725,000	11,569,000	14,294,000
Total	901,807,000	6,089,000	1%	84,000	6,173,000	22,221,000	28,310,000

This study divided buildings into two major categories by ownership: state-owned or leased facilities (SOLF) and local critical facilities (CF). SOLF buildings were further subdivided into either CFs, such as police stations, or non-critical facilities (non-CF), such as administrative offices.
**Exposure totals for SOLF include the subset of SOLF CFs.*

0 12.5 25 50 Miles

N

Source: DOGAMI

Historic Resources

Of the 337 historic resources in Region 8, fifty-four (16%) are located in an area of high flood hazard. Of those, 46 (85%) are located in Harney County.

Archaeological Resources

Of the 278 archaeological resources located in high flood hazard areas in Region 8, eighty-seven percent (251) are located in Harney County. None are listed on the National Register of Historic Places but nine are eligible for listing. Seven of the nine are located in Harney County. One has been determined not eligible and 268 have not been evaluated as to their eligibility. Two hundred thirty-three (87%) of those not yet evaluated are also in Harney County.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1–5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, Malheur County is the most socially vulnerable in the state. The county has the highest poverty rates, lowest per-capita income, and the highest share of people living in institutionalized group quarters. The county is also in the 90th percentile for the following variables: the share of residents without a high school diploma, the percentage of single-parent households, the share of people aged 17 and younger, the percentage of minorities, the percentage of occupied housing units with more people than rooms, and the share of households that lack access to a vehicle. Vulnerability in Harney County is moderate and driven by high unemployment and the percentage of manufactured homes.

For the 2020 vulnerability assessment, DLCD combined the social vulnerability scores with the vulnerability scores for state buildings, state critical facilities, and local critical facilities to calculate an overall vulnerability score for each county. According to this limited assessment, both Harney and Malheur Counties are highly vulnerable to the impacts of flooding. While Harney County is not as socially vulnerable as Malheur County, it has more value in state buildings, state critical facilities, and almost as much in local critical facilities vulnerable to flooding. Harney County also has many more historic and archaeological resources vulnerable to flooding.

Most Vulnerable Jurisdictions

Both Harney and Malheur Counties are most vulnerable to flood hazards in Region 8.

Risk

Table 2-800. Risk of Flood Hazards in Region 8

	Harney	Malheur
Risk	H	H

Source: DOGAMI, DLCD

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. The 2020 risk assessment

combined the probability with the vulnerability assessment to arrive at a composite risk score. According to the 2020 risk assessment, both Harney and Malheur Counties are at high risk from flood events.

Dam Safety

The Oregon Water Resources Department (OWRD) is the state authority for dam safety with specific authorizing laws and implementing regulations. Oregon's dam safety laws were re-written by HB 2085 which passed through the legislature and was signed by Governor Brown in 2019. This law becomes operative on July 1, 2020, with rules and guidance have been drafted and are currently in the public review and comment period.

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

Analysis and Characterization

Oregon's statutory size threshold for dams to be regulated by OWRD is at least 10 feet high and storing at least 3 million gallons. Many dams that fall below this threshold have water right permits for storage from OWRD.

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

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

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

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

Most of the largest dams, especially those owned or regulated by the Federal Government are designed to safely withstand these events and have been analyzed to show that they will. However, there are a number of dams where observations, and sometimes analysis indicates a deficiency that may make those dams susceptible to one or more of the events. The large majority of state regulated dams do not have a current risk assessment or analysis, and safe performance in these events is uncertain.

Failures of some dams can result in loss of life, damage to property, infrastructure, and the natural environment. The impacts of dam failures range from local impacts to waters below the dam and the owners property to community destruction with mass fatalities. The 1889 Johnston Flood in Pennsylvania was caused by a dam failure, and resulted in over 2000 lives lost. Oregon's

first dam safety laws were developed in response to the St. Francis dam failure in California in 1928. That failure was attributed to unsafe design practice, and because of this about 500 persons perished. In modern times (2006) a dam owner filled in the spillway of a dam on the island of Kauai causing dam failure that killed 7 people. This dam had no recent dam safety inspections because the hazard rating was incorrect.

Where a dam's failure is expected to result in loss of life downstream of the dam, an Emergency Action Plan (EAP) must be developed. The EAP contains a map showing the area that would potentially be inundated by floodwaters from the failed dam. These dams are often monitored so that conditions that pose a potential for dam failure are identified to allow for emergency evacuations.

Table 2-801. Historic Significant Dam Failures in Region 8

Year	Location	Description
1925	Bully Creek dam west of Vale in Malheur Co.	Multiple homes badly damaged, loss of livestock
1941	Willow Creek (Malheur) dam west of Vale in Malheur Co.	Near catastrophic failure with more than 100 persons at risk, extreme flooding prevented
1949	Kern Brothers dam south of Burns in Harney Co.	Property damaged
1951	N. Indian Creek dam in northern Malheur Co.	Property damaged
1952	Rock Creek dam east of Burns in Harney Co.	Property damaged
1958	Vaughn Reservoir in rural Malheur Co.	Property damaged
1978	Kern Brothers dam south of Burns in Harney Co.	Property damaged including failure of Krumbo dam, second failure at this dam site
1983	Star Mountain dam near Riverside in Malheur Co.	Washed out railroad and roads, damaged homes

Source: Oregon Water Resources Department Dam Safety Program records

Dam Hazard Ratings

Oregon follows national guidance for assigning hazard ratings to dams and for the contents of Emergency Action Plans, which are now required for all dams rated as "high hazard." Each dam is rated according to the anticipated impacts of its potential failure. The state has adopted these definitions (ORS 540.443–491) for state-regulated dams:

- "High Hazard" means loss of life is expected if the dam fails.
- "Significant Hazard" means loss of life is not expected if the dam fails, but extensive damage to property or public infrastructure is.
- "Low Hazard" is assigned to all other state-regulated dams.
- "Emergency Action Plan" means a plan that assists a dam owner or operator, and local emergency management personnel, to perform actions to ensure human safety in the event of a potential or actual dam failure.

Hazard ratings may change for a number of reasons. For example, a dam's original rating may not have been based on current inundation analysis methodologies, or new development may have changed potential downstream impacts.

There are 10 High Hazard dams and 13 Significant Hazard dams in Region 8**.**

Table 2-802. Summary: High Hazard and Significant Hazard Dams in Region 8

	Hazard Rating		
	State		Federal
	High	Significant	High
Region 8	5	13	5
Harney	0	10	0
Malheur	5	3	5

Source: Oregon Water Resources Department, 2019

Table 2-803. High Hazard and Significant Hazard Dams in Region 8

County	Name	Rating	Regulator
Harney	Beede North	Significant	State
Harney	Beede South	Significant	State
Harney	Chickahominy Reservoir	Significant	State
Harney	Corcoran	Significant	State
Harney	Cottonwood (Drewsey)	Significant	State
Harney	Griffin Creek Dam	Significant	State
Harney	Hunter Reservoir (Harney)	Significant	State
Harney	Moon Reservoir	Significant	State
Harney	South Fork Reservoir	Significant	State
Harney	Stinking Water Creek	Significant	State
Malheur	Agency Valley Dam	High	Federal
Malheur	Bully Creek Dam	High	Federal
Malheur	Owyhee	High	Federal
Malheur	Rock Creek (Malheur)	High	Federal
Malheur	Warm Springs Reservoir (USBR)	High	Federal
Malheur	Antelope	High	State
Malheur	Crowley	High	State
Malheur	Lonesome Lake	High	State
Malheur	Pole Creek	High	State
Malheur	Willow Creek 3 (Malheur)	High	State
Malheur	Love Reservoir (Malheur)	Significant	State
Malheur	Parsnip Creek Diversion	Significant	State
Malheur	Star Mountain Reservoir	Significant	State

Source: Oregon Water Resources Department, 2019

Probability

Engineering risk assessment and analysis of a dam is the best indicator of the probability of failure. Without that, the condition of a dam as determined by OWRD engineering staff is a helpful indicator OWRD has for of the failure potential of a dam.

Dam safety regulators determine the condition of high hazard rated dams, both state- and federally regulated. A dam's condition is considered public information for state-regulated dams, but the conditions of federally regulated dams are generally not subject to disclosure. State-regulated significant hazard dams do not yet have condition ratings.

Oregon uses FEMA's condition classifications. These classifications are subject to change and revisions are being considered at the national level. Currently, FEMA's condition classifications are:

- "Satisfactory" means no existing or potential dam safety deficiencies are recognized. Acceptable performance is expected under all loading conditions (static, hydrologic, seismic) in accordance with the applicable regulatory criteria or tolerable risk guidelines.
- "Fair" means no existing dam safety deficiencies are recognized for normal loading conditions. Rare or extreme hydrologic and/or seismic events may result in a dam safety deficiency. Risk may be in the range to take further action.
- "Poor" means a dam safety deficiency is recognized for loading conditions that may realistically occur. Remedial action is necessary. A poor rating may also be used when uncertainties exist as to critical analysis parameters that identify a potential dam safety deficiency. Further investigations and studies are necessary.
- "Unsatisfactory" means a dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution.
- "Not Rated" means the dam has not been inspected, is not under State jurisdiction, or has been inspected but, for whatever reason, has not been rated.

Only one of the five state-regulated high hazard dams in Region 8 is in satisfactory condition; four are in poor or unsatisfactory condition.

Table 2-804. Summary: Condition of High Hazard State-Regulated Dams in Region 8

	Condition of State-Regulated High Hazard Dams				
	Satisfactory	Fair	Poor	Unsatisfactory	Not Rated
Region 8	1	0	2	2	0
Harney	0	0	0	0	0
Malheur	1	0	2	2	0

Source: Oregon Water Resources Department, 2019

Table 2-805. Condition of High Hazard State-Regulated Dams in Region 8

County	Dam Name	Condition
Malheur	Lonesome Lake	Poor
Malheur	Pole Creek	Poor
Malheur	Antelope	Satisfactory
Malheur	Crowley	Unsatisfactory
Malheur	Willow Creek 3 (Malheur)	Unsatisfactory

Source: Oregon Water Resources Department, 2019

State-Regulated High Hazard Dams not Meeting Safety Standards

There are four state-regulated high hazard dams in Region 8 that are currently assessed to be below accepted safety standards (in Poor or Unsatisfactory Condition). These dams and the population at risk, based on a screen using the screening tool DSS-WISE, are shown in **Table**

2-806. As the dam safety program conducts analysis over time, the number of dams in less than satisfactory condition may change. Currently dams that are in poor or unsatisfactory condition are in need of rehabilitation or other action to bring them into a fully safe condition. As of December 2019, these are the dams in Region 8 that are not yet demonstrably unsafe, but that do pose unacceptable risk. When Oregon's new dam safety laws take effect July 1, 2020, the condition of some of these dams may be reclassified as unsafe or potentially unsafe.

