Mount Baker / Glacier Peak Coordination Plan

Coordinating efforts between governmental agencies in the event of volcanic unrest at Mount Baker or Glacier Peak, Washington

August 2012

Washington Military Department, Emergency Management Division

PROMULGATION

The Washington Military Department and the Emergency Management Division sincerely appreciate the cooperation and support from the agencies, local jurisdictions, and corporations which collaborated on the development and publication of the *Mount Baker/ Glacier Peak Coordination Plan*.

This plan outlines interagency and multi-jurisdictional coordination and relationships expected to occur before, during, and after an incident at either volcano. It is consistent with and supports the *National Response Framework*, the *Washington State Comprehensive Emergency Management Plan*, and also agency and local jurisdiction comprehensive emergency management plans. It is not intended to serve as an operations plan.

The *Mount Baker/ Glacier Peak Coordination Plan* is an important element in achieving our shared goal of building a Disaster-Resilient Washington State.

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Mount Baker/Glacier Peak Coordination Plan

I. INTRODUCTION

A. Mission

Provide guidelines for seamless, scalable coordination between federal, tribal, state, provincial, and local agencies, as well as the private sector, during response to Mount Baker and/or Glacier Peak volcanic incidents

B. Purpose

The purpose of this coordination plan is to identify certain common ***coordination*** tasks and responsibilities which various private sector, county, state, provincial, and federal agencies in the United States and Canada will need to accomplish before, during, and after a hazardous geologic incident at either volcano. This coordination plan supports (but does **not** supplant) each jurisdiction's and agency's Comprehensive Emergency Management Plan (CEMP).

C. Scope and Applicability

This Plan is applicable to all federal, tribal, state, provincial, private sector, and local agencies responsible for emergency preparedness and response to areas affected by Mount Baker and/or Glacier Peak. It considers the emergencies and disasters likely to occur as a result of a hazardous geologic incident at Mount Baker or Glacier Peak. These potential incidents are identified in the *Washington State Hazard Identification and Vulnerability Assessment* (HIVA) and the *Enhanced State Hazard Mitigation Plan*, as well as individual jurisdiction/agency CEMPs/HIVAs/Hazard Mitigation Plans, Threat and Hazard Identification and Risk Assessments (THIRA) and scientific/ technical references.

D. Incident Management Activities

Incident management of a volcanic incident will be consistent with principles outlined in the affected jurisdiction's CEMP and the *National Incident Management System* (NIMS). If the incident affects more than one jurisdiction, Unified and/ or Area Command(s) may be established as deemed necessary. The Incident Commander(s) will determine the need to establish a Unified Command. If necessary, the affected jurisdiction(s) may request an Incident Management Team (IMT) to augment the Incident Command structure. An outline of the potential options for Incident Command structure is contained in Section III (Concept of Operations).

E. Authorities

The federal, tribal, state, provincial, and local laws and ordinances governing this coordination plan are listed in the stakeholder jurisdictions' respective Comprehensive Emergency Management Plans.

II. SITUATION, PLANNING ASSUMPTIONS AND CONSIDERATIONS

A. This coordination plan supplements existing federal, state, and local *Comprehensive Emergency Management Plans* (CEMP) or *Emergency Operation Plans* (EOP), but does not replace them.

B. This coordination plan follows the structure and guidelines outlined in the *National Response Framework* (NRF), the *Washington State CEMP*, and the *National Incident Management System* (NIMS).

C. Mount Baker is significantly different than Glacier Peak in most respects, including likelihood of volcanic events, the potential size and nature of such events, and the populations and infrastructure which would be affected by an event. (See Appendix A for a geological summary. Detailed information can be found in each jurisdiction's Hazard Mitigation Plan, Hazard Identification and Vulnerability Analysis (HIVA), and USGS Fact Sheets included as Appendices C and D.)

D. The United States Forest Service (USFS) will be the overall lead agency during incidents at either volcano.

III. CONCEPT OF OPERATIONS

General

This plan is based on the premise that each agency with responsibilities for preparedness, response, or recovery activities has, or will develop, an individual operations plan or procedures that cover its organization and emergency operations. This plan establishes a mechanism for communication and coordination of each agency's efforts.

Direction and Control

Multi-Agency Coordinating Group (MACG)

A MACG will be established in the State Emergency Operations Center (SEOC) to assess the situation and oversee state agency actions in support of the Area Command or Unified Commands. The MACG makes recommendations to the Governor on actions for consideration. The MACG is comprised of:

- The Governor's Chief of Staff
- The Governor's Press Secretary
- The Adjutant General
- Director, Emergency Management Division
- Disaster Manager
- Department of Natural Resources, Division of Geology and Earth Resources Representative
- Affected Jurisdiction Representatives
- Affected Tribal Representatives
- U.S. Geological Survey (USGS), Cascade Volcano Observatory (CVO) Representative
- U.S. Forest Service Representative
- Provincial Government Liaison

Table 1 – MACG and Area Command Functions	
MACG	AREA COMMAND
Expansion of the off-site coordination and support systems.	Expansion of the Incident Command System.
Members are agency administrators or designees from the agencies involved or heavily committed to the incidents.	Members are the most highly skilled incident management personnel.
Organization generally consists of the MACG (agency administrators). MACG coordinator and an intelligence and information support staff.	Organization generally consists of an Area Commander, Area command Planning Chief, an Area command Logistics Chief, and an Area Command Air Operations Coordinator.
Is the agency administrator (line officer) or designee.	Is delegated authority for specific incident (s) from the agency administrator (s).
Allocates and reallocates critical resources through the dispatch system by setting incident priorities.	Assigns and reassigns critical resources allocated to them by MACG or the normal dispatch system organization.
Coordinated agency administrator level decisions on issues affecting multiple agencies.	Ensure that incident objectives and strategies are complementary between Incident Management Teams under their supervision.

Area Command

An Area Command may be established, as deemed necessary, when an incident affects more than one jurisdiction. The Area Command oversees management of a very large, multi-jurisdictional incident with multiple Unified Commands assigned to manage the incident for their jurisdiction. The Area Command, when established, is responsible for:

- Providing agency or jurisdictional authority for assigned incidents.
- Ensuring a clear understanding of agency expectations, intentions and constraints.

- Establishing critical resource use priorities between various Unified Commands.
- Ensuring Unified Command personnel assignments and organizations are appropriate.
- Maintaining contact with officials in charge, and other agencies and groups.
- Coordinating the demobilization or reassignment of resources between assigned Unified Commands.

Unified Command

The Unified Commands will consist of the Incident Commanders from various jurisdictions and response agencies within the county responding to the incident. Each Unified Command will establish its incident objectives and produces one Incident Action Plan (IAP) for all responding jurisdictions and agencies in the county.

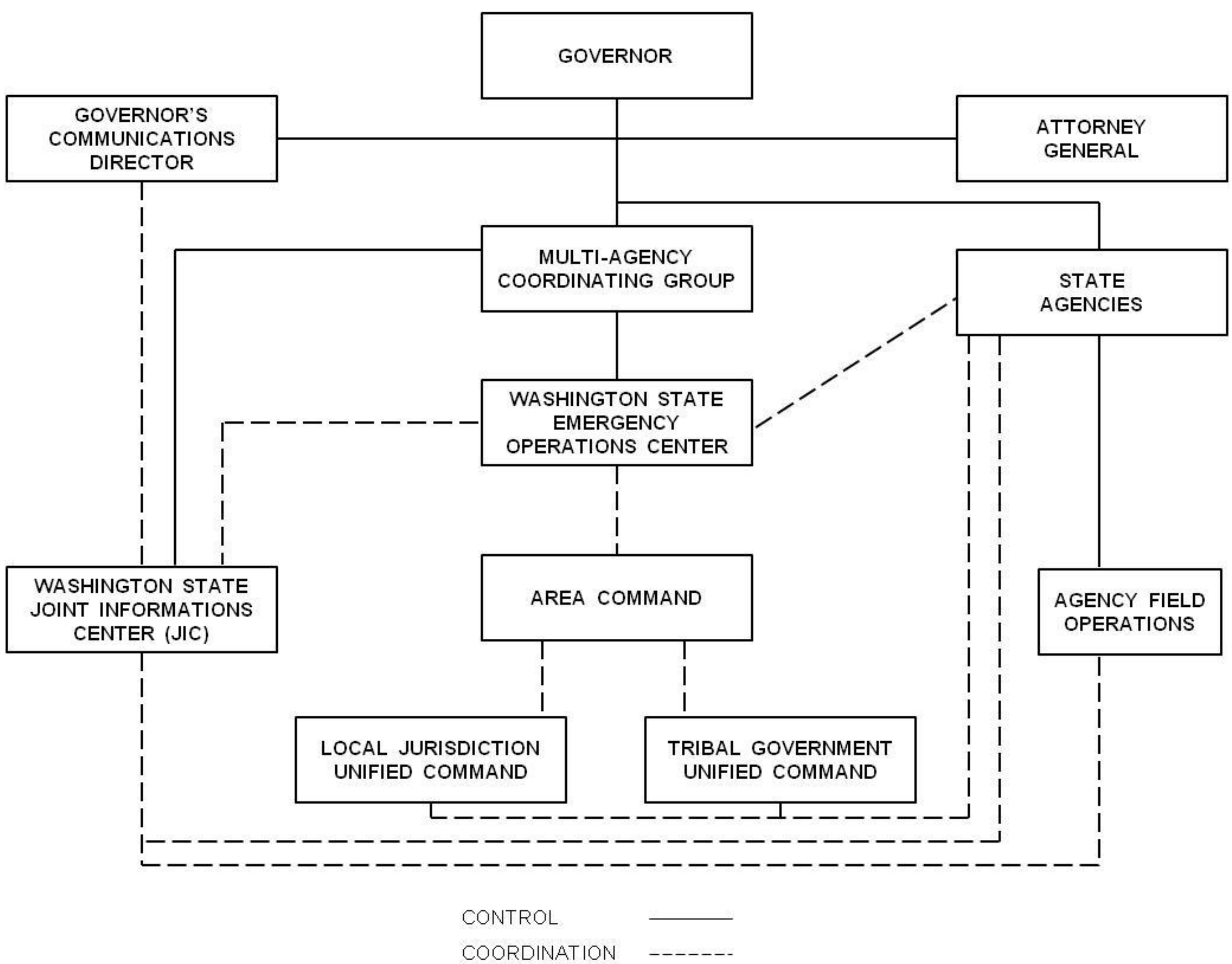

Figure 1 – Direction and Control Structure

Preparedness Activities

Planning Working Group (Membership listed in Table 2)

The Planning Working Group shall meet as needed to:

- Coordinate, write, revise and exercise this coordination plan.
- Conduct an After Action Review (AAR) post-event.
- Establish and maintain effective lines of communication between all affected jurisdictions and agencies.

