TORNADO[23]

SUMMARY

The Hazard: Tornadoes are the most violent weather phenomena known. They are characterized by funnel clouds of varying sizes that generate winds as fast as 500 miles per hour. They can affect an area of ¼ to ¾ of a mile and seldom more than 16 miles long. [24]

Impacts and Effects:

- Death
- Severe Injury
- Destruction

Previous Occurrences: Due to the sparse population in Jefferson County, tornados most frequently occur in forested regions and are only identified because of the nature of the destruction in a given area.

Probability of Future Events: Moderate – Climatic changes may be impacting the frequency and duration of tornado conditions on the Olympic Peninsula.

Natural Hazard Risk Rating: The average natural hazard risk rating for tornados for all districts in Jefferson County was estimated at 3.1, which is the lowest risk rating for all natural hazards that Jefferson County has seen.

Definition

Tornadoes are the most violent weather phenomena known. They are characterized by funnel clouds of varying sizes that generate winds as fast as 500 miles per hour. They can affect an area of ¼ to ¾ of a mile and seldom more than 16 miles long. Tornadoes normally descend from the large cumulonimbus clouds that characterize severe thunderstorms. They form when a strong crosswind (sheer) intersects with strong warm updrafts in these clouds causing a slowly spinning vortex to form within a cloud. Eventually, this vortex may develop intensity and then descend to form a funnel cloud. When this funnel cloud touches the ground or gets close enough to the ground to affect the surface it becomes a tornado. Tornadoes can come from lines of cumulonimbus clouds or from a single storm cloud. Tornadoes are measured using the Fujita Scale ranging from F0 to F6.[25] The scale increases according to the amount of damage left by the tornado.

History of Tornados in Jefferson County

Jefferson County does not have a record of significant tornado activity. Generally, the Northwest lacks the big thunderstorms that spawn tornados. From the period 1880 through 2000, there have been no recorded tornados in Jefferson County.[26] Washington usually experiences one to two tornados each year. In 2004, however, there were nine, while in 2007 none were reported. Wind patterns in Jefferson County are broken up by the Olympics, thus mitigating tornado spawning conditions.[27]

Hazard Assessment and Vulnerability Assessment

Tornadoes are not normal occurrence in the Northwest the way they are in the Midwest. Tornadoes require a confluence of warm surface temperatures and warm fronts coming from the south with cold fronts coming from the north. Northwest climates do not normally generate the temperature variations conducive to tornado formation. Washington is ranked 43 in the US for total number of tornadoes. Nonetheless, the tornado threat should be taken very seriously. The conditions conducive to tornado formation can develop in Northwest Washington, although it is not common for funnel clouds to be reported in this region. During severe thunderstorms it is possible for tornadoes to occur.

Tornadoes in Washington tend to be light or moderate, with winds ranging from 40 to 112 mph. There are a notable minority of tornadoes that cause significant to severe damage with winds going as high as 200 mph. The peak season for tornadoes is April through July. However, in Washington tornadoes may occur in the late summer months and, in a few rare cases, may occur in the winter months. While tornadoes are sometimes formed in association with large Pacific storms, most of them are caused by intense local thunderstorms. Tornadoes almost exclusively occur in the late afternoon and early evening.

Normally, Pacific Northwest tornadoes are moderate but it is possible for serious tornadoes to develop, causing death and serious injury.

Typically, tornadoes may cause severe damage to everything in their path. Walls collapse, roofs are ripped off, trees and power lines are destroyed. The challenge is that tornadoes, especially in the Northwest, are very difficult to predict and their onset is sudden. Unlike the tornado-prone areas in the plains states, there is little awareness of the tornado threat and the forecasting and warning systems are less well developed. It is extremely rare for a tornado watch or warning to be issued anywhere in the Northwest. As such, there is little public awareness of the warning systems and self-protection measures common to the tornado prone states.

CONCLUSION

Emergency response agencies should not be taken by surprise by a tornado in Jefferson County. While violent tornadoes are not a characteristic of the Northwest Washington climate, the weather systems that may generate tornadoes appear regularly. Emergency response agencies and emergency management officials should be prepared for the rapid notification of the public and for the efficient management of a mass casualty incident, and the prioritization of debris clearance.

THE FUJITA-PEARSON SCALE[25]

The National Weather Service scales tornadoes by intensity on a scale of zero to five on the Fujita-Pearson scale which include:

F-0. Light damage. Wind up to 72 mph. Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.

F-1. Moderate damage. Wind 73 to 112 mph. The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.

F-3. Severe damage. Wind 158 to 206 mph. Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.

F-4. Devastating damage. Wind 207 to 260 mph. Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.

F-5. Incredible damage. Wind above 261 mph. Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel-reinforced concrete structures badly damaged.

TSUNAMI / SEICHE[28]

SUMMARY

The Hazard: Tsunamis are wave trains, or series of waves, generated in a body of water by an impulsive disturbance including earthquakes, subaqueous or terrestrial landslides impacting water bodies, or volcanoes.

Impacts and Effects:

- Loss of life
- Loss of property
- Damage to critical transportation infrastructure
- Damage or loss of recreation facilities
- Disruption of utilities
- Loss of jobs due to damaged equipment and facilities

Previous Occurrences: Geologic evidence shows that the Jefferson County area around Discovery Bay and the City of Port Townsend have experienced at least 7 major inundations.

Probability of Future Events: High – Minor tsunamis have been documented every few years. There are several know faults and subduction zones capable of generating major tsunamis as part of an underwater subsidence.

Natural Hazard Risk Rating: The average natural hazard risk rating for tsunamis for all districts in Jefferson County was estimated at 10.45, which would be considered low. Districts with water boundaries, however, consistently rate the risk at 40, which, while moderate, is among the highest ratings given in Jefferson County.

Definition:

Tsunamis are wave trains, or series of waves, generated in a body of water by an impulsive disturbance including earthquakes, subaqueous or terrestrial landslides impacting water bodies, or volcanoes. Tsunami waves, often incorrectly described as tidal waves, are extremely destructive to life and property. Imperceptible on the open ocean, they can travel at velocities of up to 1000 km/h. Tsunami waves are usually 100 or more miles from crest to crest and can reach heights of up to 30 meters. They can traverse the entire 12,000 to 14,000 miles of the Pacific Ocean in 20 to 25 hours, striking with virtual undiminished force on coastal areas.

A seiche is the formation of standing waves in water body, due to wave formation and subsequent reflections from the ends. A seiche may be incited by earthquake motions, impulsive winds over the surface, or wave motions entering the basin.

History of Tsunamis in Jefferson County

The Washington coast, including the coastal areas of Jefferson County, experienced a large tsunami following the 1964 Alaskan earthquake; however no deaths were reported in this state. As recently as October 1994, a tsunami warning was issued for the Washington coast due to an earthquake in Japan, although it did not reach the coast.

