MOUNT ST. HELENS

VOLCANIC ACTIVITY

RESPONSE PLAN

2006

MOUNT ST. HELENS VOLCANO RESPONSE PLAN

Reviewed and
Accepted by: ______________________ 10/4/2006
Volcano Emergency Coordinator — Date
U.S. Forest Service

Recommended
By: ______________________ 10/10/2006
Monument Manager — Date
U.S. Forest Service

Approved by: ______________________ 10/13/06
Forest Supervisor — Date
Gifford Pinchot National Forest

Participating Cooperators to Mt. St. Helens Volcano Response Plan

U.S.G.S. – Cascade Volcano Observatory
1300 SE Cardinal Court — **Phone**: (360) 993-8900
Building 10, Suite 100 — **Fax**: (360) 993-8980
Vancouver, WA 98683

WA – Emergency Management Division
Building 20, M/S: TA-20 — **Phone**: (253) 512-7000
Camp Murray, WA 98430-5122 — **Fax**: (253) 512-7200

Federal Emergency Management Agency
130 228th St. SW — **Phone**: (425) 487-4600
Bothell, WA 98021 — **Fax**: (425) 487-4692

Cowlitz County Department of Emergency Services
Hall of Justice
312 SW 1st Ave. — **Phone**: (360) 577-3130
Kelso, WA 98626 — **Fax**: (360) 577-3009

Lewis County Division of Emergency Management
350 N. Market Blvd. — **Phone**: (360) 740-1151
Chehalis, WA 98532 — **Fax**: (360) 740-1471

Lewis County Sheriff
360 NW North St., MS: SHE01 — **Phone**: (360) 748-9286
Chehalis, WA 98532-1900 — **Fax**: (360) 740-1476

Clark Regional Emergency Management Services
710 W 13th St. — **Phone**: (360) 737-1911
Vancouver, WA 98660 — **Fax**: (360) 694-1954
Dispatch Fax: (360) 992-9221
24hr # (360) 696-4461

Skamania County Department of Emergency Management
P.O. Box 790 — **Phone**: (509) 427-9409
Stevenson, WA 98648 — **Fax**: (509) 427-7555
24hr # (509) 427-9496

U.S. Army Corps of Engineers
333 SW 1st Ave. — **Phone**: (503) 702-0097
Portland, OR 97208-3623 — **Fax:** (503) 808-4405
24hr # (503) 808-4400

PacifiCorp
SPCC 2nd Floor
9951 SE Ankeny
Portland, OR 97216

Phone: (503) 251-5155

Portland General Electric
P.O. Box 4404
Portland, OR 97208

Phone: (503) 464-8000

Portland Office of Emergency Management
1001 S.W. 5th Ave., Suite 650
Portland, OR 97204

Phone (Days):	(503) 823-4375
Phone: (Nights)	(503) 793-1161
Fax:	(503) 823-3903

Gifford Pinchot National Forest
10600 NE 51st Circle
Vancouver, WA 98682

Phone (Days):	(360) 891-5100
Phone: (Nights)	(360) 896-3473
Fax:	(360) 891-5145

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I. INTRODUCTION

This revision of the Mount St. Helens Contingency Plan reflects the incorporation of "Lessons Learned" from the 2004 eruption and an ongoing commitment to the management objectives and philosophies implemented during the past 25 years. The intention throughout the development and updating of this plan has been to keep it as brief as possible. The focus of this document is to define responsibilities of the U.S.D.A Forest Service in carrying out mandated policies.

Effective management of volcano emergencies requires an effective team of cooperating agencies and organizations able to provide a coordinated response. This coordination with local, state and other federal agencies will be enhanced at all opportunities. The Forest Service has taken the lead in the updating of this plan. Continued coordination and maintenance of interagency working relationships needs to be supported by all agencies.

II. PURPOSE

The purpose of this document is to provide: a summary of the responsibilities of the USDA Forest Service and the role of the Emergency Coordination Center (ECC), define the interrelationships of this organization and to serve as a contingency plan.

This document will describe the current working and communication relationships. This narrative establishes direction for organization development to manage:

1. A status quo or monitoring situation on a daily basis,

2. A small isolated volcanic event,

3. A volcanic event or flood or other emergency which necessitates a high degree of logistical coordination in the movement of the general populace in coordination with other agencies,

4. A multiple incident situation requiring an incident commander and/or Unified Command or Unified Area Command,

5. Define criteria, which if met, would lead to the establishment of a Multi-agency Coordination Group (MAC).

This plan does not imply direction or control of those agencies outside of USFS jurisdiction.

III. LEGAL AUTHORITY

Numerous laws, statues, and orders to provide for the public welfare mandate all federal agencies. The legal authorities for the U.S. Forest Service are discussed below.

- The authority for Federal action in major disasters and emergencies contained in the Disaster Relief Act of 1974 (P.L.93-288) and Executive Order 11725 of June 27,1973.

- Assistance in fire emergencies is authorized by the Act of May 27, 1955 (42 U.S.C. 1856a).

- At the request of another Federal agency, the Forest Service has authority to assist that agency with any resources available. Funding is handled with an advance of funds to the consolidated working fund or by reimbursement (under section 601 of the Economy Act of June 30,1932, 31 U.S.C. 686.) When assistance requests are anticipated, it is desirable to have an agreement with the responsible Federal agency as to the action requested of the Forest Service. Arrangements should be worked out at the Regional, Station, or Area level and confirmed in writing. (See FSM 1595 and 1596 for special authorities, civil defense planning, and rural fire defense.)

- Homeland Security Presidential Directive (HSPD)-5; the President directed the development of the National Response Plan (NRP) to align Federal coordination structures, capabilities and resources into a unified, all-discipline and all-hazards approach to domestic incident management. (National Strategy for Homeland Security; Homeland Security Act of 2002; HSPD-5)