Table 2 – Members of the Working Group: See Table 4 for full contact information

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Members shall include:	Additional Members may include:
Whatcom County Department of Emergency Mgt Skagit County Department of Emergency Mgt Nooksack Tribe Other Tribal Nations FEMA, Region X Snohomish County Department of Emergency Mgt Island County Department of Emergency Mgt National Weather Service, Seattle Chelan County Department of Emergency Mgt Washington State Emergency Management Division Washington State Department of Natural Resources U.S. Geological Survey/Cascade Volcano Observatory U.S. Forest Service U.S. Army Corps of Engineers, Northwest Division, Seattle District Puget Sound Energy Emergency Management British Columbia. Public Safety Canada Natural Resources Canada/Geologic Survey of Canada Pacific Northwest Seismic Network Mt Baker Ski Area	Washington State Patrol Other Tribal Nations Other concerned jurisdictions, agencies, Private Sector organizations, and Non-Governmental Organizations (NGO)

The U.S. Geological Survey (USGS) volcanic alert-level system provides the framework for the preparedness activities of local jurisdictions, tribal governments and state and federal agencies. The USGS ranks the level of activity at a U.S. volcano using the terms "Normal", for typical volcanic activity in a non-eruptive phase; "Advisory", for elevated unrest; "Watch", for escalating unrest or a minor eruption underway that poses limited hazards; and, "Warning", if a highly hazardous eruption is underway or imminent (Table 3 & Appendix A). These levels reflect conditions at a volcano and the expected or ongoing hazardous volcanic phenomena. When an alert level is assigned by an observatory, accompanying text will give a fuller explanation of the observed phenomena and clarify hazard implications to affected groups.

Table 3 – Volcanic Alert Level Summary

ALERT LEVEL	DESCRIPTION
Normal	Typical background activity of a volcano in a non-eruptive state. *After a change from a higher level:* Volcanic activity considered to have ceased, and volcano reverted to its normal, non-eruptive state.
Advisory	Elevated unrest above known background activity. *After a change from a higher level:* Volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
Watch	Heightened/escalating unrest with increased potential for eruptive activity (timeframe variable) OR a minor eruption underway that poses limited hazards.
Warning	Highly hazardous eruption underway or imminent.

Advisory Level Activities

Local jurisdictions, tribal governments and provincial, state and federal agencies carry out the following activities when they receive a Volcano Advisory Alert:

- Evaluate situation to determine whether or not the MACG (State Emergency Operations Center (SEOC) Phase II Activation) should be activated.
- Evaluate need for volcano area access control (i.e. "Red Zone"), implement as needed.
- Identify and designate individuals who will potentially fill positions in the local/tribal Unified Commands, Area Command, SEOC, JIC and MACG. (Consider activating and staffing the JIC in advance of other command posts/EOCs.)
- Implement notifications to all affected jurisdictions, tribes, agencies and stakeholders and issue advisories in consultation with the MAC-G, if activated.
- Refer to the Interagency Operating Plan for Volcanic Ash Events (signed in May 2011 by NWS, USGS, and FAA) for further information: **http://www.ofcm.gov/p35-nvaopa/regional_plans/PNW%20VA%20wo.pdf**

In addition to the above activities, the Cascade Volcano Observatory (CVO), Scientist-In-Charge (SIC) initiates conference call with Washington State Emergency Management Division (EMD) and USFS in conjunction with alert-level change notification. The CVO will also:

- Monitor the status of the volcano and determine the need for additional instrumentation.
- Issue alert-level notifications and updates.
- Consider establishing field observatory.
- In conjunction with the National Weather Service (NWS), monitor atmospheric and hydrologic conditions around Mount Baker and Glacier Peak and issue daily winds aloft forecast for both mountains.

The U.S. Forest Service will:

- Evaluate need for air space controls and implement as needed.
- Authorize placement of additional instrumentation as needed.

Watch Level Activities

Local jurisdictions, tribal governments and provincial, state and federal agencies carry out the following activities when they receive a Volcano Watch Alert:

- Establish local/tribal Unified Commands, as appropriate.
- Test communications systems and assess communication needs.
- Assign PIO's to the JIC, as needed.
- Coordinate support requirements for USGS Field Observatory.
- Provide technical representatives to the MACG, if SEOC is at Phase II for event.
- Contribute operational staff to field missions, as required.
- Consider coordinating joint public education programs via the JIC.
- Assign liaison(s) to local unified commands upon request.
- Monitor the status of the volcano and determine the need for additional instrumentation.

- Notify and consult with USFS, SEOC (local jurisdictions and tribal governments, if appropriate) prior to changing alert level.
- Monitor atmospheric and hydrologic conditions around Mount Baker and Glacier Peak and issue required winds aloft forecasts for both mountains as needed.
- Evaluate need for access control and implement as needed.
- Evaluate need for air space controls and implement as needed.

Warning Level Activities

Local jurisdictions, tribal governments and provincial, state and federal agencies carry out the following activities when they receive a Volcano Warning Alert:

- Fully mobilize all assigned personnel and implement all or part of the Mount Baker/Glacier Peak Coordination Plan.
- Continually broadcast emergency public information.
- Consider requesting state mobilization and possible activation of an IMT.
- Provide technical representatives to the MACG.
- Provide liaison(s) to the Unified and Area Command Posts, upon request.
- Contribute operational staff to field missions, as required.
- Provide a representative to the JIC.
- Activate the SEOC to Phase II and establish the MACG.
- Coordinate interstate mutual aid.
- Issue airspace alert warning of restricted or prohibited space and coordinate use of affected airspace by aircraft involved in emergency response.
- Monitor atmospheric and hydrologic conditions around Mount Baker and Glacier Peak and issue winds aloft forecast for either mountain, 2-4 times daily as needed.
- Issue Ash Fall Advisories, Flash Flood Watches/Warnings, and Flood Watches/Warnings, as needed.

- Coordinate observed and reported activities with Volcanic Ash Advisory Center, Aviation Weather Center, and the Center Weather Service Unit at the Auburn Air Route Traffic Control Center (ARTCC).
- Dispatch NWS forecaster to Unified and Area Command Posts, when requested.
- Monitor the status of seismic and geologic activity in the hazard area.
- Issue alert-level notifications and updates.

Response Activities

Local jurisdictions and Agencies:

- May recommend activation of the MAC-G.
- Review plans and procedures for response to the Volcanic Hazards threat.
- Evaluate need for volcano area access control (i.e. "Red Zone") and implement as needed
- Designate individuals who will be responsible for filling positions in the local ICS and/or Unified Command Structure as requested, including representatives to the JIC.
- Provide orientation sessions on updated plans and organizational structure.
- Update personnel lists.
- Update call-up procedures for all staff.
- Conduct briefings as needed, either independently or as part of a JIC.
- May establish local Incident Command and contribute liaison personnel to the Unified Command.
- Conduct surveys on resource availability and reaffirm prior commitments.
- Test communications systems and assess communication needs.
- Begin procurement of needed resources.
- Assign PIO's to the JIC as needed.

- Continue coordination with other affected jurisdictions/agencies.
- Coordinate support requirements for USGS Field Observatory.
- Fully mobilize all assigned personnel and implement all or part of the Mount Baker / Glacier Peak Coordination Plan.
- Implement *Comprehensive Emergency Management Plans*.
- Continually broadcast emergency public information.
- In accordance with NIMS, direct and control emergency response activities in each jurisdiction.
- Ensure MACC is adequately staffed and equipped.
- Consider requesting state mobilization and possible activation of an IMT.

Recovery Activities

When hazardous geologic activity has subsided to a point where reconstruction and restoration activities may be initiated, even when the mountain is still in eruptive state, recovery efforts may be initiated and carried out.

In addition to the functions previously noted, the MAC-G *may*:

- Coordinate recovery and reconstructive efforts.
- Assist Incident Commander(s) in demobilization.
- Continue to coordinate the collection and dissemination of disaster information including informing the public about hazardous conditions, health, sanitation and welfare problems, and need for volunteers.
- Determine when to stand down the MAC-G.

The Planning Working Group shall:

- Coordinate an After Action Review of the event and recommend changes to the plan as necessary.

