3.5 Volcano

The proximity of the Cascade Mountain Range (Cascades) to the cities of Troutdale, Wood Village and Fairview creates a moderate level of risk to volcanic hazards for these communities. Because the return rate for volcanic events ranges from hundreds to thousands of years, the probability of such events is low. However, when an eruption does occur, dangerous mudflows called lahars could bury all or part of these communities, and damages likely would range from severe to total. A worst-case lahar is probably the worst-case natural disaster for the City of Troutdale.

The entire Planning Area could be impacted by ashfall from eruptions along the Cascades. Even minor amounts of ashfall could impact public health, critical facilities, lifelines, public infrastructure, and the private economy and business sector.

Level of Risk* to Volcanic Hazards

High

- None

Moderate

- Fairview
- Troutdale (lahar)
- Wood Village

Low

- Gresham
- Unicorporated Multnomah County

Level of risk is based on the local OEM Hazard Analysis scores determined by each jurisdiction in the Planning Area. See **Appendix C for more information on the methodology and scoring.*

3.5.1. Overview

There are five major volcanoes in the Cascades that are in relative proximity and pose a potential threat to the Planning Area: Mount St. Helens, Mount Hood, Mount Rainier, Mount Adams and Mount Jefferson. All are known or suspected to be active, and most have geological records that indicate past histories of explosive eruptions with large ash releases. Mount Hood and Mount St. Helens pose the greatest threat to the communities in the Planning Area.

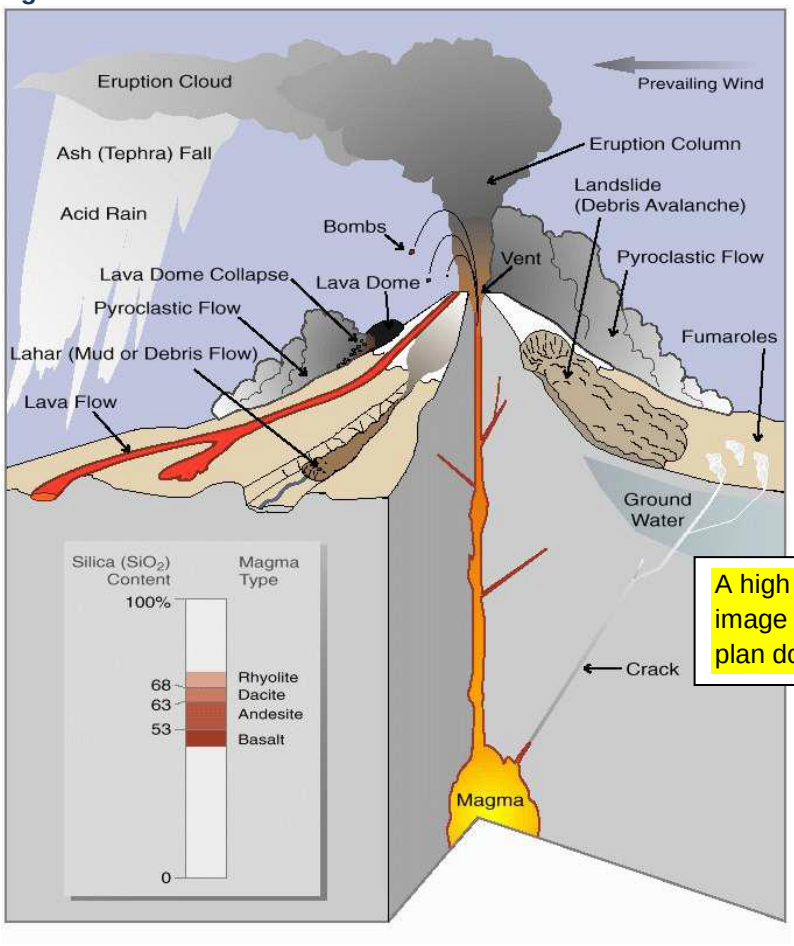
Types

The volcanoes in the Cascade Mountain Range differ markedly in their geological characteristics. The largest volcanoes, such as Mount Hood and Mount St. Helens, are stratovolcanoes. Stratovolcanoes tend to have explosive eruptions. These volcanoes may be active for tens of thousands to hundreds of thousands of years. In some cases, these large volcanoes may have explosive eruptions, such as Mount St. Helens in 1980, or Crater Lake about 7,700 years ago. More numerous among the Cascades are mafic volcanoes. Mafic volcanoes are typically active for much shorter time periods, up to a few hundred years. They generally form small craters or cones and erupt effusively as lava flows (U. S. Geological Survey [USGS], 2013), rather than large explosive events.

It should be noted that the Cascades can be the source of and location of multiple hazards, such as volcanoes, landslides, floods, severe weather, wildfires and earthquakes.

Figure 3.5-1 illustrates the types volcanic hazards commonly found in the western United States and Alaska. Some hazards, such as lahars and landslides, can occur even when a volcano is not erupting (Mount Hood Facilitating Committee, 2013). The types of volcanic hazards that can impact each jurisdiction in the Planning Area are shown in **Table 3.5-1** and described below.