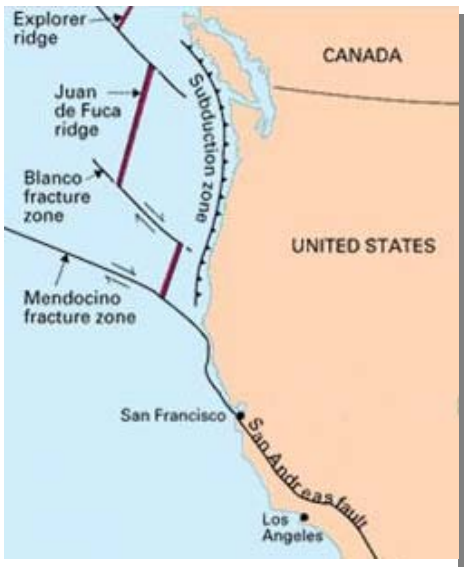
Research indicates that an earthquake on the west coast of America in 1700 caused a tsunami in Japan that killed thousands of people. Local evidence now indicates that the same tsunami damaged the west coast of Jefferson County and the lowlands of Grays Harbor and Pacific counties.

The Washington State Emergency Operations Center was activated on June 9, 1996 after the Alaska Tsunami Warning Center issued a Tsunami Watch for the Washington coast and Puget Sound. An earthquake of 7.5 near Adak, Alaska generated a seismic wave of 2.5 feet. The state EOC returned to normal operations on the same date after the Tsunami Warning Center determined there was no threat to Washington State. Although not a common occurrence, the history indicates that the potential for tsunamis exists for coastal areas and areas along the Strait of Juan de Fuca.

Figures TS-1 and TS-2 show the recognized tsunami inundation zone for Port Townsend. City Hall and half of the grocery and hardware stores are within the zone. The police station was moved out of the tsunami zone in 2009.

Hazard Identification and Vulnerability Assessment

The Pacific coastal areas and inland waters on the Strait of Juan de Fuca are the most vulnerable to tsunamis generated at a distance or by a local subduction zone earthquake. Damaging tsunamis striking the Pacific Northwest coast over the past century were generated by distant earthquakes located far across the Pacific basin. These tsunamis are distinguished from earthquakes near the coast, termed *local tsunamis*.



http://www.geophys.washington.edu

The Cascadia subduction zone is an oceanic tectonic plate (the Juan de Fuca plate—the edge is indicated here by the Juan de Fuca Ridge) that is being pulled and driven (i.e. subducted) beneath a continental plate (the North American plate). Earthquakes along the fault that is the contact between the two plates, termed the interplate thrust or megathrust, may generate local tsunamis in the Pacific Northwest. Except for the 1992 Cape Mendocino earthquake at the southernmost part of the subduction zone, there have been no major earthquakes on the megathrust in historic time.

Some geologists offer that the Cascadia subduction zone is poised between major earthquakes. Therefore, the possibility exists that local tsunamis may someday accompany a major earthquake along the Cascadia megathrust. Pacific coastal areas and inland waters on the Strait of Juan de Fuca are the most vulnerable to tsunamis generated at a distance or by a local subduction zone earthquake.

As a tsunami leaves the deep water of the open ocean and travels into the shallower water near the coast, it transforms. A tsunami travels at a speed that is related to the water depth - hence, as the water depth decreases, the tsunami slows. The tsunami's energy flux, which is dependent on both its wave speed and wave height, remains nearly constant. Consequently, as the tsunami's speed diminishes as it travels into shallower water, its height grows. Because of this shoaling effect, a tsunami, imperceptible at sea, may grow to be several meters or more in height near the coast. When it finally reaches the coast, a tsunami may appear as a rapidly rising or falling tide or a series of breaking waves.

A tsunami generated by a Cascadian Subduction Zone earthquake directly off the coast of Washington State, could arrive in less than a half hour. Tsunami waves from a Cascadia Subduction Zone earthquake located off the shore of Northern California or Northern British Columbia may reach the coast of Washington State in an hour or less.

Puget Sound is vulnerable to tsunamis generated by local crustal earthquakes or by submarine landslides triggered by earthquakes. Wave oscillations in enclosed or semi-enclosed bodies of water are called seiches. Seiches are caused by earthquake induced land surface waves that generate oscillations in bodies of water, resulting in fluctuations of the water levels causing sloshing from one end to the other. In 1891, an earthquake centered near Port Angeles caused eight-foot waves in Lake Washington.

The death and damage that can be inflicted by a tsunami is notable. The wave action is destructive in itself, however floating debris left after the wave can continue batter coastline structures and development. Boats moored in harbors and marinas often are swamped and sunk, or are destroyed and stranded on the shore. Breakwaters and piers collapse. Storage tanks situated near the waterfront are vulnerable. Port facilities, fishing fleets, and public utilities are frequently the backbone of the economy of the affected areas, and these are the very resources that generally receive the most severe damage.

Until debris can be cleared, wharves and piers rebuilt, utilities restored, and the fishing fleets reconstituted, communities may find themselves without fuel, food and employment. Wherever water transport is a vital means of supply and economic sustainment, disruption of coastal and inland seaports can have far reaching economic effects. Tsunami effects on fishing, mollusks, shore plants and marine and land organisms can be devastating. In addition to the enormous direct destruction caused by the waves themselves, salt water can invade coastal lakes and destroy, at least temporarily the fresh water habitat.

Jefferson County's ocean coastal areas have many miles of cliffs and high banks that slow or retard wave inundation. Lower elevation lands of river and stream outlets, however, do have small communities near their banks.

Port Townsend: The National Tsunami Hazard Mitigation Program's Center for Tsunami Inundation Mapping Efforts has developed tsunami models to help jurisdictions along the Southern Washington Coast, and Port Angeles and Port Townsend prepare evacuation plans for a future tsunami. The models use a moment magnitude 9.1 earthquake on the Cascadia Subduction Zone off the Washington coast as the generator of the tsunami.

Projects covering these areas have identified at-risk communities (all census designated and incorporated places within one kilometer of the coast) and developed arrival times and wave elevations for them.

For communities on the outer coast, the first wave crest is predicted to arrive between 30 and 60 minutes after the earthquake; in Willapa Bay and Grays Harbor, the first crest is not expected to arrive for more than an hour.

Significant flooding can occur before the first wave crest because a Cascadia Subduction Zone earthquake is expected to lower the ground surface along the coast. Flooding of areas less than six feet above tide stage is expected immediately. Maximum flooding depth and extent will depend on tide height at the time of tsunami arrival.

For the Port Angeles and Port Townsend areas, the crest of the first wave is expected within 90 minutes of the earthquake, with significant flooding before the crest.

West Jefferson County: Jefferson County's west end consists of about 27 miles of open ocean frontage, small unincorporated towns, and two Indian tribes: the Quileute and the Hoh. Modeling of the Cascadia fault suggests that tsunami waves in excess of thirty feet high could inundate the shoreline. The Hoh Tribe of Indians have the most vulnerable community with approximately 62 individuals, of which 60% are in the inundation zone at the mouth of the Hoh River. They have been working diligently to acquire elevated land around the perimeter of the reservation in order to move their community center and emergency facilities to high ground to give tribe members a place to go during a tsunami emergency.