Table 4: Primary Agency Points of Contact

AGENCY/RESPONSIBILITIES	CONTACT INFORMATION
LOCAL and TRIBAL GOVERNMENT Local jurisdictions are responsible for the overall direction and control of emergency activities undertaken within their jurisdictional boundaries, through use of the Incident Command System. Each county or tribal entity may activate an emergency operations center located at the address listed in their respective Comprehensive Emergency Management Plans (CEMP).	**Snohomish County:** County Emergency Operation Center, 3509 109th Street SW, Everett, 425-388-5060. Stillaguamish Tribe, 3310 Smokey Point Drive, Arlington, WA 98223, 360-652-7362 Tulalip Tribes, 6700 Totem Beach Road, Marysville, WA 98270, 360-716-4000 **Skagit County:** Consolidated Communication Center, 2911 East College Way, Mount Vernon, 360-428-3250 Samish Nation, PO Box 217, Anacortes, WA 98221, 360-293-6404 Sauk-Suiattle Tribe, 5318 Chief Brown Lane, Darrington, WA 98241, 360-436-0131 Swinomish Tribe, 11404 Moorage Way, LaConner, WA 98257, 360-466-3163 Upper Skagit Tribe, 25944 Community Plaza, Sedro Woolley, WA 98284, 360-854-7000 **Whatcom County:** Laurel Fire Hall, 6028 Guide Meridian, Bellingham, 360-676-6681 Lummi Nation, 2616 Kwina Road, Bellingham, WA 98226, 360-384-1489 Nooksack Tribe, PO Box 157, Deming, WA 98244, 360-592-5176

STATE GOVERNMENT The Governor, the Governor's cabinet, composed of the Executive Heads of State agencies or their representatives, and staff from the State Military Department Emergency Management Division, are responsible for the conduct of emergency functions and will exercise overall direction and control of state government operations.	**Washington State Military Department**, Emergency Management Division (EMD), Building 20, Camp Murray, WA 98430, 800-258-5990 **Department of Natural Resources**, Division of Geology and Earth Resources (DGER), Natural Resources Building, Room 148, 1111 Washington St. SE, Olympia, WA 98501, 360-902-1450 **Washington State Department of Transportation** (WSDOT), Emergency & Security Operations, 310 Maple Park Ave, Olympia, WA 98504, 360-705-7973 **Pacific Northwest Seismology Network,** Seismology Lab, University of Washington, Dept. of Earth and Space Sciences, Box 351310, Seattle, WA 98195-1310, 206-543-7010
PROVINCIAL GOVERNMENT Coordination of provincial response and recovery would occur under the direction of the Emergency Management British Columbia.	**Emergency Management British Columbia (Provincial Emergency Coordination Centre),** 455 Boleskine Road, Victoria, British Columbia, 800-363-3456

FEDERAL GOVERNMENT	
FEMA is responsible for federal agency coordination and operation of the Regional Response Coordination Center (RRCC).	**FEMA** RRCC, 130-228th Street S.W., Bothell, WA 98021, 425-487-4600
The USGS/CVO will conduct field operations, monitoring and provide advice to other agencies regarding the status of the volcano. The USGS may locate with an appropriate county.	**USGS**, Cascades Volcano Observatory, 1300 SE Cardinal Court, Bldg 10, Vancouver, WA 98683, 360-993-8900 Duty Scientist: 360-601-1628
The U.S. Forest Service (USFS), Mount Baker-Snoqualmie National Forest, is responsible for management of lands within the National Forests and the Skagit Wild and Scenic River.	**USFS,** Mount Baker-Snoqualmie National Forest, 2930 Wetmore Ave, Suite 3-A, Everett, WA 98201. 425-783-6000 Mount Baker Ranger District, 810 State Route 20, Sedro Woolley, WA 98284, 360-856-5700
National Weather Service (NWS) provides meteorological forecasts, advisories and reports in support of response operations.	**NWS,** Seattle 7600 Sandpoint Way NE., Seattle, WA 98115-6349, 206-526-6087

Public Safety Canada (PSC) is Canada's federal coordinating department and is responsible for coor**din**ating a whole-of-government response to emergencies, providing situation awareness to partners and providing support to provinces and territories, if requested.	**Public Safety Canada,** 490-877 Expo Blvd., Vancouver, BC, V6B1K9, 604-666-0089 **US Army Corps of Engineers (USACE)**, P.O. Box 3755, Seattle, WA 98124-3755, 206-764-3406 (24-hour EOC line) **Federal Aviation Administration (FAA),** Northwest Mountain Region, 1601 Lind Avenue SW, Renton, WA 98057
PRIVATE SECTOR PARTNERS The listed private sector businesses and agencies are responsible for the conduct of emergency preparedness, coordinating evacuation of patrons and employees, and will operate within the guidelines of federal, state, and local laws in the event of a volcano-related incident.	**Mount Baker Ski Area,** 1420 Iowa St., Bellingham, WA 98229, 360-734-6771 **Puget Sound Energy,** Baker River Recreation Area 46110 E Main St. Concrete WA 98237 360-853-8341

IV. ROLES AND RESPONSIBILITIES

A. Interagency Organizations

1. The overriding principle in a volcanic emergency is that that preservation of human life takes precedence over protection of lands and property.

B. Federal, Tribal, State, Provincial and/or Local Jurisdictional Authorities

1. May protect life and property by, among other actions, closing high-risk areas to public access, or evacuating local residents from hazard zones.

2. This will be accomplished in close coordination with private sector organizations operating in the planning area.

C. During a response, each agency and organization will provide resources and administrative support, and will act in accordance with the basic principles of the Incident Command System (ICS).

1. County and Tribal Emergency Management agencies (DEMs), the Washington State Emergency Management Division (EMD), Emergency Management British Columbia (EMBC) , and the Federal Emergency Management Agency (FEMA) have primary responsibilities for coordinating local, tribal, regional, state, provincial and Federal responses, respectively.

2. The responsibilities of local, state, private sector, tribal, and federal agencies are summarized in Table 2.

D. Mount Baker/Glacier Peak Planning Working Group

1. The Planning Working Group is an ad hoc organization which develops the coordination and response plan for volcanic events.

   - The Planning Working Group is made up of members from each jurisdiction and/or agency with responsibilities or pertinent knowledge. (Table 1).

   - The Working Group will meet on a regular basis until the plan is completed and approved, and then on an “as needed” basis.

   - The USFS will be responsible for coordinating the exercising of this plan, with support from EMD’s Exercise and Training Section.

   - The Washington State Emergency Management Division will coordinate a quadrennial review of the plan.

- The Working Group has no operational role whatsoever.

E. Agency Responsibilities

1. Divisions, Offices, or Departments of Emergency Management

   a. During a crisis, information about the status of a volcano would normally be transmitted from the USGS to USFS and through the Washington State EOC to the MAC and to county Divisions or Departments of Emergency Management (DEMs).

   b. The DEMs would then relay the information to local jurisdictions and agencies. As needed, the county DEMs would:

      - Implement Comprehensive Emergency Management Plans (CEMPs), maintain and activate Emergency Operations Centers.
      - Provide local public warnings and information.
      - Activate the Emergency Alert System (EAS) in coordination with State Alert and Warning Center.
      - Assist Incident Commander(s).
      - Participate in establishing a Unified Command structure.
      - Provide local Public Information Officers (PIO's) for a JIC.
      - Assist the USGS in establishing a Field Volcano Observatory if needed.
      - Provide for the welfare of citizens impacted by a volcanic event.
      - Initiate and coordinate local declarations of emergency or requests for assistance from state and/or federal resources.
      - Develop crisis-response plans for their jurisdictions.
      - Provide information and training on volcanic-hazard response to emergency managers and the public.
      - Assess volcanic risk as part of a larger Hazard Identification and Vulnerability Analysis (HIVA).

F. State Military Department, Emergency Management Division (EMD)

EMD, through its 24 hour Emergency Operations Center (SEOC), is responsible for providing alerts and warnings to local jurisdictions potentially impacted by volcanic unrest. Additionally, EMD will notify specific state and federal agencies that have a response role during a volcanic event. The SEOC would then work with other entities in order to coordinate resources to support local and state agency response. In support of the State CEMP, EMD's responsibilities include:

1. Coordinating the acquisition and distribution of resources when local resources have been exhausted.

2. Coordinating the activities of the Mt. Baker/Glacier Peak Planning Working Group, to include the annual plan review.

3. Acting as the central point of contact for local government requests for specific state and federal disaster related assets and services.

4. Activating and providing staffing for the Washington State Emergency Operations Center (SEOC).

5. Activating the State Emergency Alert System (EAS) to advise the public of the existence of emergency conditions and protective actions that should be taken, in coordination with local jurisdictions.

6. Participate in the Joint Information Centers (JIC) to provide event related public information.

7. Coordinating with the Federal Government on supplemental disaster assistance necessary to preserve lives and property, and on recovery assistance necessary to restore damaged areas to pre-disaster condition.

8. Deploying State Liaison Officers to affected jurisdictions.

G. State Department of Natural Resources, Division of Geology and Earth Resources (DGER)

DGER's mission is to collect, develop, use, distribute, and preserve geologic information. This information is used to support and promote the safety, health, and welfare of the populace, and to protect both the environment and economy of the State of Washington. DGER is mandated by RCW 43.92.900 and 43.92.025 to serve as the State's geological survey, providing information and assessment of geologic hazards and events to government agencies and people within the state. In support of this plan, DGER will (as resources are available):

1. Provide technical representative(s) to the MAC-G.

2. Provide a liaison to the USGS/CVO.

3. Provide a representative to the JIC.

4. Provide a liaison to the Unified Command Post.

5. Contribute operational staff to field missions as required.

H. Emergency Management British Columbia (EMBC)

The role of EMBC with regard to volcanic eruptions in British Columbia or Washington State is to:

1. Receive information from the Geological Survey of Canada or the U.S. Geological Survey.

2. Disseminate timely and accurate information to all Federal and Provincial agencies as and when required.

3. Provide timely and accurate information to those communities which may be at risk - issue warnings.

4. Coordinate the Provincial Government's response to and recovery from volcanic eruptions.

5. Manage the media, in relation to the Provincial Government involvement.

I. Federal Emergency Management Agency (FEMA)

The Federal Emergency Management Agency (FEMA) roles and responsibilities during a disaster and or an emergency are governed by the *Robert T. Stafford Disaster Assistance and Emergency Relief Act*, as amended, 42 USC 5121, et seq., and the *National Response Framework* (NRF) for Public Law 93-288, as amended. The primary responsibility of FEMA is to coordinate and deliver assistance and support to state and local governments when requested. This request is typically through the governor as a Request for a Presidential Declaration of Disaster. A volcanic eruption would be handled in much the same way as any natural disaster. FEMA's responsibilities include:

1. Coordinating Federal level emergency planning, management, mitigation and assistance functions of Federal agencies in support of State, Tribal, and local efforts.

2. Providing and maintaining the Federal and State NAWAS Warning Circuits.

3. Providing FEMA liaison staff to the Planning Working Group, MAC and the State EOC.

4. Prior to a Presidential Declaration, coordinate support for Federal agencies.

5. Following a Presidential Declaration:

    a. Establishing a Joint Field Office.

    b. Coordinating public information activities for all federal agencies and disseminating to news media.

    c. Participating in the Joint Information Center.

    d. Coordinating State requests for Federal or military assistance.

    e. Coordinating Federal assistance operations

J. United States Geological Survey Cascades Volcano Observatory (USGS-CVO)

The USGS-CVO Volcano Hazards Program seeks to lessen the harmful impacts of volcanic activity by monitoring active and potentially active volcanoes, assessing their hazards, responding to volcanic crises, and conducting research on how volcanoes work. USGS responsibilities include:

1. Issuing timely warnings of potential geological hazards to responsible emergency management authorities and the populace affected.