Figure 3.5-1 Volcanic Hazards



Source: Mount Hood Facilitating Committee, 2013

Table 3.5-1 Types of Volcanic Hazards that Impact Each Jurisdiction

Jurisdiction	Ashfall	Blast Effects	Lahars	Landslides
Unincorporated Multnomah County	✓	✓	✓	✓
Fairview	✓	✓	✓	✓
Gresham	✓	✓	✓	✓
Troutdale	✓	✓	✓	✓
Wood Village	✓	✓	✓	✓

Source: Oregon Department of Land Conservation and Development (DLCD), 2015; and Natural Hazards Mitigation Plan (NHMP) Steering Committee, 2016

Ashfall

Ashfall occurs when explosive eruptions blast rock fragments into the air. Such blasts may include solid and molten rock fragments called tephra. The largest rock fragments — sometimes called “bombs” — generally fall within two miles of the eruption vent. Smaller ash fragments less than about 0.1 inch typically rise into the area forming a huge eruption column. In very large eruptions, ash falls may total many feet in depth near the vent and extend for hundreds or even thousands of miles downwind. Modest production of ashfall would pose chiefly non-life-threatening hazards to nearby communities (USGS, 2016).

Blast Effects

Blast effects may occur with violent eruptions, such as Mount St. Helens in 1980. Most volcanic blasts are largely upwards. However, the Mount St. Helens blast was lateral, with impacts 17 miles from the volcano. Similar or larger blast zones are possible for any of the major Cascades volcanoes.

Lahars

Lahars, also known as mudflows, are common when volcanoes erupt with heavy loads of ice and snow. These flows of mud, rock and water can rush down channels at 20 to 40 miles per hour, and can extend for more than 50 miles. For some volcanoes, lahars are a major hazard because highly populated areas are built on lahar flows from previous eruptions.

Landslides

Landslides are the rapid downslope movement of rocky or earthen material (e.g., soil, trees, etc.), snow or ice. Volcano landslides can range from small movements of loose debris to massive collapses of the entire summit or sides of a volcano. Debris avalanches are a type of landslide. See **Section 3.3 Landslides** for additional details.

Lava Flows

Lava flows are eruptions of molten rock. Lava flows for the major Cascades volcanoes tend to be thick and viscous, forming cones, and thus typically affecting areas only very near the eruption vent. However, flows from the smaller mafic volcanoes may be less viscous and may spread out over wider areas. Lava flows destroy everything in their path.

Pyroclastic Flows

Pyroclastic flows are high-speed avalanches of hot ash, rock fragments and gases. Pyroclastic flows can be as hot as 1500 degrees Fahrenheit and move downslope at 100 to 150 miles per hour. Pyroclastic flows are extremely deadly for anyone caught in their path.

Location and Extent

The Smithsonian Institution's Global Volcanisms Project lists 20 active volcanoes in Oregon and seven in Washington (**Table 3.5-2**).

Table 3.5-2 Active Volcanoes in Oregon and Washington

Volcano	Type	Last Eruption
Oregon		
Mount Hood	Stratovolcano	1866
Mount Jefferson	Stratovolcano	950; main volcano inactive for >10,000 years
Blue Lake Crater	Crater	1490 BC
Sand Mountain Field	Cinder cones	1040 BC?
Mount Washington	Shield volcano	620; main volcano inactive
Belknap Field	Shield volcano	460?
North Sister Field	Complex volcano	350
South Sister	Complex volcano	50 BC?
Mount Bachelor	Stratovolcano	5800 BC
Davis Lake	Volcanic field	2790 BC?
Newberry Volcano	Shield volcano	620; crater formation 300,000 to 500,000 years ago
Devil's Garden	Volcanic field	Unknown
Squaw Ridge Lava Field	Volcanic field	Unknown
Four Crater's Lava Field	Volcanic field	Unknown
Cinnamon Butte	Cinder cones	Unknown
Crater Lake	Caldera	2290 BC; crater formation about 7,700 years ago
Diamond Craters	Volcanic field	Unknown
Saddle Butte	Volcanic field	Unknown
Jordan Craters	Volcanic field	1250 BC
Jackies Butte	Volcanic field	Unknown
Washington		
Mount Baker	Stratovolcano	1880
Glacier Peak	Stratovolcano	1700 ± 100
Mount Rainier	Stratovolcano	1825 (?)
Mount Adams	Stratovolcano	950 AD (?)
Mount St. Helens	Stratovolcano	1980 - 2008
West Crater	Volcanic Field	5760 BC (?)
Indian Heaven	Shield Volcanoes	6250 ± 100 BC

Source: Smithsonian Institution, 2016

Volcanic hazards typically have impacted the Planning Area locally. However, lahars can travel considerable distances through stream valleys, and ashfall can blanket areas many miles from the source. (Oregon Department of Land Conservation and Development [DLCD], 2015)

