5.3 Volcanic Hazards

- Washington State is home to five active volcanoes located in the Cascade Range, east of Seattle: Mt. Baker, Glacier Peak, Mt. Rainier, Mt. Adams and Mt. St. Helens (see figure [Cascades volcanoes]). Washington and California are the only states in the lower 48 to experience a major volcanic eruption in the past 150 years.
- Major hazards caused by eruptions are blast, pyroclastic flows, lahars, post-lahar sedimentation, and ashfall. Seattle is too far from any volcanoes to receive damage from blast and pyroclastic flows.
    - Ash falls could reach Seattle from any of the Cascades volcanoes, but prevailing weather patterns would typically blow ash away from Seattle, to the east side of the state. However, to underscore this uncertainty, ash deposits from multiple pre-historic eruptions have been found in Seattle, including Glacier Peak (less than 1 inch) and Mt. Mazama/Crater Lake (amount unknown) ash.
    - The City of Seattle depends on power, water, and transportation resources located in the Cascades and Eastern Washington where ash is more likely to fall. Seattle City Light operates dams directly east of Mt. Baker and in Pend Oreille County in eastern Washington. Seattle's water comes from two reservoirs located on the western slopes of the Central Cascades, so they are outside the probable path of ashfall.
    - If heavy ash were to fall over Seattle it would create health problems, paralyze the transportation system, destroy many mechanical objects, endanger the utility networks and cost millions of dollars to clean up. Ash can be very dangerous to aviation.
- Lahars are mudflows and debris flows that originate from the slopes of a volcano and travel down river systems. Mt. Rainier is the only volcano connected to Seattle via a river system.
- Lahars from Mt. Rainier have buried the Kent Valley in the past, but there is no evidence a lahar has reached Seattle in the past 10,000 years. A Washington Department of Natural Resources analysis states that it is possible for a lahar to reach Seattle but would be extremely unlikely.[246]
- Seattle faces vulnerabilities from a lahar reaching the Kent Valley. Interstate 405, as well as oil and natural gas pipelines, water lines, power lines, and sewer mains that serve Seattle all cross the potential lahar area in the Kent Valley. This area also hosts many of Seattle's major food distributors.
- Lahars can cause floods that transport massive amounts of sedimentation farther downstream. In a Mt. Rainier eruption, if lahars reach as far as the Kent Valley, Seattle's Duwamish Valley could experience post-lahar sedimentation.

5 3.1 Context

Washington's volcanoes are part of the same tectonic motion that gives the Pacific Northwest its seismic activity. As the earth's continents and oceanic plates move, the heavier oceanic plates slip under the lighter continental plates. This process is called "subduction" and it causes friction along the plate faces (see figure [Subduction in the Pacific Northwest]). Typically, the hottest part of the subduction area is under the continental plate about 100-200 miles inland from the coast, where the heat and pressure melt rock into magma. The magma forms reservoirs near the surface. As the rock melts into magma it expands.

Under normal conditions, the constraining pressure of the surrounding rock keeps the expansive force of the magma in check. An eruption is triggered when the balance of forces is upset. Sometimes an increase in pressure from tectonic activity causes the magma to blow out the surface. On other occasions water mixes with the magma, gets superheated, and produces enormous steam explosions.

Washington's volcanoes have explosive eruptions. They produce viscous magma that plugs the vent of the volcano. As the magma rises to the earth's surface, pressure decreases, and gases separate from liquid. When the pressure from the trapped gases exceeds the pressure of the hardened magma, the volcano erupts.[247] These violent eruptions produce several hazards, including pyroclastic flows, landslides, gases, lava flows, tephra (ejected ash and rock) and lahars (see figure [Volcano Hazards]). While the Hollywood image of a volcanic eruption may be fast flowing lava, the viscous lava of Washington volcanoes typically cools and hardens before traveling very far. The major hazards to Seattle are tephra (ash falls) and post-lahar sedimentation.

Figure 5-14. Cascade Volcanoes

Ashfall

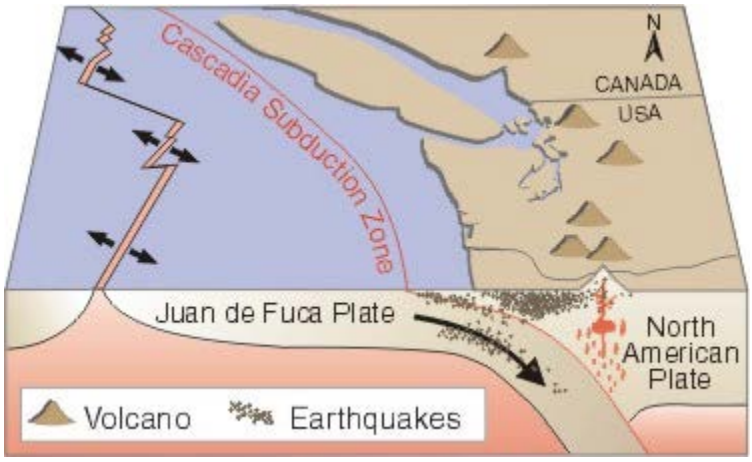
The most widespread eruption impact is ash, which can cover hundreds of square miles. Ash is a health risk to people with respiratory problems. Ash also has many indirect effects by causing hazardous driving conditions, damage to mechanical equipment, and interference with wireless communications. Ash flows can also interfere with aviation. If ash is ingested into a jet engine it can melt and coat turbine blades and eventually cause them to stop running. Roughly 300,000 people fly over or near volcanoes every day, mostly those located in Alaska.[248] In 2010, an ash cloud from a volcanic eruption in Iceland forced the week-long closure of airspace for most of northern Europe.[249] The cost of this disruption was estimated at $10 billion.

