Chapter 12
Volcano-Related Events

(Hazard Analysis Score = 178)

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Why are Volcano-Related Events a Threat to Beaverton?

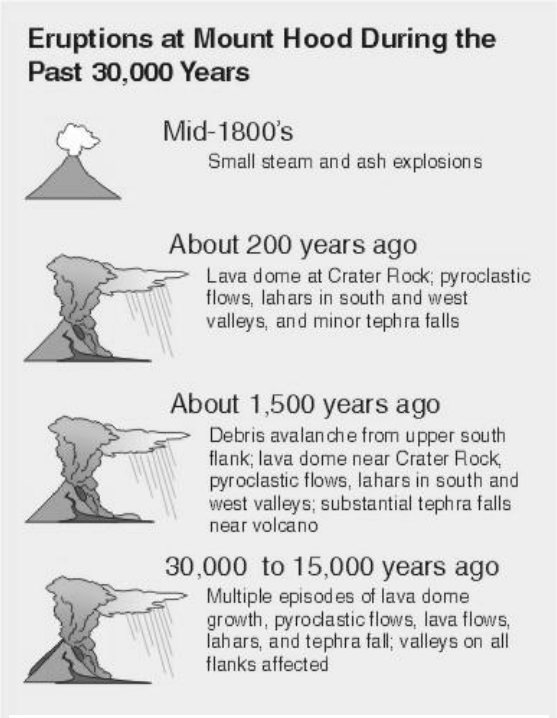
Beaverton and the Pacific Northwest lie on the "Ring of Fire," an area of very active volcanic activity surrounding the Pacific Basin. Volcanic eruptions occur regularly along the Ring of Fire, in part because of the movement of the Earth's tectonic plates. The Earth's outermost shell, the lithosphere, is broken into a series of slabs know as tectonic plates. These plates are rigid, but they float on a hotter, softer layer in the Earth's mantle. As the plates move about on the layer beneath them, they spread apart, collide, or slide past each other. Volcanoes occur most frequently at the boundaries of these plates and volcanic eruptions occur when the hotter molten materials, or magma, rise to the surface.

The primary threat to lives and property from active volcanoes is from violent eruptions that unleash tremendous blast forces, generate mud and debris flows, and produce flying debris and ash clouds. The immediate danger area in a Volcano-Related Events generally lies within a 20-mile radius of the blast site. Although there are no active volcanoes in Beaverton or Washington County, there are a number of active volcanoes within the 100-mile danger areas that do pose a threat to city residents and property. The threat they pose is associated primarily with ash fall.

History of Volcano-Related Events in the Pacific Northwest

There are five major volcanoes in the Cascade region that are in relative proximity and pose a potential threat to Beaverton. They include Mount St. Helens, Mount Hood, Mount Rainier, Mount Adams, and Mount Jefferson. Of the five, 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 is the only volcano that has no geological evidence of large explosive events, though it still poses a threat of ash releases.

Figure 12-1



Source: USGS Cascades Volcano Observatory

Mount Hood

Mount Hood is located about 50 miles southeast of Portland. It has been recurrently active over the past 50,000 years. It has had two significant eruptive periods in

geologically recent times, one about 1,500 years ago and another about 200 years ago. Figure 12.1 shows the major geologic events in the Mount Hood Region during the past 30,000 years.

While Mount Hood has shown no recent signs of volcanic activity, scientists predict the next eruption will consist of small explosions generating pyroclastic flows, ash clouds, and lahars (mud and debris flows).