2. Monitoring volcanic unrest, tracking its development, forecasting eruptions, and evaluating the likely hazards

3. Deploying staff and monitoring equipment during times of volcanic crisis.

4. Establishing a temporary volcano observatory if necessary, located so as to provide ready access to the volcano for the USGS hazard-assessment team and ready access to the hazard-assessment team for the emergency managers.

5. Provide staff to the JIC, and provide technical advisors to the Incident Commander.

K. U.S. Forest Service (USFS) Mt Baker-Snoqualmie National Forest

1. The Forest Service manages public lands on and around both Mt. Baker and Glacier Peak.

    a. Authorities include land management responsibility related to use, management and protection of these lands.

b. Roles and responsibilities during a disaster or emergency include protection of life, property and national forest resources, including serving as the Incident Command in the Unified Area Command structure.
c. Control of access and use of national forest is regulated by the U.S. National Forest in coordination with adjoining landowners and agencies.

L. National Weather Service (NWS)

The National Weather Service Forecast Office in Seattle, Washington provides the following information to the Emergency Coordination Center and the U.S. Geological Survey:

1. Flood forecasting in consultation with USGS for areas of potential volcanic hazards

    a. Flood forecasts (2).

    b. Flood warnings, and

    c. Flood watch over NAWAS.

    d. NOAA

    e. Weather radio (when available), and

    f. NOAA weather wire service.

    g. Volcanic plume forecasts for aviation and surface activities.

    h. Tests NAWAS for disseminating weather or flood-related volcanic hazard information.

    i. Radar plume information to the VEC/ECC Director and USGS, i.e. plume height, tracking location, as requested (Seattle NWS office only).

M. Public Safety Canada (PSC)

Under the federal *Emergency Management Act*, the Minister of Public Safety is responsible for coordinating the Government of Canada's response to an emergency. If an emergency escalates beyond their capabilities, provinces or territories can seek assistance from the federal government. Public Safety Canada coordinates a whole-of-government response, provides support to the provinces/territories, if requested, and disseminates situational awareness to partners.

Public Safety Canada receives notification of volcanic events from EMBC and/or Public Safety Canada's Government Operations Centre. Notification procedures are outlined in the *Interagency Volcanic Event Notification Plan – Western Canada*.

The Government Operations Centre provides strategic-level coordination on behalf of the federal Government of Canada in response to an emerging or occurring event affecting the national interest. It provides 24/7 monitoring and reporting, national-level situational awareness, warning products and integrated risk assessments, as well as national-level planning and whole-of-government response management.

Upon receipt of confirmation, Public Safety Canada disseminates information to regional, provincial and federal partners.

If required, Public Safety Canada will provide support to EMBC, if requested, and, if the situation escalates beyond provincial capacity, will coordinate a whole-of-government response.

V. ONGOING PLAN MANAGEMENT AND MAINTENANCE

A. Coordination

Washington State Emergency Management Division (EMD) is responsible for coordinating periodic and special updates with members of the Planning Working Group.

B. Plan Maintenance

The Planning Working Group will normally convene once annually, either in person or by conference call, in order to review any suggested changes or updates to this plan. As stated elsewhere in this plan, the Planning Working Group will always convene in the aftermath of a significant incident at either MT Baker or Glacier Peak for an After Action Review (AAR), which may also result in changes to the plan.

C. Training and Exercises

The USFS Mt Baker-Snoqualmie National Forest is the lead proponent for coordinating the training and exercising of this plan. WA EMD Exercise and Training Section will normally provide assistance to the USFS in accomplishing these responsibilities.

D. NIMS Integration

All members of the Planning Working Group are responsible for insuring that the plan reflects the most current doctrine outlined in the National Incident Management System (NIMS).

APPENDIX A: Geologic Summary

Duration of eruption unrest and activity (with or without graphic):

Monitored volcanoes generally give signs of re-awakening (volcanic unrest) before an eruption because it takes time for magma to move from its storage area, several miles beneath the volcano, to the surface. As magma moves towards the surface, it breaks open a pathway, which produces earthquakes; it goes from higher to lower pressures, resulting in the release of volcanic gases; and as the amount of magma decreases in the storage area and temporarily pools at shallower levels it deforms the earth. All these processes can be monitored through a variety of techniques, although none can be measured directly.

Volcanic events often differ from other natural hazards because the duration of unrest and eruptive activity are generally longer. Although volcanic unrest prior to eruptions can be only hours, these short timescales most frequently occur at volcanoes that have erupted in the recent past (years to decades). At volcanoes, like Mount Baker and Glacier Peak, which have not erupted for more than a century, their conduit systems which convey magma to the surface have solidified and will have to be fractured and reopened for the next magma batch to reach the surface. Thus, we anticipate that we will likely have several days to weeks of warning before an eruption, although hazardous events such as small steam and ash explosions and expulsion of water to form lahars may occur before an eruption begins. Eruption durations are also quite variable, ranging from hours to decades. At present, when an eruption begins scientists cannot foretell when it will end or whether the activity will be intermittent or continuous. Worldwide, the average eruption duration is about two months, although the most recent eruptions in the Cascades have been of greater duration (Mount St. Helens, Washington: intermittent activity from 1980 to 1986 and continuous activity from late 2004 to early 2008; Lassen Peak, California: intermittent activity from 1914 to 1917).

Incident Notification:

Newly standardized Alert Levels issued by USGS volcano observatories are based on a volcano's level of activity. These levels are intended to inform people on the ground and are issued in conjunction with the Aviation Color Code. The highest two alert levels (Watch and Warning) are National Weather Service terms for notification of hazardous meteorological events, terms already familiar to emergency managers that are becoming increasingly more familiar to the public. Alert levels are as follows:
NORMAL—The typical background state of a volcano when not erupting. It includes periods of increased steaming, seismic events, deformation, thermal anomalies, or detectable levels of volcanic degassing, as long as that activity is within the background range seen during its monitoring history or at similar types of volcanoes. It is not an "alert" level per se, inasmuch as no concern of potentially hazardous activity is implied. In some cases, unrest that is initially seen as "anomalous," such as increased steaming or elevated seismic activity, may after some time become considered normal background activity. At volcanoes that appear quiet but are not monitored with ground-based instruments, the absence of unrest cannot be confirmed; consequently, Normal is not assigned to such volcanoes.

ADVISORY—Declared when one or more volcano monitoring parameters are outside the background range of activity. Progression towards an eruption is by no means certain, but the volcano is closely watched to see how unrest develops. After being downgraded from a higher level, Advisory means that volcanic unrest has decreased significantly but that the level of unrest has not yet reached background.

WATCH—Declared for two different situations: (1) heightened or escalating unrest indicating a higher potential that an eruption is likely but still not certain or (2) an eruption that poses only limited hazard to people on the ground. In situation 2, it is implied that erupting volcanoes are inherently unstable and that conditions could change quickly. After downgrading from Warning to Watch, this level indicates that the potential for renewal of hazardous eruptive activity is high (situation 1) or that the volcano has settled into an eruptive style that poses only limited hazards (situation 2).

WARNING—Declared when a highly hazardous eruption is underway, suspected, or believed to be imminent. Such events include large explosive eruptions that could destroy nearby communities and cause volcanic ash to fall on others downwind, eruptions of lava that are flowing towards nearby homes, and eruptions that could spawn powerful volcanic mudflows (lahars) that might inundate down-stream communities. During an eruption, information accompanying the alert levels and frequent updates will indicate in as much detail as possible the time of onset, intensity, ash-plume height, and types of hazardous phenomena. When an eruption ends or settles into milder, less hazardous activity the level is downgraded. (Follow this link for further information: **http://pubs.usgs.gov/fs/2006/3139/fs2006-3139.pdf**)

APPENDIX B: Joint Information Center Plan

References:

- Emergency Support Function 15 Annex F to DHS #15 External Affairs
- Emergency Support Function 15 Annex to Washington State CEMP

I. JIC Mission

1. Provide the central coordination point for timely and accurate incident information to the public and media; external affairs activities; and for media access.

II. Operating Concepts

1. Co-located site for local, state and federal information staff to attain a coordinated incident information response.

2. Scalable and Flexible to adapt to the size and scope of the incident.

3. Distribution and dissemination of information approved by MAC-G command through JIC communications, press releases, interviews, news briefings, social media responses and web site products.

4. Individual agencies will speak to their specific statutory responsibilities with prior coordination of information releases

III. JIC Type

1. An area JIC -- physical or virtual -- is proposed as the default structure to commence the Mt. Baker/Glacier JIC operations because of the incident will affect a large geographic area with multiple jurisdictions.

    a. Because of the volcanic activity could occur in some or all of the counties, physical sites for an Area JIC need to be identified in each of the major affected counties – Snohomish, Skagit and Whatcom. These facilities would be identified through discussion and site visits of potential JICs.

    b. An assessment also needs to be made of the Camp Murray/EMD facilities to determine adequacy of facilities and systems to operate as an Area JIC if the event expands to a state-wide emergency.

    c. The plan must further identify capabilities for a virtual JIC connecting each of the major counties and the state EOC at Camp Murray.

IV. JIC Establishment

1. Activation of the JIC at the onset of the volcano advisory or as events/media interest dictates.

2. Staffing should come from responding agencies based on the size and nature of the incident and the anticipated needs of the agency partners.

3. Co-location at one site of federal, state and local public information officers.

4. As much as practically possible, the JIC should be close to the MAC-G command center with adequate size and appropriate space, sufficient power / communication / sufficient parking and security.

5. Equipment requirements should include but not be limited to: telephone lines, wireless internet, cellular phone service, capacity for multiple computers, printers and copiers; press conference space, video equipment, television monitors, office furniture and supplies.