Lahars

The USGS defines lahars as mudflows and debris flows that originate from the slopes of a volcano. Lahars contain at least a 60% concentration of rock debris. Most, but not all, are preceded by volcanic

and seismic activity. Most commonly, they are triggered by pyroclastic flows. Other possible triggers are intense rainfall on loose volcanic rock deposits, breakout of a lake dammed by volcanic deposits, and debris avalanches.[250] Lahars are especially hazardous in areas of Western Washington along rivers originating on the slopes of volcanoes. Lahars can look and behave much like flowing concrete. They can travel at speeds of a few tens of miles per hour along gently sloping distal valleys. Higher speeds of more than 60 miles per hour are possible on steep slopes near Mt. Rainier. Though spontaneous lahars are possible, most would be preceded by volcanic and seismic activity. Lahars from Cascades volcanoes can travel tens of miles from their source, making them extremely dangerous to communities close to volcanoes. A lahar that occurred 5,600 years ago covered roughly 212 square miles of the Puget Sound lowlands.[251]

Figure 5-15. Subduction in the Pacific Northwest



Source: Myers, B., Faust, L., & Janda, C. (0Mount Hood-History and Hazards of Oregon's Most Recently Active Volcano. *United States Geological Survey*. Retrieved August 2, 2018, from http://pubs.usgs.gov/fs/2000/fs060-00/

Post-Lahar Sedimentation

After a lahar initially stops, the erosion and transport of loose volcanic deposits can lead to large sediment loads that flow downstream. "Post-lahar sedimentation" is the incremental transport of excess sediment from the headwaters of a river to lower river reaches that occurs days, weeks, or even years after a lahar occurrence. The resulting rise in sediment can decrease carrying capacity for river channels and increase flood risk. It is a risk to navigation and the environment that can persist for decades.

Volcano Hazards That Are Not a Threat to Seattle

Volcanoes produce a variety of hazards that are localized to the volcanoes immediate area and are therefore not a threat to Seattle. These are:

Pyroclastic Flows

The USGS defines a pyroclastic flow as a chaotic mixture of rock fragments, gas, and ash that travels rapidly (tens of meters per second) away from a volcanic vent or collapsing flow front. Pyroclastic flows hug the ground, flattening most everything in their path. The ejected material melts the glaciers and other snow covering the volcano. The melt water combined with the volcanic material can create muddy slurries called lahars and is even more dangerous since it increases the size of the pyroclastic flow and

enables it to move farther. This process caused the mudflows that raced down the Toutle River following the Mt. St. Helens eruption.

Volcanic Landslides

Volcanoes are naturally weak structures and experience slope collapses, typically during an eruption. Volcanic landslides are huge. When Mt. St. Helens erupted in 1980, 2.5 cubic kilometers of rock collapsed. Despite their large size, these landslides are a direct danger only to the immediate area surrounding the volcano. The major danger they pose to communities farther away is by supplying material that, when mixed with water, can transform into a lahar.

Volcanic Gases

Magma contains dissolved gases. These gases are ejected along with tephra high into the atmosphere during eruptions. They can become attached to tephra particles or water droplets and fall with them back to earth. The major gases are water vapor, carbon dioxide (a greenhouse gas), hydrogen sulfide (acid rain), hydrogen, carbon monoxide, hydrogen chloride, hydrogen fluoride and helium. A few historic eruptions have caused gas concentrations that were acutely lethal to people, animals, and vegetation, but the highest probability effect of volcanic gases is exacerbating existing pollution problems.

Lava Flows

Lava is the classic Hollywood volcano hazard, but the volcanoes of the Pacific Northwest produce a very viscous type of lava that moves very slowly and extends only a few miles from its source if it even moves at all. Much of the lava in nearby volcanoes is so thick and viscous that it builds domes.

5 3.2 History

Only two volcanoes have fully erupted in the Cascades in the 20th century, Mt. Lassen in northern California in 1917 and Mt. St. Helens in 1980. The events listed in this section focus on the most recent activity observed for the volcanoes with the greatest hazard risks for Seattle.