Mount St. Helens

Mount St. Helens, located in southwestern Washington about fifty miles northeast of Portland, is fifty thousand years old. Over the past 521 years, it has produced four major explosive eruptions and dozens of smaller eruptions. On May 18th, 1980, Mount St. Helens "…exploded violently after two months of intense earthquake activity and intermittent, relatively weak eruptions, causing the worst volcanic disaster in the recorded history of the United States."[1]

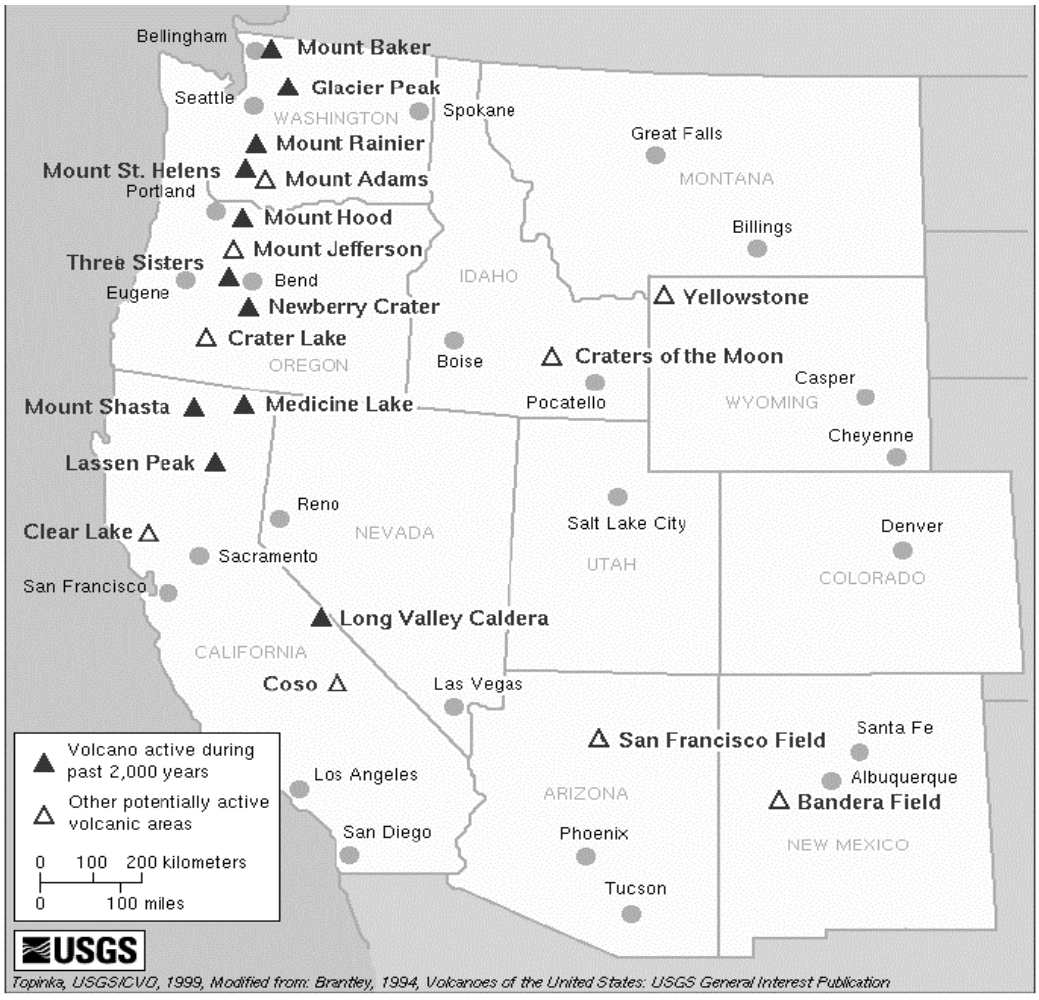
Damage to the built environment within the immediate hazard vicinity in Washington state included twenty-seven bridges, about two hundred homes, more than 185 miles of highways and roads, and fifteen miles of railways. Ash from the eruption column and cloud spread across the United States in three days and circled around the Earth in fifteen days. Detectable amounts of ash were noted in an area covering 22,000 square miles. Debris flows quickly filled the Toutle and Cowlitz Rivers and ultimately flowed into the Columbia River at Longview, Washington. The debris blocked the main shipping channel in the Columbia, stranded ships in port, and closed the ports of Portland, Vancouver, and Kalama for over a month. Several water and sewage treatment facilities were also damaged or destroyed. The estimated damage attributed to the eruption was $1.1 billion.