CONCLUSION

Tsunami damage can be minimized through land use planning, preparation, and evacuation. Tsunamis tend to impact the same localities over and over again. Therefore, if tsunamis have damaged an area before, they are likely to do so again. One choice is to avoid living in or using areas with significant tsunami hazard. Alternatively, communities can review land use in these areas so that no critical facilities, such as hospitals and police stations, or high occupancy buildings, such as auditoriums or schools, or petroleum-storage tanks are located where there is tsunami hazard.

If warning is received early enough (two to five hours) which is possible for tsunamis generated at a distance, preventative action can be taken. People can be evacuated; ships can clear harbors or seek a safe anchorage; equipment and vehicles can be moved; and buildings can be boarded up and sandbagged. The time from initiation of an earthquake to a tsunami for local earthquakes, however may be only a few minutes to at most a little more than an hour. Residents in areas susceptible to tsunamis should be made aware of the need to seek high ground if they feel strong shaking. Coastal communities should identify evacuation routes even if they do not have good information about potential inundation areas. Standard signs have been adopted for use throughout tsunami prone areas on the west coast. These signs have been posted along highways, beach areas, and campgrounds. Brochures with information on tsunamis have also been provided to these areas.

The U.S. West Coast/Alaska Tsunami Warning Center (WC/ATWC) was established in Palmer, Alaska in 1967 as a direct result of the great Alaskan earthquake that occurred in Prince William Sound on March 27, 1964.

Since 1986, it has taken the Center an average of 10 minutes to get a warning out to potentially affected areas. Messages are composed automatically based on earthquake location and are sent to National Weather Service (NWS) offices. The NWS offices forward the message to NOAA Weather Radio, the Emergency Alert System, the Emergency Managers Weather Information Network, and other communication systems available to the public and media.

Coastal areas ranging from Cape Flattery to Long Beach can now receive weather and emergency alert warning information for a radio transmitter site on Mt. Octopus in West Jefferson County. This weather radio site is predicted to help save lives and alert property owners of wind, wave and storm conditions. The Mt. Octopus radio transmitter will also provide residents and visitors critical warnings in case of tsunamis generated by distant earthquakes in the Pacific area.

Photo by Bob Hamlin

A transmitter, called AHAB (All Hazard Alert Broadcast), installed at the Port Townsend Boat Haven will also provide information on tsunamis, local weather warnings, and other appropriate emergency warning information for the Port Townsend area.

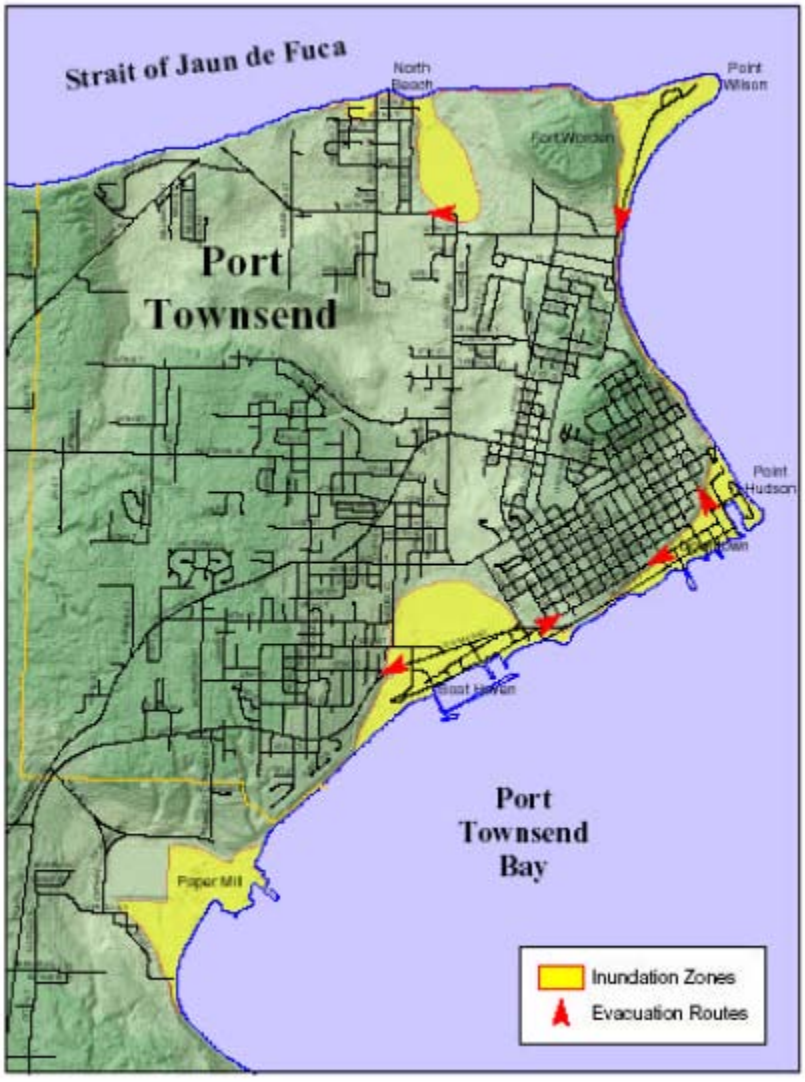
Figure TS-1: Tsunami Inundation Zone – Port Townsend and Vicinity

Figure TS-2 Hazard Profile – Tsunami[29]

Jefferson County

Communities with population at risk:
Marrowstone Island
Port Townsend
Port Hadlock-Irondale

Projected at-risk population: 9,612



Tsunami inundation and evacuation map from Jefferson County Department of Central Services, September 2003

VOLCANIC EVENT / ASH FALL[30]

SUMMARY

The Hazard: Volcano is an opening in Earth's surface through which lava (molten rock), hot gases, and rock fragments erupt from the earth's interior.[31] The hazard can come in the direct form of molten lava, poisonous and corrosive gases, or ash fall that affects people and equipment.

Impacts and Effects:

- Loss of life
- Loss of property
- Resultant earthquakes
- Potential clouds of carbon dioxide, toxic gases, and regional acid rains
- Flooding, landslides, avalanches, ash falls
- Damage to mechanical and electronic equipment from fine ash falls
- Damage to critical transportation infrastructure
- Destruction of dams
- Disruption of hydroelectric power sources
- Heavy demands on power supplies as heavy ash falls block out light
- Destruction of stream beds and salmon habitat
- Damage or loss of recreation facilities
- Loss of jobs due to damaged equipment

Previous Occurrences: The last significant volcanic eruption to affect Jefferson County was the Mount St. Helens eruption in 1980.

Probability of Future Events: Low – Due to prevailing westerly winds, the probability of an annual ash fall from any major Cascade volcano of one centimeter ranges from 1 in 1000 to 1 in 5000.[32]

Definition

A volcano is an opening in Earth's surface through which lava (molten rock), hot gases, and rock fragments erupt from the earth's interior. Such an opening forms when melted rock from deep within Earth (magma) blasts through the surface.

Volcanoes take many forms according to the chemical composition of their magmas and the conditions under which the magmas are erupted. Most volcanoes are mountains, particularly cone-shaped ones, which were built up around the opening by lava and other materials thrown out during eruptions.