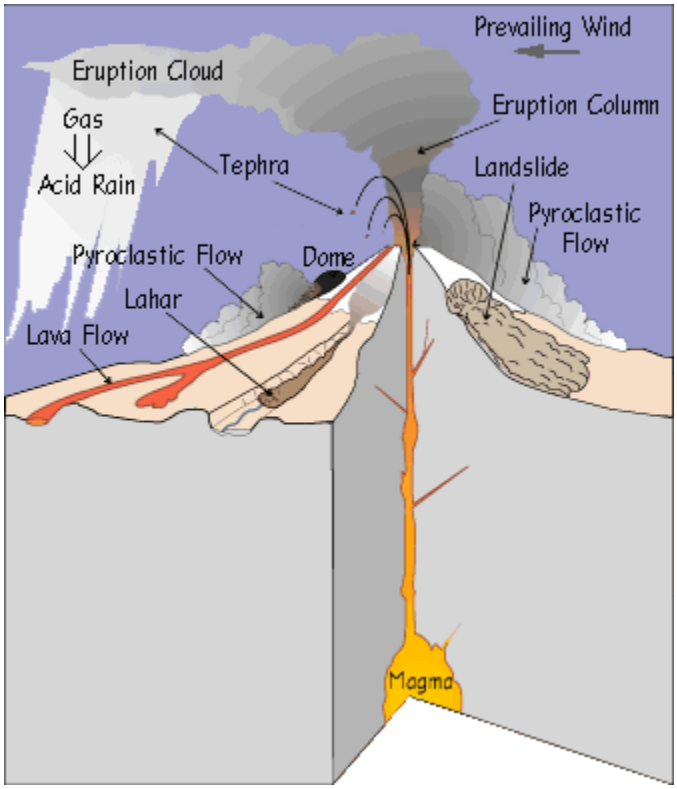
Mt. Rainier

The last magmatic eruption is believed to be about 1,000 years ago.[252] Explorers and pioneers of the 19th century reported smoke and earthquakes near the mountain, but there is no physical evidence of eruptive activity during this time. Geologic records show Rainier was active 5,600 to 4,500 years ago and again 2,700 to 2,000 years ago. Both eruptive periods are believed to have produced excess sedimentation in the Duwamish river, near Seattle.

During the past 10,000 years, at least 60 lahars of various sizes have moved down valleys that head at Mount Rainier; but there is no evidence that any have reached Seattle.[253] The two largest lahars that have originated from Mt. Rainier were not triggered by an eruption. One is the Osceola Mudflow that occurred about 4,500 to 5,600 years ago. At least ten times larger than any other known lahar from Mount Rainier, it was the product of a large debris avalanche composed mostly of hydrothermally-altered material. It may have been triggered as magma forced its way into the volcano. Osceola deposits cover an area of about 212 square miles in the Puget Sound lowland; they buried the area around Enumclaw and extended at least as far as Kent and to Tacoma's Commencement Bay.

At least six smaller debris avalanches have spawned lahars in the past 5,600 years. As recently as 500 years ago, the Electron Mudflow nearly reached Puyallup.[254] The Electron Mudflow has not been correlated with an eruption. It is thought to have derived from a slope failure on the west flank of Mount Rainier. The Electron Mudflow was more than 90 feet deep at its head. Its deposits at Orting are

Figure 5-16. Types of Volcano Hazards



Source: United States Geological Survey website: http://pubs.usgs.gov/fs/fs002-97/

as much as 18 feet thick and contain remnants of an old-growth forest. About 1,200 years ago, a lahar of this type filled valleys of both forks of the White River to depths of 60 to 90 feet and flowed 60 miles. Less than 2,200 years ago, the National Lahar inundated the Nisqually River valley to depths of 30-120 feet and flowed all the way to Puget Sound. More than a dozen lahars of this type have occurred at Mount Rainier during periods of volcanism in the past 6,000 years. In 1963 and 1967, large landslides occurred the slopes of the mountain. Increased heat was responsible, suggesting renewed volcanic activity.[255]

Mt. St. Helens

The 1980 eruption was the largest in the Cascades in recent history but only produced trace ash dustings in Seattle. A magnitude 5.1 earthquake preceded the eruption, which produced the largest debris avalanche in recorded history.[256] Mt. St. Helens has been consistently the most explosive of the Cascade volcanoes, with earlier, smaller eruptions in 1800, 1831, 1842 and 1857.[257] Mt. St. Helens is the most prolific tephra (ash) producer of the past few thousand years because of the frequency of its eruptions. It produced a small ash plume in 2004.[258]

Out of Washington's volcanoes, Mt. St. Helens is believed to be the most likely to erupt in the future. A future eruption probably would not have a major lateral blast or landslide again because of the deep crater that was produced in the 1980 eruption.[259]

Mt. Baker

The last major eruption was approximately 6,700 years ago. Since then, Mt. Baker has experienced a steam eruption in the mid-1800s and an increase in steam and heat in 1975 but did not erupt.[260] Small lahars occur from Mt. Baker every decade or so. It is not showing any current signs of eruption, but the biggest threat of a future eruption would be lahars, which could reach the Puget Lowlands.[261]