The May 18, 1980 eruption was preceded by about two months of precursor activity, including dome building, minor earthquakes, and venting of gasses. The lateral blast, debris valance, and mudflow associated with the eruptions caused extensive loss of life and widespread destruction of property. The eruption triggered a magnitude 5.1 earthquake about one mile beneath the volcano. In the six-year period after the initial eruption, hundreds of small ash emissions at Mount St. Helens occurred.

The eruption of Mount St. Helens took the lives of 57 people and nearly 7,000 big game animals. All birds and most small mammals in the area were killed as were twelve million Chinook and Coho salmon fingerlings that perished when their hatcheries were destroyed.

The May 18, 1980 eruption was followed by five smaller explosive eruptions over a period of five months.[2] A series of 16 dome-building eruptions constructed the new, 880-foot high lava dome in the crater formed by the May 18, 1980 eruption. An eruption occurring in 1480 A.D. was approximately five times larger than the May 18, 1980 event.[3]

Figure 12-2. Potentially Active Volcanoes in the West



Source: United States Geological Survey.
http://www.volcano.si.edu/reports/usgs/maps.cfm#usa

History of Volcano-Related Events Affecting Beaverton

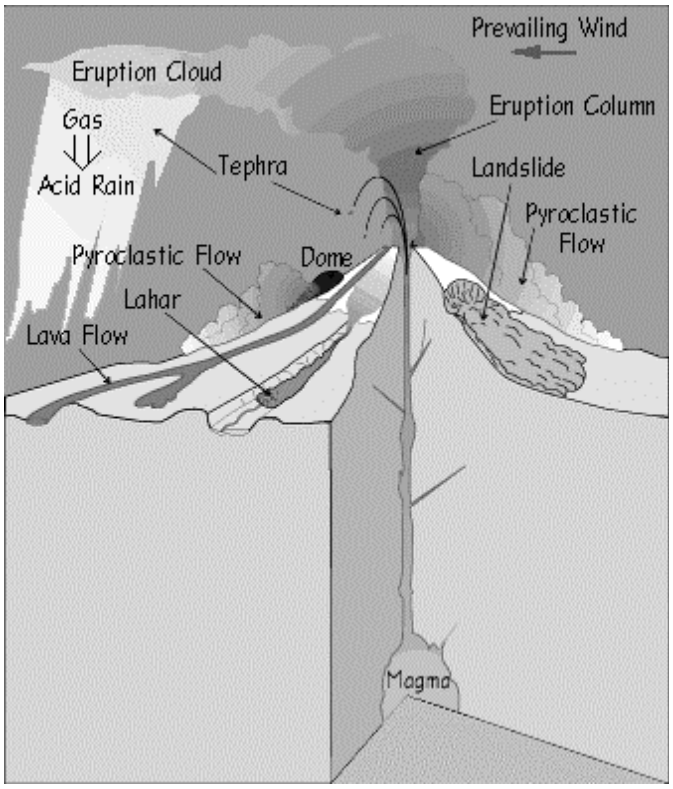
The only historical incidence of a volcano directly affecting Beaverton was the eruption of Mount St. Helens on May 18, 1980. The Beaverton *Valley Times* followed the story of "mountain watchers" who watched the volcano from a campground near Cougar, Washington, throughout the spring of 1980. The eruption resulted in massive mudflows, floods and other land-changing forces."[4] Ash from the eruption clouded the air in the Portland Metropolitan area, but did not ultimately cause damage in Beaverton. Emergency management in Washington County was prepared for the ash by providing facemasks and preparing for road closures. Because wind direction continued to head to the east after the eruption, Beaverton escaped significant accumulations of ash fall.[5]