It is important to note that many state regulated dams have not received a deep level of risk analysis and review, so the number of dams not meeting minimum standards may increase as additional analyses are performed.

Table 2-806. State-Regulated High Hazard Dams Not Meeting Safety Standards in Region 8

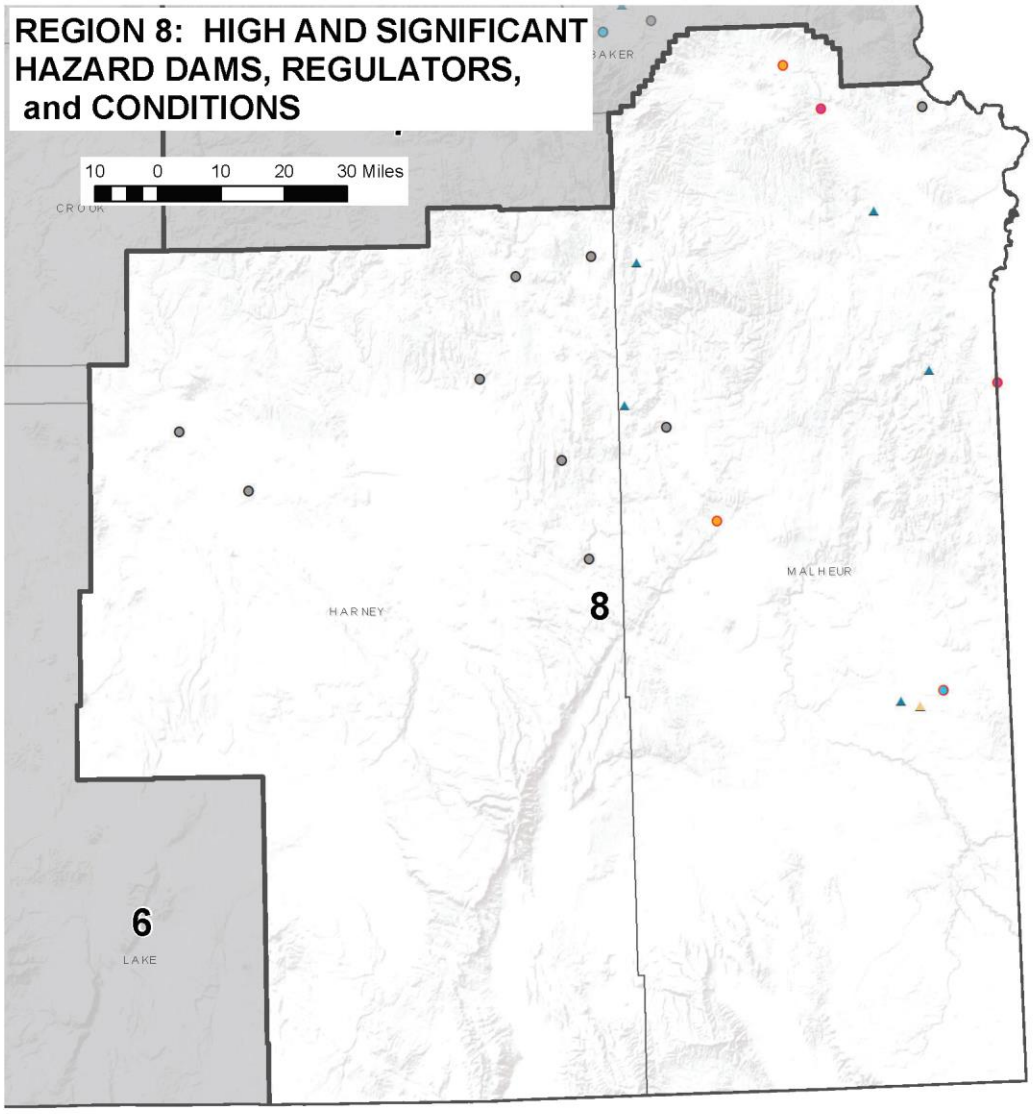
Dam	NID#	Condition Rating	Daytime PAR (number of people)	Nighttime PAR (number of people)	County
Crowley Reservoir	OR00132	UNSAT	3	3	Malheur
Lonesome Lake		POOR	Small	Small	Malheur
Pole Creek	OR00239	POOR	37	103	Malheur
Willow Creek 3 (Malheur)	OR00390	UNSAT	3,426	3,518	Malheur

Note: "PAR" is number of "Persons At Risk" in the dam failure inundation zone based on a conservative estimate using DSS-Wise dam breach estimator. It includes all persons that normally could be in the inundation area. Actual impacts depend on the velocity and depth of water and will be determined as part of Oregon's HHPD grant tasks.

Source: DSS-Wise output

Figure 2-315 shows state- and federally regulated high and significant hazard dams as well as the condition of state-regulated dams in Region 8. The table on the map shows the total number of these dams in each of the seven mapped hazard areas.

Figure 2-315. High- and Significant-Hazard Dams, Regulators, and Conditions in Region 8



	Coastal	Earthquake	Flood	Landslide	Volcanic	Tsunami	Wildfire
Region 8	0	11	*	6	0	0	11
Harney	0	6	*	1	0	0	6
Malheur	0	5	*	5	0	0	5

* - flood risk affected by function and condition of dam, not by presence in mapped flood prone location

State regulated dams**

Condition assessment

- Poor
- Unsatisfactory
- Fair
- Satisfactory
- No assessment

** - Significant hazard dam symbols have a black outline. **High hazard dam symbols have a red outline.**

Federal regulated dams

Hazard

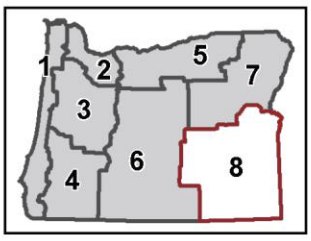
- High
- Significant

- Mitigation Planning Regions
- Counties

Projection:
Oregon Lambert Coordinate Reference System, Unit: International Feet, Horizontal datum: NAD83, EPSG #2992

Source Data:
State regulated dams: Oregon Water Resources Dept., July 2020
Mitigation Planning Regions: Oregon Emergency Management
Counties: U.S. Bureau of Land Management (BLM)
Base map: Esri, World Terrain Base

Author: Robert Harmon, GISP, Oregon Water Resources Dept. (July 2020)



Climate Change

Most climate change models indicate there may be more extreme precipitation due to the increased energy in the oceanic and atmospheric systems. Of main concerns for dams is the potential for larger floods than experienced in the past. Almost half of the historical dam failures around the world have been due the floods that exceed the flow capacity of the spillway and overtop the dam. Another issue for the Pacific coast is the shorter record of precipitation and flood events in the data records. Even without climate change there is uncertainty in the extreme storms that could occur in an extreme atmospheric river event (about which there is much to learn). If the actual flood is larger than the design flood, spillway capacity may be exceeded and the dam may overtop, or the spillway may erode so that it can rapidly empty the reservoir. These scenarios can present real risks to some dams in Oregon, risks that depending on the location may be greater than earthquake related risks.

Vulnerability

Table 2-806, State-Regulated High Hazard Dams Not Meeting Safety Standards in Region 8, indicates the number of people currently anticipated to be impacted by potential failure of the state-regulated high hazard dams in poor or unsatisfactory condition. OWRD plans to do more analysis to determine the number and value of structures that may be impacted as well.

Risk to dams from non-flood hazards in Region 8 is generally fairly low, with some volcanic risk possible for at least one dam.

Three dams meet FEMA HHPD eligibility criteria in Region 8. There is one major highway in the inundation area below two of these dams.

Most Vulnerable Jurisdictions

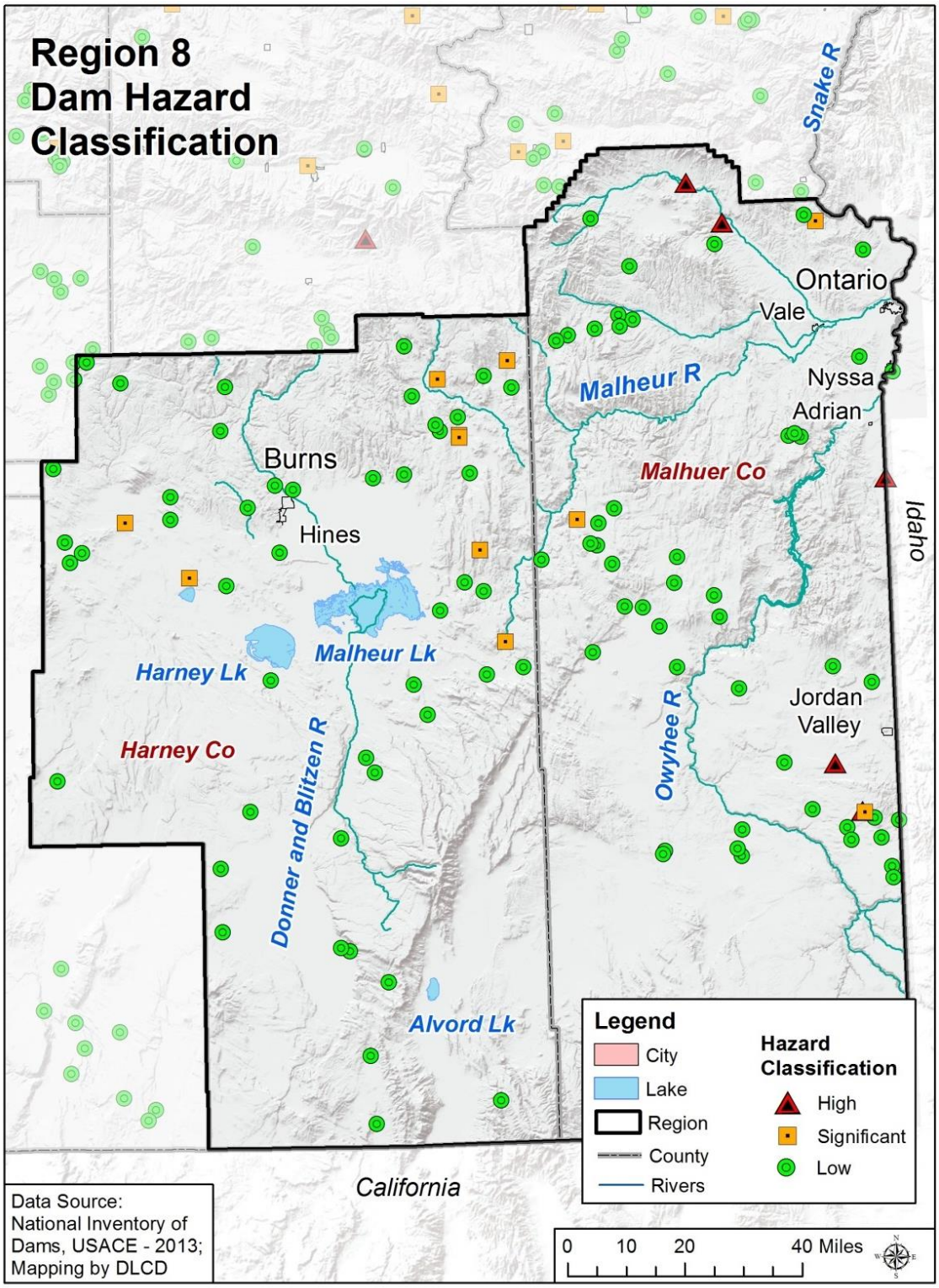
Given the information presented about state-regulated high hazard dams (county and condition; failure expected to result in loss of life) and significant hazard dams (county; failure expected to result in extensive property or infrastructure damage), only Malheur County in Region 8 has high hazard dams in poor or unsatisfactory condition is therefore considered most vulnerable.