Glacier Peak

Glacier Peak generated a sequence of six tephra eruptions over a period of several hundred years about 13,000 years ago. The largest ejected more than five times as much tephra as the 1980 Mt. St. Helens eruption. Ash from these eruptions have been found under Lake Washington and Portage Bay. More recently, Glacier Peak experienced small steam eruptions in the 1700s.[262] The Cascades Volcano Observatory estimates that each year there is a 1 in 1,000 chance that Glacier Peak will erupt.[263]

Mt. Adams

Mt. Adams has erupted in recent geologic time although not during the past 1,000 years. It has had several debris avalanches over the past 10,000 years. Physical evidence suggests that past eruptions were fairly quiet with little ash or pyroclastic material. Some observers speculate that it is dormant or extinct, but the Cascades Volcano Observatory states that it will erupt again but probable future eruptions would be small tephra and lava flows from vents on the summit.[264]

Mt. Hood

Mt. Hood has been very active recently, with an eruptive period in the late 1700s. Early settlers reported eruptive activity in 1859 and 1865, but no deposits have been found that confirm these accounts.[265] Ashfall and pyroclastic flows from Mt. Hood eruptions have been limited to Oregon and southern Washington.[266] Mt. Hood is more of a threat to Portland than Seattle.

Mt. Shasta

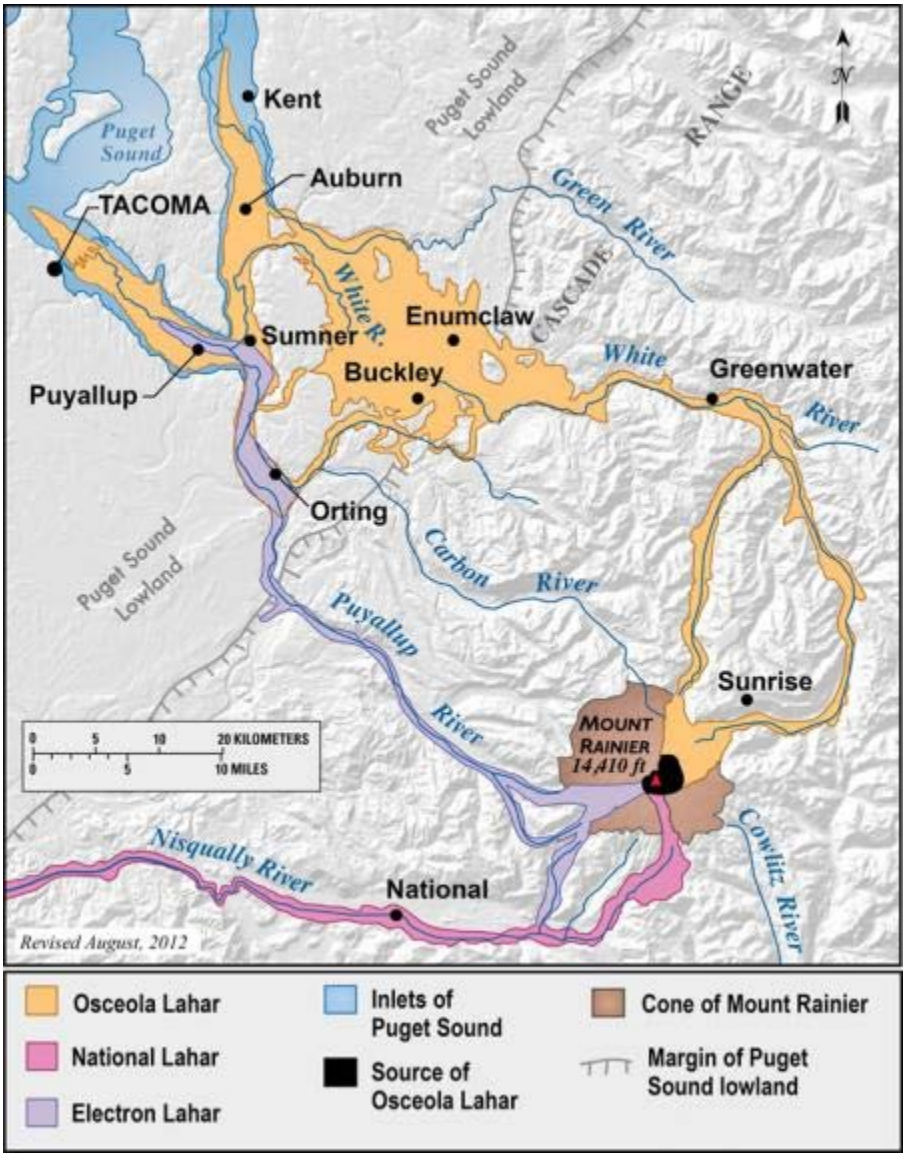
Mt. Shasta has erupted roughly once per 250 years in the past 750 years, with the last eruption in 1786. Eruptions in the past 10,000 years have produced lava flows and pyroclastic flows that have reached as far as 12.4 miles from the summit. It is possible that ash from Mt. Shasta could reach as far as Seattle.