IV. ORGANIZATION

A. EMERGENCY COORDINATION CENTER (ECC)

1. Administration

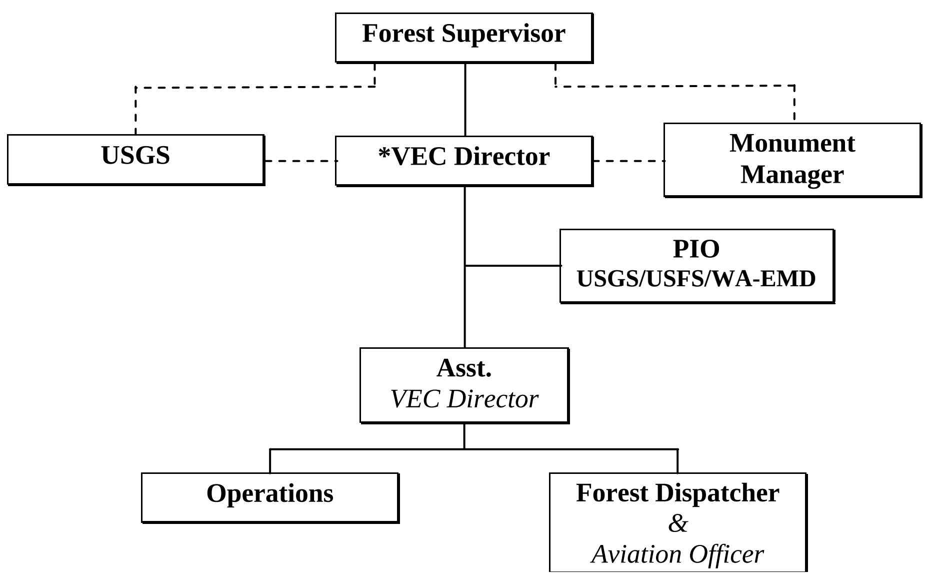
While the basic organization has evolved from 1980 to the present, the overall function has had only minor changes to date. The operation of the Emergency Coordination Center will be built around the existing Gifford Pinchot Fire Management organization. The following chart is the basic organization through Volcano Advisory. As emergency conditions change, the level of staffing will change.

National Incident Management System (NIMS) Incident Command System (ICS) structure will be used to develop the organization, including interagency coordination and communication, necessary to respond to current and anticipated geological activity.

Organization Chart

Emergency Coordination Center

(Basic Organization)



*** Volcano Emergency Coordinator**

2. Operations

The ECC is located at the Gifford Pinchot National Forest headquarters at 10600 N.E. 51st Circle, in Vancouver, Washington 98682. The Forest Communication Center Office and adjoining conference rooms may be used as a coordination and command center.

The present location has ample room for all personnel involved and a communication network is in place. In the event more space is needed for support organizations, i.e., Joint Information Center, Sheriffs, Corps of Engineers, Pacific Power, Portland General Electric, etc., the current location is suited to accommodate trailer offices on-site.

If it becomes necessary, it is possible to relocate the center for management or emergency reasons. Cowlitz and Clark Counties have Emergency Operations Centers (E.O.C) facilities for our use in an emergency situation. Also, the Mount St. Helens National Volcanic Monument has a warehouse at its Amboy headquarters with 24 available telephone lines. The Forest Service will have only one ECC or may be co-located with an EOC.

In the event radio and telephone communications break down, the option to utilize Federal Emergency Management Agency's (FEMA) resources exist. FEMA has a highly sophisticated communications van stationed in Seattle that can provide an unlimited array of systems for our use.

The ECC (when not activated) operates during normal work hours, Monday through Friday, 0800am-1630pm, but staffing will be augmented according to staged alert levels. The communication system that is in place on a daily routine basis includes:

a. *ECC Equipment and Communications:*

Radio network for Forest & Support Agencies
(programmable radios), composed of 14 channels.

Telephone—30 Commercial lines

Computer Data Lines—14 available

FAX

Cellular phones

b. ECC Staff & Phone Numbers (Office)

ECC Dispatch (0800-1630, M-F)	(360) 891-5140
24-Hour Answering Service	(360) 896-3473
VEC Director—Mike Matarrese	(360) 891-5146
Asst. Director—Ron Freeman	(360) 891-5156
Forest Dispatcher (Operations) & Aviation Officer— Steve Arasim	(360) 891-5142
FAX (ECC)	(360) 891-5145
Forest Supervisor—Claire Lavendel	(360) 891-5100
Deputy Supervisor—Lynn Burditt	(360) 891-5101
Forest Special Agent—Chris Lynch	(360) 891-5135

B. ROLES AND RESPONSIBILITIES

The role of the ECC organization is to expedite a coordinated emergency response to hazardous volcanic conditions.

The primary objectives of this organization are:

1. Establish and maintain communication channels with scientists at the USGS-Cascade Volcano Observatory, Ranger Districts and the Monument.

2. Notify other Federal Agencies and Cooperators of situation. (See Appendix I)

3. Direct a coordinated response to minimize the potential loss to human life and property.

4. Be decisive in directing personnel effort and commitment of resources.

5. Facilitate accurate and timely exchange of volcanic information, ideas and concerns.

6. Provide a continuum of data flow concerning hazard assessment, evaluation, and decisions.

7. Utilize more effectively human and physical resources eliminating duplication of effort.

8. Determine appropriate ordering procedures for acquiring resources.

9. Determine need for Public Affairs staffing.

V. AGENCY'S POSITION AND ROLES

The following agencies and positions comprise the foundation of the ECC and are in 24-hour contact by telephone or pager at the "Volcanic Advisory" level. Decisions to issues information statements, alert-level statements, or update statements are made by the USGS in consultation with the USDA Forest Service and WA-EMD.

A. USDA FOREST SERVICE

The U.S. Forest Service is the primary land manager for Mount St. Helens and the immediate surrounding area. As such the Forest Service will implement an Incident Command organization prior to the need for other agencies to do so. The Forest Volcano Incident Management Team (IMT3) may be mobilized, depending on the complexity of expected volcanic events.

The Forest Service will establish and maintain an effective 24-hour emergency notification operation staffed by qualified individuals.

Provide assistance to other agencies and organizations in developing their contingency actions.

Expand the Emergency Coordination Center as needed for the situation.

Make the appropriate contacts as outlined in Appendix I, page 31.

Provide for public and response team safety and communications.