As with high hazard dams, whether counties with significant hazard dams are actually “most vulnerable jurisdictions” depends on the conditions of those dams. Since the dams’ conditions have not yet been rated, we cannot determine the counties’ vulnerability with respect to significant hazard dams. The county with the most state-regulated significant hazard dams is Harney County (10).

Risk

With FEMA and State funding, OWRD will be completing risk assessments for three of Region 8’s state-regulated high hazard dams in poor or unsatisfactory condition over the next several years. For now, the potential for damage to the dam from extreme floods, lack of protection against internal erosion, earthquakes, or landslides and debris indicates greater potential for failure. Coupled with the potential for loss of life and extensive damage to property and public infrastructure, risk is qualitatively determined.

Figure 2-316. Region 8 Dam Hazard Classification



Source: National Inventory of Dams, USACE, 2013

Note: Federally regulated significant hazard dams are not shown.

Landslides

Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. On occasion, major landslides sever major transportation routes such as U.S. or state highways and rail lines, causing temporary but significant economic damage.

Historic Landslide Events

There are no readily known significant landslides in this region.

Probability

Table 2-807. Assessment of Landslide Probability in Region 8

	Harney	Malheur
Probability	L	L

Source: DOGAMI, 2020

The probability of future landslides in the southeastern Oregon region is low to moderate. The probability of an area to have a landslide is increased depending on the factors that reduce the stability without causing failure. When several of these factors are combined, such as an area with steep slopes, weak geologic material, and previous landslide movement, the probability of future landsliding is increased. There is a strong correlation between intensive winter rainstorms and the occurrence of rapidly moving landslides (debris flows).

Climate Change

Landslides are often triggered by heavy rainfall events when the soil becomes saturated. It is *very likely* (>90%) that Oregon will experience an increase in the frequency of extreme precipitation events (*high confidence*). Because landslide risk depends on a variety of site-specific factors, it is *more likely than not* (>50%) that climate change, through increasing frequency of extreme precipitation events, will result in increased frequency of landslides.

Vulnerability

Table 2-808. Local Assessment of Vulnerability to Landslides in Region 8

	Harney	Malheur
Vulnerability	L	L

Source: Most recent local hazard vulnerability analyses (**Table 2-4**)

Table 2-809. State Assessment of Vulnerability to Landslides in Region 8

	Harney	Malheur
Vulnerability	L	H

Source: DOGAMI and DLCD, 2020

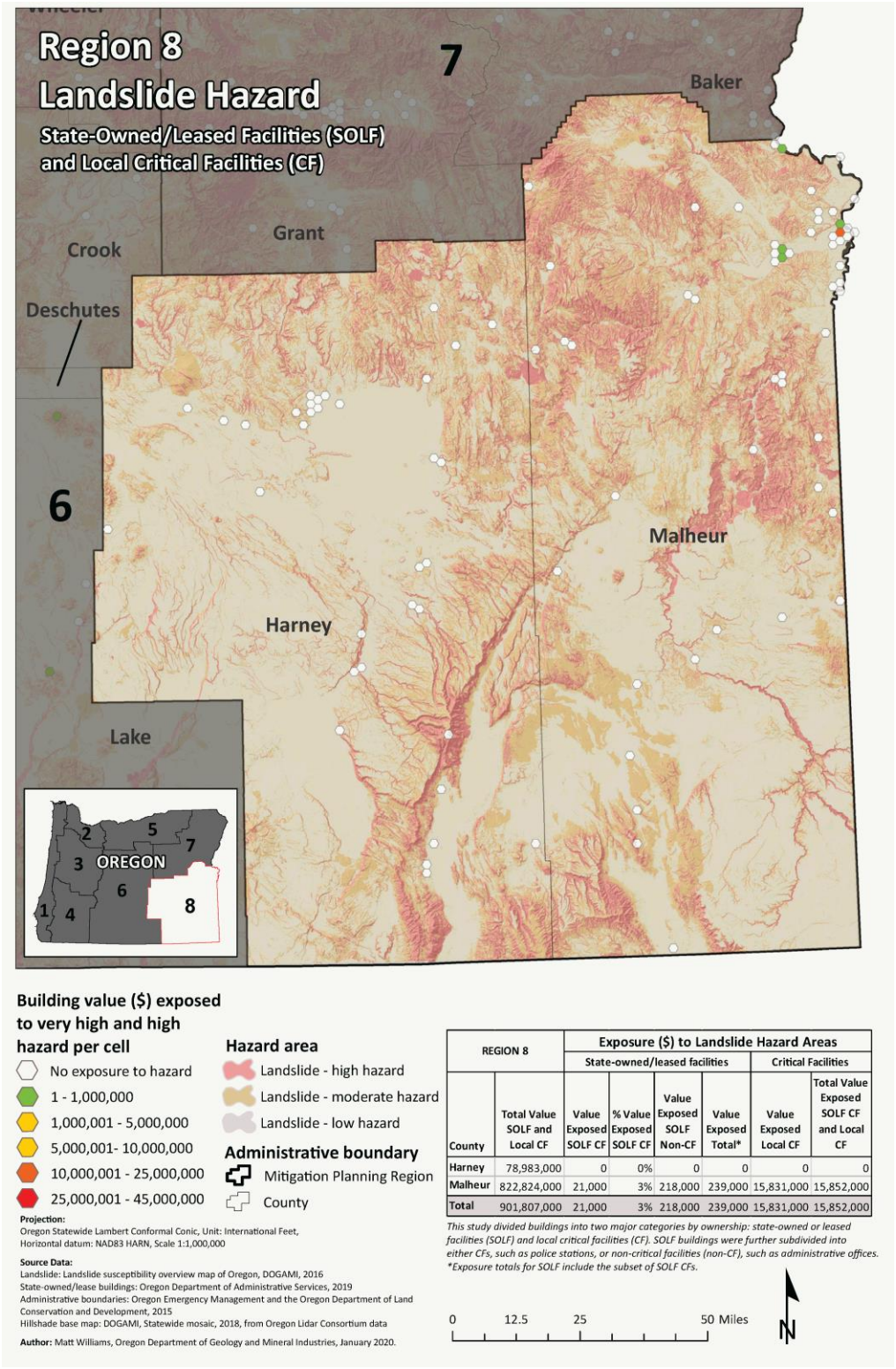
Landslides pose significant threats to people and infrastructure. Landslides have caused damage and loss in Region 8, and it is very likely that they will again. Most of the people and infrastructure in Region 8 are located in one of the major cities in the region which are located along highways. The generalized landslide hazard for the region is low to moderate.

According to the 2020 risk assessment, Harney County's high vulnerability is driven by its very high social vulnerability score. Malheur County's social vulnerability score is appreciably lower, and the presence of state buildings and state and local critical facilities in landslide hazard areas is low enough to keep Malheur County's overall vulnerability score low.

State-Owned/Leased Facilities and Critical and Essential Facilities

DOGAMI analyzed the potential dollar loss from landslide hazards to state buildings and critical facilities as well as to local critical facilities in Region 8. About $239K in value of state assets is exposed to landslide hazards in Region 8, all of it in Malheur County. The total value of the Region's local critical facility assets, $15.8M, is also located in Malheur County. **Figure 2-317** illustrates the potential loss to state buildings and critical facilities and local critical facilities from landslide hazards.

Figure 2-317. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in a Landslide Hazard Zone in Region 8.High-resolution, full-size image linked from Appendix 9.1.26.



REGION 8		Exposure ($) to Landslide Hazard Areas					
		State-owned/leased facilities				Critical Facilities	
County	Total Value SOLF and Local CF	Value Exposed SOLF CF	% Value Exposed SOLF CF	Value Exposed SOLF Non-CF	Value Exposed Total*	Value Exposed Local CF	Total Value Exposed SOLF CF and Local CF
Harney	78,983,000	0	0%	0	0	0	0
Malheur	822,824,000	21,000	3%	218,000	239,000	15,831,000	15,852,000
Total	901,807,000	21,000	3%	218,000	239,000	15,831,000	15,852,000

Source: DOGAMI, 2020

Historic Resources

All of the 337 historic resources in Region 8 are exposed to landslide hazards: 8 are exposed to very high or high landslide hazards; 41 to moderate; and 288 to low. Sixty percent of the historic resources in Region 8 are located in Malheur County, as are seven of the eight exposed to high or very high landslide hazards.

Archaeological Resources

Of the 3,058 archaeological resources located in landslide hazard areas in Region 8, fifty-two percent (1,596) are in high landslide hazard areas. Of those, only one is listed on the National Register of Historic Places and 156 are eligible for listing. Twenty have been determined not eligible, and 1,419 have not been evaluated as to their eligibility. About half the archaeological resources in high or very high landslide hazard areas are located in each county. Overall, 71% of the archaeological resources in landslide hazard areas in Region 8 are in Harney County.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1–5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, Malheur County is the most socially vulnerable in the state. The county has the highest poverty rates, lowest per-capita income, and the highest share of people living in institutionalized group quarters. The county is also in the 90th percentile for the following variables: the share of residents without a high school diploma, the percentage of single-parent households, the share of people aged 17 and younger, the percentage of minorities, the percentage of occupied housing units with more people than rooms, and the share of households that lack access to a vehicle. Vulnerability in Harney County is moderate and driven by high unemployment and the percentage of manufactured homes.