5 3.3 *Likelihood of Future Occurrences*

The most likely volcanic hazard facing Seattle is ashfall. The USGS estimates that there is a 1 in 5,000, or 0.02% chance per year that Seattle will accumulate 1 centimeter or more of tephra.[267] The USGS has produced a map showing annual probabilities of 1 cm ash accumulation throughout the West Coast (see Figure [Annual Probability of 1cm Ash Accumulation]). Geologists have found volcanic ash deposits from eruptions that happened thousands of years ago in various areas of Seattle. Ash from the Glacier Peak eruption (roughly 13,400 years ago) and the Mt. Mazama/Crater Lake eruption (roughly 7,600 years ago) have been found on the bottom of Lake Washington and Portage Bay.[268] Ash deposits that date roughly 200,000 years ago have also been found under Hamm Creek in the Duwamish Valley, but their origin is unknown.[269] The Glacier Peak ash layer was less than 1-inch thick, and the amount of ash received from the other eruptions is unknown.

Lahars happen more commonly than eruptions. Mt. Rainier is a major producer of lahars because of its size, relatively westward location, and the volume of water trapped in the glaciers along its slopes. Lahars that are not caused by an eruption on Mt. Rainier are more likely to occur in the summer or fall, when melting water is prevalent and intense rain can fall on exposed, unconsolidated ground.[270] Most Cascade glaciers, including those on Mt. Rainier, are shrinking. As they retreat very unstable terrain is exposed. As a result, small debris flows are becoming more common and the released sediment is being

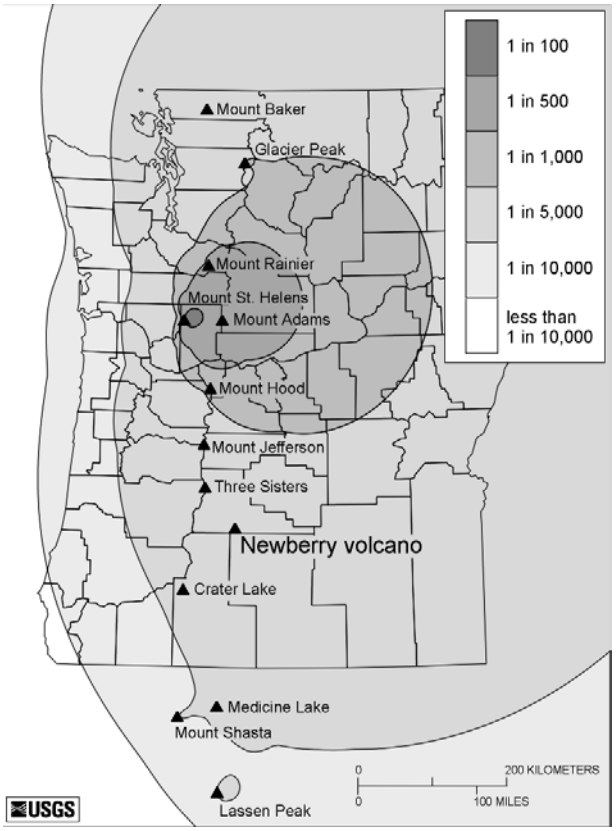
Figure 5-17. Past Mt. Rainier Lahars



Source: United States Geological Survey, Cascades Volcano Observatory
(website: https://volcanoes.usgs.gov/volcanoes/mount_rainier/hazard_lahars.html)

washed downstream. This, in turn, decreases the capacity of rivers originating at Mt. Rainier and makes them more likely to overflow their banks with water or lahar debris. These types of lahars would be too small to reach Seattle, and typically do not even go outside the Mt. Rainier National Park boundaries. Larger lahars with the potential for post-lahar sedimentation in the Duwamish Valley are estimated to occur every 500 to 1000 years, according to the Cascades Volcano Observatory.[271] Although the risk of lahars seems quite small, some uncertainty exists because the last major lahars occurred hundreds of years ago before modern development. It is not fully understood whether or how the development will affect a lahar.

Figure 5-18. Annual Probability of 1cm Ash Accumulation



Source: Sherrod, D. R., Mastin, L. G., Scott, W. E., & Schilling, S. P. (1997) Volcano Hazards at Newberry Volcano, Oregon. *United States Geological Survey.* Retrieved August 3, 2018, from http://vulcan.wr.usgs.gov/Volcanoes/Newberry/Hazards/OFR97-513/OFR97-513_inlined.html

5 3.4 Vulnerability

Seattle's main vulnerability is to ashfall and post-lahar sedimentation. It is possible that a lahar could reach Seattle because of the connection between the Duwamish river and Mt. Rainier. However, there is no evidence of a past lahar reaching this far.