1. VEC/ECC DIRECTOR

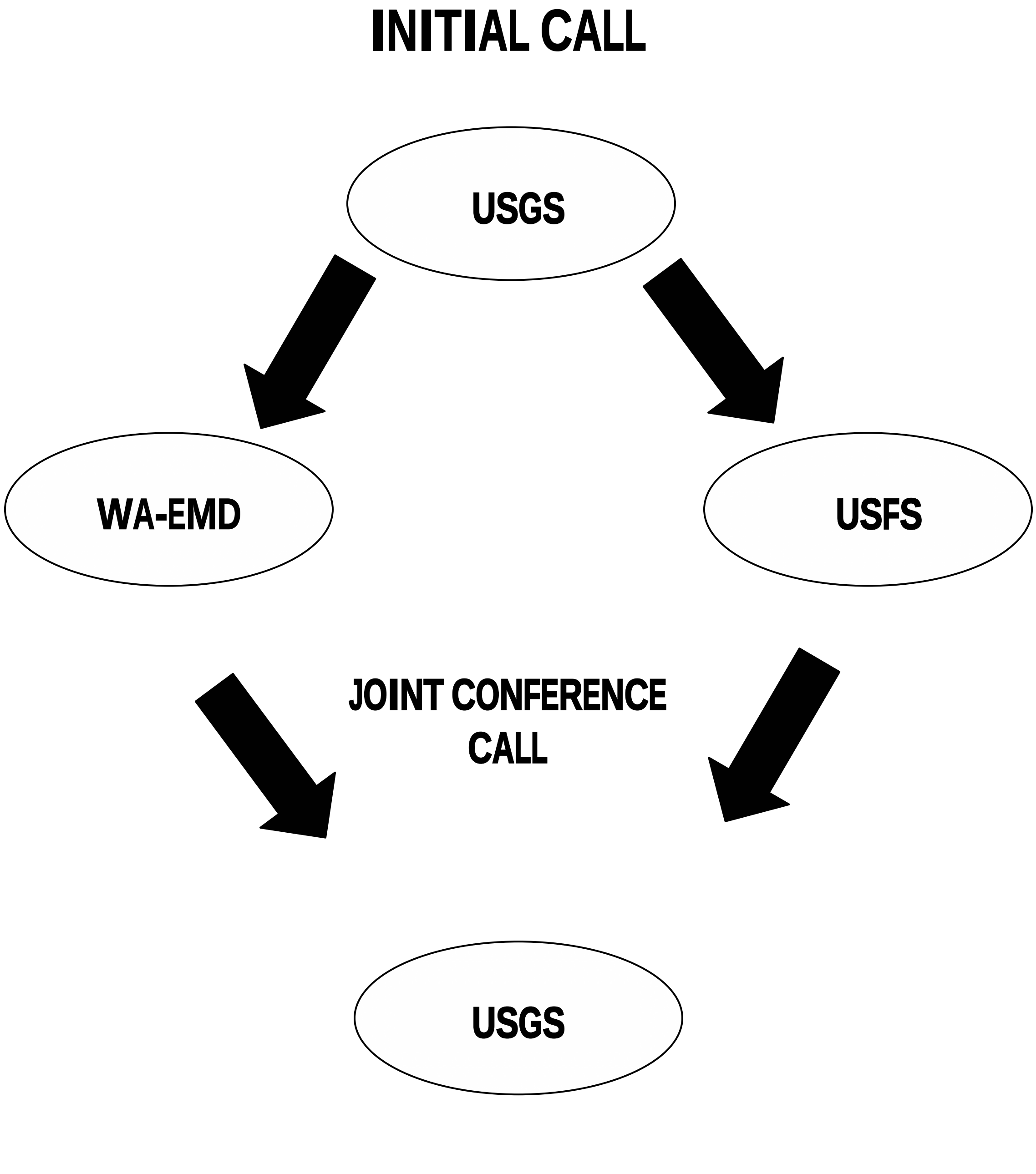
The purpose of the Director is to provide leadership and direction to the overall emergency effort.

The VEC/ECC Director is also the Forest Supervisor's Representative, so delegated by this plan.

The VEC/ECC Director:

- Provide leadership and direction to the overall emergency effort for the Forest Service.
- May serve as the Incident Commander (IC) for the Forest's Type 3 Incident Management Team, with a Delegation of Authority describing the appropriate Agency Administrator's considerations for management.
- Brief the Forest Supervisor of significant issues, events or problems the Director cannot resolve.
- Brief other Agency Liaisons as they are identified.

- Ensure quality coordination between the ECC, the Response Team, other agencies and the Public Affairs organization.
- Establishes and maintains key contacts with other agencies and landowners.
- Establishes priorities and directs the logistical and political phase of operations for the Forest Service.
- Ensures statutory authorities are complied with.
- Establishes goals and objectives and implements them.
- Ensures 24-hour communications is appropriate for the incident.
- Staffs the ECC adequately for the alert level and/or imminent alert level.
- Resolves managerial and organizational problems/issues and concerns as they develop.
- Establishes procedures for ordering resources.
- With consultation from USGS, prepare a risk and complexity analysis of the situation for Forest Service supervisors and employees.
- Makes recommendations to the Forest Supervisor for changes in the Forest Service EEC role, location or other organizational changes necessary to meet the support and overall emergency response effort in cooperation with other agencies and landowners.



As appropriate, the USGS will issue, in coordination with the U.S. Forest Service and WA-EMD, public statements on anticipated eruptive activity and associated potential hazards. A USGS information scientist or geologist will be available for consultation with the ECC at all times during periods of elevated volcanic activity.

2. PUBLIC INFORMATION OFFICER (Joint Information Center)

When conditions warrant or at any alert level, a Joint Information Center (JIC) may be established at a location that is compatible with operations in progress. (See page 20 for discussion of alert levels.) The primary purpose of this information center will be to provide information to all news media and other multi-agency approved media, such as websites.

It will be administered by a qualified Public Information Officer and will be staffed as required. The U.S. Forest Service PIO will coordinate with the USGS information scientist or geologist, and WA-EMD Public Information liaison.

Daily news briefings, as required, will be provided for the media and phone numbers will be available to them, which provide taped current interviews on the status of the emergency and other information.

3. INTELLIGENCE OFFICER

The Intelligence Officer is responsible for the collection and organization of incident status and situation information and evaluation, analysis, and display of information. This position will be located in Plans.

An equivalent position for WA-EMD, and the Public Information branch should be co-located so that operational decisions and public information may be well coordinated.

4. AGENCY COORDINATOR (FS)

The Agency Coordinator position may be activated at any Alert Level as part of the Incident Management Team. The primary purpose of this position is to work with cooperating agencies, governments, and private parties or groups that are directly affected by the volcano. The Agency Coordinator is to keep the liaisons advised of any current or imminent changes in the volcano's activity and what actions the Forest Service anticipates. The Agency Coordinator works with these groups on such things as area closures permit systems, and any other items that should be coordinated.

The Agency Coordinator monitors incident operations to identify current or potential inter-organizational problems.

5. LAW ENFORCEMENT-SPECIAL AGENT

As a member of the operations section, acts as a liaison between Forest Service Law Enforcement and County Sheriffs and provides assistance to counties in coordination of evacuations, search and rescue, and traffic management as needed and requested.

6. AVIATION OFFICER

The Aviation Officer is a liaison position in the ECC organization. The Forest Aviation Officer fills this position during the Information Statement, and Notice of Volcanic Unrest levels. When alert levels increase to Volcanic Advisory or Volcano Alert, this position may become an Air Operations Branch Director, if qualified. An AOBD will be ordered to coordinate all tactical and logistical aircraft activities and provide air support as necessary at a volcano-related incident.

The Aviation Officer also works closely with the U.S Geological Survey air operations officer to coordinate air activities during a volcano-related incident. The U.S. Geological Survey can provide geologists to serve as aerial observers on reconnaissance missions.

Under the Incident Command System, the AOBD has primary responsibility for preparing the air operations portion of an Incident Action Plan, for implementing its strategic aspects, and for providing logistical support to aircraft operations on an incident.

The Aviation Officer, through the Northwest Interagency Coordination Center's Regional Airspace Coordinator, coordinates with the FAA on airspace restrictions and on entry authorization. S/He supervises all air operations activities associated with an incident and establishes procedures for emergency reassignment of aircraft. The Aviation Officer also schedules approved flights of non-incident aircraft in the restricted airspace area.