For the 2020 vulnerability assessment, DLCD combined the social vulnerability scores with the vulnerability scores for state buildings, state critical facilities, and local critical facilities to calculate an overall vulnerability score for each county. According to this limited assessment, Malheur County is much more vulnerable to landslides than Harney County.

Risk

Table 2-810. Assessment of Risk to Landslides in Region 8

	Harney	Malheur
Risk	VL	M

Source: DOGAMI and DLCD, 2020

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. The 2020 risk assessment methodology combined the probability of landslide hazards occurring with the potential cost of damage to exposed state buildings and state and local critical facilities and with an assessment of the social vulnerability of the local population.

According to the 2020 Risk Scores and DOGAMI's expert assessment, Malheur County carries more risk to landslides than Harney County, but with moderate and very low risk ratings, neither is a "most vulnerable community."

Volcanoes

Characteristics

The volcanic Cascade Range is not within Region 8 counties, but there is some risk from volcanic ash derived from these volcanoes. This fine-grained material, blown aloft during a volcanic eruption, can travel many miles from its source. For example, during the May 1980, Mount St. Helens eruption, the cities of Yakima and Spokane, Washington, 80 and 160 miles away, respectively, were inundated with ash. Ash can reduce visibility to zero and bring street, highway, and air traffic to an abrupt halt. The material is noted for its abrasive properties and is especially damaging to machinery.

Ashfall is largely controlled by the prevailing wind direction. The predominant wind direction over the Cascade Range is west to east. Previous eruptions documented in the geologic record indicate most ashfall drifting to and settling in areas east of the Cascade volcanoes. Geologic hazard maps have been created for most of the volcanoes in the Cascade Range by the U.S. Geological Survey Volcano Hazards Program at the Cascade Volcano Observatory in Vancouver, Washington and are available at http://volcanoes.usgs.gov/observatories/cvo/.

Besides the distant Cascade volcanoes to the west, there are numerous examples of local volcanic activity throughout southeastern Oregon, such as the abundant thermal hot springs, and some large volcanic fields (e.g., Diamond and Jordan Craters), which attest to its not too distant volcanic past. Jordan Craters, located about 36 miles southwest of Adrian, is thought to have erupted lava roughly 3,200 years ago.

Historic Volcanic Events

Table 2-811. Historic Volcanic Events in Region 8

Date	Location	Description
< 7,000 YBP	Diamond Craters, eastern Oregon	lava flows and tephra in Diamond Craters field
< 3,200 YBP	Jordan Craters, eastern Oregon	lava flows and tephra in Jordan Craters field

Note: YBP is years before present.

Source: Source: U.S. Geological Survey, Cascades Volcano Observatory: http://volcanoes.usgs.gov/observatories/cvo/

Probability

Table 2-812. Assessment of Volcanic Hazards Probability in Region 8

	Harney	Malheur
Probability	L	L

Source: DOGAMI, 2020

Mount St. Helens remains a probable source of ash. It has repeatedly produced voluminous amounts of this material and has erupted much more frequently in recent geologic time than any other Cascade volcano. It blanketed Yakima and Spokane, Washington, during the 1980 eruption and again in 2004. The location, size, and shape of the area affected by ash are determined by the vigor and duration of the eruption and the wind direction.

The eruptive history of the nearby Cascade volcanoes to this region can be traced to late Pleistocene times (approximately 700,000 years ago) and will no doubt continue. But the central question remains: When? The most recent series of events at Newberry Volcano, which occurred about 1,300 years ago, consisted of lava flows and ashfall. Newberry Volcano's history also includes pyroclastic flows and numerous lava flows. Volcanoes in the Three Sisters region, such as Middle and South Sister, and at Crater Lake have also erupted explosively in the past. These eruptions have produced pyroclastic flows, lava flows, lahars, debris avalanches, and ash. Any future eruptions at these volcanoes would most likely resemble those that have occurred in the past.

Geoscientists have provided some estimates of future activity in the vicinity of Newberry Caldera and its adjacent areas. They estimate a 1 in 3,000 chance that some activity will take place in a 30-year period. The estimate for activity at Crater Lake for the same time period is significantly smaller at 0.003 to 0.0003. In the Three Sisters region, the probability of future activity is roughly 1 in 10,000 but any restlessness would greatly increase this estimate.

Local eruptions within Region 8 occurred most recently at Diamond Craters about 6000 years ago and younger activity at Jordan Craters dates after 3,200 years ago. These events consisted of short-lived effusion of basaltic lava and blanketing of the surrounding landscape with basaltic ash. These volcanoes are now extinct, but future eruptions in Southeast Oregon will occur. However, neither the timing nor the location of such events can be forecast in the absence of volcanic unrest.

Vulnerability

Table 2-813. Local Assessment of Vulnerability to Volcanic Hazards in Region 8

	Harney	Malheur
Vulnerability	L	L

Source: Most recent local hazard vulnerability analyses (Table 2-4)

Table 2-814. State Assessment of Volcanic Hazards Vulnerability in Region 8

	Harney	Malheur
Vulnerability	L	M

Source: DOGAMI and DLCD, 2020

State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

DOGAMI analyzed the potential dollar loss from volcanic hazards to state-owned and –leased buildings and critical facilities as well as to local critical facilities in Region 8. No state buildings, state or local critical facilities are located in volcanic hazard areas.

Historic Resources

None of the 337 historic buildings in Region 8 are exposed to volcanic hazards. See Appendix **9.1.12** for details.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1–5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, Malheur County is the most socially vulnerable in the state. The county has the highest poverty rates, lowest per-capita income, and the highest share of people living in institutionalized group quarters. The county is also in the 90th percentile for the following variables: the share of residents without a high school diploma, the percentage of single-parent households, the share of people aged 17 and younger, the percentage of minorities, the percentage of occupied housing units with more people than rooms, and the share of households that lack access to a vehicle. Vulnerability in Harney County is moderate and driven by high unemployment and the percentage of manufactured homes.

According to the 2020 vulnerability scores, Harney County is the more vulnerable to volcanic hazards of the two counties in Region 8. Harney County's high vulnerability score is driven by very high social vulnerability. Malheur County, by contrast, has moderate social vulnerability.

Risk

Table 2-815. Assessment of Risk to Volcanic Hazards in Region 8

	Harney	Malheur
Risk	M	VL

Source: DOGAMI and DLCD, 2020

According to the 2020 risk scores, none of the communities identified by DOGAMI as being most vulnerable to volcanic hazards are located in Region 8.

Areas within Region 8 could be affected by ashfall from Cascade volcanic eruptions and more locally by small eruptions of lava from the numerous youthful volcanic cones scattered across Harney and Malheur Counties. Most of the region's people and infrastructure are located in the major cities along I-84, US-20, and US-395. The most vulnerable jurisdictions are Burns, Ontario, and Jordan Valley.

Wildfires

Characteristics

Southeastern Oregon contains large tracts of ponderosa pine forests, primarily in the northern part of Harney County. Less extensive forests occur in Malheur County near Ironside and in scattered mountain ranges throughout the region. These areas are highly vulnerable to wildfire because of natural aridity and the frequency of lightning strikes. Grasslands, which naturally cover most of the region, also are problematic. Wildfire always has been a part of these ecosystems. Past management practices, which included the suppression of all wildfires, has favored the growth of a brushy understory and the accumulation of dead or dying trees. This leads to devastating fires. State and federal agencies seek to alleviate the problem through a controlled (i.e., prescribed) burning program. **Table 2-816** lists some of the significant wildfires that have occurred in the region.

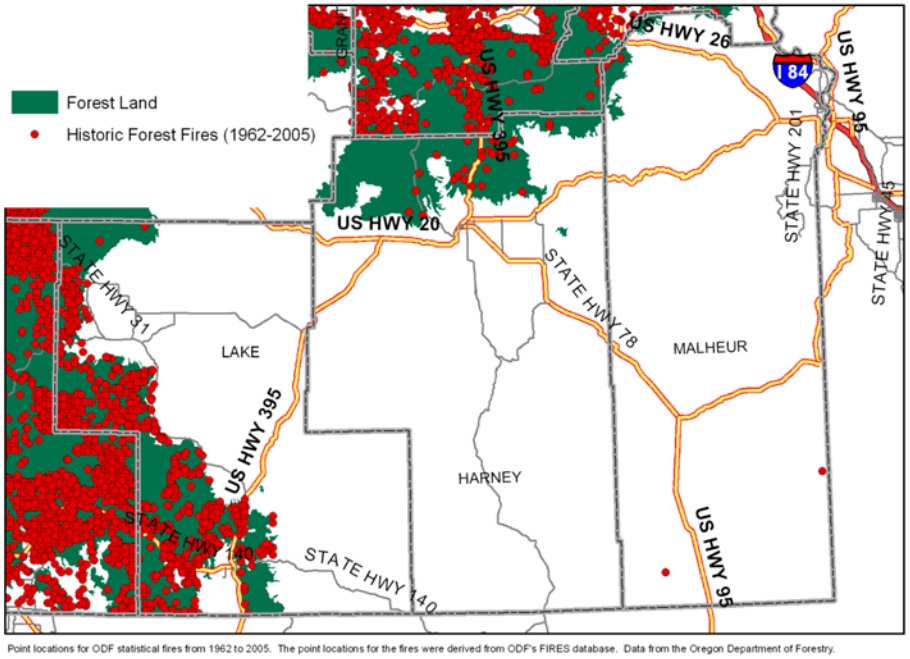
Historic Wildfire Events

Table 2-816. Significant Wildfires in Region 8

Date	Name of Fire	Location	Acres Burned	Remarks
1998	Ontario	Malheur County		
2000	Jackson	Malheur County	79,875	
2001	Sheepshead	Malheur County	51,452	
2006	South End Complex	Harney County	117,553	
2007	Egley	Harney	140,360	
2017	Cinder Butte	Harney	>52,000	human-caused; burned rangeland; threatened Tribal archaeological sites

Source: Oregon Department of Forestry, 2020

Figure 2-318. Historic Forest Fires in Region 8



Source: The Oregon Department of Forestry Database and extent of forested land (http://egov.oregon.gov/ODF/GIS).