Lahar Vulnerability

Seattle's Duwamish river valley is exposed to lahars and a process known as post-lahar sedimentation. The Kent Valley is more likely than Seattle to be directly affected by a lahar. Seattle is indirectly exposed to potential damage in the Kent Valley because it is heavily dependent on lifelines and facilities located in the area.

Seattle is downstream from Mount Rainier, the Pacific Northwest's major lahar producer. Seattle's major river, the Duwamish, originates on Mt. Rainier's slopes. In theory, a lahar could reach Seattle, but geologists have not found evidence that they have. It is most likely that a lahar would stop south of Seattle in the Kent Valley. Then in the coming days, weeks or months, lahar sediments would push downstream to Seattle in a process known as post-lahar sedimentation.

Hydrologists state that levees will probably contain the sediment inside the river channel but cannot provide guarantees. Therefore, most of the Sodo area should be considered at risk of sediment inundation (see Figure [Potential Post-Lahar Sedimentation Area with Key Transportation

Infrastructure]). Containing the sediment depends on its volume, its speed, the time of year, and the levees' condition. Only about 3% of the area exposed to post-lahar sedimentation is residential. If sediment overtops levees or they fail, low-lying areas along to the river could be inundated.

Table 5-3. Washington Volcano Hazard Summary

Volcano	Ashfall	Lahar	Post-Lahar Sedimentation
Mt. Rainier	✓	Highly unlikely	✓
Mt. St. Helens	✓	No	No
Glacier Peak	✓	No	No
Mt. Baker	✓	No	No
Mt. Adams	✓	No	No

Seattle's transportation and utility lifelines would be exposed to post-lahar sedimentation in a worst-case scenario. All major utilities cross the area susceptible to post-lahar sedimentation. They include electrical transmission lines, water supply lines, sewer mains and the BP Olympic Pipeline. The area houses key transportation corridors, including I-5, SR 99, SR 509, and SR 599. It includes the King County International Airport (Boeing Field), rail yards, and large parts of the Port of Seattle.

The Kent Valley is highly exposed to lahar hazards and contains many critical lifelines. They include I-405, the BP pipeline, water lines from Seattle's main watershed, natural gas mainlines, and major power lines. Much of the food that reaches Seattle's grocery stores is distributed from huge centers in this area. Many people who work in Seattle either live in or commute through the Kent Valley.

This indirect vulnerability due to exposure of lifelines outside the city extends to the whole Puget Lowland region. All the Cascade volcanoes can generate lahars that can reach Puget Sound, crossing many transportation and utility trunks along the way.