V. Operational Elements

1. JIC Lead
   a. Rotated by shift among USFS, USGS and WEMD to reflect MAC-G
   b. Oversees EA operations
   c. Direct liaison to incident command
2. Assistant JIC Leads
   a. Liaison
      i. Assists JIC lead
      ii. Acts as first-line contact for counties, coordinating agencies and unit leads
   b. Media/Production/Operations
      i. Assists JIC Lead
      ii. Oversees media, production and operations units
3. Logistics Unit Lead
   a. Administrative support
   b. Logistics procurement
4. Media Unit Lead
   a. Oversees media unit operations
   b. Direct report to JIC Lead
   c. Works in close coordination with Plans and Products Unit on production of materials

5. News Desk Manager

    a. Serves as primary initial contact for media for the event

    b. Oversees documentation of media contacts and media lists

        i. Media Analysis

            i. Reviews media reporting for accuracy, content to provide feedback on incident information to the JIC and MAC-G

        ii. Web Sites

            i. Overseas production and posting of web site material

        iii. Field Manager

            i. Oversees media relations staff in the field

            ii. Gathers and summarizes field reports for the JIC

        iv. Special Projects/Press Conferences

            i. Overseas production of special events and press conferences

        v. Writing Unit

        vi. Social Media

        vii. Media/Press Conferences talking points

6. Plans and Products Unit Lead

    a. Overseas production of news releases, fact sheets, updates, talking points and social media responses

    b. Direct report to JIC Lead

7. Operations Unit Lead

    a. Direct report to JIC lead

    b. Overseas production of video, mapping and photography products for JIC operations

8. Community Relations Unit Leader

    a. Direct report to JIC lead

b. Oversees public phone team

c. Monitors social media in coordination with media monitoring

9. Tribal Liaison Unit Lead

    a. Direct report to JIC lead

10. Legislative/Congressional Unit Lead

    a. Direct report to JIC lead

11. Private Sector Unit Lead

    a. Coordinated with Operations

    b. Direct report to JIC lead

12. International Unit Lead

    a. Direct report to JIC lead

13. Special Needs Liaison (as needed)

VI. Operation Schedule

1. 12-hour shifts, 0700-1900; 1900-0700
2. Press briefings – 1000 daily
3. Afternoon conference call with locals, state and federal PIOs
4. Updates/statements/press releases – as events warrant
5. ECC briefing / one per shift

APPENDIX C: Mt Baker Fact Sheet

USGS
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U.S. GEOLOGICAL SURVEY—REDUCING THE RISK FROM VOLCANO HAZARDS

Mount Baker—Living with an Active Volcano

Mount Baker (10,781 feet) viewed from east side with steam plume rising from Sherman Crater (left side of summit, inset shows crater interior). Scar of the 1891 flank collapse is visible in lower left of photo. Photos by Kevin Scott and (inset) Robert Symonds, USGS.

Mount Baker dominates the skyline from Bellingham, Washington, and Vancouver, British Columbia. On cold, clear winter days, dramatic increases in the steam plume rising continuously from Sherman Crater can alarm local residents. This apparent increase in plume vigor occurs because of condensation of steam in cold, calm air. In 1975, however, increased steaming and melting of snow and ice around Sherman Crater did signify a change in heat output from the volcano's interior. Although the increased heat flow gradually subsided, it could have signaled the start of eruptive activity, and precautions were wisely undertaken.

So that the public can be warned of, and be prepared for, future eruptions and other hazardous events at Mount Baker, U.S. Geological Survey (USGS) scientists are studying the volcano's past behavior and monitoring its current activity.

What Are the Hazards?

The next eruption of Mount Baker may produce **lava flows, pyroclastic flows,** volcanic ash (**tephra**), and **lahars**. Lahars are by far the greatest concern at Mount Baker because of its history of frequent lahars, the ability of lahars to flow for tens of miles, and the potential for hazardous future impacts of lahars on two reservoirs on the east side of the volcano. Tephra hazards at Mount Baker are less important than at neighboring Glacier Peak volcano to the south.

Lahars can originate in two ways:

1) During eruptions, pyroclastic flows can melt snow and ice to create torrents of ash, rock, and water that move downvalley as sandy (noncohesive) lahars.

2) Because the volcano is locally weakened and altered to clay by percolating, acidic, hot water and steam (like that venting from Sherman Crater), future volcanic landslides known as flank collapses can mobilize to form muddy (cohesive) lahars.

Lahars of collapse origin occur during eruptions. They also occur during non-eruptive periods triggered by regional earthquakes, gravity, or increases in hydrovolcanic activity not associated with magma intrusion.

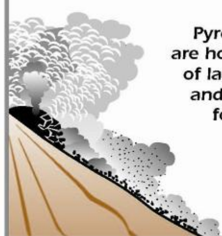
When ground water comes in contact with either magma or hot rock, hydrovolcanic

VOLCANO HAZARDS AT MOUNT BAKER

LAVA FLOWS

Lava is molten rock (magma) that pours or oozes onto the Earth's surface. Numerous eruptions of lava interbedded with rock rubble constructed Mount Baker.

PYROCLASTIC FLOWS



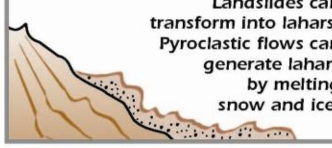
Pyroclastic flows are hot avalanches of lava fragments and volcanic gas formed by the collapse of lava flows or eruption clouds.

TEPHRA

Explosive eruptions blast fragments of rock high into the air. Large fragments fall to the ground close to the volcano. Small fragments (called ash) from the largest eruptions can travel hundreds of miles.

LAHARS

Lahars are fast-moving slurries of rock, mud, and water that look and behave like flowing wet concrete.



Landslides can transform into lahars. Pyroclastic flows can generate lahars by melting snow and ice.

U.S. Department of the Interior
U.S. Geological Survey

USGS Fact Sheet-059-00
May 2000

Deposit of the largest lahar from Mount Baker, exposed near the confluence of the Middle and North Forks of the Nooksack River, about 20 miles from its source at the Roman Wall. Note the protruding logs and branches from living trees that were knocked down and carried by the lahar. Ice axe, 3 ft, shows scale. Lahars are the greatest hazard at Mount Baker. Inset shows the flow front of a slurry of rock and water, typical of lahars. The flow is about 10 feet deep, moving right to left at 20 miles per hour. Photos by Kevin Scott, USGS.

Volcanic ash (tephra) layers on Mount Baker's south flank. Lower white band is from an eruption of Crater Lake, Oregon (7,700 years ago); upper yellow band is from a hydrovolcanic eruption of Mount Baker (6,600 years ago). Above the yellow band is a black ash from a magmatic eruption of Mount Baker (also about 6,600 years ago). Tephra hazards at Mount Baker are less significant than at neighboring Glacier Peak volcano to the south. Photo by Kevin Scott, USGS.

explosions of steam and rock can occur. Such events, in addition to possibly triggering collapse, can themselves be hazardous.

Mount Baker— Early History

USGS research in the last decade shows Mount Baker to be the youngest of several volcanic centers in the area and one of the youngest volcanoes in the Cascade Range. Volcanic activity in the Mount Baker area began more than one million years ago, but many of the earliest lava and tephra deposits have been removed by glacial erosion. The pale-colored rocks northeast of the modern volcano mark the site of ancient Kulshan Caldera that collapsed after an enormous ash eruption one million years ago. Subsequently, eruptions in the Mount Baker area have produced cones and lava flows of andesite, the rock that makes up much of other Cascade Range volcanoes like Mounts Rainier, Adams, and Hood. From about 900,000 years ago to the present, numerous andesitic volcanic centers in the area have come and gone, eroded by glaciers. The largest is the Black Buttes edifice, active between 400,000 and 300,000 years ago and formerly bigger than today's Mount Baker.

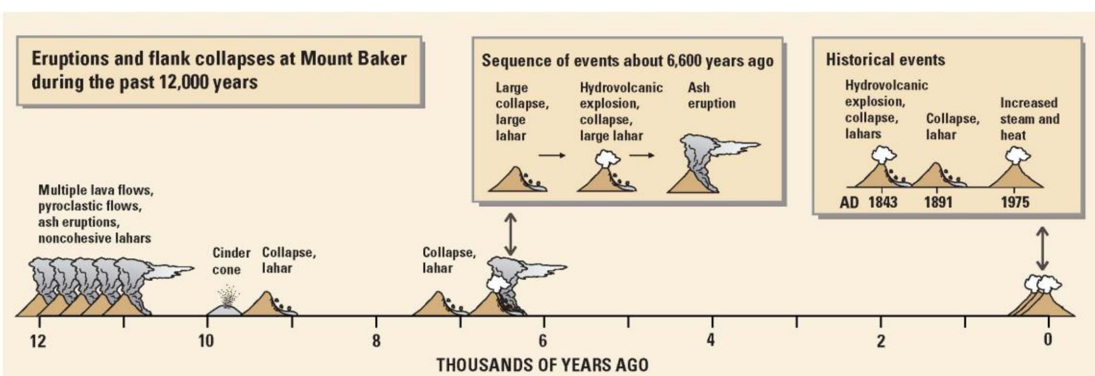
Although numerous in Oregon and southern Washington, cinder cones formed of the rock type called basalt are rare around Mount Baker. A cinder cone that formed 9,800 years ago in Schriebers Meadow produced a widespread tephra layer, and lava flows that reached the Baker River.