Probability

Table 2-817. Assessment of Wildfire Probability in Region 8

	Harney	Malheur
Probability	H	H

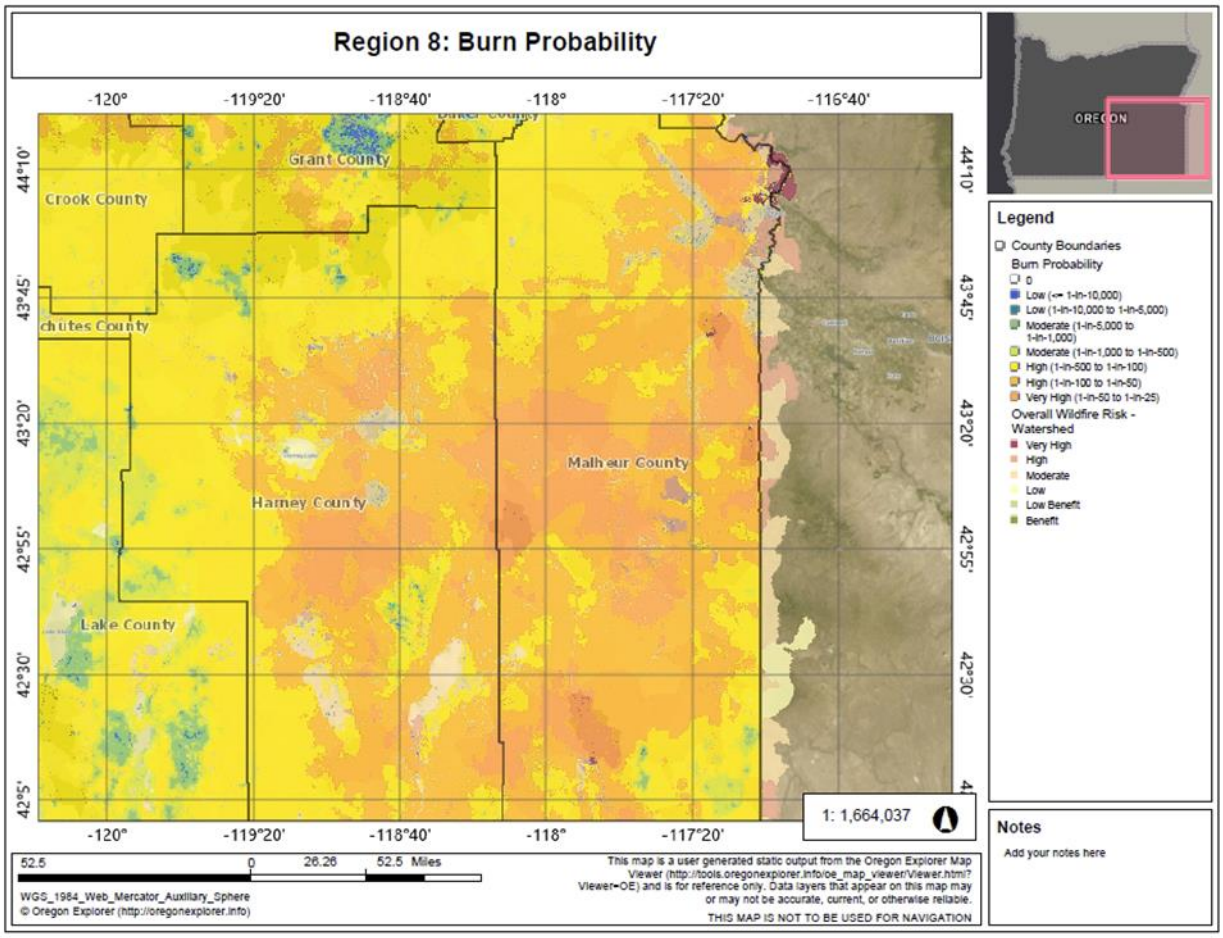
Source: Oregon Wildfire Risk Explorer: Burn Probability layer; PNW Quantitative Wildfire Risk Assessment, 2020

In the PNW Quantitative Wildfire Risk Assessment, Burn Probability was used to look at the likelihood of a large wildfire (>250 acres occurring). In conjunction with that data, examining the number of fire starts reported by ODF for all acreage sizes, gives a full picture of probability of wildfire.

These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these statewide assessments and methodologies is that the scale of the data is not necessarily reflective of the probability at the local and parcel levels, so the fire start data is utilized to help reflect that local level assessment to a certain extent.

Figure 2-319 shows the likelihood of a wildfire >250 acres burning a given location, based on wildfire simulation modeling. This is an annual burn probability, adjusted to be consistent with the historical annual area burned. Be aware that conditions vary widely with local topography, fuels, and weather, especially local winds. In all areas, under warm, dry, windy, and drought conditions, expect higher likelihood of fire starts, higher fire intensities, more ember activity, a wildfire more difficult to control, and more severe fire effects and impacts.

Figure 2-319. Burn Probability



Source: Oregon Wildfire Risk Explorer, March 2020

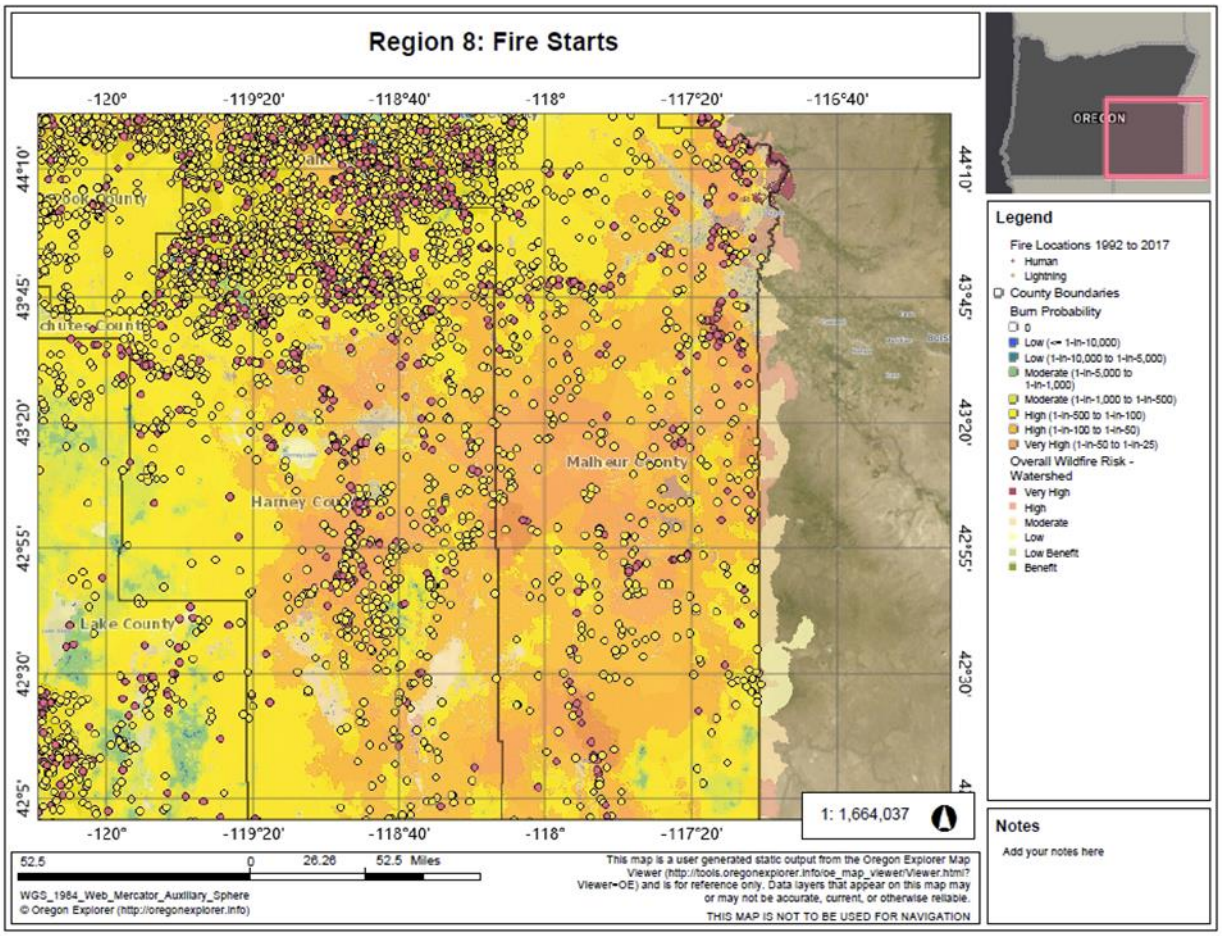
The forests and grasslands of Region 8 are highly susceptible to wildfire and many of the cities and unincorporated communities, in addition to rangelands and agricultural lands, are vulnerable to its effects. Wildfires are an annual occurrence and have varied in size from under 10 acres to over 100,000 acres.

Most wildfires started by lightning. Human causes are mostly associated with abandoned campfires, debris burning, or fires started along the interstate and highways (faulty vehicle equipment, cigarettes tossed out of windows of vehicles, etc.).

Hilly or mountainous topography exacerbates wildfire hazards. These areas can cause a wildfire to spread rapidly and burn larger areas in a shorter period of time, especially as fires migrate uphill. Wildfire has been known to move at speeds of 30 mph or higher on grasslands.

Large fires have, at times, exceeded the capability of structural and wildland resources, not only calling for the declaration of the Conflagration Act, but also requiring National Incident Management Teams to manage fires at the project fire level.

Figure 2-320. Human- and Lightning-Caused Wildfires in Region 8, 1992-2017



Source: Oregon Wildfire Risk Explorer, March 2020

Climate Change

Over the last several decades, warmer and drier conditions during the summer months have contributed to an increase in fuel aridity and enabled more frequent large fires, an increase in the total area burned, and a longer fire season across the western United States. Human-cause climate change is partially responsible for these trends, which are expected to continue increasing under continued climate warming (Dalton, Dello, Hawkins, Mote, & Rupp, 2017).

Fuel-limited systems, such as those in eastern and southeastern Oregon, have non-contiguous fuels including sagebrush and bunchgrasses. As invasive annual grasses increase (e.g., Cheatgrass), fuels become contiguous since invasive grasses regrow quickly outcompeting other vegetation. Warming winters will lead to more fine fuels from greater cold season growth. Also, conditions conducive to conversion to invasive grasses can lead to frequent fires and conversion to invasive-dominated systems as climate changes, including reduction in habitat for sage grouse. It is likely (>66%) that Region 8 will experience increasing wildfire frequency and intensity under future climate change.

One proxy for future change in wildfire risk is a fire danger index called 100-hour fuel moisture (FM100), which is a measure of the amount of moisture in dead vegetation in the 1–3 inch diameter class available to a fire. A majority of climate models project that FM100 would decline across Oregon under future climate scenarios. This drying of vegetation would lead to greater wildfire risk, especially when coupled with projected decreases in summer soil moisture. The number of "very high" fire danger days—in which fuel moisture is below the 10th percentile—is projected to increase across the state and in Region 8 counties (**Table 2-818**).