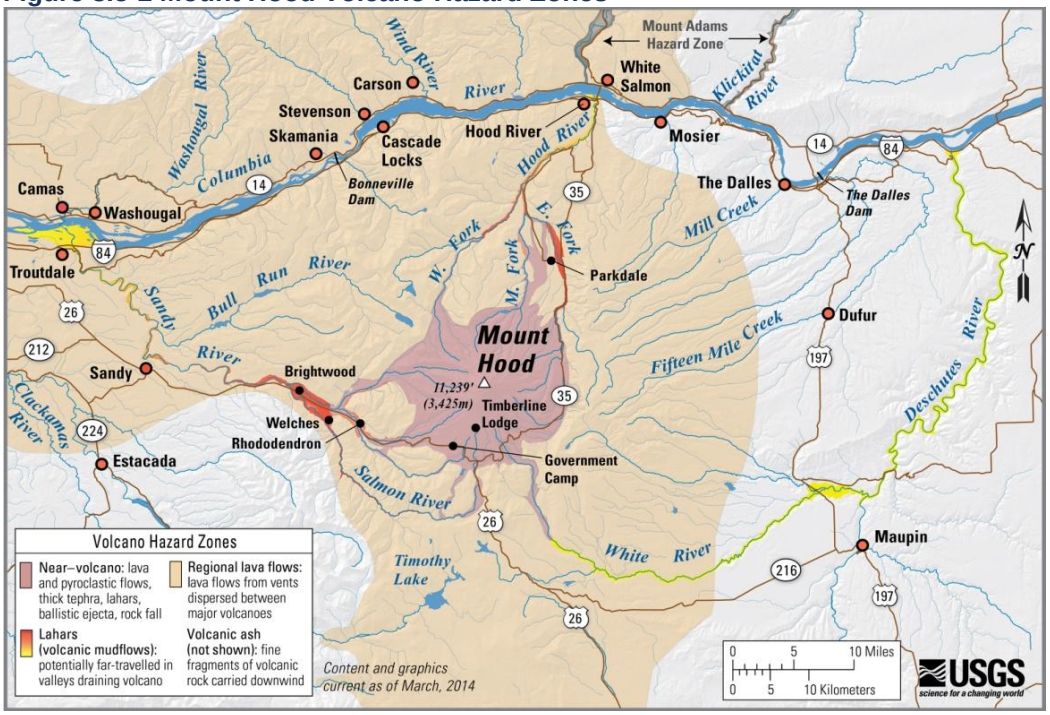
Ashfall and lahars from Mount Hood and Mount St. Helens pose the most significant volcanic threats to the Planning Area — Mount Hood because of its proximity, and Mount St. Helens because of its proximity and high level of volcanic activity. Mount Hood is located near the boundary of Clackamas County and Hood River County, about 10 miles from the southeast corner of Multnomah County. Mount St. Helens is located approximately 50 miles northeast from downtown Portland.

Mount Hood

Mount Hood continues to show signs that it is a functioning active volcano. Even when not erupting, Mount Hood produces frequent earthquakes and earthquake swarms, and steam and volcanic gases are emitted in the area around Crater Rock near the summit (Mount Hood National Forest and USGS, 2015). The Cascade Mountain Range volcanoes are located in proximity to the active Cascadia Subduction Zone and nearby potentially active crustal faults, which contribute to moderate seismic hazard in the area (DLCD, 2015).

Mount Hood's primary eruptive style has alternated between lava dome building and lava flows. The most likely widespread and hazardous consequence of a future eruption of Mount Hood would be for lahars to sweep down the entire length of the Sandy and White river valleys. Modest production of ashfall would also pose chiefly non-life-threatening hazards to nearby communities (USGS, 2016). **Figure 3.5-2** shows volcanic hazard zones around Mount Hood, mapped by the USGS (USGS, 2014).