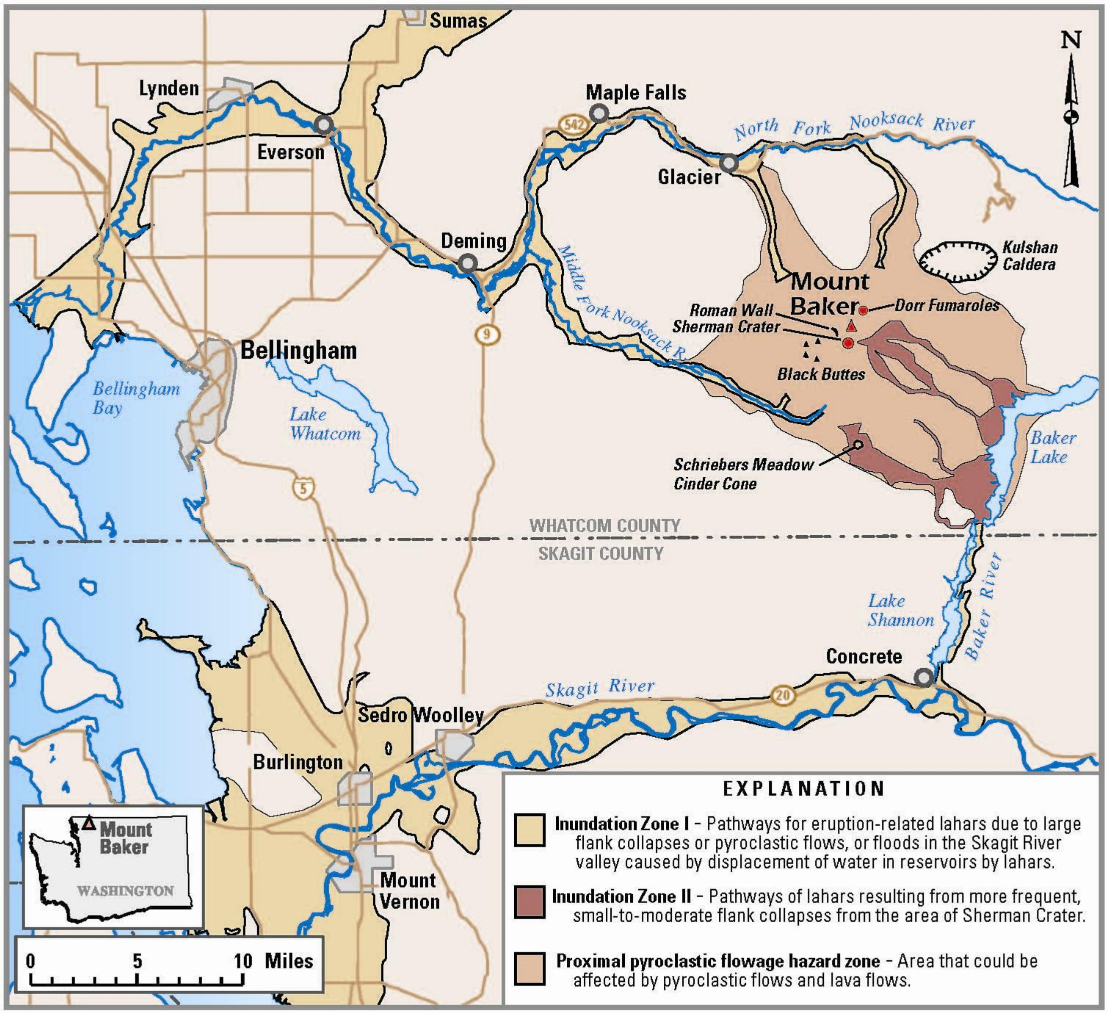
Today's Mount Baker

Modern Mount Baker formed during and since the last ice age, which ended about 15,000 years ago. Lava flows from the summit vent erupted between 30,000 and 10,000 years ago and, during the final stages of edifice construction, blocky pyroclastic flows poured down most of the volcano's drainages. An eruption 6,600 years ago produced a blanket of ash that extended more than 20 miles to the northeast. This eruption probably occurred from the presently ice-filled summit crater. Subsequently, sulfurous gases have found two pathways to the surface—Dorr Fumaroles, northeast of the summit, and Sherman Crater, south of the summit. Both these area are sites of pervasive bedrock alteration, converting lavas to weak, white-to-yellow material rich in clays, silica, and sulfur-bearing minerals. At Sherman Crater, collapses of this weakened rock created lahars in 1843 and as recently as the 1970's.

Past Events — Future Hazards

Like most volcanoes, Mount Baker's history records great variations in behavior. Scientists believe the following case histories are good examples of the range in size and types of hazardous activity that have occurred in the





Map showing hazard zones for lahars, pyroclastic flows and lava flows (for more detail see Plate 1 in US Geological Survey Open-File Report 95-498).

past and could occur again. Small events are more common than large ones, and during a future hazardous event only parts of the hazard zones shown on the map may be affected.

Flank Collapses, Lahars, and Tephra Eruptions, about 6,600 Years Ago

A series of discrete events culminated with the largest tephra-producing eruption in post-glacial time at Mount Baker. First, the largest collapse in the history of the volcano occurred from the Roman Wall (see map) and transformed into a lahar that was over 300 feet deep in the upper reaches of the Middle Fork of the Nooksack River. It was at least 25 feet deep 30 miles downstream from the volcano and probably reached Bellingham Bay. Next, a huge hydrovolcanic explosion occurred near the site of present day Sherman Crater, triggering a second collapse of the flank just east of the Roman Wall. That collapse also became a lahar that mainly followed the course of the first one for at least 20 miles, but also spilled into tributaries of the Baker River. Finally, an eruption cloud deposited several inches of ash as far as 20 miles downwind to the northeast.

Sherman Crater Forms in 1843

The present shape of Sherman Crater originated with a large hydrovolcanic explosion. In 1843, explorers reported a widespread layer of newly fallen rock fragments "like a snowfall" and the forest "on fire for miles around." Rivers south of the volcano were clogged with ash, and Native Americans reported that many salmon were killed. A short time later, two collapses of the east side of Sherman Crater produced two lahars, the first and larger of which flowed into the natural Baker Lake, raising its level at least 10 feet. The location of this 19th-century lake is now covered by waters of the modern dam-impounded Baker Lake. Similar but lower level hydrovolcanic activity at Sherman Crater continued intermittently for several decades afterwards.

Flank Collapse and Lahar in 1891

In 1891, about 20 million cubic yards of rock fell from the scar shown in the photo on the front page, producing a lahar that traveled more than 6 miles and covered 1 square mile.

Sherman Crater Heats Up in 1975, Triggering Concern

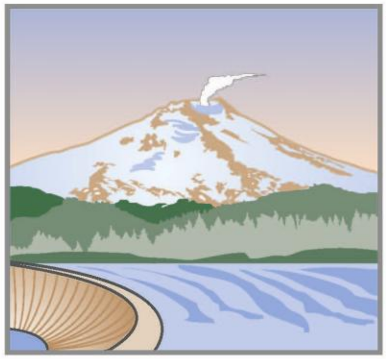
Beginning in March 1975, the rate of gas and steam emission from Sherman Crater increased significantly. Heat flow increased more than tenfold. The activity gradually declined over the next 2 years but stabilized at a higher level than before 1975. Several small lahars formed from material ejected onto the surrounding glaciers. Acidic water was discharged into Baker Lake for many months.

Response to the 1975 Activity—Strategies for the Future

In 1975, scientists believed that the dramatic increase in the steam plume and heat output from Sherman Crater could herald either a new magmatic eruption or hydrovolcanic activity like that of 1843. Either of these possibilities would have increased the risk of collapse, raising concerns that lahars could flow rapidly into Baker Lake or Lake Shannon, displacing water and creating a flood surge or even causing dam failure. The volcano was subjected to the most intensive monitoring ever applied to a Cascade Range volcano up to that time. As time passed, no signs of rising magma– earthquakes, significant changes in gas composition, or surface deformation– appeared. The main risk, therefore, was of flank collapses and lahars similar to those of 1843 (Map Inundation Zone II). Had magmatic activity been confirmed, a much larger collapse and flow would have been possible (Map Inundation Zone I), and a magmatic eruption could have ensued like those between 30,000 and 10,000 years ago or that of 6,600 years ago.

When magmatic activity does recur, all the drainages of Mount Baker will be at risk from lahars, and upstream areas will be at risk from pyroclastic flows and lava flows in the hazard zone shown on the map. The Dorr Fumaroles are also a potential site of hydrovolcanic explosions. Steep headwalls on the north flank are also at risk of flank collapse, but Sherman Crater is the most likely area on Mount Baker for renewed failure.

On the basis of conclusions by USGS scientists in June 1975, an interagency task



CLOSURE

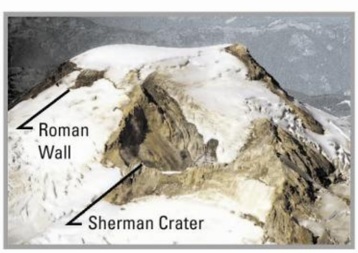
REASONS FOR THE CLOSURE

Based on scientific information obtained from the U.S. Geological Survey and scientists studying steam activity on Mt. Baker, the Forest Service has closed the shoreline and all campgrounds at Baker Lake. The closure is in the interest of public safety.

There is danger that the heavy steam acitivity will trigger a massive mudslide from the upper slopes of Mt. Baker. Such a slide could enter the lake with great force, sending a wave of water along the lakeshore and into the campground areas.

This closure includes Horseshoe Cove, Boulder Creek, Maple Grove, Baker Lake, Park Creek and Shannon Creek Campgrounds as well as.......

This notice was posted at campgrounds around Baker Lake by the US Forest Service in June 1975. Normally, Baker Reservoir approaches capacity during mid-summer. At most other times, reservoir levels are low enough to impound lahars the size of those that occurred in 1843.



View looking north at Mount Baker summit, Sherman Crater, and the Roman Wall. Photo by Dave Tucker.

force advised lowering the level of Baker Lake so that it could accommodate lahar inflow without displacing water from the reservoir that could have flooded the downstream Skagit River valley. Because a lahar could also trigger waves that would inundate areas around the lake, shoreline residences, campgrounds, and businesses were evacuated. On the basis of recent research, the west side of Sherman Crater, site of a previous collapse, could also be unstable. Today, if there were a similar increase in activity at Sherman Crater, USGS scientists might also recommend drawdown of Lake Shannon, the smaller downstream reservoir that is the catchment for drainages from the west side of the crater.

Monitoring for the Future

The University of Washington Geophysics Program, in cooperation with the USGS, monitors seismic (earthquake) activity at Mount Baker and other Cascade Range volcanoes. Seismic activity is the most common precursor of magma intrusion, which potentially could lead to an eruption. The risk and potential size of flank collapse and lahars increase progressively as magma rises toward and into a volcano's edifice.