B. U.S. GEOLOGICAL SURVEY - CASCADES VOLCANO OBSERVATORY (USGS-CVO)

The primary role of the USGS-CVO is monitoring the state of the volcano, assessing eruptive and hydrologic hazards stemming from volcanic activity, and advising the ECC accordingly. The USGS will provide notification to the U.S.F.S. and WA-EMD of the state of the volcano and anticipated volcanic hazards. As appropriate, the USGS-CVO, in coordination with the ECC and WA-EMD, will issue public statements on anticipated eruptive activity and potential hazards. WA-EMD will initiate a briefing conference call between the above-mentioned agencies. Each responsible agency will then disseminate the given information by priorities listed in each agency's emergency action plan document (i.e. - WA-EMD Annex W-8 Mt. St. Helens Plan).

In addition, volcanic information will also be available through the USGS-CVO web page. (http://vulcan.wr.usgs.gov).

C. WASHINGTON STATE EMERGENCY MANAGEMENT DIVISION

The Washington State Military Department- Washington State Emergency Management Division is authorized to act on the Governor's behalf to coordinate response activities, organizations, and resources within the state. The department coordinates with local, state, and federal jurisdictions to ensure emergency plans compatibility and coordination of operations and recovery activities.

Upon receipt of information statements, alert-level notifications or updates from the USGS, Washington State Emergency Management Division disseminates this information by means of the National Warning System (NAWAS) telephone and local government system radio.

At any Alert Level above normal, a position at the ECC may be staffed by a Washington State Emergency Management Division representative from Camp Murray to disseminate information from the ECC to the State Emergency Operations Center.

If commercial telephone service fails, Washington State Emergency Management Division may arrange for use of government and /or amateur radio organizations.

D. CLARK, COWLITZ, LEWIS, AND SKAMANIA COUNTIES

Each County has the prime responsibility for dealing with local events in their respective county. Evacuation procedures will be developed and become part of this plan.

An essential linkage between the ECC to the most heavily impacted county offices is provided by an Agency liaison. The liaison coordinator reports directly to the county keeping the VEC informed of the Mount St. Helens situation as it affects their local jurisdiction.

The Forest Service may elect to establish an Agency liaison to sit with a county (counties) EOCs.

When a volcanic eruption occurs, additional liaisons may be dispatched to the ECC so that each county is personally represented.

The principal activities conducted by the Agency liaison are:

1. Obtain a briefing from VEC

2. Provide a point of contact for assisting/cooperating agencies.

3. Make recommendations to the ECC Director as it relates to coordination between USFS and local jurisdictions.

4. Monitor incident operation to identify current or potential inter-organizational problems.

5. Participate in planning meetings providing current resource status, limitations and capabilities of agency resources.

6. Report directly to County Emergency Managers.

E. U.S. ARMY CORPS OF ENGINEERS

The Corps is concerned with the sediment retention structure on the North Fork of the Toutle River and maintaining flood protection along the Cowlitz River.

The Corps of Engineers may provide emergency flood assistance under the authorities of PL 84-99 and AR 500-60. This assistance may be provided to increase levels of preparedness, emergency operations (flood fighting), levee rehabilitation and advanced measures.

The Corps maintains a representative at the ECC during eruptive phases (Volcanic Alert).

F. NATIONAL WEATHER SERVICE

The National Weather Service Forecast Office in Portland 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

2. (1) Flood forecasts, (2) flood warnings, and flood watch over NAWAS, NOAA weather radio (when available), and NOAA weather wire service.

3. Volcanic plume forecasts.

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

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

VI. *EVENT NOTIFICATION*

Event notification occurs under two distinctly different circumstances:

(1) In response to unexpected short-lived events.

(2) In response to developing volcanic unrest that may culminate in eruptive activity with attendant volcanic and Hydrologic hazards. The former is handled through information statements, the latter through staged Alert levels.

NOTIFICATION OF THE STATUS OF ACTIVITY AT CENTRAL OREGON VOLCANOES

[All USGS volcano observatories will adopt this new system by 30 September 2006]

Under the Stafford Act (Public Law 93-288), the USGS has the Federal responsibility to issue timely and effective warnings of potential volcanic disasters to the affected populace and civil authorities. USGS-CVO has this responsibility for volcanoes in the Cascade Range of central Oregon. CVO, along with its chief partner, the Pacific Northwest Seismograph Network (PNSN) at the University of Washington, issues public statements about the status of activity at central Oregon volcanoes using a system for characterizing the level of hazardous activity at volcanoes that is used by all five USGS Volcano Observatories. The system is a means to communicate the status of a volcano in a clear, direct form to non-volcanologists and to prompt people and organizations potentially at risk to seek further information or decide upon mitigation measures. The system employs a set of familiar terms (Advisory, Watch, Warning) used by the National Weather Service for hazardous meteorological phenomena. As part of the system, color codes are used to provide quick information about volcanic-ash hazards to the aviation sector.

A system for communicating the status of volcanic activity must account for the up-and-down nature of activity during many volcanic crises and the diverse types of hazardous phenomena that can be produced. During unrest, volcanoes exhibit a wide range in precursory styles and durations, and episodes of unrest commonly do not culminate with eruptions. Periods of increasing and decreasing unrest may occur before or after an individual eruptive episode, or before it becomes clear that no eruption is forthcoming. Volcanoes operate on a wide variety of time scales; some progressing to eruption very quickly (days to weeks), others taking months or more. Volcanic eruptions vary in style, from relatively modest events that produce small lava flows to extremely explosive events. Typically, an eruption involves episodes of eruptive activity separated by non-eruptive intervals of hours to months. The duration of a single eruptive episode usually ranges from a few minutes to tens of hours, whereas an entire eruption can last for a day to decades.

The USGS-CVO issues notifications of unrest and eruption at volcanoes in cooperation with emergency-management and land-management agencies, which then start a branching process of information dissemination to other state agencies, counties, cities, and adjacent states, as appropriate. CVO volcanic-activity notices and accompanying information also are made available directly to the public through the internet and to local news media.

For aviation hazards, USGS reports of volcanic activity are part of an integrated worldwide warning system that follows procedures sanctioned by the International Civil Aviation Organization (ICAO) and that, in the United States, involves the Federal Aviation Administration (FAA) and National Oceanic and Atmospheric Administration (NOAA). Under ICAO procedures, volcano observatories notify the aviation sector about precursory activity and eruptions using a four-level color code initially developed in 1990 by the USGS for Alaskan volcanoes.

Description of Volcanic-Activity Levels

The USGS ranks the level of activity at a U.S. volcano using the terms, **Normal, Advisory, Watch,** and **Warning**. These levels reflect conditions at the volcano and the expected or ongoing hazardous volcanic phenomena. Assigning an activity level depends upon monitoring data and interpretation of changing phenomena. Activity levels are not always followed sequentially. Volcanic-activity notices are accompanied by explanatory text to give fuller explanation of the observed phenomena and to clarify hazard implications to affected groups. Updates that describe the ongoing activity are issued at increasing frequency at higher activity levels.