In some eruptions, huge fiery clouds rise over the mountain, and glowing rivers of lava flow down its sides. In other eruptions, red-hot ash and cinders shoot out the mountaintop, and large chunks of hot rock are blasted high into the air. A few eruptions are so violent they blow the mountain apart.

History of Volcanoes as they Affect Jefferson County

There are no volcanoes in Jefferson County; however, the proximity to potentially active volcanoes in the Cascade Mountains to the east could impact the county. When Mt. St. Helens erupted on May 18, 1980, heavy ash from a west wind blanketed much of Eastern Washington. Subsequent eruptions on May 25 and June 12 similarly affected Western Washington, although to a lesser degree.

Eruptions of any of the active volcanoes in Western Washington and Oregon could significantly affect travel, tourism and air quality conditions in Jefferson County.

Hazard Identification and Vulnerability Assessment

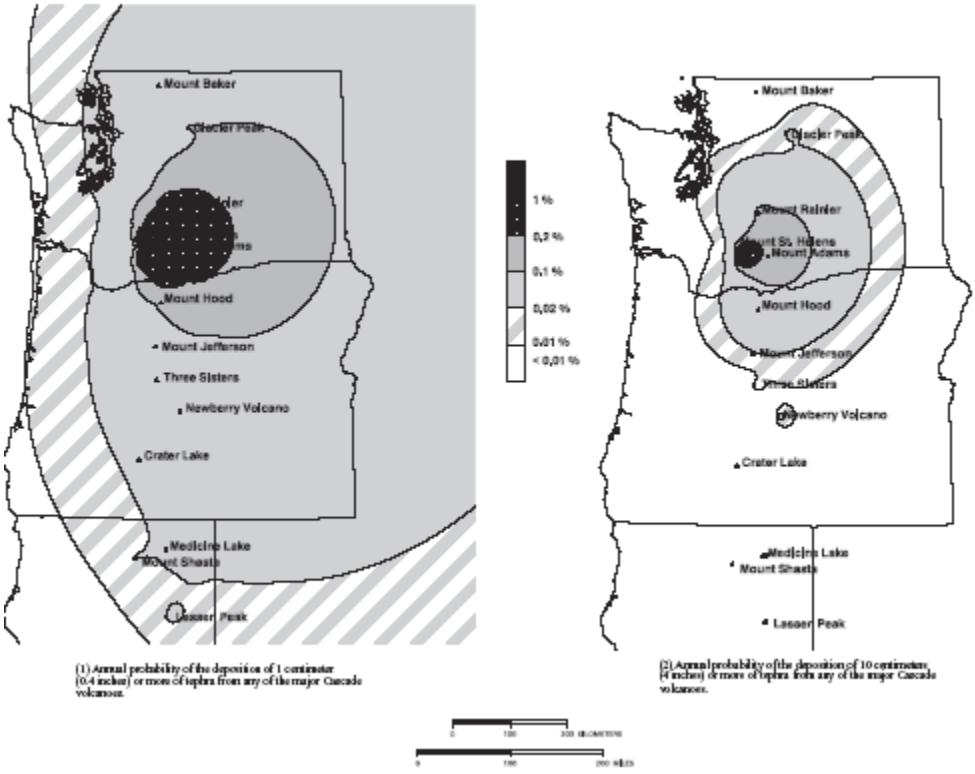
Volcanologists and geologists define Mounts Baker, Rainier, Hood, and St. Helens as active volcanoes. Even Glacier Peak, long thought to have been without an eruption for over 10,000 years is now known to have erupted as recently as a thousand years and possibly as late as the 17th century. Mount Adams is also capable of renewed activity. Seven separate hazards can be associated with volcanoes. They include earthquakes, lava flows, mud flows, ash flows, rock flows, ejecta, and ash falls.

Volcanic hazards can occur with or without an actual eruption. Earthquakes associated with volcanic activity can cause landslides and avalanches in the areas surrounding the actual volcanic sight. With property wind conditions ash deposits could be deposited from all of Washington's volcanoes and from several of those in Oregon. Depending on the size of the eruption and the time of year, the ash could: clog drainage channels; cause electrical short circuits; drift onto roadways; collapse roofs of houses and other buildings, cause skin and eye irritation to the general population , and or respiratory distress to the aged, young and infirm; clog engines and air filters, and create acid rain.

In addition it can disrupt radio, television and telephone transmissions. Since the ash remains on the surface, it can be resuspended in the atmosphere when disrupted by wind or human activities. Heavy ash fall blots out light. Sudden heavy demand for electric light and air conditioning may cause a drain on power supplies, leading to a partial or full power failure. Under normal wind conditions, the ash would move into eastern Washington. In a south or southeasterly wind, Jefferson County could be affected.

The following chart delineates the potential volcanic hazard from Mount Baker erupting.[33] Under those circumstances, most of Jefferson County would be subject to a Tephra hazard. Tephra is the heated rocks that are shot out of the volcano. Large heavy ones fall close to the volcano; small light ones become the volcanic ash that can float in the air for hundreds, even thousands of miles.

Map A: Total Cascades Tephra Hazards



In studying Mount Rainier's active eruptive history, volcanologists and geologists know that it will erupt again. Since the exact type and scale of the eruption(s) cannot be predicted, an awareness of the hazards of ash deposits must be communicated to Jefferson County residents. The hazard is considered "low"; however, the potential for eruptions and the potential results remain.

United States Geologic Survey (USGS) volcanologists and Department of Natural Resources (DNR) geologists identify Mount Rainier as being an active eruptive volcano. From the magnitude of past events it is surmised that the consequences of a lahar (mudflow) or debris flow down the populated river valleys near Mount Rainier will be catastrophic and will potentially result in a tremendous loss of life and property. New studies show that the process of geothermal hydroalteration is unevenly weakening the inside of Mount Rainier. This is a process whereby the slopes of the mountain are being internally eaten away by hot, acidic water, which makes the slopes more susceptible for failure, increasing both the possibility and risk of lahars.

Washington State areas including King, Pierce, and Thurston County have much higher risk of loss of life and property than Jefferson County. Jefferson County's location with respect to the active volcanoes would limit the number of hazards, however impacts would be felt. The economic, cultural and transportation impacts that would be experienced in Jefferson County, however, would be severe if such an eruption were to occur on Mount Rainier. Most certainly, Interstate 5 and Interstate 90 would be closed, thus disrupting key routes for trade and travel. Ash and some debris could fall on Jefferson County depending on prevailing winds at the time. Jefferson County could serve as a haven for displaced residents for not only days, but perhaps for decades to come, thus impacting the infrastructure and resources of the County. Puget Sound fishing resources and economic foundations of the timber and recreation industries could be impacted for decades. The tourism industry and economic benefits derived could also be affected for Jefferson County.

CONCLUSION

Emergency Plans must advise people of potential hazards. Being aware of the potential hazards and responding appropriately will help mitigate the loss of life and could potentially help reduce losses of property in the eventuality of a volcanic eruption. Emergency plans must be tested and practiced ahead of time and used without hesitation when a volcano threatens to erupt.