The USGS monitors gas emissions from Sherman Crater in order to detect changes in the volcano's "plumbing system" that may be a warning of impending magmatic activity or an increase in hydrovolcanic activity, and thus an increased chance of eruption or collapse.

Preparing for the Future

Scientists do not know when an eruption or other hazardous event like a flank collapse will occur at Mount Baker, but surely they will occur again. As Mount St. Helens taught us, it is best to be prepared. The USGS works with Federal, State, Provincial, and local agencies to prepare for disruption that might accompany renewed activity. A coalition of these agencies, known as the Mount Baker and Glacier Peak Facilitating Committee, has drafted a plan outlining how agencies will work together in the event of unrest at either volcano.

What You Can Do

- **Learn** about the volcano hazards that could affect your community, and determine whether you live, work, play, or go to school in a volcano hazard zone.
- **Plan** what you and your family will do if a hazardous event occurs.
- **Participate** in helping your community be prepared.

A few moments spent in preparation now could keep you, your family, and your community safe when Mount Baker next erupts.

Kevin M. Scott, Wes Hildreth, and Cynthia A. Gardner

Graphics and design by
Lisa Faust, Bobbie Myers, and Christine Janda

COOPERATING ORGANIZATIONS
U.S. Department of Agriculture, Forest Service
University of Washington, Geophysics Program

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or
USGS Volcano Hazards Program
http://volcanoes.usgs.gov/
or
your local emergency management agency:
Skagit County (360) 428-3250
Whatcom County (360) 676-6681

See also *Potential Volcanic Hazards from Future Activity of Mount Baker, Washington* (USGS Open-File Report 95-498), and *What are Volcano Hazards?* (USGS Fact Sheet 002-97)

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APPENDIX D: Glacier Peak Fact Sheet

USGS
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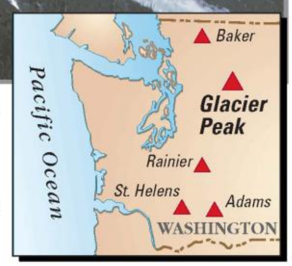
U.S. GEOLOGICAL SURVEY — REDUCING RISK FROM VOLCANO HAZARDS

Glacier Peak — History and Hazards of a Cascade Volcano

Glacier Peak is the most remote of the five active volcanoes in Washington State. It is not prominently visible from any major population center, and so its attractions, as well as its hazards, tend to be overlooked. Yet since the end of the last ice age, Glacier Peak has produced some of the largest and most explosive eruptions in the state. During this time period, Glacier Peak has erupted multiple times during at least six separate episodes, most recently about 300 years ago. What were these eruptions like? Could similar ones affect us today? Scientists from the U.S. Geological Survey (USGS) are working to answer these questions and help prepare for future activity.

The stunning snow-capped volcanoes of Washington State have long been recognized by Native Americans in their language and legends, and they immediately caught the eyes of U.S. and European explorers in the late 18th and early 19th centuries. By the 1790's, Mounts Baker, Rainier, and St. Helens were noted and named in the first written descriptions of the Columbia River and Puget Sound regions. In 1805 Lewis and Clark noted Mount Adams. By the mid-19th century each of these four volcanoes had their place on a published map.

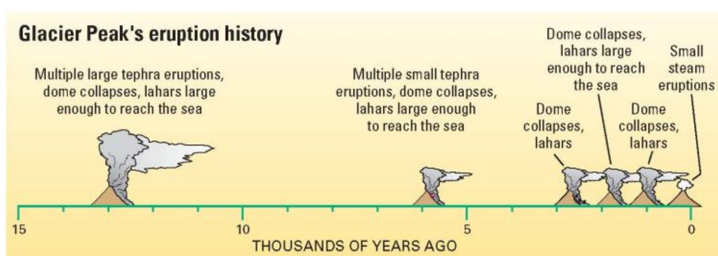
Glacier Peak wasn't known by settlers to be a volcano until the 1850's, when Native Americans mentioned to naturalist George Gibbs that "another smaller peak to the north of Mount Rainier once smoked." Not until 1898 did Glacier Peak appear on a published map under its current name.



Glacier Peak lies in Washington State's North Cascade Mountains, in the heart of a wilderness area bearing its name. Its past eruptions have melted snow and ice to inundate downstream valleys with rocks, mud, and debris. Large eruptions from Glacier Peak have deposited ash throughout much of the western United States and southwestern Canada. Photo by D.R. Mullineaux, USGS.

Glacier Peak lies only 70 miles northeast of Seattle—closer to that city than any volcano except Mount Rainier. But unlike Mount Rainier, it rises only a few thousand feet above neighboring peaks, and from coastal communities it appears merely as a high point along a snowy saw-toothed skyline. Yet Glacier Peak has been one of the most active and explosive of Washington's volcanoes.

Since the continental ice sheets receded from the region, Glacier Peak has erupted repeatedly during at least six episodes. Two of these eruptions were among the largest in Washington during the past 15,000 years. These pages describe some of the effects of past eruptions and possible consequences of future activity.



Known eruptive episodes at Glacier Peak during the past 15,000 years. Each episode (depicted by a single icon) represents many individual eruptions. The ages of these episodes, in calendar years before present are corrected from dates based on a radiocarbon time scale. The uncorrected radiocarbon ages for these episodes, which appear in some publications, are 11,200, 5,100, 2,800, 1,800, 1,100, and 300 years before present.

U.S. Department of the Interior
U.S. Geological Survey

USGS Fact Sheet 058-00
2000

Eruption column from Mount St. Helens on May 18, 1980. Rock fragments (tephra) give the column the gray color. Tephra from the eruption fell as far away as Colorado. About 13,100 years ago, an explosive eruption from Glacier Peak generated a sequence of tephra eruptions, the largest of which ejected more than five times as much tephra as the May 18,1980 eruption of Mount St. Helens. Photo by Austin Post, USGS.

During Past Eruptions . . .

Tephra Covered the Landscape

Glacier Peak and Mount St. Helens are the only volcanoes in Washington State that have generated large, explosive eruptions in the past 15,000 years. Their violent behavior results from the type of molten rock (magma) they produce. Dacite, the typical magma type of Mount St. Helens and Glacier Peak, is too viscous to flow easily out of the eruptive vent; it must be pressed out under high pressure. As it approaches the surface, expanding gas bubbles within the magma burst and break it into countless fragments. These fragments are collectively known as tephra; the smallest are called ash.

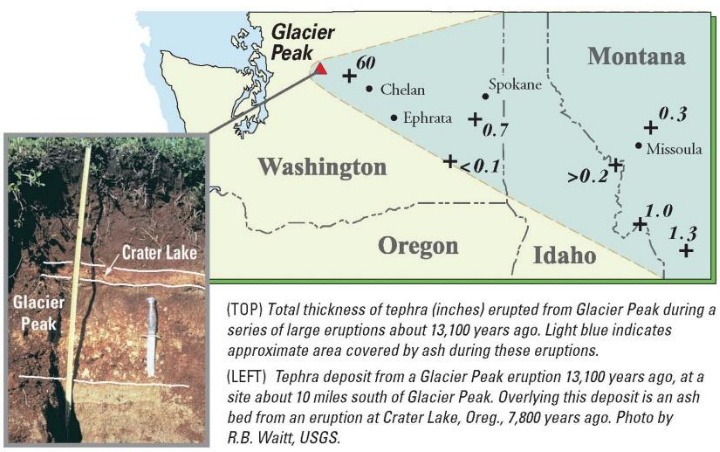
About 13,100 years ago, Glacier Peak generated a sequence of nine tephra eruptions within a period of less than a few hundred years. The largest ejected more than five times as much tephra as the May 18, 1980, eruption of Mount St. Helens and was one of the largest in the Cascade Range since the end of the last ice age.

Some of the tephra from these eruptions fell back onto the volcano and avalanched down its flanks. Much of the rest rose high into the atmosphere and drifted hundreds to thousands of miles downwind. Deposits from these eruptions are more than a foot thick near Chelan, Washington, and an inch thick in western Montana.

Since these events, Glacier Peak has produced several tephra eruptions, all of much smaller volume.

Lava Domes Collapsed onto the Volcano's Flanks

During most of Glacier Peak's eruptive episodes, lava domes have extruded onto the volcano's summit or steep flanks. Parts of these domes collapsed repeatedly to produce pyroclastic flows and ash clouds. The remnants of prehistoric lava domes make up Glacier Peak's main summit as well as its "false summit" known as Disappointment Peak. Pyroclastic-flow deposits cover the valley floors east and west of the volcano. Ridges east of the summit are mantled by deposits from ash clouds.



(TOP) *Total thickness of tephra (inches) erupted from Glacier Peak during a series of large eruptions about 13,100 years ago. Light blue indicates approximate area covered by ash during these eruptions.*

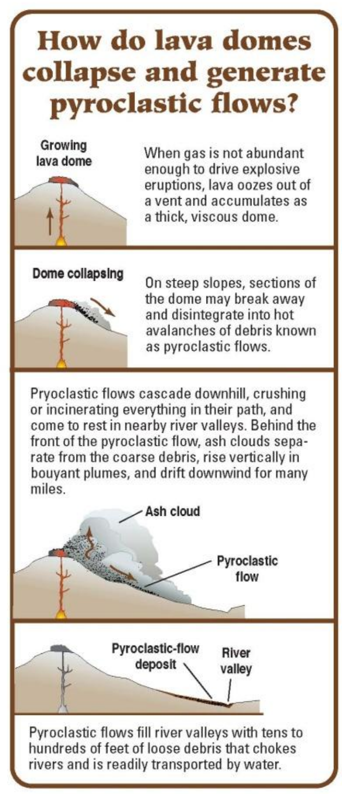
(LEFT) *Tephra deposit from a Glacier Peak eruption 13,100 years ago, at a site about 10 miles south of Glacier Peak. Overlying this deposit is an ash bed from an eruption at Crater Lake, Oreg., 7,800 years ago. Photo by R.B. Waitt, USGS.*

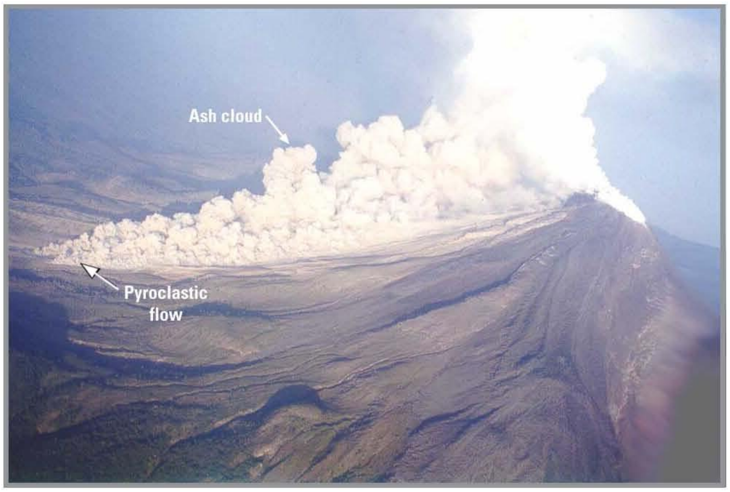
Glacier Peak from the east, showing the main summit and Disappointment Peak, which are remnants of prehistoric lava domes. Photo by Austin Post, USGS.