Figure 3.5-2 Mount Hood Volcano Hazard Zones



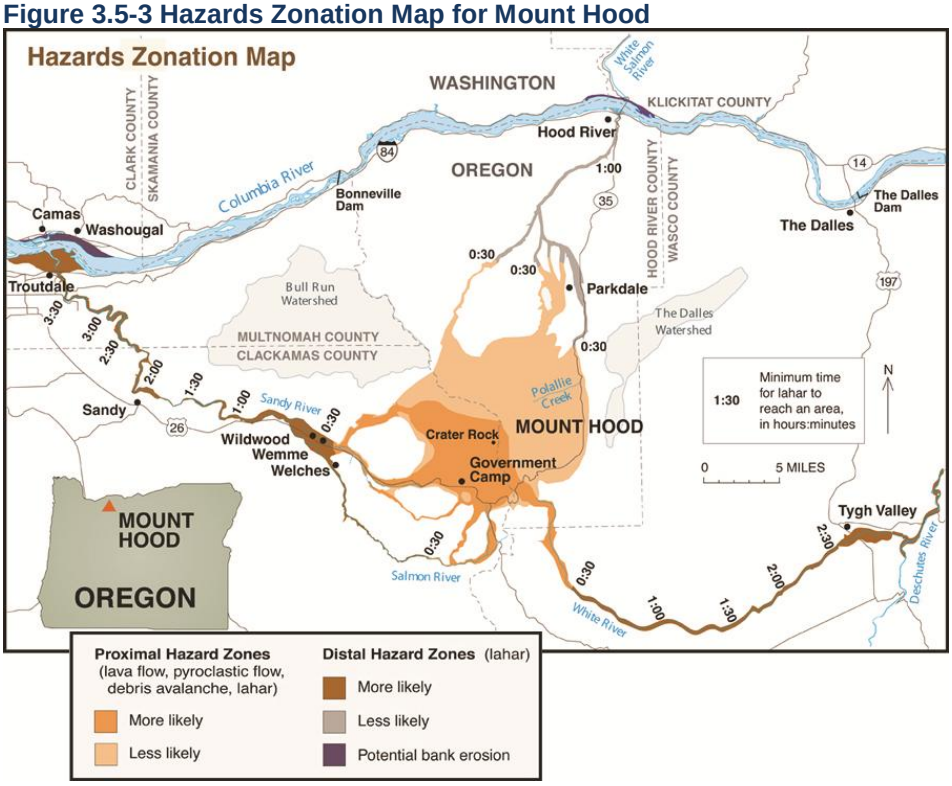
Source: USGS, 2014

As shown in **Figure 3.5-3**, volcanic hazard zones are classified as proximal and distal, based on distance from the volcano, vent location and type of hazardous events. Proximal volcanic hazard zones (P) are areas subject to the volcanic hazards within 30 minutes, including but not limited to slow-moving lava flows, pyroclastic flows and lahars. Areas within a proximal volcanic hazard zone should be evacuated before an eruption begins, because there is little time to get people out of harm's way once an eruption starts. Most pyroclastic flows and lava flows should stop within the proximal hazard zone, but lahars can travel much farther (Mount Hood Facilitating Committee, 2013). There are no proximal volcanic hazard zones in Multnomah County.

Distal volcanic hazard zones (D) are areas adjacent to rivers that are pathways for lahars. Estimated travel time for lahars to reach these zones is more than 30 minutes, which may allow individuals time to move to higher ground and greater safety if given warning. **Figure 3.5-3** shows inundation areas for lahars of a size similar to lahars that swept through the Sandy River 1,500 year ago. Lahars could affect transportation corridors by damaging or destroying bridges and roads. Some water from the Bull Run Watershed, the primary drinking water supply for the Portland metropolitan region, is transported in a conduit that crosses distal hazard zones along the Sandy River (Mount Hood Facilitating Committee, 2013).

The vent location on Mount Hood during the past two eruptions was near Crater Rock. Scientists anticipate that the vent for the next eruption most likely will be in the same area. Thus, areas within the hazard zones identified in **Figure 3.5-3** have a high probability of being affected during the next eruption (Mount Hood Facilitating Committee, 2013).