Volcanoes behave differently enough that it is not possible to predetermine a set of monitoring criteria for each level. The following activity-level definitions are guidelines for scientists to use to gauge the level of hazardous activity and for public officials and the public to consider when deciding what actions they need to take. Note that **Watch** is used for both heightened precursory unrest and minor eruptive activity because both states bear close watching, but do not have immediate, major hazardous effects.

Normal: *Typical background activity of a volcano in a non-eruptive state*
This level applies to inactive, non-erupting volcanoes. It allows for periods of increased steaming, earthquakes, ground deformation, thermal anomalies, or detectable gas emissions, as long as such activity is within the range of typical background activity.

Advisory: *Elevated unrest above known background activity*
This level is declared when a volcano is exhibiting signs of elevated unrest above known background levels. Progression toward eruption is by no means certain. Following a higher level, **Advisory** means that volcanic activity has decreased but continues to be closely monitored.

Watch: *Heightened or escalating unrest with potential for eruptive activity OR a minor eruption underway that poses limited hazards*
This level is declared for two situations: (1) when a volcano is exhibiting heightened or escalating unrest with potential for eruptive activity (not necessarily imminent) or (2) when a minor eruption is underway with limited hazardous impact. When following **Advisory**, this level implies increased potential for an eruption (timeframe variable). Following **Warning**, this level signifies that the volcano is still showing signs of heightened activity that may lead to renewed

highly hazardous activity or that the volcano has settled into eruptive activity with limited hazards.

Warning: *Major or highly hazardous eruption underway or imminent*
This level is declared when a major or highly hazardous eruption appears to be imminent or is confirmed or suspected to be underway. Accompanying information will indicate in as much detail as possible the eruption's time of onset, duration, size, intensity or explosivity, and impact on the landscape and atmosphere.

At any level of activity, but chiefly during the **Normal** activity level, the need to release additional information is accomplished through an:

Information Statement: *Notable event at a volcano, not necessarily eruptive*
Phenomena such as prominent steam plumes, small avalanches and rock falls, minor debris flows, changes in appearance of a lake in a volcanic crater, and minor seismic activity may occur while a volcano is at **Normal** level. Most such events are short-lived and lack recognizable precursors, and do not necessarily suggest volcanic unrest. However, owing to public and media inquiries that often result from a notable event, the USGS along with other involved agencies will attempt to verify the nature and extent of the event and issue explanations in the form of an **Information Statement**. An **Information Statement** also may be issued periodically to provide commentary about a significant event or change occurring within higher activity levels.

SUMMARY OF VOLCANIC-ACTIVITY LEVELS

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 <u>OR</u>** **a minor eruption underway that poses limited hazards**
WARNING	**Highly hazardous eruption underway or imminent**

Aviation Color Codes

Eruptions threaten aviation safety when plumes of volcanic ash, or tephra, are explosively dispersed as airborne clouds in flight paths of jet aircraft. Numerous instances of aircraft flying into volcanic-ash clouds have demonstrated both the economic costs and life-threatening potential of this hazard. The accepted mitigation strategy is to avoid encounters of aircraft with ash clouds, which requires that pilots, dispatchers, and air-traffic controllers quickly learn of locations and paths of ash clouds.

In accord with recommended ICAO procedures, the USGS issues color-coded activity levels–**Green, Yellow, Orange,** and **Red–**focused on ash hazards to aviation. As with the **Watch** term, **Orange** is used for both heightened precursory unrest and minor eruptive activity, and there are two levels (**Orange** and **Red**) to cover the range of eruption size and impact.

All Volcanic-Activity Notices will include the "Aviation Color Code," clearly identified as such to differentiate it from other hazard statements. In most cases, the activity term and aviation-specific color code will move together (e.g., **Normal** and **Green**; **Advisory** and **Yellow**; **Watch** and **Orange**; **Warning** and **Red**). However, there may be occasions when activity at a volcano poses a hazard to the aviation sector that is significantly lower than hazards posed to ground-based communities. In those cases, the aviation color code will be lower than what is normally associated with the activity term. An example is a large lava flow heading towards a town (Volcano **Warning** in effect) that is unlikely to produce any ash in flight routes or near an airport (Aviation Color Code **Orange**). Conversely, an ash plume that does not yield significant ash fall onto ground communities but does drift into air routes might warrant a Volcano **Watch** and Aviation Color Code **Red**.

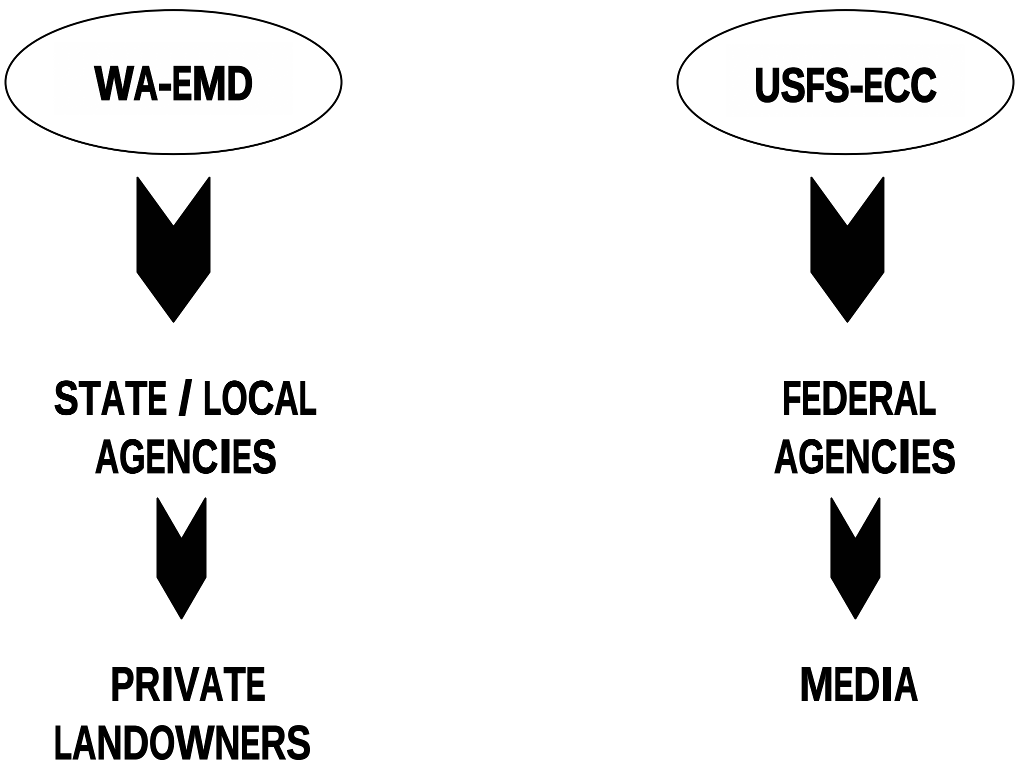
AVIATION COLOR CODES	
GREEN	Volcano is in normal, non-eruptive state. *or, after a change from a higher level*: Volcanic activity considered to have ceased, and volcano reverted to its normal, non-eruptive state.
YELLOW	Volcano is exhibiting signs of elevated unrest above known background levels. *or, after a change from higher level*: Volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
ORANGE	Volcano is exhibiting heightened unrest with increased likelihood of eruption, or, Volcanic eruption is underway with no or minor ash emission *[specify ash-plume height if possible].*
RED	Eruption is forecast to be imminent with significant emission of ash into the atmosphere likely. *or,* Eruption is underway with significant emission of ash into the atmosphere *[specify ash-plume height if possible]*.