A few millimeters of ash fell onto Beaverton during small events on May 25, June 12, and October 16-18, 1980. The May 25 event left ash covering buildings, vehicles, lawns, and streets. For days, even weeks afterward, residents and government officials worked to clear away the fine powder and local hospitals treated a large number of patients suffering from respiratory problems attributed to the ash. They handed out surgical masks to help filter the ash, but the masks were largely ineffective. Residents and government officials worked aggressively to remove the ash deposits by flushing them into storm drains or sweeping them up and hauling them to landfill sites. Parks and outdoor swimming pools were particularly hard hit, requiring pool drainage and frequent filter cleaning. Ash also worked its way into equipment causing premature failures or requiring unscheduled maintenance.[6]

Hazards Related to Volcano-Related Events

(Revised 03/2011) This section describes hazards related to Volcano-Related Events. Figure 12.3 shows a cross-section of a volcano and some of the hazards associated with volcanoes. Tephra, or ash, is the primary volcano related hazard that may impact the City.

Figure 12-3. Cross section of a volcano



Source: United States Geological Survey.
http://volcanoes.usgs.gov/Hazards/What/hazards.html

Tephra

Tephra consists of sand-sized or finer particles of volcanic rock and larger fragments. During explosive eruptions, tephra, together with a

mixture of hot volcanic gases, is ejected rapidly into the air from volcanic vents. The suspended materials are carried high into the atmosphere and begin to move downwind. As the ash particles cool or become moisture laden they start to fall under the influence of gravity. The larger fragments fall near the volcanic vent, while finer particles drift downwind as a large cloud and then fall to the ground to form a blanket-like deposit of ash.[7]

Tephra generates a number of hazards including the impacts of falling fragments, the suspension of abrasive particles in the air and water, and the burial of structures, transportation routes, and vegetation. Tephra can also threaten public health, clog drainage and facility ventilation systems, clog the air intakes of internal-combustion engines (especially vehicles), and create major debris management problems. The 1980 eruption of Mount St. Helens, for example, injected tephra to altitudes of twelve to twenty miles and deposited it over an area of 40,000 square miles or more. The direction and velocity of the wind, along with the magnitude and duration of the eruption, determine the location, size, and shape of the tephra fall. Wind forecasts from National Weather Service and models of ash dispersal developed by volcanologists can provide short-term forecasts for areas that might be subject to ash fall.[8]

As indicated, ash fall can have significant impacts on water drainage systems. The accumulation of ash in Beaverton's drainage system from the 1980 eruption of Mount St. Helens resulted in the accumulation of a cement-like substance, which has reduced the capacity of the system over time. Beaverton must be aware of the potential tephra hazards that can arise from eruptions at nearby volcanoes.

Lahars

Melting snow and ice caused by pyroclastic flows and surges can generate lahars, also called volcanic mudflows or debris flows. Lahars are rapidly flowing, water-saturated mixtures of mud and rock fragments. Lahars range in consistency from mixtures resembling freshly mixed concrete to very muddy water, and can carry materials as large as truck size boulders. Past lahars at Mount Hood completely buried valley floors in the Sandy, Hood, and White River drainages. Beaverton is not at risk from lahars. However, water from the Bull Run Watershed, which supplies drinking water to about 15% of Beaverton residents, could be affected directly or indirectly by lahars from Mount Hood.[9]

Lava Flows

Magma under the Earth that reaches the surface is called lava. Lava flows downhill and is channeled into river valleys. A lava flow only affects terrain that is down-slope from its vent. While lava flows are destructive, they are not normally life threatening. There are ninety-five named and unnamed Boring Lava Field vents in the Portland area. The Swede Hill area, on the northeastern side of Beaverton, has seven vent locations, with four of them named.[10] There is a very low

probability of a Volcano-Related Events beginning in Beaverton. However, if an eruption occurred, it would likely be effusive and form lava flows.[11]

Earthquakes

Volcanic eruptions can both be triggered by earthquakes and can cause them. An earthquake produced by stress changes in solid rock from injection or withdrawal of magma (molten rock) is called a volcano-tectonic earthquake. The other categories of volcanic earthquakes, called long period earthquakes, are produced by the injection of magma into surrounding rock. Volcanic earthquakes tend to be mostly small and not a problem for areas tens of miles from the volcano. For specific hazards related to earthquakes, see Chapter 11 of this document.