Scientists and public officials must announce warnings early and clearly. The Cascades Volcano Observatory in Vancouver, Washington, monitors and assesses hazards from the volcanoes of the Cascade Range of Washington, Oregon, and California. Seismic monitoring is shared with the USGS center in Menlo Park, California, (for northern California) and the Geophysics Program of the University of Washington in Seattle (for Washington and Oregon). CVO also is home to the Volcano Disaster Assistance Program.

The Volcano Disaster Assistance Program, home-based in Vancouver, Washington, was formed in the mid 1980s to respond to volcanoes in all parts of the world. An experienced team of USGS and other scientists can rapidly respond to developing volcanic crises with a state-of-the-art portable cache of monitoring equipment. VDAP has proven to be effective in saving lives and property by assistance provided to local scientists for determining the nature and possible consequences of volcanic unrest and communicating eruption forecasts and hazard-mitigation information to local authorities.

WILDFIRE / FOREST / URBAN INTERFACE[34,35]

SUMMARY

The Hazard: Forest and wildland fires are the uncontrolled destruction of forested and wild lands by fire caused by natural or human-made events. Forest and wildland fires occur primarily in undeveloped areas, although there are significant pockets of residences within Jefferson County woodlands.

Impacts and Effects:

- Loss of civilian lives and firefighters
- Loss of homes and businesses
- Loss of crops and livestock
- Destruction of wildlife habitat and watersheds
- Damage to salmon habitat
- Damage or total loss of scenic vistas and recreation facilities
- Destruction of timber resources
- Loss of jobs due to destroyed and damaged equipment and facilities
- Decreased tourism
- High costs to fight fires
- Fire and emergency response teams unable to meet "routine" obligations and fight wildland fires simultaneously
- Vulnerability to flooding increases

Previous Occurrences: According to the National Fire Information Reporting System (NFIRS), Jefferson County averages 5 – 10 acres of wildland fires every year. The last major wildfire, the Chimney Peak fire, occurred in 1981

Probability of Future Events: High – An annually recurring dry season combined with encroaching residential development is resulting in a regular brush fire season. So far, the rapid response of rural fire departments has kept the impact of these fires to a minimum.

Definition

Forest and wildland fires are the uncontrolled destruction of forested and wild lands by fire caused by natural or human-made events. Forest and wildland fires occur primarily in undeveloped areas.

Interface fires are a recent phenomenon that occurs in developed forest and wildlands, only partially cleared, and occupied by structural development. In interface fires people, homes and small businesses intermingle with the wildland and forest areas.

When weather conditions are dry and fuels are abundant, rapidly spreading fires can cause significant loss of life and property.

History of Fires as it Affects Jefferson County

Jefferson County has had an active history of wildland fires during the past millennium. The fact that the oldest of old-growth timber stands are rare attests to the fact that most of the area has burned and re-burned many times during the past 1000 years. Stands of trees older than 500 years do not occur except in small patches or scattered trees found in moist draws and stream bottoms at the headwaters of a few creeks and rivers.

It is difficult to trace the fire history of this area back more than 350 years. However, old-growth trees and fire scars suggest fires about 450, 480, 540 and 670 years ago. Historically, wildland fires were not considered a hazard. Fire is a normal part of most forest and range ecosystems. Fires historically burned on a fairly regular cycle.

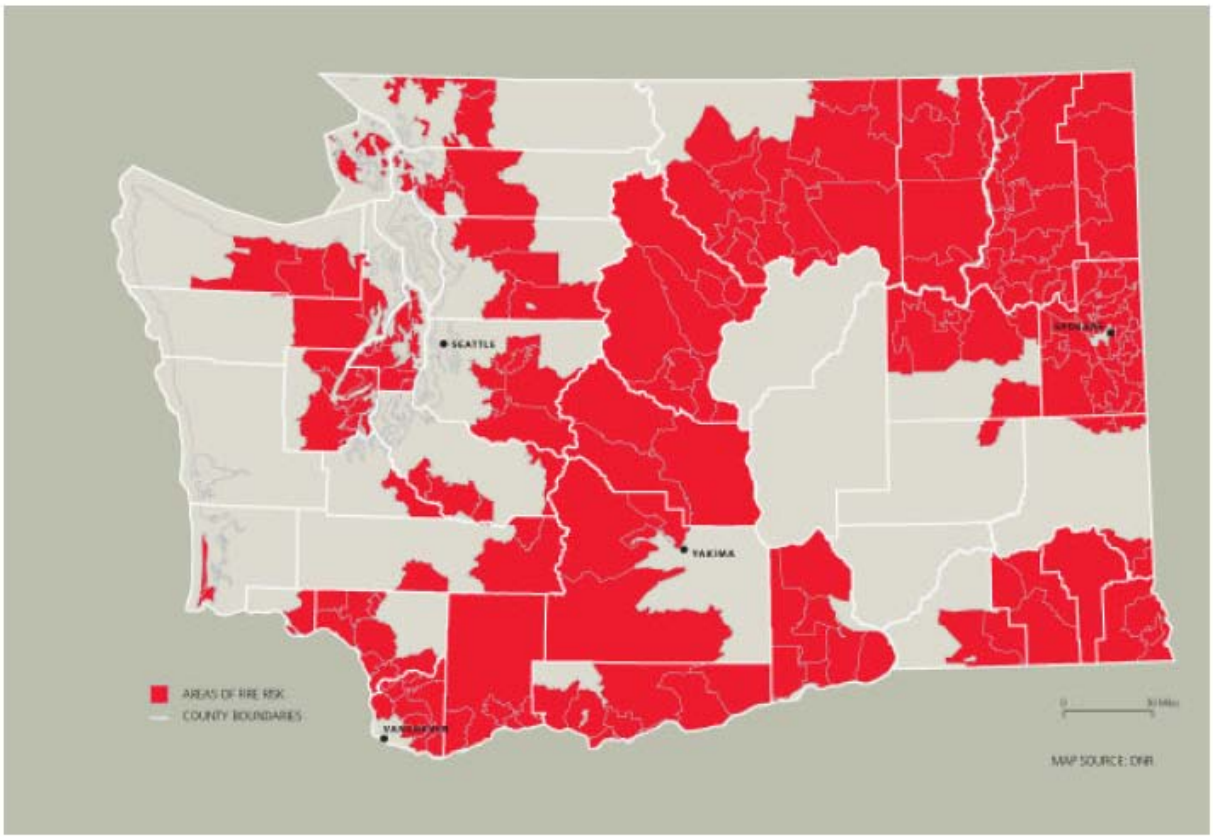
The burning cycle in western Washington appears to be about every 100 – 150 years. A preponderance of evidence, however, has been obliterated by logging, major windstorms that toppled older trees, and more recent fires in the areas. Recorded history of fires in the area, however, indicates Jefferson County has had an active history of fires. As communities expand farther and farther into forested lands, and the desire to maintain the wilderness ambiance, interface fires are becoming a significant hazard, having the potential for loss of life and destruction of property.

Some of the more prominent wildland fires that have affected Jefferson County are:

1864 (?)	Ludlow-Quilcene Fire;
1890	Quilcene Fire—30,000 acres;
1902	Green Mountain Fire;
1918	Dosewallips & Duckabush Fires;
1924-1925	Green Mountain, Mt. Zion, Snow Creek Fires;
1929	Interorrem Fire—9,000 acres;
1961	Mt. Bretherton Fire;
1978	Hoh Fire—1050 Acres; and
1981	Chimney Peak Fire.