Lahars Inundated River Valleys

Past eruptions have severely affected river valleys that head on Glacier Peak. Pyroclastic flows mixed with melted snow and glacial ice to form rapidly flowing slurries of rock and mud known as lahars.

About 13,100 years ago, dozens of eruption-generated lahars churned down





A collapsing lava dome generates a pyroclastic flow and ash cloud at Colima Volcano, Mexico, November 22, 1998. Photo by Abel Cortes, ©1998, University of Colima.

the White Chuck, Suiattle, and Sauk Rivers, inundating valley floors. Lahars then flowed down both the North Fork Stillaguamish (then an outlet of the upper Sauk River) and Skagit Rivers to the sea. In the Stillaguamish River valley at Arlington, more than 60 miles downstream from Glacier Peak, lahars deposited more than seven feet of sediment. Shortly after the eruptions ended, the upper Sauk's course via the Stillaguamish was abandoned and the Sauk River began to drain only into the Skagit River, as it does today.

About 5,900 years ago and 1,800 years ago, dome-building eruptions generated lahars that extended once again to the sea, this time only along the Skagit River. In small eruptions since 1,800 years ago, lahars have extended the entire length of the White Chuck River and part way down the Suiattle.

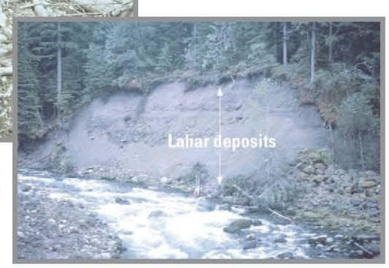
Lahars can also be generated by landslides (also called flank collapses) on volcanoes, as has happened repeatedly at Glacier Peak's neighbor to the north, Mount Baker. At Mount Baker, lahars from numerous landslides, some without accompanying eruptive activity, have affected valley floors near the volcano. A few much larger landslides during eruptive periods generated lahars that flowed hundreds of feet deep through upper valleys and reached the sea. At Glacier Peak landslide-generated lahars have occurred less frequently than at Mount Baker.

During Future Eruptions . . .

Glacier Peak's eruptive episodes are typically separated by several hundred to a few thousand years. Thus in any given year, the probability of a new episode beginning is roughly one in a thousand. It is unlikely that we will see an eruption within our lifetimes. If one does take place, its impact would vary dramatically in different geographic areas depending on the size of the eruption, wind direction, and type of hazards produced.

In undeveloped areas near the volcano, the landscape would be severely altered by lava domes, pyroclastic flows, ash clouds, lahars, and associated phenomena.

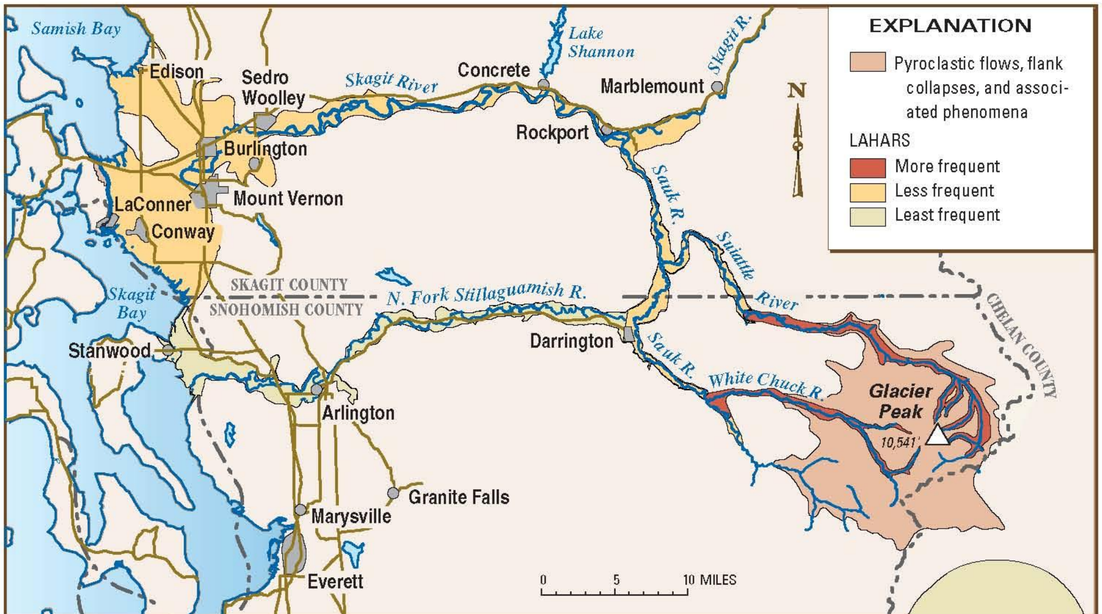
More than 200 homes and over 120 miles of roads were destroyed by the 1980 lahars at Mount St. Helens. Pictured is a damaged home along the South Fork Toutle River. Photo by Lyn Topinka, USGS.



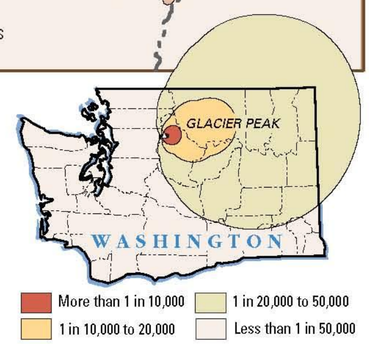
A few hundred yards upstream from its confluence with the Sauk River, the White Chuck River erodes into lahar deposits produced by prehistoric eruptions of Glacier Peak. Photo by R.B. Waitt, USGS.

In river valleys downstream from the volcano, lahars could block transportation routes, destroy highways and bridges, bury houses in mud, cover farmland with debris, choke river channels, and increase the severity of floods for years or decades after the eruptions stop. These effects will be most frequent in the White Chuck and upper Suiattle River valleys. They will be less frequent, but potentially more damaging due to greater population and infrastructure, in the Sauk and Skagit River valleys. Still less likely would be lahars in the Stillaguamish River valley, which would occur only if the Sauk River became choked with enough debris to be diverted west into the Stillaguamish River valley. When a lahar takes place, residents of communities along these rivers should move to high ground as quickly as possible.

In areas downwind from the volcano, even small tephra eruptions could disrupt air and ground transportation and dust towns with ash. Tephra could clog drainage ducts and ventilation filters, short-circuit power transformers, damage machinery and electronic equipment, reduce visibility, exacerbate respiratory ailments, and stall transportation. Large tephra eruptions (comparable to Glacier Peak's largest) would have more widespread effects and could deposit enough tephra to collapse roofs in nearby downwind communities. Owing to prevailing wind patterns, tephra fall during future eruptions is most likely east of Glacier Peak. But tephra could affect communities in all directions from the volcano depending on wind patterns during an eruption. Five tephra eruptions from Mount



Areas at risk from lahars, lava domes, pyroclastic flows, and associated phenomena from Glacier Peak. Map modified from R.B. Waitt and others, U.S. Geological Survey Open-File Report 95-499.



Annual probability of tephra fall exceeding 0.5 inch thick from an eruption of Glacier Peak. Communities east of the volcano are more susceptible to tephra fall because the wind is normally from the west. Glacier Peak has produced large tephra eruptions, but not frequently.

St. Helens in 1980, for example, deposited ash north, east, west, and south of the volcano. Damage from tephra can be mitigated by such actions as shutting down and covering equipment, frequently replacing air filters in machinery, wearing dust masks, and avoiding unnecessary travel.

Preparing for the Next Eruption

Future eruptions from Glacier Peak will almost certainly be preceded by an increase in earthquake activity, and possibly by measurable swelling of the volcano and emission of volcanic gases. In cooperation with the USGS, the University of Washington's Geophysics Program continuously monitors earthquakes that could portend Glacier Peak's next eruption. The USGS also works with Federal, State, Provincial, and local agencies to prepare for disruption that might accompany renewed activity. A coalition of these agencies, known as the Mount Baker–Glacier Peak Facilitating Committee, has drafted a plan outlining how agencies will work together in the event of unrest at Mount Baker or Glacier Peak. If Glacier Peak were to reawaken, the USGS would rapidly deploy additional monitoring instruments and, together with these agencies, establish a local volcano observatory and command center that would keep nearby communities informed of developments.

What You Can Do

- **Learn** about the volcano hazards that could affect your community, and determine whether you live, work, play, or go to school in a volcano-hazard zone.
- **Plan** what you and your family will do if a hazardous volcanic event occurs.
- **Participate** in helping your community be prepared.

A few moments spent now could help prevent the next eruption from becoming a disaster for you, your family, and your community.

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See also *Volcanic-Hazard Zonation for Glacier Peak Volcano, Washington* (USGS Open-File Report 95-499) and *What are Volcano Hazards?* (USGS Fact Sheet 002-97)

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