Figure 3.5-3 Hazards Zonation Map for Mount Hood

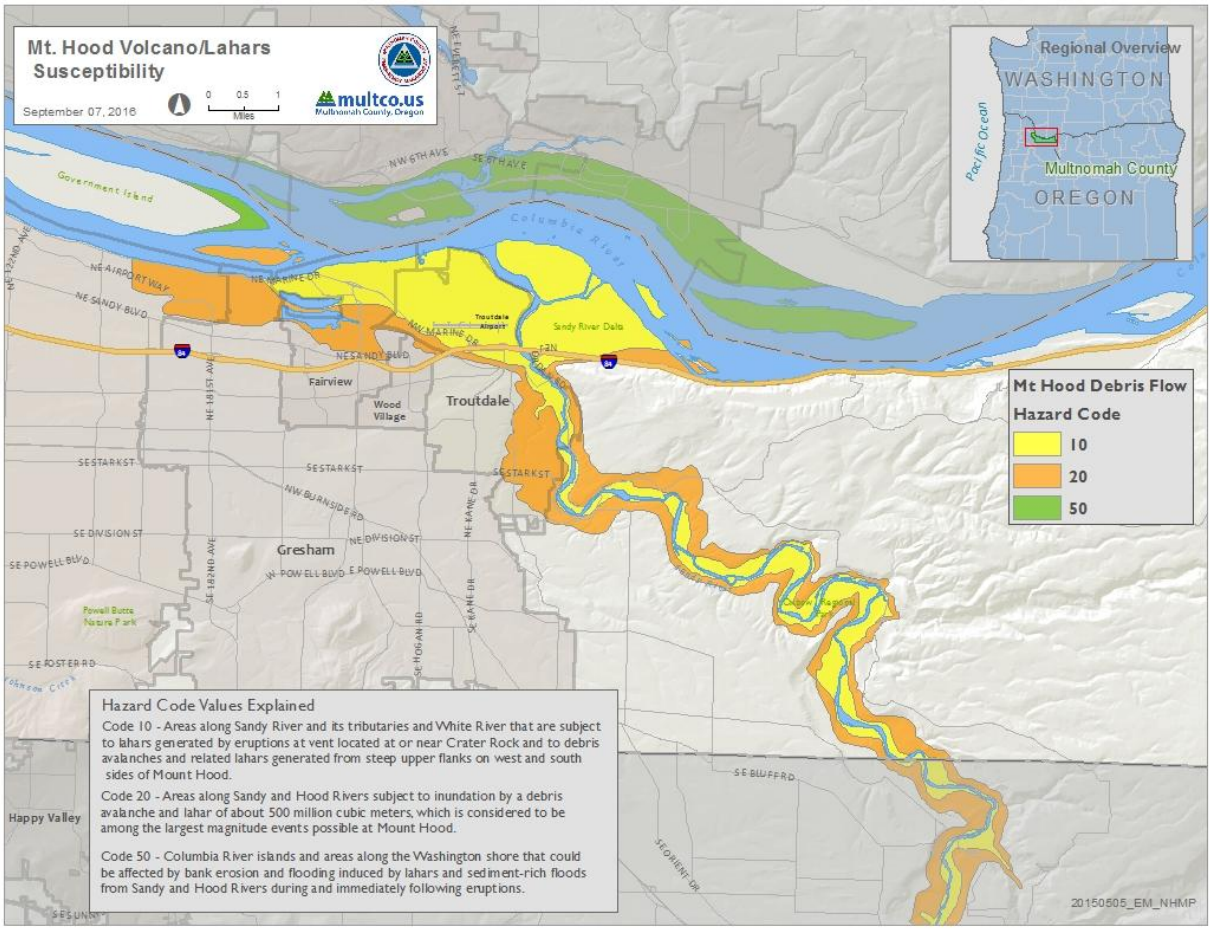


Source: Scott, W.E., et al, 1997

During and after an eruption, large amounts of sediment could be carried by rivers and discharged into the Columbia River. This sediment could narrow the Columbia's channel, forcing it to the north and potentially causing bank erosion along the river's north bank (Mount Hood Facilitating Committee, 2013).

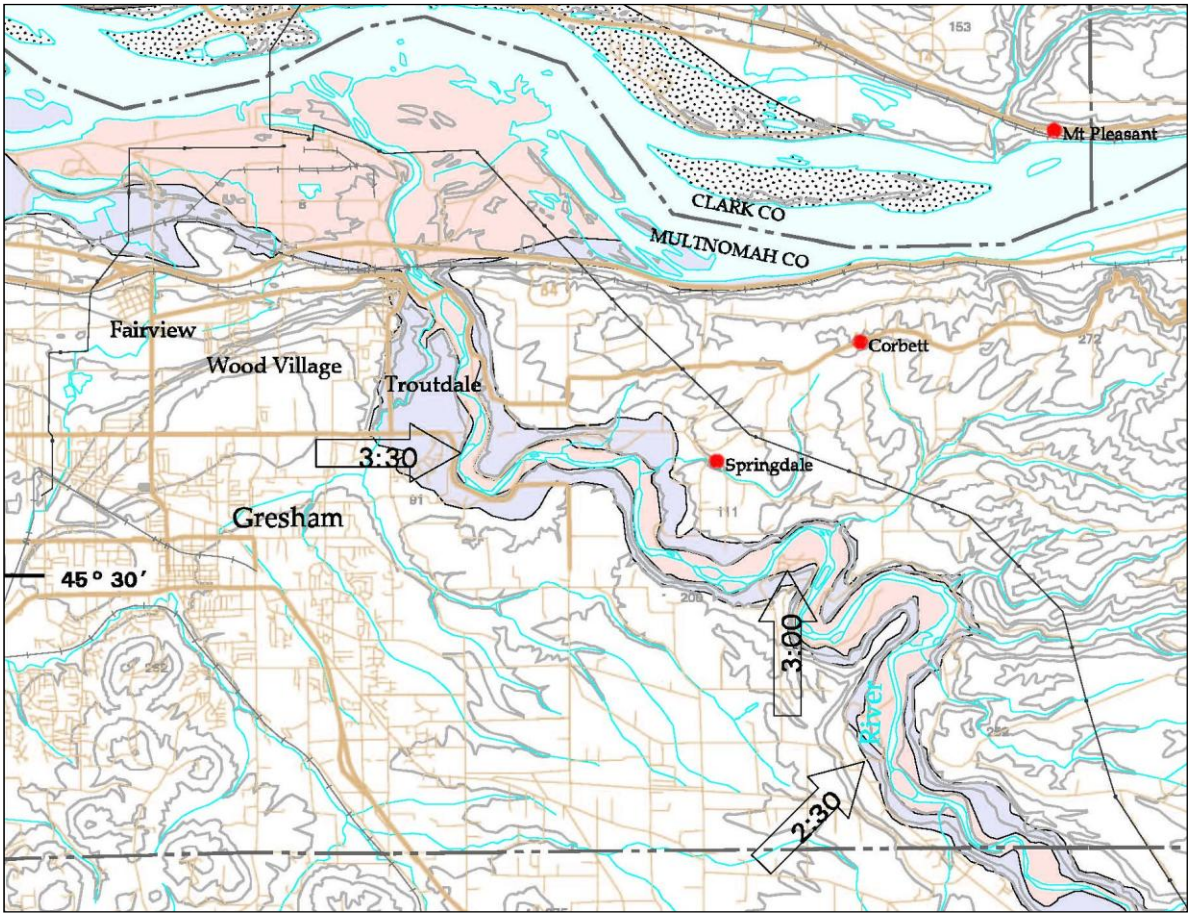
Lahars are a particular concern for communities on the east side of the county. Lahar hazard zones and the 30-year probability of occurrence for areas on the east side of Multnomah County are shown in **Figure 3.5-4.** Troutdale is the largest developed area in the county with high risk to lahars. Portions of Wood Village and Fairview also are at risk to lahars, as well as small communities along the Sandy River between Troutdale and Mount Hood. **Figure 3.5-5** is excerpted from the USGS report *OFR 97-89* and shows the estimated arrival times of a lahar from the time of eruption to the areas on the east side of the county.

Figure 3.5-4 Mount Hood Lahar Hazard Areas



Source: USGS, 1989

Figure 3.5-5 Mount Hood Lahar Hazard Map Showing Arrival Times from the Time of Eruption



Source: USGS, 1997

Map Legend

Hazard zone DA – Areas along Sandy River and its tributaries and White River that are subject to lahars generated by eruptions at vent located at or near Crater Rock, and to debris avalanches and related lahars generated from steep upper flanks on west and south sides of Mount Hood. The 30-year probability of inundation of a substantial portion of the zone is about 1 in 15 to 1 in 30.