Directed Blasts, Pyroclastic Flows and Volcanic Landslides

Directed blasts, also known as lateral blasts, are sideways-directed volcanic explosions that can shoot large pieces of rock at high speeds for several miles.[12] Pyroclastic flows are fluid mixtures of hot rock fragments, ash, and gases that sweep down the flanks of volcanoes. Landslides, or debris avalanches, are a rapid downhill movement of rocky material, snow, or ice.[13] Though these hazards could cause great impact to communities near an erupting volcano; they do not pose a threat to Beaverton resident.

Community Volcano-Related Events Issues

Volcano-Related Events are not immediate threats to the residents of Beaverton, as there are no active volcanoes within Washington County. Nevertheless, the presence of a few geologically young volcanic structures near Beaverton and the secondary threats caused by volcanoes in the Cascade region must be considered. Volcanic ash can contaminate water supplies, cause electrical storms, create health problems, and collapse roofs.[14] Additionally, lahars from Mount Hood could cause the loss of some potable water supplies for the city.

Building and Infrastructure Damage

Beaverton is not within the major hazard zones of any Cascade volcanoes. It is not likely to encounter any major building or infrastructure damage where buildings could be buried, smashed, or carried away by lahar, pyroclastic flow, or landslide. The primary impacts facing city residents are related to ash fall.

Ash fall of about 0.4 inch is capable of creating temporary disruptions of transportation operations and sewage disposal and water treatment systems. Highways and roads could be closed for hours, days, or weeks afterwards. The impact of the ash fall caused the Portland International Airport to close for a few days during the eruption of Mt. St. Helens. The airport faced a series of challenges in cleaning up the ash that accumulated on its runways.

The fine-grained, gritty ash can also cause substantial problems for internal-combustion engines and other mechanical and electrical

equipment. The ash can contaminate oil systems, clog air filters, and scratch moving surfaces. Fine ash can also cause short circuits in electrical transformers, which in turn cause power blackouts. Sewage disposal systems, high tech facilities, and other critical industries in Beaverton face these challenges.

Pollution and Visibility

Ash fallout from an eruption column can blanket areas within a few miles of the vent with a thick layer of pumice. High-altitude winds may carry finer ash from tens to hundreds of miles from the volcano, posing a hazard to flying aircraft, particularly those with jet engines.[15] Fine ash in water supplies will cause brief muddiness and chemical contamination. The Tualatin River and the Bull Run Watershed, which provide some of the drinking water for Beaverton residents, face potential pollution by ash fall. Air quality could also be affected. For individuals with breathing problems, a few millimeters of ash fall may cause difficulties in breathing.[16]

Ash fall also decreases visibility and disrupts daily activities. For example, some individuals may encounter eye irritation. Visibility is especially a concern for airports, where passenger and airfreight movement could be disturbed. When the ash fall produced by the Mount St. Helens' eruption started to blow towards Oregon in June 1980, some of the airlines at the Portland International Airport responded immediately by stopping their service. Hillsboro Airport, which lies near Beaverton and handles a large volume of private aircraft, would probably have to curtail or cease operations during an ash fall event.

Economy

Volcano-Related Events can disrupt the normal flow of commerce and daily human activity without causing severe physical harm or damage. Ash that is a few inches thick can halt traffic, and cause rapid wear and tear of machinery, clog air filters, block drains, creeks, water intakes, and impact agriculture.[17] Removal and disposal of large volumes of deposited ash can also have significant impacts on government and business.

The interconnectedness of the region's economy can be disturbed after a Volcano-Related Events. The Mount St. Helens' May 1980 eruption had a negative affect on the tourism industry. Conventions, meetings, and social gatherings were canceled or postponed in cities and resorts throughout Washington and Oregon in areas not initially affected by the eruption.