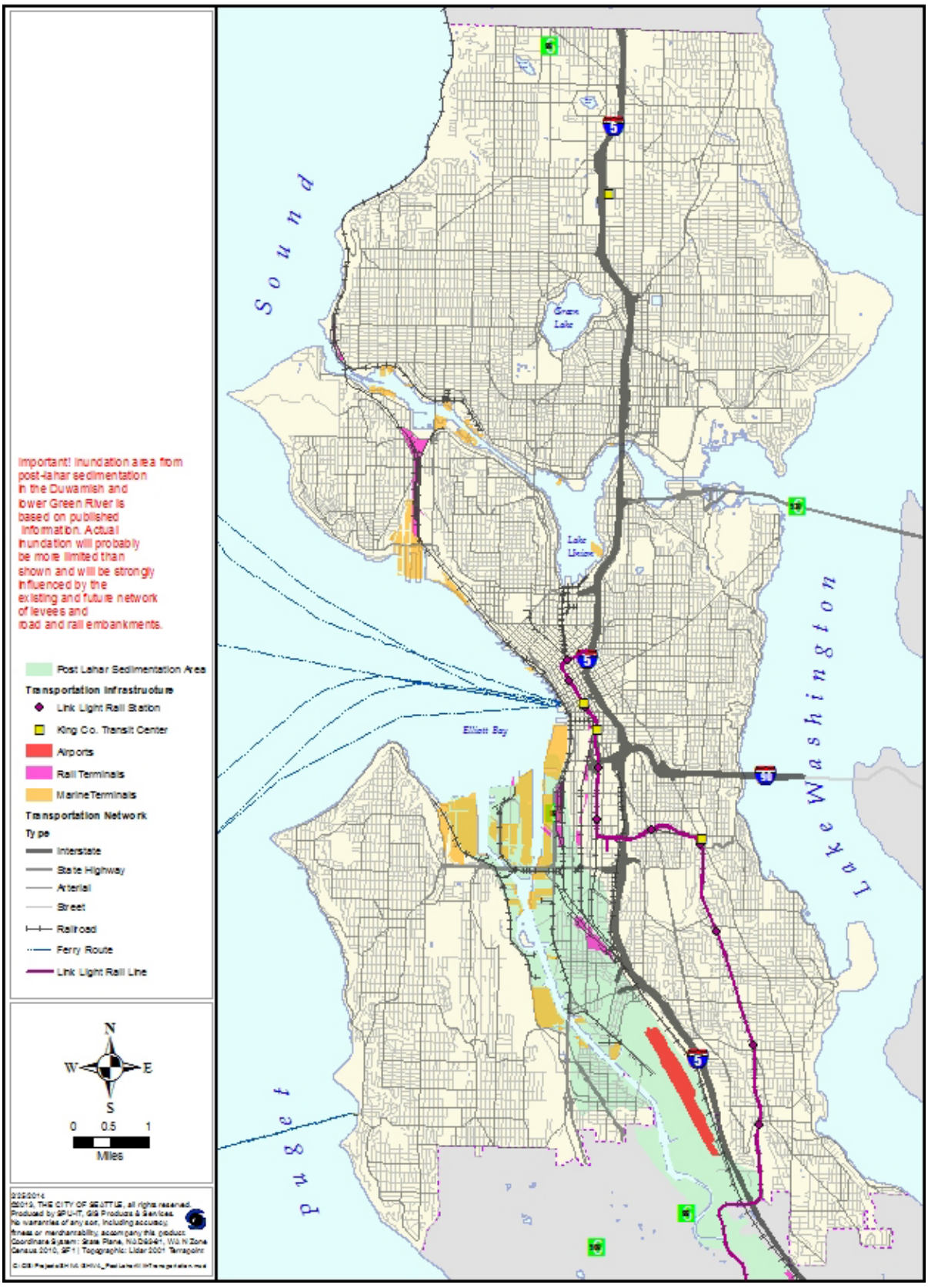
Ashfall Vulnerability

Seattle is exposed to ashfall, but the likelihood of a large event is remote. Volcanic ash deposits from eruptions that occurred thousands of years ago have been found in Seattle, but the severity of these events is unclear. One ash layer found was less than 1-inch thick. If Seattle does receive ash, the most likely source would be Mount St. Helens, which has had the most frequent eruptions and largest ash eruptions of all the Cascade volcanoes in recent history. In the Pacific Northwest, prevailing winds blow from the west to the east. Seattle is west of the Cascade volcanoes. Weather patterns would have to reverse to carry ash into Seattle.

Seattle is made more vulnerable due to its reliance on watersheds and hydroelectric facilities in the Cascades. Seattle is more likely to be impacted by ash falling into its watershed or onto power infrastructure than by ash falling directly on the city. When ash falls into a reservoir it can affect its chemistry and turbidity (clearness).

The power system can be vulnerable in the right conditions. Ash that falls on electrical insulators can cause flashover, a disruptive electrical discharge that can cause outages.[272] Flashover is more likely to happen when the ash has become wet from dew, light rain, or mist. If enough ash accumulates on transmission lines, it can overload them and increase the risk of an outage. Flashovers occurred in areas

Figure 5-19. Potential Post-Lahar Sedimentation Area with Major Transportation Infrastructure



with more than 5 millimeters of ash (and rain) and power lines broke due to ash accumulation during the Mt. St. Helens eruption in 1980. It is difficult to fully assess the vulnerability of the hydroelectric power generation system because there have been so few instances of this happening.

Seattle is vulnerable to impacts of ash on aviation. When ash enters jet engines, it has been shown to cause many damaging and dangerous effects, including mid-flight engine failure.[273] Ash can lead to the closure of airspace, cancelled or delayed flights, and reduced visibility on runways.

Seattle's ground transportation network is vulnerable to ashfall. Reduced visibility and reduced traction on roads can make driving conditions dangerous.[274] Additionally, ash can clog track switches for railways. Both the BNSF railway and Amtrak shut down for a day in Montana due to 1 to 2-millimeter ash accumulation following the Mt. St. Helens eruption.[275]

5 3.5 Consequences

Seattle's consequences to ashfall or post-lahar sedimentation mainly pose threats to property, infrastructure, and the environment. Seattle faces secondary consequences of a Lahar reaching the Kent Valley.

Lahars and Post-Lahar Sedimentation

The consequences of a lahar would depend on where it originated and how far it traveled. Mt. Rainier poses the biggest risk because it can generate very large lahars and sits closer to the densest part of the Puget Sound area than the other Cascade volcanoes. In the most likely case, Seattle would have to deal with the effects of a lahar in areas outside the city. For example, a lahar from Glacier Peak or Mt. Baker could close Interstate 5, north of Seattle. In the case of a Mt. Rainier lahar, the greatest consequence is post-lahar sedimentation in the Duwamish waterway.

In a post-lahar sedimentation event, sediment could wash down the river for years. Lahar material from the Kent Valley would introduce more polluted debris into the waterway which is already undergoing a cleanup. The increased sediment and dredging operations would set back environmental restoration efforts. Salmon and other wildlife populations in the Duwamish/Green River floodplain could be devastated if their habitat is dramatically altered.

If sediments accumulated, economic activity in Seattle could be affected. Even a short closure could be costly. Portland lost $13 million (2009 dollars) when its port closed after the 1980 Mt. St. Helens eruption.[276]

Sedimentation could possibly alter the course of several rivers, including the White River which joins the Puyallup River as it flows to Tacoma. A large lahar could alter the White River's course and link it with the Green River instead of the Puyallup River. This would increase water volume and transport sediment to Seattle.