Extras

Some eruptions, such as those producing only lava flows or mudflows, may affect only ground-based communities, whereas eruptions producing ash clouds may affect only the aviation sector. Explosive eruptions that occur at volcanoes with nearby communities or that are large enough to produce significant ash fall on more distant populated areas will involve both ground and aviation risks.

Color codes are especially suitable for the aviation sector because pilots, dispatchers, and air-traffic controllers planning or executing flights over broad regions of the globe quickly need to ascertain the status of numerous volcanoes and determine if continued attention, re-routing, or extra fuel is warranted.

ALERT LEVEL CALL-DOWN RESPONSIBILITIES



C. ECC RESPONSE TO ALERT LEVELS

1. Monitoring – Day to Day Operation of ECC

a. Duty officer on call 24-hours a day through answering service, pager and/or cellular phone.

b. ECC staffing and schedules are established.

c. Advise answering service of notification importance when it comes to volcanic activity.

d. Keep current a listing of emergency numbers of primary cooperating agencies and designated key contacts.

e. Establish appropriate teleconferencing time frames and list participants.

NOTE: The USGS-CVO maintains summary volcano information on its public website (http://vulcan.wr.usgs.gov).

2. **Information Statement**

(Usually a short-lived, isolated event; maybe nonvolcanic)

a. After notification by USGS and conference call with USFS and WA-EMD, the ECC response time is 15 to 30 minutes. ECC to document time and statement given to cooperators and follow up with information in a timely manner.

b. If appropriate, implement MSHNVM Evacuation/Contingency Plan. Coordinate evacuation and contingency planning with the Mount St. Helens line officer and the appropriate county sheriff. The Forest Supervisor has evacuation authority.

c. ECC will need to initiate telephone calls in the following progression to the listed cooperators so that they can respond to public and media inquiries:

- Coldwater Visitor Center
- Mount St. Helens National Volcanic Monument Manager
- Forest Service Special Agent
- Cowlitz Valley and Mt. Adams Ranger Districts
- Portland Water Bureau (steam/ash event only)
- Media (Forest PIO lead in coordination with USGS & WA-EMD)

WA-EMD will activate call-down as designated in Annex 8-A, Mount St. Helens Plan.

3. **Advisory**

(Elevated unrest above known background activity.)

a. After notification from USGS and conference call with USFS and WA – EMD that it is preparing a notice of volcanic unrest for public release. ECC call:

- Coldwater Visitor Center
- Mount St. Helens National Volcanic Monument Manager
- Forest Service Special Agent
- Cowlitz Valley and Mt. Adams Ranger Districts
- Army Corp of Engineers (Portland) (steam/ash event only)
- Media (Forest PAO lead in coord. With USGS and WA- EMD)

WA-EMD will activate call-down as designated in Annex 8-A, Mt. St. Helens Plan.

b. If appropriate, implement MSHNVM Evacuation/Contingency Plan.

c. In addition, ECC will take the following action:

- Identify staffing and establish schedules of staff.
- Establish 24-hour contact with all ECC staff.
- Provide situation briefings to the Forest Supervisor, Monument Manager, Ranger Districts, Forest Public Information Officer, and Forest Special Agent.
- Provide situation updates by telephone to agencies listed above.
- The decision to prepare for and close the hazard areas will be made in consultation with the VEC Director and Monument Manager, as dictated by the nature of the eruptive activity and the perceived risks at this point in time.

4. Watch

(Heightened/escalating unrest with increased potential for eruptive activity OR a minor eruption underway that poses limited hazards.)

A Volcano WATCH prompts the following actions from the ECC:

a. As dictated by pre-eruption prediction and by proximity of people to the volcano, consider or affect a closure and evacuation of the hazard areas. Prior to any closure consult and coordinate with WA-EMD.

b. With consultation from USGS, prepare a risk and complexity analysis of the situation.

c. Evaluate activation of a Type I or II Incident Management Team.

d. Notify the following cooperators/agencies;

- Coldwater Visitor Center
- Mount St. Helens Volcanic Monument Manager
- Forest Special Agent
- Notify Forest unit managers and consider message to all employees
- Notify the following agencies:
- Portland Water Bureau
- Army Corps of Engineers (Portland)
- Yakima Indian Nation
- U.S. Coast Guard (Portland)
- Northwest Coordination Center (NWC)
- Media (Forest PIO lead coord. with USGS and WA-EMD)
- Establish the Joint Information Center as dictated by media interest.
- Coordinate with USGS information scientist or geologist and WA-EMD.
- Continue to provide situation briefings to Forest Supervisor.
- Request a “transport winds forecast” from the National Weather Service (Portland) at least twice a day until danger of ash emissions has passed. Relay to cooperating agencies.
- Assess need for Unified Command, Area Command and/or MAC.

WA-EMD will activate call-down as designated in Tab W-8A, Mt. St. Helens Plan.

5. WARNING

(Highly hazardous eruption underway or imminent)

a. ECC will notify the following cooperators/agencies;

- Coldwater Visitor Center
- Mt. St. Helens Volcanic Monument Manager
- Forest Special Agent
- Notify Forest unit managers and consider message to all employees
- Notify the following agencies:
- FAA (Seattle)
- National Weather Service (Portland)
- Portland Water Bureau
- Army Corps of Engineers (Portland)
- Yakima Indian Nation
- U.S. Coast Guard (Portland)
- Northwest Coordination Center (NWC)
- Media (Forest PIO lead coordination with USGS and WA-EMD)
- Establish the Joint Information Center as dictated by media interest.
- Coordinate with USGS information scientist or geologist and WA-EMD.
- Continue to provide situation briefings to Forest Supervisor.
- Request a "transport winds forecast" from the National Weather Service (Portland) at least twice a day until danger of ash emissions has passed. Relay to cooperating agencies.
- Assess need for Unified Command, Area Command and/or MAC.

b. Actions to be taken:

i. Close and evacuate the hazard areas as appropriate. Authority for approval is the Forest Supervisor.