Transportation of goods and people to and from Beaverton may be halted. Subsequent airport closures can disrupt airline schedules for travelers and airfreight shipments. Other transportation operations can be impacted as well. Clouds of ash often cause electrical storms that start fires and damp ash can short-circuit electrical systems and disrupt radio communication. Ash fall can directly or indirectly disrupt the light rail system and Tri-Met bus service. Volcanic activity can also

lead to the closure of nearby recreation areas as a safety precaution long before the activity ever culminates into an eruption.[18]

Volcano-Related Events Hazard Assessment

Hazard Identification

The USGS/Cascades Volcano Observatory (CVO) produced volcanic hazard zonation reports for Mount St. Helens and Mount Hood in 1995 and 1997 as well as an update to the Mount Hood report in 2000. The reports include a description of potential hazards that may occur to immediate communities. In 2001, the CVO created an updated map on the annual probability of tephra fall for the Cascade region, which can be used by the City as a guide for forecasting potential tephra hazard problems.

The map is based on the combined likelihood of tephra-producing eruptions occurring at Cascade volcanoes. Probability zones extend father east of the range because winds blow from westerly directions most of the time. The map shows annual probabilities for a fall of one centimeter (about 0.4 inch). The patterns on the map show the dominating influence of Mount St. Helens as a tephra producer. Because small eruptions are more numerous than large eruptions, the probability of a thick tephra fall at a given location is lower than that of a thin tephra fall. The annual probability of a fall of one centimeter or more of tephra is about 1 in 10,000 on the county level, even less for the City.

Vulnerability Assessment

Vulnerability assessment is the second phase of a hazard assessment. It combines information generated through hazard identification with an inventory of the existing development exposed to Volcano-Related Events. Vulnerability assessments assist in predicting how different types of property and population groups will be affected by a hazard.[19] Data that includes areas susceptible to ash fall in the City can be used to assess the population and total value of property at risk from Volcano-Related Events.

While a quantitative vulnerability assessment (an assessment that describes number of lives or amount of property exposed to the hazard) has not been conducted for Beaverton Volcano-Related Events events, there are many qualitative factors (issues relating to what is in danger within a community) that point to potential vulnerability. Beaverton faces no direct threat from a Volcano-Related Events. However, its proximity to a number of Cascade Range volcanoes places the City at risk from ash fallout originating from such an event.

Future Activity at Mount Hood: While Mount Hood has shown no recent signs of volcanic activity, scientists predict the next eruption will consist of lava dome growth accompanied by small explosions, and lava-dome collapse generating pyroclastic flows, ash clouds, and lahars.

Future eruptions from Mount Hood could seriously disrupt transportation, water supplies, and hydroelectric power generation and transmission in northwestern Oregon and southwestern Washington.

The City also faces an indirect threat to a small percentage of its water supply based on a volcanic scenario impacting the Bull Run Water System. The impacts of a significant ash fall are substantial. Persons with respiratory problems are endangered, transportation, communications, and other lifeline services are interrupted, drainage systems become overloaded/clogged, buildings can become structurally threatened, ventilation systems can become clogged and the economy takes a major hit. Any future eruption of a nearby volcano (e.g., Hood, St. Helens, or Adams) occurring during a period of easterly winds would likely have adverse consequences for the City.

Risk Analysis

Risk analysis is the third, and most advanced phase of a hazard assessment. It builds upon the hazard identification and vulnerability assessments. Key factors in assessing risk from volcanic-related evetns include population and property distribution in the hazard area, the frequency of events, and potential wind direction. At the time of publication of this plan, data was insufficient to conduct a risk analysis and the software needed to conduct this type of analysis was not available.