Hazard Identification and Vulnerability Assessment

The Washington Department of Natural Resources and its federal and local partners determined that 181 communities are at high risk for wilderness fires after evaluating them for fire behavior potential, fire protection capability, and risk to social, cultural and community resources. Risk factors included area fire history, type and density of vegetative fuels, extreme weather conditions, topography, number and density of structures and their distance from fuels, location of municipal watershed, and likely loss of housing or business. The evaluation used the criteria in the wildfire hazard severity analysis of the National Fire Protection Association's NFPA 299 Standard for Protection of Life and Property from Wildfire, 1997 Edition.



Source: *Progress Report on the National Fire Plan in Washington State*, Department of Natural Resources, September 2002.

As seen from the map preceding, Jefferson County is among the counties in which the wildfire threat is high.[36] Jefferson County communities that are on the list of areas at high risk for urban interface wildfires are: Brinnon, Port Hadlock, Port Townsend, and Quilcene.

Jefferson County and Port Townsend are served by 5 active fire districts, all with mutual aid agreements. During any fire incident, the incident commander can ask for units from any of the districts. At such times, units not involved redeploy to cover the areas left exposed by units fighting the wildfire. This "floating battalion" allows all of the districts to put more equipment on a fire and still have coverage in their home district.

Jefferson County's fire season usually runs from mid-May through October. Any prolonged period without significant precipitation presents a potentially dangerous situation, particularly if strong dry, east winds prevail. The probability of a forest fire or an interface fire in any one location depends on fuel conditions, topography, the time of year, the past weather conditions, and if there is human activity such as debris burning, camping, etc., which are taking place.

The combination of a dryer climate along with a plethora of illegal meth labs hidden in the wildlands has resulted in an increase the number and severity of urban interface fires. In addition, as the buildable space in the towns and city are used up, numerous housing developments are being created in the unincorporated portion of the county.

Washington State fires responded to by city and county fire departments were largely started by human causes. Included in the list of human causes are cigarettes, fireworks, and outdoor burning. Wildland fires started by heat spark ember of flames caused the largest dollar loss, followed by debris burning and cigarettes. Loss per incident for debris fires is three times higher than any other fire cause.

Short-term loss caused by fires is the complete destruction of valuable resources such as timber, wildlife, habitat, scenic vistas, and watersheds. Vulnerability to flooding increases due to the destruction of watersheds. Long-term effects are reduced amounts of timber for building and recreation areas.

Home building near forests and wildlands increases the loss from fires. There is a trend for families to move into more rural and forested areas. Many homes are built with an effort to maintain the scenic aspects of the surrounding area. These areas are farther from fire fighting assets. Frequently, there is little clearance of vegetation resulting in a lack of defensible space.

Narrow access roads frequently found in these areas interfere with fire suppression efforts. Frequently roads are so narrow that standard sized fire apparatus cannot adequately turn around or pass on the roads. More diverse fire apparatus such as brush rigs and smaller engines are needed. Smaller fire districts may not be able to financially support these additional requirements.

Conclusion

Jefferson County, the City of Port Townsend, and the unincorporated towns of Brinnon, Port Hadlock, and Quilcene are all considered at high risk for urban interface wildfire. The commingling of residential enclaves adjacent to and among forested areas also means that these areas are highly vulnerable.

A number of activities can be undertaken which will reduce the actual numbers of fires and resulting loss of fires.

- Forest fire education and enforcement programs must be emphasized to include early reporting of fires
- Effective early fire detection and emergency communication systems are essential
- Effective early warning systems are essential to notify local inhabitants and persons in the area of the fire. An evacuation plan detailing primary and alternate escape routes should be developed if possible.
- Fire-safe development planning should be undertaken by jurisdictions to include:
    - Sufficient fuel free areas around structures
    - Fire resistant roofing materials
    - Adequate two-way routes and turnaround areas for emergency vehicles
    - An adequate water supply
    - Development of local ordinances to control human caused fires
- Road closures should be increased during peak fire periods to reduce access to fire prone areas

WINTER STORM [36,37,38]

SUMMARY

The Hazard: The National Weather Service defines a winter storm as having significant snowfall, ice, and/or freezing rain; the quantity of precipitation varies by elevation. Heavy snowfall is 4 inches or more in a 12-hour period, or 6 inches or more in a 24-hour period in non-mountainous areas; and 12 inches or more in a 12-hour period or 18 inches or more in a 24-hour period in mountainous areas.[39]

Impacts and Effects:
- Loss of life
- Damage to homes and businesses
- Damage to critical transportation infrastructure
- Loss of timber resources
- Emergency responses are delayed
- Damage or loss of recreation facilities
- Disruption of utilities
- Loss of jobs due to damaged equipment and facilities
- School closures
- Business closures resulting in economic impacts

Previous Occurrences: Although Jefferson County gets a few days of snow every year, the last snow storm justifying a disaster declaration was in December, 1955. In 1991, the area received an "Arctic Express Blizzard". Disaster declarations were made for severe winter storms in 2006 and 2007, but these were primarily due to wind, flooding and mudslides. In 2009, snow storms set record levels, thus resulting in Public Assistance (PA) being made available due to extraordinary costs of snow removal incurred by municipalities.

Probability of Future Events: High – The State of Washington Hazard Mitigation Plan puts the probability of a severe winter storm in Jefferson County at "125%" – intending to mean that the county experiences more than one storm every year. Most of the time, it manifests as damaging winds and rain, although it can be as ice or snow.

Definition: An atmospheric disturbance manifested in strong winds, rain, snow, or other precipitation.

History of Severe Winter Storms Affecting Jefferson County

Most storms move into Washington from the Pacific Ocean with a southwest to northeast airflow. Maritime air reaching the Olympic Mountains rises upwards and cools. As this airflow reaches higher elevations and cools, there is less ability to hold moisture and precipitation occurs.

History of Storms Affecting Jefferson County's People and Economic Activity

High Winds (Tacoma Narrows Bridge blown down)
- **1950** – Blizzard
- **1961** – Snowstorm
- **1962** – Columbus Day Storm
- **1964** – Snowstorms
- **1979** – High Winds & Rain (Hood Canal Bridge destroyed)
- **1981** – Windstorm
- **1991** – Arctic Express Blizzard
- **1993** – Inauguration Day Windstorm
- **1995** – Wind and rainstorms
- **1997** – Snow, wind and snowmelt
- **2006** - Snow, wind and snowmelt
- **2009** – Record snow

Jefferson County is subject to several severe local storms each year. These storms have included high wind, snow, ice, rain, and hail. Snowstorms or blizzards are the most likely and potentially devastating phenomena, with the ability to isolate people from emergency services and to interrupt utility services and other lifelines. In 1996-1997, snowstorms were also associated with other natural hazards such as flooding and landslides. Ice storms can occur when rain falls out of the warm moist upper layer atmosphere into a dry layer with freezing or sub-freezing air near the ground. Rain freezes on contact with the cold ground and accumulates on exposed surfaces – as illustrated by Figure WS-1, a frozen Haller Fountain.