Table 2-818. Projected Increase in Annual Very High Fire Danger Days in Region 8 Counties by 2050 under RCP 8.5

County	# Additional Days	Percent Change
Harney	14	39%
Malheur	15	40%

Note: Very High fire danger days are defined as days in which the fuel moisture is below the 10th percentile. By definition, the historical baseline has a 36.5 Very High fire danger days. These numbers represent the multi-model mean change.

Source: Oregon Climate Change Research Institute (OCCRI)

Vulnerability

Table 2-819. Local Assessment of Vulnerability to Wildfire in Region 8

	Harney	Malheur
Vulnerability	H	M

Source: Most recent local hazard vulnerability analyses (**Table 2-4**)

Table 2-820. State Assessment of Vulnerability to Wildfire in Region 8 – Communities at Risk

	Harney	Malheur
Vulnerability	H	H

Source: ODF Communities at Risk Report, 2020

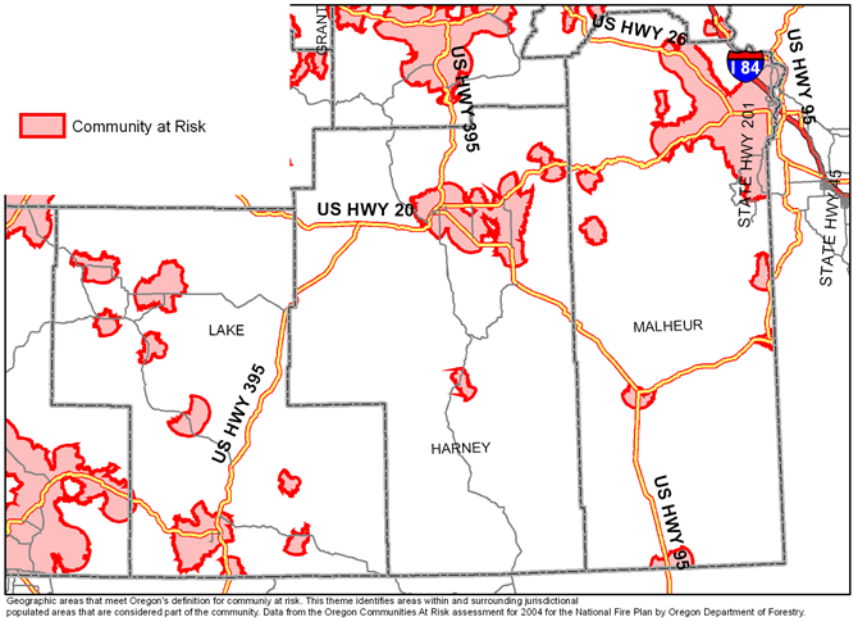
Table 2-821. Assessment of Vulnerability to Wildfire in Region 8 – 2020 Vulnerability Assessment

	Harney	Malheur
Vulnerability	M	VH

Source: DOGAMI and DLCD, 2020

According to ODF's assessment of Communities at Risk, the generalized wildfire hazard for Region 8 is moderate to high; however, there are areas within the region that have a very high hazard. Most of the region's people and infrastructure are located in the major cities along I-84, US-20, and US-395 (**Figure 2-321**). The region's total exposure for buildings and transportation systems alone is roughly 11.5 billion dollars.

Figure 2-321. Region 8 Communities at Risk of Wildfire



Source: ODF Communities at Risk Report, 2004

Preliminary analyses indicate a high likelihood of damage and losses from future wildfire in the region. Threatened assets include businesses, farmland, ranchland, grazing land, and hunting and recreation land. Action should be taken to reduce the damage and losses through pre-disaster mitigation and prepare for effective emergency response after the disaster. Special action should be taken for critical facilities including schools and emergency facilities and infrastructure such as roadways.

Wildland fire protection in unincorporated areas is protected by Rangeland Fire Protection Associations or BLM. Where the majority of BLM land is leased for ranching operations, large wildfires can have significant economic impacts on ranchers' stock and range allotments, as burned land is unfit for grazing use for several years after a fire.

Known sage-grouse habitat is a top wildfire suppression priority in this region. Rangeland Protection Associations and Oregon Department of Forestry have implemented conservation measures to reduce the negative impacts of wildland fire on sagebrush plant communities within the range of the sage-grouse.

The communities in Region 8 are particularly vulnerable because they are scattered throughout the landscape on large acreages with highly flammable vegetation. Many communities have no structural fire protection, and wildland agencies would have extended response times.

Table 2-822. Wildland-Urban Interface Communities in Region 8

Harney	Malheur
Andrews	Annex
Blitzen	Arock
Burns	Brogan
Crane	Danner
Diamond	Jamieson
Double O	Ironside
Drewsey	Adrian
Fields	Burns Junction
Frenchglen	Harper
Narrows	Jordan Valley
Riley	Juntura
	McDermitt
	Nyssa
	Ontario
	Ontario Heights
	Owyhee Reservoir
	Riverside
	Rockville
	Rome
	Vale

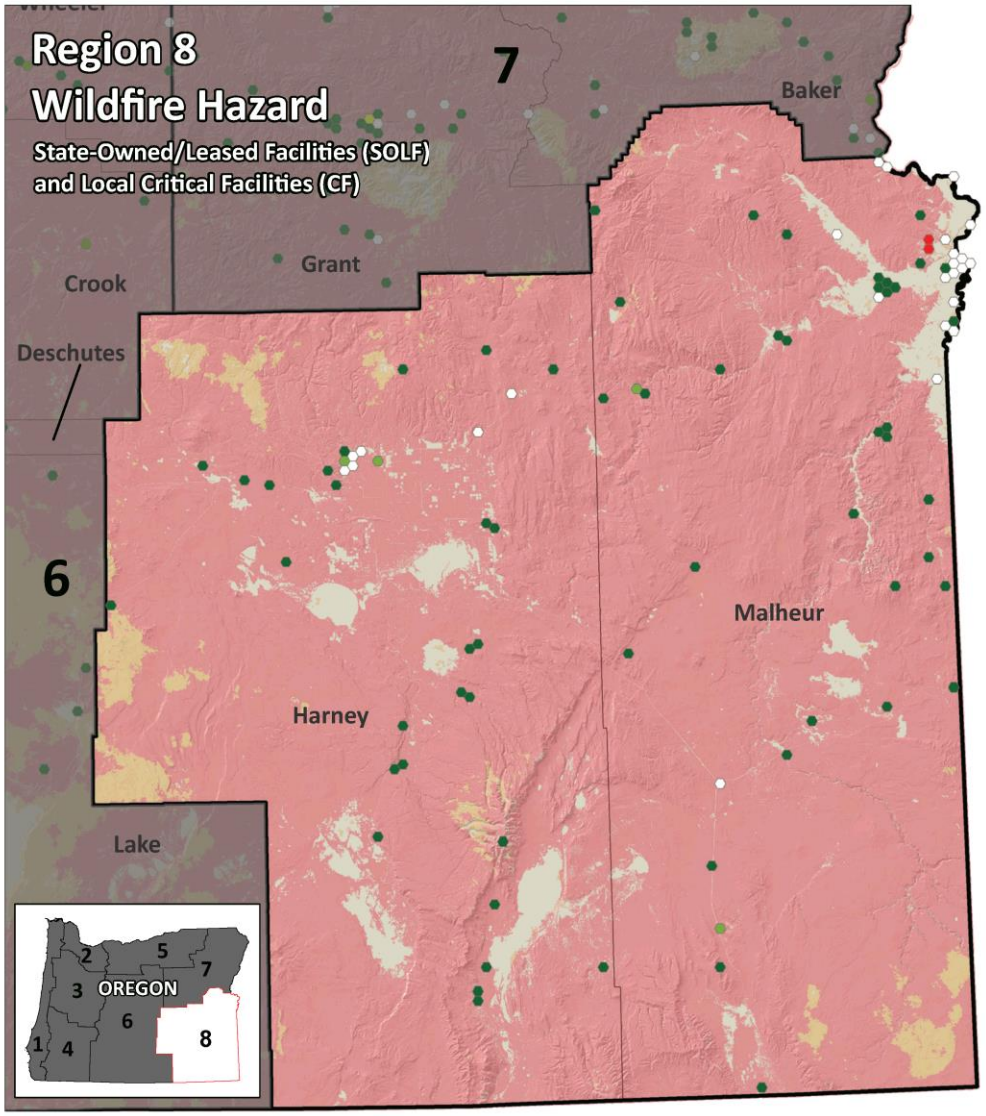
Source: Oregon Department of Forestry 2020 Communities at Risk Report

State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

For the 2020 vulnerability assessment, DOGAMI followed ODF guidance and evaluated building exposure to wildfire using the Burn Probability dataset which was classified by ODF in "High," "Moderate," and "Low" categories. Urban areas, lake surfaces, and areas bare of vegetation do not have fire risk classifications in the data and are represented here as "Low."

In Region 8, there is a potential loss to wildfire of almost $352M in state building and critical facility assets, 98% of it in Malheur County. There is a much lesser potential loss in local critical facilities: about $38M. Fifty-six percent of that value is also located in Malheur County.

Figure 2-322. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in a Wildfire Hazard Zone in Region 8.High-resolution, full-size image linked from Appendix 9.1.26.



Building value ($) exposed to high or moderate hazard per cell

- No exposure to hazard
- 1 - 2.500,000
- 2,500,001 - 10,000,000
- 10,000,001 - 25,000,000
- 25,000,001 - 50,000,000
- 50,000,001 - 290,000,000

Hazard area

- Wildfire - high hazard
- Wildfire - moderate hazard
- Wildfire - low hazard

Administrative boundary

- Mitigation Planning Region
- County

Projection:
Oregon Statewide Lambert Conformal Conic, Unit: International Feet,
Horizontal datum: NAD83 HARN, Scale 1:1,000,000

Source Data:
Wildfire: Burn probability data, Oregon Department of Forestry, 2018
State-owned/lease buildings: Oregon Department of Administrative Services, 2019
Administrative boundaries: Oregon Emergency Management and the Oregon Department of Land Conservation and Development, 2015
Hillshade base map: DOGAMI, Statewide mosaic, 2018, from Oregon Lidar Consortium data

Author: Matt Williams, Oregon Department of Geology and Mineral Industries, January 2020.