Existing Mitigation Activities

The mitigation plan goals and action items are derived from a review of city, county, regional, state, and national natural hazards mitigation plans and planning literature, guidance from the Beaverton Natural Hazards Mitigation Steering Committee, and interviews with both Beaverton and Washington County stakeholders. The goals for the City of Beaverton Natural Hazards Mitigation Action Plan are broad based to include all of the identified hazards addressed in the plan. Goals for this mitigation plan address four categories:

1. Protect Human Life, Commerce, Property and Natural Systems
2. Improve Hazard Communication and Coordination through Partnerships
3. Enhance Emergency Services
4. Ensure Implementation of Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies or organizations.

City Programs

Emergency Management Program

Beaverton's Office of Emergency Management maintains a web site with numerous links to information about volcanoes and the National Weather Service.

County Programs

Cooperative Public Agency of Washington County

Every city in Washington County belongs to the Cooperative Public Agency of Washington County (CPAWC). This agency allows cities within the county to share resources, such as equipment, labor, resources, and trainings before, during, and after emergency situations. Through Intergovernmental Agreements (IGA's), the cities can then bill each other for loaned equipment and services.[20]

Federal Programs

Monitoring Volcanic Activity at Mount Hood and Mount St. Helens

The USGS collaborated with scientists from the Geophysics Program at the University of Washington to monitor seismic activity at both Mount St. Helens and Mount Hood after the May 1980 eruption at Mount St. Helens.[18] When unusual activity is observed, scientists immediately notify government officials and the public. The U.S. Forest Service serves as the primary dissemination agency for emergency information. As the activity changes, USGS scientists provide updated advisories and meet with local, state, and federal officials to discuss the hazards and appropriate levels of emergency response. The experience since 1980 at Mount St. Helens and elsewhere indicates that monitoring is sufficient for scientists to detect the ascent of fresh magma that must take place before another large eruption. This information will enhance warnings and facilitate updated assessments of the hazard.

In addition, the USGS and the National Weather Service monitor lahar and flood hazards at Mount St. Helens. The latter agency has responsibility for providing warnings of floods, including lahars. These monitoring activities not only help nearby communities, but can also provide significant benefit to the Pacific Northwest, including Beaverton.

Volcanic Event Notification Emergency Coordination

An emergency coordination center (ECC) was established at the US Forest Service (USFS) facility in Vancouver, Washington after the 1980 eruption of Mount St. Helens. A communications network and telephone call-down procedure was developed to facilitate rapid dissemination of information about the activity of the volcano. Information was also disseminated through public meetings, press conferences, and briefings with governmental agencies and private businesses. Currently, the system has the capability of issuing written predictions weeks in advance of most eruptions. This eliminates the need for 24-hour duty for both USFS/ECC and CVO staff except when eruptions are imminent. It can enter all predictions and updates into a computer "news" system for easy review by those on the call-down list; update volcanic activity reports when the volcano is quiet; and develop a seismic alarm to alert scientists to small events that occur without precursors.

USGS Video Programs

One good example of education and outreach is the USGS series of videos related to Volcano-Related Events. The USGS has produced a video program "At Risk: Volcano Hazards from Mount Hood, Oregon." The video describes and illustrates the types of volcanic hazards posed by Mount Hood, and shows areas near the volcano that could be affected by future activity. The video was produced to provide nearby residents, businesses, and public agencies basic information about future potential hazards from the volcano.[19]

Decade Volcanoes

The Decade Volcanoes project began as part of the International Decade for Natural Disaster Reduction (IDNDR). The aim of the Decade Volcanoes project is to direct attention to a small number of selected, active volcanoes world-wide and to encourage the establishment of a range of research and public-awareness activities aimed at enhancing an understanding of the volcanoes and the hazards posed by them. Mount Rainier, in the Cascade Range, has been designated one of the Decade Volcanoes.[21]

Volcano-Related Events Mitigation Action Items (Revised 03/2011)

The Volcano-Related Events mitigation action items provide direction on specific activities that the City, organizations and residents can undertake to reduce risk and prevent loss from volcanic events. There are two short-term and two long-term volcanic action items described below. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation.