Areas along Sandy and Hood rivers subject to inundation by a debris avalanche and lahar of about 500 million cubic meters, which is considered to be among the largest magnitude events possible at Mount Hood. Estimated 30-year probability of such an event is very low – less than 1 in 3,000.

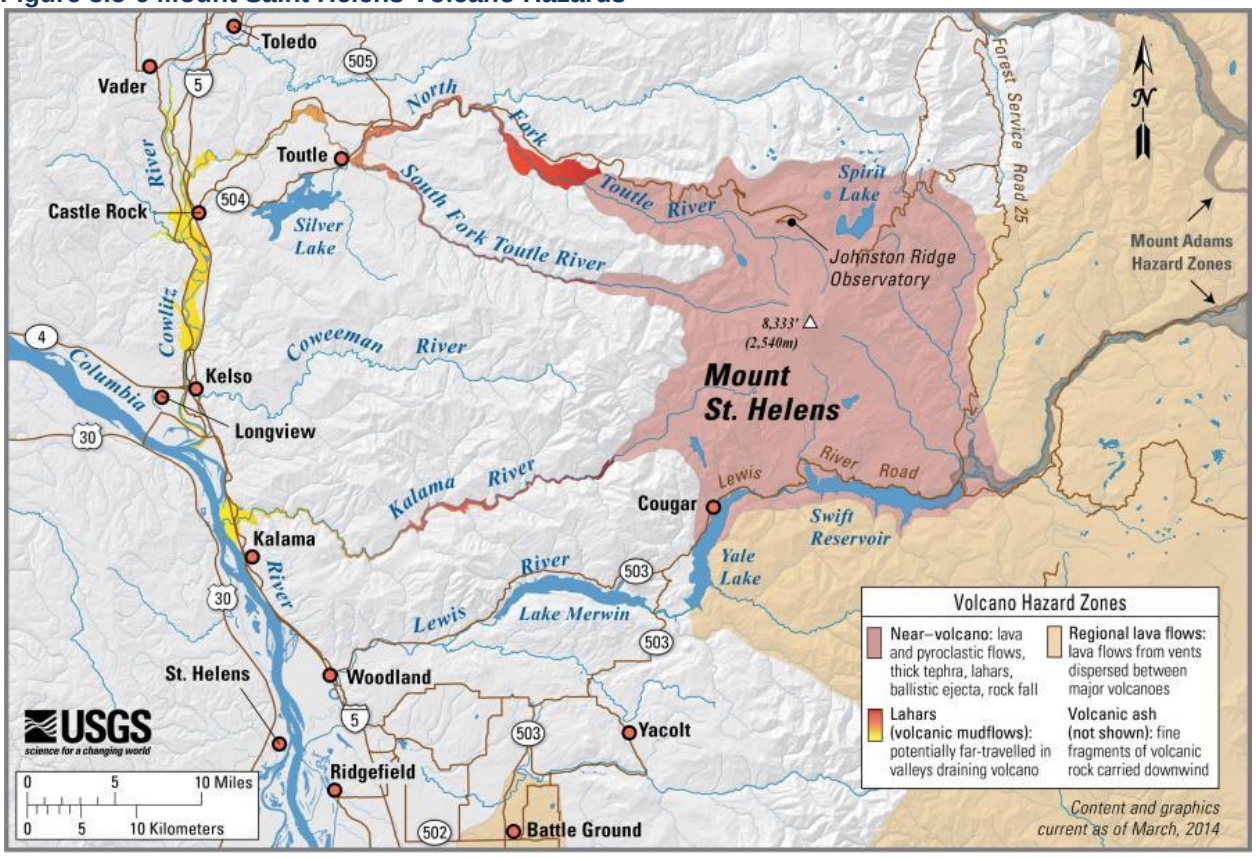
Mount St. Helens

In 1980, Mount St. Helens in Washington erupted and killed 57 people. Lateral blast effects covered 230 square miles and reached 17 miles northwest of the crater. Pyroclastic flows covered six square miles and reached five miles north of the crater. Landslides covered 23 square miles. Ash accumulations were about 10 inches at 10 miles downwind, 1 inch at 60 miles downwind, and ½ inch at 300 miles downwind. Lahars affected the north and south forks of the Toutle River, the Green River and, ultimately, the Columbia River, as far as 70 miles from the volcano.

Mount St. Helen's high frequency of eruptions during the recent geologic past and its two eruptive episodes of the past three decades indicate a high probability of renewed eruptive activity. In addition, the volcano has produced four large explosive eruptions during the past five centuries that affected the Pacific Northwest region and sent large amounts of volcanic ash downwind (USGS, 2014).

Among the possibilities for renewed activity at Mount St. Helens are resumption of lava-dome growth, eruption of basaltic or andesitic ashfall and lava flows, explosive eruptions of dacitic ashfall and pyroclastic flows, and large lahars that sweep down valleys heading on the volcano. **Figure 3.5-6** shows volcano hazard zones for Mount St. Helens (USGS, 2014). The Planning Area's primary risk from Mount St. Helens is ashfall.