Snow Storms – Winter Storm – The National Weather Service defines a winter storm as having significant snowfall, ice, and/or freezing rain; the quantity of precipitation varies by elevation. Heavy snowfall is 4 inches or more in a 12-hour period, or 6 inches or more in a 24-hour period in non-mountainous areas; and 12 inches or more in a 12-hour period or 18 inches or more in a 24-hour period in mountainous areas. Figure WS-2 shows Port Townsend after 12" of snow fell in a single day in 1955.

Areas most vulnerable to winter storms are those affected by convergence of dry, cold air from the interior of the North American continent, and warm, moist air off the Pacific Ocean. Typically, significant winter storms occur during the transition between cold and warm periods.

Counties considered most vulnerable to winter storm are 1) those most affected by conditions that lead to such storms, as described above, **and** 2) those with a recurrence rate of 50 percent, meaning the county experiences at least one damaging winter storm event every two years. If damaging wind storms are separated out, Jefferson County does not meet that criteria.

HAZARD IDENTIFICATION AND VULNERABILITY ASSESSMENT

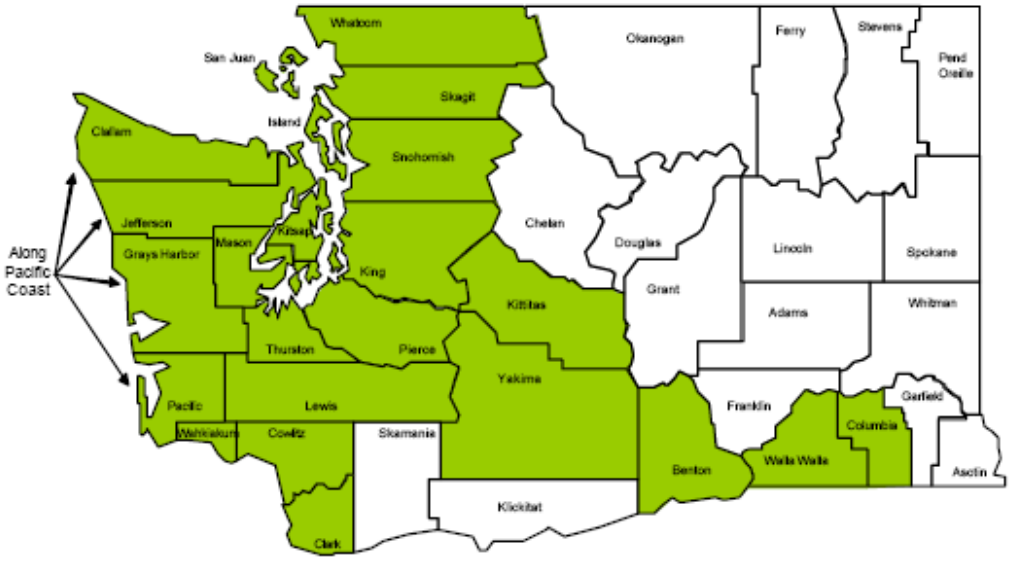
All areas of the County are vulnerable to various severe local storms. Western Washington has had an average of 11.4 inches of snowfall annually over the past 30 years. Windstorms generally occur between October and April as well. Power outages are common as a result of these storms. Road travel is often treacherous due to snow, ice, and fallen trees. As a result, schools are often closed and local businesses are impacted. Emergency responses can be delayed.

The general effects of most severe local storms are immobility and loss of electrical power and telephone service. Physical damage to homes and businesses can occur from wind damage, accumulation of snow, ice, and hail. Even a small accumulation of snow can wreak havoc on transportation systems due to a lack of snow clearing equipment and experienced drivers.

If damaging wind storms are included in the winter storms, Jefferson County is considered among the most vulnerable to storms. Counties considered most vulnerable to high winds are 1) those most affected by

conditions that lead to high winds, as described above, **and** 2) those with a high wind recurrence rate of 100 percent, meaning the county experiences at least one damaging high wind event every year. Counties that meet both criteria are highlighted in and on the map, below.[4]

Counties Most Vulnerable to High Winds



Jefferson County is considered among the most vulnerable to high winds because it is affected by conditions leading to high winds, and has a recurrence rate of "125%". A recurrence rate greater than 100% means that Jefferson County has more than one damaging wind storm a year.

If damaging winds are excluded from the winter storms, Jefferson County is not considered vulnerable to winter storms.[5]

Counties Most Vulnerable to Winter Storm

Table WS-1, "Winter Storms", details the significant winter storms that have impacted Jefferson County. It was adapted from a similar table in the state Hazard Mitigation Plan.

CONCLUSION

Jefferson County is at high risk for wind storms and coastal flooding, but not recognized as being at high risk for winter storms, as defined by the weather services.

Severe local storms are probably the most common widespread hazard. They affect the entire county area when they occur. These types of storms can quickly overwhelm county resources. Citizens should be prepared for these storms; family plans should be developed, disaster kits should be assembled, and every family member should be taught how to shut off utilities to prevent damage from abrupt resumption and to prevent damage from freezing and breaking pipes. Initiating early dismissal from schools and businesses is an effective mitigation measure and should be encouraged.

Local jurisdiction plans should provide a priority for road and street clearance, provision of emergency services, mutual aid with other public entities, and procedures for requesting state and federal aid if needed. The public should be given information on emergency preparedness and self-help to prepare for better response during severe storms.

Figure WS-1: Ice dresses up Haller Fountain in Port Townsend on an unusually cold day.

Figure WS-2: Port Townsend's Water Street in 1955.

—Tom Camfield photo

Water Street, December 1955.—This is some of the aftermath of "12 inches or more" of snow that fell in the city (more in the outlying areas) on Dec. 22. Of particular interest is the lack of traffic by today's standards. This also is a nice view of the Eisenbeis Building (owned by Olympic Hardware & Furniture Co.) just before the large bays were removed from the front in a drastic remodeling project the following July. Fissures caused by the sagging bays had effected rain-water leaks and unwanted "ventilation" in the upstairs apartments, said E. A. Witheridge of the hardware co. Pedestrians are beer distributor Ray Lundgren (back to camera) and Forrest (Frosty) Miller, examining the snow. George Mueller operated Olberg's Shoe Store, down the street at left.