ST-VE#1: Identify critical facilities and industries that may be affected by ash fall and collaborate with them on ash fall emergency response.

Possible Actions

- Collaborate and exchange experiences and knowledge among facility managers of critical industries in the region to reduce the impact of ash fall on their sites.

Coordinating Organizations: City of Beaverton
Internal Partners: Emergency Management, Public Works
External Partners: United States Geological Survey– Cascades Volcano Observatory (USGS-CVO), Major Industries, Department of Geology and Mineral Industries (DOGAMI), United States Forest Service (USFS), Utility Providers, Federal Emergency Management Agency (FEMA)
Timeline: On-going

Plan Goals Addressed: Improve Partnerships for Communication and Coordination, Enhance Emergency Services

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ST-VE#2: Collaborate with USGS-CVO and related agencies to increase awareness of volcanic response efforts through ash fall related messages.

Possible Actions

- Collaborate with USGS-CVO, OCEM, FAA, National Weather Service, law enforcement offices, and the media to develop a warning message framework that is more appropriate for the area so that communities and individuals have a clear sense of how to respond;
- Continually update information, monitor and track in the event of a volcanic emergency; and
- Educate residents on what to do and where to go in the event of a volcanic event in the Cascades.

Coordinating Organizations: City of Beaverton
Internal Partners: Emergency Management
External Partners: United States Geological Survey – Cascades Volcano Observatory (USGS-CVO), Federal Aviation Administration (FAA), Department of Geology and Mineral Industries (DOGAMI), Oregon Emergency Management (OEM), National Weather Service, law enforcement offices, local media, Regional Emergency Management Technical Committee (REMTC), Federal Emergency Management Agency (FEMA) Region 10 Volcanic Working Group, Tualatin Valley Fire and Rescue District, School Districts
Timeline: On-going
Plan Goals Addressed: Protect Human Life, Commerce, Property and Natural Systems; Improve Partnerships for Communication and Coordination

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LT-VE#1: Map and model ash fall.

Possible Actions

- Map and model ash fall to assist in interpreting potential scenarios, including prevailing winds that could impact Beaverton.

Coordinating Organizations: City of Beaverton
Internal Partners: ISD/GIS, Emergency Management
External Partners: United States Geological Survey – Cascades Volcano Observatory (USGS-CVO), Department of Geology and Mineral Industries (DOGAMI), National Weather Service, Washington County
Timeline: Future Plan Cycle

Plan Goals Addressed: Protect Human Life, Commerce, Property and Natural Systems

LT-VE#2: Establish a plan for ash removal following a volcanic event.

Possible Actions

- Educate residents on what they can do to assist in clean-up and debris removal efforts following a volcanic event;
- Assist the public in removing ash by developing a system for ash removal; and
- Develop public and private partnerships to ensure proper clean-up.

Coordinating Organizations: City of Beaverton
Internal Partners: Emergency Management, Public Works Department
External Partners: Washington County, Waste Management
Timeline: Future Plan Cycle
Plan Goals Addressed: Protect Human Life, Commerce, Property and Natural Systems

Volcano-Related Events Resource Directory

(Revised 03/2011) – See Appendix G: Consolidated Resource Directory.

Volcano-Related Events Endnotes

[1] Tilling, et.al.,1990. http://www.Vulcan.wr.usgs.gov/Volcanoes/MSH/Hazards

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[3] Community Planning Workshop, 2002

[4] The Valley Times, May 21, 1980. Vol.60 No.37.

[5] The Valley Times, May. 23, 1980. Vol.60 No.38

[6] Community Planning Workshop, 2002

[7] Ibid

[8] Ibid

[9] The City of Beaverton web site http://www.ci.Beaverton.or.us

[10] *Volcano Hazards of the Lassen Volcanic National Park Area,* (March 2001), USGS.

[11] Community Planning Workshop, 2002

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[19] Burby, R. (Ed.). Cooperating with Nature. (1998). Washington D.C. Joseph Henry Press.

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