Figure 3.5-6 Mount Saint Helens Volcano Hazards



Source: USGS, 2014

3.5.2 History

In Oregon, awareness of the potential for volcanic eruptions was greatly increased by the 1980 eruption of nearby Mount St. Helens in Washington, which killed 57 people. In this eruption, lateral blast effects covered 230 square miles and reached 17 miles northwest of the crater, pyroclastic flows covered six square miles and reached five miles north of the crater, and landslides covered 23 square miles. Ash accumulations were about 10 inches at 10 miles downwind, 1 inch at 60 miles downwind, and ½ inch at 300 miles downwind. Lahars (mudflows) affected the north and south Forks of the Toutle River, the Green River and, ultimately, the Columbia River, as far as 70 miles from the volcano.

Over the past 4,000 years in Oregon — a geologically short time period — there have been three eruptions of Mount Hood, four eruptions in the Three Sisters area, two eruptions in the Newberry Volcano area, and minor eruptions near Mount Jefferson, at Blue Lake Crater, in the Sand Mountain Field, near Mount Washington and near Belknap Crater. During this time period, the most active volcano in the Cascades has been Mount St. Helens in Washington State with about 14 eruptions.

In the past 200 years, seven of the Cascade volcanoes in have erupted, including Mount Baker, Glacier Peak, Mount Rainier, Mount St. Helens, Mount Hood, Mount Shasta and Mount Lassen. The most recent series of events (1760–1907) consisted of small lahars, debris avalanches, steam explosions and minor ashfalls (DLCD, 2015).

Table 3.5-4 includes documented historic events that have impacted the Planning Area specifically.

Table 3.5-4 Significant Historic Volcanic Events

Date	Location	Description
About 20,000 to 13,000 years before present (YBP)	Polallie eruptive episode, Mount Hood	lava dome, pyroclastic flows, lahars, tephra
About 1,500 YBP	Timberline eruptive period, Mount Hood	lava dome, pyroclastic flows, lahars, tephra
1760–1810	Crater Rock/Old Maid Flat on Mount Hood	pyroclastic flows in upper White River; lahars in Old Maid Flat; dome building at Crater Rock
1859/1865	Crater Rock on Mount Hood	steam explosions/tephra falls
1907	Crater Rock on Mount Hood	steam explosions
1980	Mount St. Helens (Washington)	debris avalanche, ashfall, flooding on Columbia River

Sources: USGS, no date; Wolfe and Pierson, 1995; and Scott et al.,1997

3.5.3 Probability

Multnomah County is closest to Mount Hood (in Clackamas County), a stratovolcano. According to the 2015 Oregon Natural Hazards Mitigation Plan (NHMP):

> *Stratovolcanoes have wide ranging modes of eruption, making future volcanic activity difficult to predict definitively. Mount Hood's eruptive history can be traced to late Pleistocene times (15,000–30,000 years ago) and will no doubt continue. However, the central question remains: When?*
>
> *Geoscientists have provided estimates of future activity in the vicinity of Crater Rock, a well-known feature on Mount Hood. They estimate a 1 in 300 chance that some dome activity will take place in a 30-year period (1996–2026). For comparison, the 30-year probability of a house being damaged by fire in the United States is about 1 in 90 (Scott et al., 1997).*

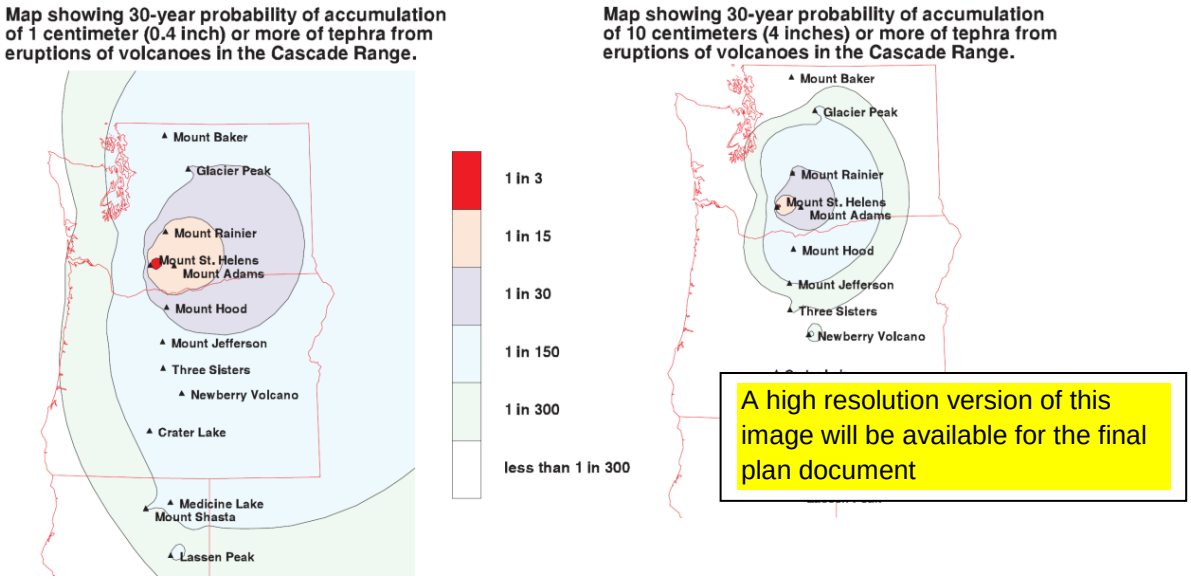
Ashfall

Return periods for ashfall from the Cascades are estimated by the USGS and shown in **Figure 3.5-7**. These maps predominantly reflect volcanic eruptions at Mount St. Helens, because this volcano is much more active than the other volcanoes in the Cascades. These maps indicate the following return periods and probabilities:

- 1,000 year return period; 1 centimeter (about 0.4 inch) or more of volcanic ash; 0.1% probability; and
- 4,000 year return period; 10 centimeters (about 4 inches) or more of volcanic ash; 0.025% probability.