Table WS-1
Severe Winter Storms Affecting Western Washington

Date	Storm Type	Description
February 1, 1916	Snowstorm and wind	Twenty-one inches of snow fell in Seattle in 24 hours and 2 to 4 feet in other parts of Western Washington. In January and February Seattle received 58 inches of snow
November 7, 1940	Wind	Tacoma Narrows Bridge collapsed due to induced vibrations from 40 miles per hour winds.
January 1950	Snowstorm and wind	Blizzard dumped 21 inches of snow on Seattle and killed 13 people in the Puget Sound region. The winter of 1949-50 was the coldest recorded in Seattle with average temperatures of 34.4 degrees.
December 1955	Snowstorm	Twelve inches of snow in Port Townsend. See photos by Tom Camfield in Winter Storm section.
November 1958	Wind	High winds in Western Washington.
October 1962	Wind	Columbus Day Storm struck from northern California to British Columbia and is the windstorm to which all others are compared. Recorded winds gusts were 150 miles per hour in Naselle, 100 in Renton, 92 in Bellingham and Vancouver, and 88 in Tacoma. Federal disaster number 137 was assigned for the event.
February 1979	Wind	Hood Canal Bridge destroyed by windstorm.
November 1981	Wind	High winds in Western and Eastern Washington.
November 1990	Wind and flood	The Lake Washington floating bridge sank, killing two and causing $250 million in damages.
January 20, 1993	Wind	Inauguration Day Storm damaged homes, businesses, and public utilities leaving thousands without power for days from Longview to Bellingham. The state EOC coordinated resources. The National Guard provided generator power and equipment. The Energy Office priorities power restoration. The American Red Cross sheltered 600 people and fed 3,200 meals. Department

Table WS-1
Severe Winter Storms Affecting Western Washington

Date	Storm Type	Description
		of Transportation and State Patrol coordinated transportation routes and road closures. Federal Disaster Number 981 was assigned for the event.
December 1995	Rain, flood, and wind	Storms, starting in California generated winds of 100 miles per hour, continued north causing three states, including Washington, to issue disaster proclamations. Federal Disaster Number 1079 was issued for the incident.
February 7, 1996	Rain and flood	The Washington State Emergency Operations Center (EOC) activated to handle severe floods covering state. These were considered the most destructive and costly in state history and 19 counties were covered under a Presidential disaster declaration. Three people were killed. Total damages were estimated at $400 million, an estimated 691 homes destroyed and 4,564 damaged. The EOC remained activated through February 23. Federal Disaster Number 1100 was issued for the incident.
April 24, 1996	Rain, flood, and wind	The state EOC activated because the state was covered with flooding rivers and high wind warnings. Six counties declared states of emergency. The EOC remained activated until April 25.
November 19, 1996	Ice storm	The state EOC activated in response to storm conditions around the state. The city of Spokane and Spokane County declared an emergency, and 100,000 customers were without power for nearly two weeks. In Puget Sound 50,000 customers were without power as well as thousand others across the state. There were 4 deaths and $22 million in damages. The EOC remained activated until December 1. Federal Disaster Number 1152 was issued for the storm.

Table WS-1
Severe Winter Storms Affecting Western Washington

Date	Storm Type	Description
December 4, 1996	Winter storm, ice, wind, and gale warning	The state EOC activated in response to storms rushing across the state, which caused road closures and power outages. Pend Oreille County declared an emergency because of snow and power outages. The Governor proclaimed emergencies for Pend Oreille and Spokane Counties. The EOC remained activated until December 5. This storm was part of Federal Disaster Number 1152.
December 26, 1996	Winter storm, wind, gale warning, flood, landslide, and avalanche	The state EOC activated in response to storm fronts pushing across the state causing structures to collapse under the heavy weight of snow, road closures, power outages, landslides, and 20 weather related deaths. The Governor declared emergencies for 37 counties - only Douglas and Franklin Counties were not included. The Washington National Guard had 110 personnel on active duty. The EOC remained activated until January 15, 1997. Federal Disaster Number 1159 was issued for the storm.
January 31, 1997	Rain and flood	The state EOC activated in response to lowland floods in Walla Walla, Asotin, and Columbia Counties. Flood warnings were in effect for Klickitat and Columbia Rivers. The EOC remained activated until February 1. This incident was part of Federal Disaster Number 1159.
March 18, 1997	Rain and flood	The state EOC activated in response to widespread flooding throughout Washington State and remained activated until March 26.
October 29, 1997	Rain and wind	Heavy rain and gusty winds passed over the state on October 29 especially the southern Cascade Range. The EOC activated on October 30 in response to floods. Flood warnings were in effect for 11 Western Washington rivers and watches for all rivers in five western counties. The EOC remained activated until October 31.

Table WS-1
Severe Winter Storms Affecting Western Washington

Date	Storm Type	Description
January 11, 1998	Winter storm and flood	The state EOC activated on January 14 in response to storms affecting Lewis, Mason, Thurston, and Pierce Counties. The EOC remained activated until January 19.
November 19, 1998	Winter storm	The state EOC activated for problems associated with forecast high winds. Winds of 80 miles per hour were recorded toppling trees and causing power outages to 15,000 customers. The EOC remained activated until November 23.
December 29, 1998	Winter storm	The state EOC activated in response to flooding threat caused by heavy rain and mountain snow melt. Stevens and Snoqualmie passes were closed due to avalanche hazard. Stranded holiday travelers unable to go over Snoqualmie Pass caused Kittitas County to declare an emergency. Nisqually river flooding caused evacuation of 45 residents of a McKenna nursing home. In Cathlamet, 400 residents were without water causing Wahkiakum County to declare an emergency. Pullman declared an emergency because of flooding. The EOC remained activated until December 31.
October 27, 1999	Wind	A strong Pacific frontal system moved across Washington causing power and phone outages. Marine storm and coastal flood warnings were issued for the coast. One citizen died when a tree fell on them. The EOC remained activated until March 28.
November 9, 1999	Rain and flood	The state EOC activated on November 12 because of weather conditions in Western Washington. The Skagit River rose to six feet above flood stage. Flooding was most severe in Hamilton. Two shelters were opened for evacuees. The EOC remained activated until November 13.
December 14, 1999	Rain and flood	The state EOC activated on December 15 in response to widespread flooding in Western Washington. A tropical weather system brought in heavy rain and caused snowmelt and flooding. Emergency declarations were issued in Grays Harbor, Jefferson, Skamania, and Wahkiakum Counties. Sixteen counties were impacted

Table WS-1
Severe Winter Storms Affecting Western Washington

Date	Storm Type	Description
		by the weather system. The EOC remained activated until December 18.
October 2003	Severe Storms and Flooding	DR 1499 - Chelan, Clallam, Grays Harbor, Island, **Jefferson**, King, Kitsap, Mason, Okanogan, Pierce, San Juan, Skagit, Snohomish, Thurston, and Whatcom Counties
January 27 to February 4, 2006	Severe Storms, Flooding, Tidal Surge, Landslides, and Mudslides	DR 1641 - **Clallam**, Grays Harbor, Island, **Jefferson**, **Kitsap, Mason**, Pacific, Pend Oreille, San Juan, Snohomish, and Wahkiakum Counties
November 2-11, 2006	Severe Storms, Flooding, Landslides, and Mudslides	DR 1671 - All counties in the State of Washington are eligible to apply for assistance under the Hazard Mitigation Grant Program.
December 14-15, 2006	Severe Winter Storm, Landslides, and Mudslides	DR 1682 - All counties in the State of Washington are eligible to apply for assistance under the Hazard Mitigation Grant Program
December 1 - 17, 2007	Severe Storms and Flooding	DR 1743 - **Clallam**, Grays Harbor, **Jefferson**, King, **Kitsap**, Lewis, **Mason**, Pacific, Skagit, Snohomish, Thurston and Wahkiakum Counties
January 2009	Record Snowfall	Public Assistance made available to Jefferson County and the City of Port Townsend because of extraordinary costs of snow removal.