REGION 8		Exposure ($) to Wildfire Hazard Areas					
		State-owned/leased facilities				Critical Facilities	
County	Total Value SOLF and Local CF	Value Exposed SOLF CF	% Value Exposed SOLF CF	Value Exposed SOLF Non-CF	Value Exposed Total*	Value Exposed Local CF	Total Value Exposed SOLF CF and Local CF
Harney	78,983,000	5,179,000	79%	2,007,000	7,186,000	16,918,000	22,097,000
Malheur	822,824,000	343,490,000	64%	1,059,000	344,549,000	21,187,000	364,677,000
Total	901,807,000	348,669,000	64%	3,066,000	351,735,000	38,105,000	386,774,000

This study divided buildings into two major categories by ownership: state-owned or leased facilities (SOLF) and local critical facilities (CF). SOLF buildings were further subdivided into either CFs, such as police stations, or non-critical facilities (non-CF), such as administrative offices.
**Exposure totals for SOLF include the subset of SOLF CFs.*

0 12.5 25 50 Miles

N

Source: DOGAMI, 2020

Historic Resources

Of the 337 historic resources in Region 8, fifty-nine (18%) are located in an area of high wildfire hazard. Of those, around 56% are located in Malheur County and 44% in Harney County. Only three historic resources are located in a moderate wildfire hazard area, all of them in Harney County.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1–5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, Malheur County is the most socially vulnerable in the state. The county has the highest poverty rates, lowest per-capita income, and the highest share of people living in institutionalized group quarters. The county is also in the 90th percentile for the following variables: the share of residents without a high school diploma, the percentage of single-parent households, the share of people aged 17 and younger, the percentage of minorities, the percentage of occupied housing units with more people than rooms, and the share of households that lack access to a vehicle. Vulnerability in Harney County is moderate and driven by high unemployment and the percentage of manufactured homes.

For the 2020 vulnerability assessment, DLCD combined the social vulnerability scores with the vulnerability scores for state buildings, state critical facilities, and local critical facilities to calculate an overall vulnerability score for each county. According to this limited assessment, Malheur County has very high vulnerability to wildfire and Harney County has moderate vulnerability. The Communities at Risk assessment found both counties highly vulnerable.

Risk

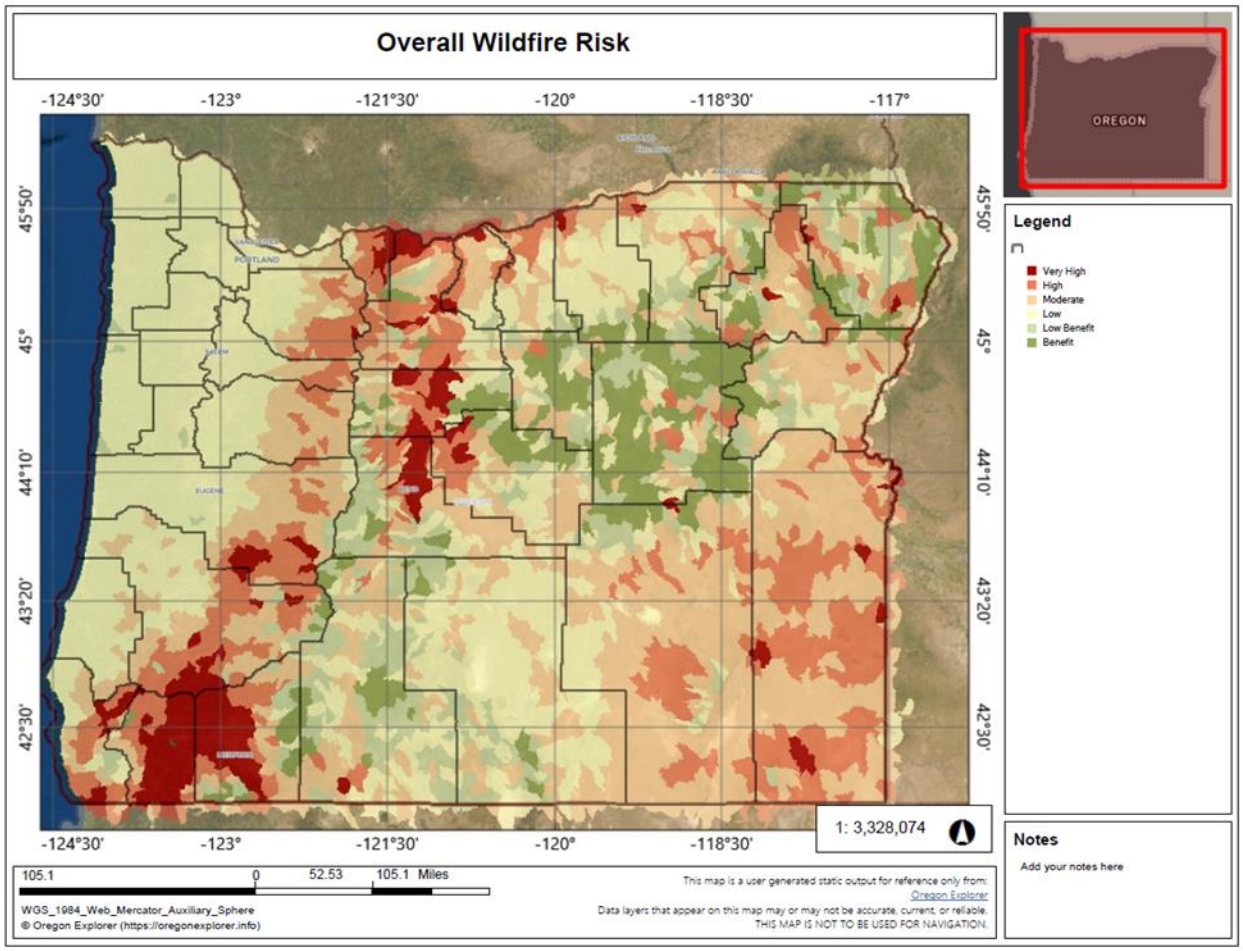
Table 2-823. Risk of Wildfire Hazards in Region 8

	Harney	Malheur
Risk	H	VH

Source: DOGAMI and DLCD, 2020

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. The 2020 risk assessment combined the wildfire probability with the vulnerability assessment to arrive at a composite risk score. According to the 2020 risk assessment, Malheur County is at very high risk from wildfire and Harney County is at high risk. This is generally consistent with ODF's assessment, mapped in **Figure 2-323**.

Figure 2-323. Overall Wildfire Risk



Source: Oregon Explorer, 2020

Windstorms

Characteristics

High winds in the intermountain areas of Region 8 are not uncommon. There is little in the way of mountain protection for much of these counties; the landscape is flat and open with the exception of a few areas. Winds in Harney and Malheur Counties are often associated with thunderstorms, which have strong outflow and coincidentally strong surface winds. Windstorms can be problematic in burned areas, where dust may be lifted and transported across the landscape, causing reductions in visibility and localized damage.

Tornadoes

Small to moderate sized tornadoes have been recorded in virtually every area of Oregon. Six have been recorded in Region 8 (**Table 2-824**), but others probably have occurred. Wind speeds have varied; estimates are somewhere between 40 to 112 mph, corresponding to “gale” (F0 on the Fujita Scale of Tornado Intensity) and “moderate” (F1 on the Fujita Scale) tornadoes. Damage was estimated to be an amount between $5,000 and $50,000 (Taylor & Hatton, 1999).

Historic Windstorm Events

Table 2-824. Historic Windstorms in Region 8

Date	Affected Area	Characteristics
Apr. 1931	northeast Oregon	unofficial wind speeds reported at 78 mph; damage to fruit orchards and timber
Nov. 10-11, 1951	statewide	widespread damage; transmission and utility lines; Wind speed 40–60 mph; Gusts 75–80 mph
Dec. 1951	statewide	wind speed 60 mph in Willamette Valley; 75-mph gusts; damage to buildings and utility lines
Dec. 1955	statewide	wind speeds 55–65 mph with 69 mph gusts; considerable damage to buildings and utility lines
Nov. 1958	statewide	wind speeds at 51 mph with 71 mph gusts; every major highway blocked by fallen trees
Oct. 1962	statewide	Columbus Day Storm; Oregon's most destructive storm to date.; 116-mph winds in Willamette Valley; estimated 84 houses destroyed, with 5,000 severely damaged; total damage estimated at $170 million
Aug. 1966	Malheur County	tornado between Nyssa and Ontario; telephone poles and some farm buildings destroyed
June 1967	Malheur County	two tornadoes reported; some damage
June 1969	Malheur County	tornado reported 40-60 miles south of Jordan Valley (Malheur County)
Mar. 1971	most of Oregon	greatest damage in Willamette Valley; homes and power lines destroyed by falling trees; destruction to timber in Lane County
Apr. 1974	Malheur County	tornado path parallel to Oregon- Idaho border; farm building destroyed
Nov. 1981	statewide	60-mph winds common throughout state
Jan. 1990	statewide	severe wind storm
Jan. 1991	most of Oregon	severe wind storm
Dec. 1991	NE and central Oregon	severe wind storm
Dec. 1992	northeastern mountains, Oregon	severe wind storm
May 1994	eastern Oregon	strong winds in Treasure Valley area (Ontario); blowing dust caused many car accidents
May 2005	Malheur County	hail storm causes $3,000 in crop damage
July 2006	Harney County	wind storm produces winds of 75 mph
Aug. 2006	Harney County	three high windstorms in Harney County with winds measured at 67, 58 and 58 mph, respectively
Aug. 2007	Harney County	high wind storm produces winds of 58 mph
Apr. 2010	Harney County	75-mph winds caused $200,000 in property damage, including 52 downed power poles

Source: Taylor and Hannan (1999), *The Oregon Weather book;* The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org

Table 2-825. Tornadoes Recorded in Region 8

County	Date	Location	Damage
Malheur	Aug. 1966	Adrian to Oregon border just north of Ontario, Oregon	several farm buildings destroyed; trees uprooted; telephone poles displaced
Malheur	June 1967	13 miles west of Sheaville, Oregon	two tornadoes; limited in extent and duration; one damaging; the other, no damage
Malheur	June 1967	remote	some damage
Malheur	June 1969	40–60 miles west of Jordan Valley, Oregon	grain fields damaged
Malheur	Apr. 1974	10 miles SW of Nyssa, Oregon	farm buildings destroyed
Harney	Mar 1995	near Happy Valley	no damages
Malheur	Apr. 1997	near Ontario Oregon	two tornadoes; limited damage to barn and farm equipment
Harney	Sept 1997	Near Burns	damage to ranch property - $15,000
Malheur	June 1997	north of Ontario Oregon	tornado blew a pick-up truck off the road
Harney	Aug 2001	Burns	two tornadoes; both F0 no damages from either
Harney	Jun. 2006	Wagontire	F0; no damage reported
Harney	Jun. 2019	Blitzen; north of French Glen	EF0; no damage reported

Source: Taylor and Hatton (1999), pp. 123-137; https://www.ncdc.noaa.gov/stormevents/

Probability

Table 2-826. Assessment of Windstorm Probability in Region 8

	Harney	Malheur
Probability	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

The 100-year storm in this region is defined as one-minute average winds of 75 mph. A 50-year storm includes winds of 65 mph. A 25-year storm has winds of up to 55 mph.