Depending on the volume of ash ejected by an eruption and on prevailing wind directions at the time of an eruption, various thicknesses of ash may impact the Planning Area. Non-prevailing winds would be needed to transport volcanic ash from the nearest Cascades volcano to our communities These winds do occur, but are much less common than the prevailing westerly winds.

Figure 3.5-7 Probable Ashfall from Volcanoes in Oregon and Washington



Source: Scott et al., 1997

Lahar

The 30-year probability for a moderate lahar event is estimated at about 1 in 15 to 1 in 30. A major lahar has a return period of about 450 to 900 years. The worst case lahar is from Mount Hood and has a 30-year probability of less than 1 in 3,000, about 10,000 years.

The length of time for a lahar to arrive in the Planning Area ranges from about 2 hours and 30 minutes near the southern border of Multnomah County to 3 hours and 30 minutes in Troutdale (**Figure 3.5-5**).

3.5.4 Vulnerability

According to the 2015 Oregon NHMP, communities within Multnomah County are at risk and should consider the impact of volcano-related activity on small mountain communities, dams, reservoirs, energy-generating facilities, highways and the local economy (e.g., wood products and recreation). In addition, debris entering the Columbia River from eruptions at Mount St. Helens or Mount Hood may disrupt shipping operations based in Multnomah County (DLCD, 2015).

Ashfall

Even minor amounts of ashfall can result in significant impacts, and 100% of the population, critical facilities, lifelines, public infrastructure, and the private economy and business sector are exposed. Possible impacts of ashfall on the Planning Area include (USGS, 2003):

- Reduced sunlight and visibility
- Respiratory problems for at-risk population such as elderly, young children or people with respiratory problems, and irritation to eyes
- Impacts on public water supplies drawn from surface waters, including degradation of water quality (high turbidity) and increased maintenance requirements at water treatment plants

- Electric power outages from ash-induced short circuits in distribution lines, transmission lines and substations
- Disruptions of air traffic from the Portland International Airport, Troutdale Airport and other airports in the Pacific Northwest
- Clogging of filters, abrasion and corrosion, and other possible severe damage to vehicle engines, furnaces, heat pumps, air conditioners, commercial and public building combined HVAC systems (heating, ventilation and air conditioning), and other engines and mechanical equipment
- Clean-up and ash removal from roofs, gutters, sidewalks, roads, vehicles, HVAC systems and ductwork, engines and mechanical equipment
- Collapse of roofs and structures due to weight, and slippery conditions when wet (a one-inch layer of ash weighs five to 10 pounds per square foot when dry, but 10 to 15 pounds per square foot when wet)

Lahar

Lahar events could profoundly disrupt transportation to and from Multnomah County if the Interstate 84 bridge and other bridges across the Sandy River were to fail. Critical infrastructure would be damaged. Interstate 84 and other east-west routes probably would be closed for long periods of time. A major lahar event could completely destroy buildings in the Planning Area.

In a moderate lahar event, large portions of Troutdale, Fairview and Wood Village could be inundated. Depending on the volume of the lahar, all or part of this area could be buried. Large lahars could result in extreme levels of damage and a high potential for casualties unless complete evacuations were carried out before the lahar reached populated areas. Depending on the depth of the lahar deposits, damage likely would range from severe to total. Possible impacts include:

- **Troutdale:** Troutdale is especially exposed to lahars along the Sandy River and its tributaries, the White River and Hood River. Most of the city is within the inundation zone. A moderate lahar could impact areas along the Sandy River, the lower reach of Beaver Creek and most of Troutdale north of Interstate 84. In the worst-case event, a lahar could affect the area extending westward from the Sandy River as far as the vicinity of South Troutdale Road and South Buxton Road. Such events also would profoundly disrupt transportation to and from Troutdale, especially across the Sandy River Valley. Interstate 84 and other east-west routes probably would be closed for long periods of time. The worst-case lahar is probably the worst-case natural disaster for Troutdale.

- **Fairview:** A moderate lahar could impact portions of the Interlachen area and the parts of Fairview north and northeast of Interlachen. In the worst-case event, severe to total damage would extend further south, including most of the city north of Sandy Boulevard.

- **Wood Village:** A moderate lahar probably would not reach Wood Village, but would disrupt transportation routes and utilities to the east of Wood Village. In the worst-case lahar event, the flows could cover portions of Wood Village, especially in the northeastern most parts of the city north of Interstate 84, near the Union Pacific Railroad tracks. In Wood Village, the area at most risk from lahars is the Wood Village Mobile Home Park on NE Sandy Boulevard. This park includes 91 manufactured homes and two site-built residential structures.

3.5.5 References

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