As indicated by monitoring and hazard assessment, consider expanding the closure area. Consult and coordinate with WA-EMD.

ii. Using the risk and complexity analysis, determine need to activate Unified Command, Area Command, Multi-agency Coordination (MAC) Group.

Continue to provide situation briefings to the Forest Supervisor.

Request cooperating agencies send representatives to the ECC.

iii. Alert FAA to anticipated ash hazards to aircraft, general character of small ash emissions, and large tephra-producing events. Consult with the FAA regarding airspace closures.

Request temporary flight restrictions as appropriate (FAR 91.137).

iv. Request radar monitoring from Portland National Weather Service for ash cloud detection.

Maintain request to NWS for the transport winds forecast.

Request a "transport winds forecast" from the National Weather Service (Portland) at least twice a day. Relay to cooperating agencies as appropriate.

v. Request from USGS computerized graphic representation of ash plume trajectory. USGS will fax map to ECC and WA-EMD.

Consider, in conjunction with USGS, aircraft monitoring of the volcano as dictated by eruptive activity and by the reliability of other monitoring activities.

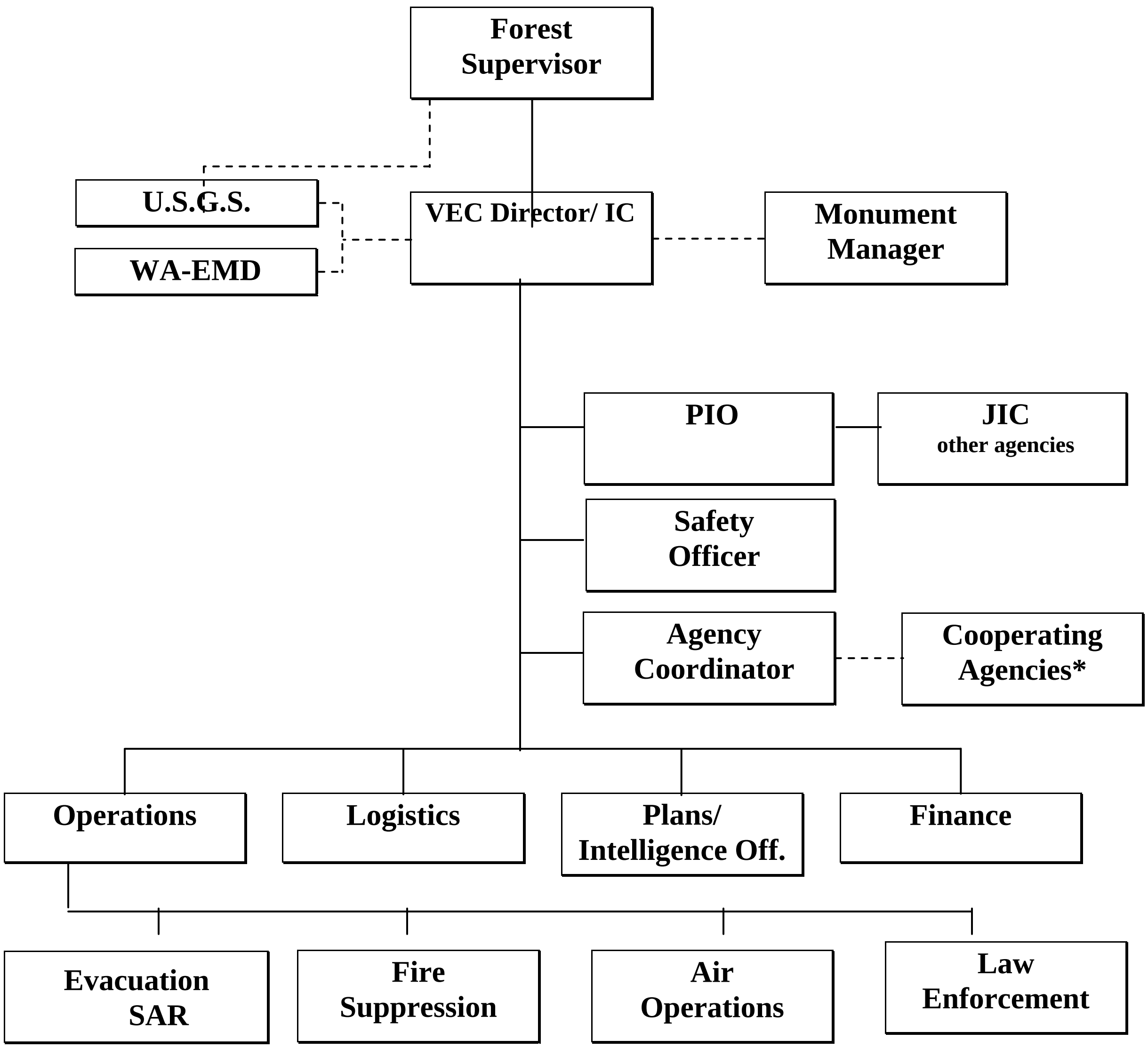
vi. In the event of communications failure or expected failure begin the process to move FEMA's "EMRV" system into place. Requests will be made through the Northwest Coordinating Center.

WA-EMD will activate call-down as designated in Tab W-8A, Mt. St. Helens Plan.

Organization Chart

Single Command

(Complex Organization)



*Cooperating Agencies: FAA (Seattle), NWS (Portland), Army Corps of Engineers, Yakima Indian Nation, U.S. Coast Guard (Portland), Northwest Coordination Center (NWC), Clark/Cowlitz/Lewis/Skamania Counties.