Climate Change

There is insufficient research on changes in the likelihood of windstorms in the Pacific Northwest as a result of climate change. While climate change has the potential to alter surface winds through changes in the large-scale free atmospheric circulation and storm systems, there is as yet no consensus on whether or not extratropical storms and associated extreme winds will intensify or become more frequent along the Pacific Northwest coast under a warmer climate.

Vulnerability

Table 2-827. Local Assessment of Vulnerability to Windstorms in Region 8

	Harney	Malheur
Vulnerability	L	M

Source: Most recent local hazard vulnerability analyses (Table 2-4)

Table 2-828. State Assessment of Vulnerability to Windstorms in Region 8

	Harney	Malheur
Vulnerability	L	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

Many buildings, utilities, and transportation systems within Region 8 are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It also is true in forested areas, along tree-lined roads and electrical transmission lines, and on residential parcels where trees have been planted or left for aesthetic purposes. Structures most vulnerable to high winds include insufficiently anchored manufactured homes and older buildings in need of roof repair.

Fallen trees are especially troublesome. They can block roads and rails for long periods, which can affect emergency operations. In addition, uprooted or shattered trees can down power or utility lines and effectively bring local economic activity and other essential facilities to a standstill. Much of the problem may be attributed to a shallow or weakened root system in saturated ground. Many roofs have been destroyed when uprooted trees growing next to a house fall during a windstorm. In some situations, strategic pruning may be the answer. Prudent counties will work with utility companies to identify problem areas and establishing a tree maintenance and removal program.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1–5). Social vulnerability scores do not vary by hazard. The counties with the greatest social vulnerability statewide are Marion, Morrow, Umatilla, Wasco, Jefferson, Klamath, and Malheur.

According to the CDC Social Vulnerability Index, Malheur County is the most socially vulnerable in the state. The county has the highest poverty rates, lowest per-capita income, and the highest share of people living in institutionalized group quarters. The county is also in the 90th percentile for the following variables: the share of residents without a high school diploma, the percentage of single-parent households, the share of people aged 17 and younger, the percentage of minorities, the percentage of occupied housing units with more people than rooms, and the share of households that lack access to a vehicle. Vulnerability in Harney County is moderate and driven by high unemployment and the percentage of manufactured homes.

Based on the information in **Table 2-824** and **Table 2-825**, Malheur County appears to have suffered greater damages from windstorms. Coupled with its higher social vulnerability, Malheur County is considered to be the more vulnerable to windstorms in Region 8.

State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

The value of state-owned and leased buildings and critical facilities in Region 8 is approximately $573,310,000 representing the total potential for loss of state assets due to windstorms. The value of locally owned critical facilities is $328,497,000. Because windstorms could impact the entire region, these figures together represent the maximum potential loss to state assets and local critical facilities due to windstorms. Because the state is self-insured, FEMA funds are rarely used to cover damage to state assets from natural hazards. It is unclear from the Department of Administrative Services' records how many losses to state facilities were sustained in Region 8 since the beginning of 2015. Eight losses were due to windstorms statewide. Of those, it is possible that one or two may have been located in Region 8. One claim was for approximately $6,200 and the other has not been settled.

Risk

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life.

With greater probability of windstorms and greater vulnerability, Malheur County is considered to have the greater risk from windstorms in Region 8.

Winter Storms

Characteristics

Within the State of Oregon, Region 8 communities are known for cold, snowy winters. Winter weather in Region 8 can be characterized by extreme cold, snow, ice, and sleet. There are annual winter storm events in Region 8 with an average of 24 inches of snow; most communities are prepared for them. Moderate to heavy snowfall is prepared for and expected on an annual basis in this region.

Historic Winter Storm Events

Table 2-829. Significant Winter Storms in Region 8

Date	Location	Remarks
Dec. 1861	entire state	storm produced 1–3 feet of snow throughout Oregon
Dec. 1892	northern counties, Oregon	15–30 inches of snow fell throughout the northern counties
Jan. 1916	entire state	two storms; heavy snowfall, especially in mountainous areas
Jan. and Feb. 1937	entire state	deep snow drifts
Jan. 1950	entire state	record snowfalls; property damage throughout state
Mar. 1960	entire state	many automobile accidents; two fatalities
Jan. 1969	entire state	heavy snow throughout state
Jan. 1980	entire state	series of string storms across state; many injuries and power outages
Feb. 1985	entire state	2 feet of snow in northeast mountains; downed power lines; fatalities reported
Feb. 1986	central /eastern Oregon	heavy snow; traffic accidents; broken power lines
Mar. 1988	entire state	strong winds; heavy snow
Feb. 1990	entire state	heavy snow throughout state
Nov. 1993	Cascade Mountains, Oregon	heavy snow throughout region
Feb. 1994	southeastern Oregon	heavy snow throughout region
Winter 1998-99	entire state	one of the snowiest winters in Oregon history (snowfall at Crater Lake: 586 inches)
Dec.28, 2003–Jan. 9, 2004	statewide storm	DR-1510 Harney and Malheur declared in Region 8. The most significant winter storm in several years brought snowfall to most of Oregon. Freezing rain in eastern Oregon. President Bush issued a major disaster declaration for 26 Oregon counties affected by the winter storm, later extended to 30 of Oregon's 36 counties. Estimated the cost of damages to public property at $16 million.
Dec. 6-23, 2015	statewide storm events	DR-4258. Clatsop, Columbia, Multnomah, Clackamas, Washington, Tillamook, Yamhill, Polk, Lincoln, Linn, Lane, Douglas, Coos, and Curry Counties declared. Severe winter storms, straight-line winds, flooding, landslides, and mudslides. Several pacific storm systems moved across the region over the Dec 12-13 weekend. Another series of storms moved across Oregon on Dec 16-17 and Dec 21-23. Each storm system brought several inches of snow to the mountain areas. Another in a long series of storms brought heavy snow to portions of south central Oregon in 24 hours ending Dec. 17th.
Feb. 22-26, 2019	Malheur County (central Oregon)	DR-4432. Jefferson, Lane, Douglas, Coos and Curry Counties declared. Severe Winter Storms, Flooding, Landslides, And Mudslides. Persistent troughing off the coast of the Pacific Northwest focused a stream of mid-level moisture over the Inland Northwest resulting in a long duration snow event as the plume drifted north and south several times between the 22nd and 27th of February.

Source: Taylor and Hatton (1999), p. 118–122; https://www.fema.gov/disaster; https://www.ncdc.noaa.gov/stormevents

Probability

Table 2-830. Probability Assessment of Winter Storms for Region 8

	Harney	Malheur
Probability	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

On the basis of historical data, severe winter storms could occur about every 4 years in this region. We can expect to have continued annual storm events in this region. However, there are no solid statistical data available upon which to base these judgments. There is no statewide program to study the past, present, and potential impacts of winter storms in the state of Oregon at this time.

Climate Change

There is no current research available about changes in the incidence of winter storms in Oregon due to changing climate conditions. However, the warming climate will result in less frequent extreme cold events and high-snowfall years.

Vulnerability

Table 2-831. Local Assessment of Vulnerability to Winter Storms in Region 8

	Harney	Malheur
Vulnerability	H	H

Source: Most recent local hazard vulnerability analyses (**Table 2-4**)

Table 2-832. State Assessment of Vulnerability to Winter Storms in Region 8

	Harney	Malheur
Vulnerability	M	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

Within the State of Oregon, Region 8 communities are known for cold, snowy winters. This is advantageous in at least one respect: in general, the region is prepared, and those visiting the region during the winter usually come prepared. However, there are occasions when preparation cannot meet the challenge. Drifting, blowing snow has often brought highway traffic to a standstill. Also, windy, icy conditions have often closed mountain passes and canyons to certain classes of truck traffic. In these situations, travelers must seek accommodations, sometimes in communities where lodging is very limited. Local residents also experience problems. During the winter, heating, food, and the care of livestock and farm animals are everyday concerns. Access to farms and ranches can be extremely difficult and present a serious challenge to local emergency managers. Road closures due to winter weather are more common in this region. In general, the impacts of winter storms to southeastern Oregon communities are less significant because communities are prepared for long winters.

Winter storms, particularly east of the Cascades where snow storms are typically more intense, bring larger amounts of snow and last longer. They can strand livestock in pastures, leaving them without food and water and exposed to extreme cold for long periods of time. As a consequence, substantial losses in livestock from starvation, dehydration and freezing, significantly impact producers, and state and local economies. In addition, water quality and health hazards develop when dead livestock are not retrieved until roads are cleared and vehicles can be used to remove the carcasses. Livestock buried under snow may not be found until the snow melts. The snowmelt may carry the carcasses to streams and wash them downstream.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1–5). Social vulnerability scores do not vary by hazard. The counties with the greatest social vulnerability statewide are Marion, Morrow, Umatilla, Wasco, Jefferson, Klamath, and Malheur.

According to the CDC Social Vulnerability Index, Malheur County is the most socially vulnerable in the state. The county has the highest poverty rates, lowest per-capita income, and the highest share of people living in institutionalized group quarters. The county is also in the 90th percentile for the following variables: the share of residents without a high school diploma, the percentage of single-parent households, the share of people aged 17 and younger, the percentage of minorities, the percentage of occupied housing units with more people than rooms, and the share of households that lack access to a vehicle. Vulnerability in Harney County is moderate and driven by high unemployment and the percentage of manufactured homes.

While both Harney and Malheur Counties are vulnerable to the economic impacts of winter storms, Malheur County's very high social vulnerability makes it more vulnerable to the adverse effects of winter storms than Harney County.

State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

The value of state-owned and leased buildings and critical facilities in Region 8 is approximately $573,310,000 representing the total potential for loss of state assets due to winter storms. The value of locally owned critical facilities is $328,497,000. Because winter storms could impact the entire region, these figures together represent the maximum potential loss to state assets and local critical facilities due to winter storms. Because the state is self-insured, FEMA funds are rarely used to cover damage to state assets from natural hazards. It is unclear from the Department of Administrative Services' records how many losses to state facilities were sustained in Region 8 since the beginning of 2015. Thirteen losses were due to winter storms statewide. Of those, one loss for over $353,000, the most expensive recorded, was in Region 8. It is possible that up to four more totaling a little over $72,000 may also have been located in the Region 8.

Risk

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life.

Both counties in Region 8 are at risk from the adverse impacts of winter storms. Malheur County's elevated social vulnerability increases its risk beyond that of Harney County.