If sediments breach the levees, the consequences grow more severe. Property, lifelines, and critical facilities would be affected. The property exposed to the lahar hazard (surrounding the Duwamish) is predominantly commercial and industrial but includes roughly 117 acres of residential area and all of the King County International Airport. The area is heavily used by the Port of Seattle, Boeing, and commodity distribution centers. The Georgetown and South Park residential communities are in the same area. Given the time sensitivity of many port freight operations and very competitive margins, prolonged outages could have severe economic effects.

If the Duwamish Valley floor is inundated, several vital transportation routes, SR-99 and I-5 could be blocked. Most of Seattle's rail lines, including major railyards occupy this area. These yards include the Union Pacific yard where Seattle's garbage is loaded daily onto trains bound for landfills in Oregon.

If a lahar were to reach Seattle, there could be high loss of life if people did not evacuate. Transportation, utilities, and economic activity would suffer long-lasting damage due to infrastructure damage. The Duwamish Valley and all the other valleys leading up to Mt. Rainier would be buried under mud ranging from a few feet thick near the end of the lahar to hundreds of feet thick closer to Mt. Rainier.

Roughly 3,300 people live in the Post-Lahar Sedimentation Area, mostly in the Georgetown and South Park areas. The precise day time population is unknown, but it is a major employment area. People are exposed to danger only from a lahar reaching Seattle, not from post-lahar sedimentation.

Ashfall

The experiences of Yakima and Spokane in 1980 reveal a "typical" case of an ashfall emergency. Yakima received about 3 inches; Spokane received 2 inches. Both communities were shut down for days. The ash falls darkened the sky, causing a "midnight at noon" effect in Eastern Washington that lasted for 18 hours. The ash caused power outages and damage to sewer treatment equipment. Interstate 90 was closed for one week, and over 1,000 commercial flights had to be canceled.[277] It took Yakima 10 weeks to clean up the ash. While both cities are well prepared for snowstorms, both were overwhelmed by the ash.

An ashfall in Seattle would have five potentially large direct impacts:

- Ash would irritate people's eyes and throats, especially those with existing respiratory trouble, but it would rarely cause death.[278] Many people had to wear masks in Eastern Washington or stay inside while the ash fell. The same could happen in Seattle. Blowing ash could prolong these problems, especially if the ash is very fine.
- Traffic would stop if ash covered the roads. Many people would be stuck, and accidents would probably increase. Although the timeframe of an eruption could generally be predicted, an actual eruption could catch many people on the roads, making it worse that a snowstorm.
- Vehicles and other machines would break down as the ash clogged their moving parts. This would compound traffic and clean-up problems.
- Ash could disrupt the city's utilities. Waste water systems are especially vulnerable to ash, especially if sewage and stormwater are collected in one network as they are in parts of Seattle. In reservoirs, it would increase turbidity, making the water undrinkable until it settled. It could also damage power distribution and generation facilities, prompting expensive emergency power purchases.[279] Wireless communications and public safety would be impeded.
- The City would incur clean-up costs. The City of Yakima paid at least $1.1 million at the time to remove ash from the streets.[280] Considering that cost would be $3.5 million in 2018 dollars, and Seattle's population is over 6 times as large as Yakima, the cost of clean-up in Seattle would be significant. These problems would be worse if it were to combine with water and fall from the sky as mud. When ash becomes wet, it acts like cement. The weight could lead to roof collapses throughout the city.

A heavier ashfall would cause more severe versions of problems expected by the more "typical" scenario. If the ash is acidic or acidic rain falls, injuries and damage would increase. One Alaskan volcano produced acidic ash that burned victims' eyes, throats, and lips, making eating difficult. Other acidic rains burned the skin. Acidic rains have also destroyed clothing and corroded metal. These alarming effects are rare and did not occur during the 1980 Mt. St. Helens eruption.

The costs of a heavy ashfall would halt economic activity for several days or weeks. Since an ashfall would affect the whole Puget Sound region, Seattle could not rely on aid from neighboring governments. A mudflow would increase the damage and probably stop port activity for several weeks. Aviation would be disrupted. Seattle could be economically impacted even if not physically damaged.

5 3.6 Conclusions

Casualties are likely to be small compared to the economic effects. A lahar, the deadliest volcanic hazard, is extremely unlikely to reach Seattle. Unusual weather patterns could produce ash falls heavier than those in Eastern Washington during the 1980 Mt. St. Helens eruption.

Since geologists can generally detect conditions that precede eruptions, the city would likely have time to prepare itself for ashfall or post-lahar sedimentation. Mitigating sediment loads through dredging and sediment retention dams might make evacuation unnecessary.

Planners should be prepared for ashfall. During the Mt. St. Helens eruption many cities were caught unprepared because they assumed they would not be hit.