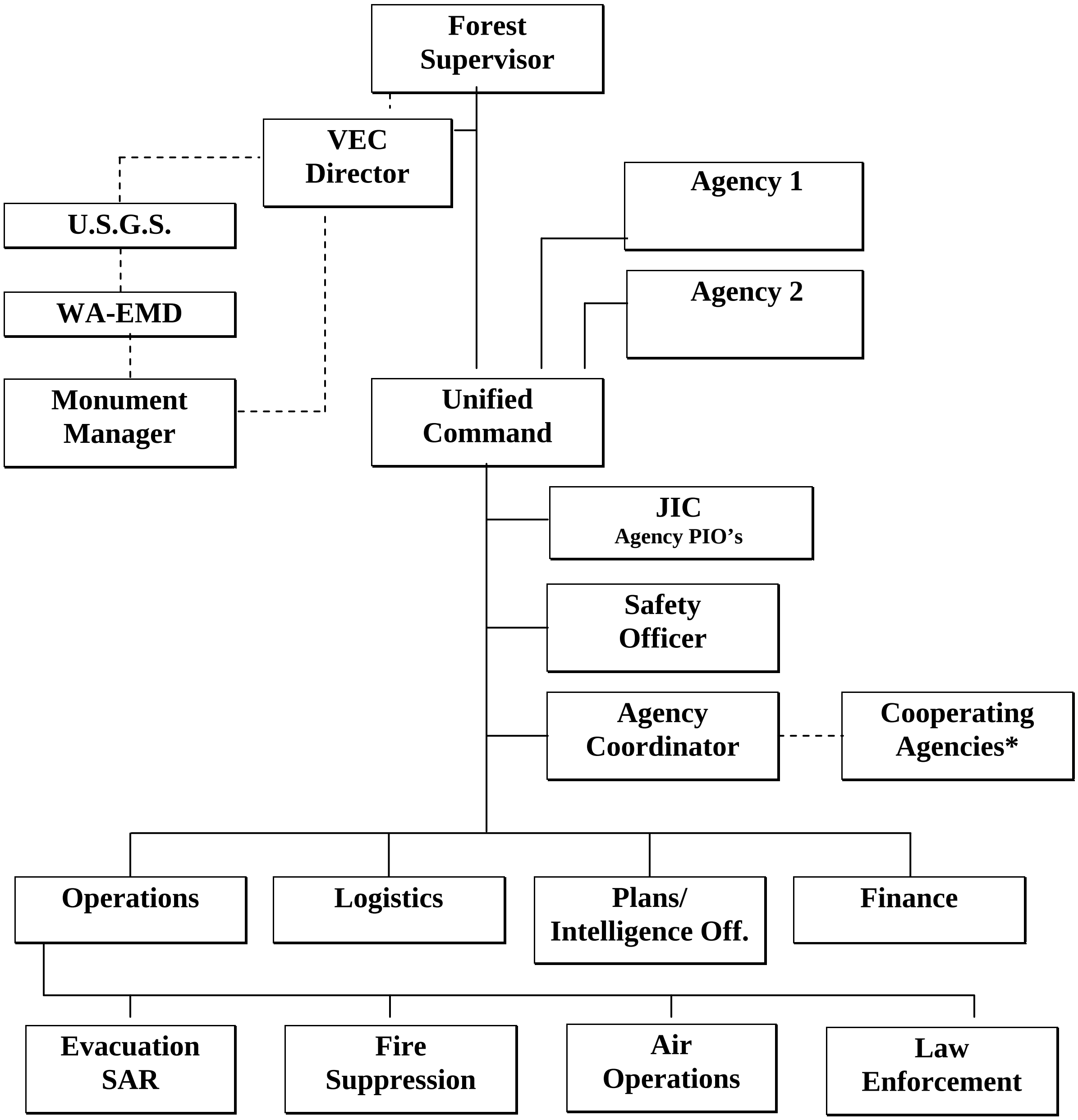
v. Request from USGS computerized graphic representation of ash plume trajectory. USGS will fax map to ECC and WA-EMD.

   Consider, in conjunction with USGS, aircraft monitoring of the volcano as dictated by eruptive activity and by the reliability of other monitoring activities.

vi. In the event of communications failure or expected failure begin the process to move FEMA’s “EMRV” system into place. Requests will be made through the Northwest Coordinating Center.

WA-EMD will activate call-down as designated in Tab W-8A, Mount St. Helens Plan.

Organization Chart
Unified Command



Unified Command: FEMA, USFS, WA-EMD and other agencies as determined by jurisdiction or administrative authorities.

*Cooperating Agencies: USGS, FAA (Seattle), NWS (Portland), Army Corps of Engineers, Yakima Indian Nation, U.S. Coast Guard (Portland), Northwest Coordination Center (NWC), Clark/Cowlitz/Lewis/Skamania Counties.

CALL DOWN NOTIFICATION BY ALERT LEVEL

USFS ECC | **WA-EMD EOC**

INFORMATION STATEMENT

USFS ECC:

MSHNVM MGR.
ALL OTHER UNIT MGRS.
NORTHWEST COORDINATION CENTER
REGIONAL OFFICE (F&AM)
USFS SPECIAL AGENT
MEDIA (Coord. w/ USGS & WA-EMD)

WA-EMD EOC:

CLARK, SKAMANIA, COWLITZ,
LEWIS COUNTIES, WSP YAKIMA,
WSP LIASON, D.O.T. LIASON,
DNR LIASON, WEYERHAEUSER,
EMD OPS MANAGER

VOLCANO ADVISORY

USFS ECC:

MSHNVM MGR.
ALL OTHER UNIT MGRS.
ADJACENT FORESTS/NPS
NORTHWEST COORDINATION CENTER
REGIONAL OFFICE (F&AM)
ARMY C.O.E. (PDX – ash only)
USFS SPECIAL AGENT
MEDIA (Coord. w/ USGS & WA-EMD)

WA-EMD EOC:

ALL COUNTIES
YAKIMA DIST. WSP
OREGON, IDAHO, B.C. (Canada)
WSP LIAISON
WEYERHAEUSER, TRIBES,
MONTANA, D.O.T. LIASON,
DNR LIASON,
EMD OPS MANAGER

CALLDOWN NOTIFICATION BY ALERT LEVEL

USFS ECC

WA-EMD EOC

VOLCANO WATCH

MSHNVM MGR.
FOREST SPECIAL AGENT
ALL OTHER UNIT MGRS.
NORTHWEST COORDINATION CENTER
REGIONAL OFFICE (F&AM)
PORTLAND WATER BUREAU
YAKIMA INDIAN NATION
U.S. COAST GUARD
NWC
ARMY C.O.E. (PDX)
MEDIA (Coord. w/USGS & WA-EMD

ALL COUNTIES
YAKIMA DIST. WSP
OREGON, IDAHO, B.C. (Canada)
WSP LIAISON
WEYERHAEUSER
ANNEX 1 & 2 OF MSH PLAN
EMERGENCY OPS. SUPERVISORS,
MONTANA, TRIBES, DNR LIASON,
MILITARY LIASON, DOH LIASON, DOA
LIASON, EMPLOYMENT SECURITIES
LIASON, INDIAN AFFAIRS,
PARKS & RECREATION

VOLCANO WARNING

MSHNVM MGR.
FOREST SPECIAL AGENT
ALL OTHER UNIT MGRS.
NORTHWEST COORDINATION CENTER
REGIONAL OFFICE (F&AM)
PORTLAND WATER BUREAU
YAKIMA INDIAN NATION
U.S. COAST GUARD
NWC
ARMY C.O.E. (PDX)
MEDIA (Coord. w/USGS & WA-EMD)

ALL COUNTIES
YAKIMA DIST. WSP
OREGON, IDAHO, B.C. (Canada)
WSP LIAISON
WEYERHAEUSER
ANNEX 1 & 2 OF MSH PLAN
EMERGENCY OPS. SUPERVISORS

VII. INCIDENT COMMAND SYSTEM

A. INCIDENT COMMANDER

The occurrence of a major volcano-related incident demands an automatic, immediate and coordinated response. The Incident Command System, therefore, will be used during an eruption or for a volcano-related incident. At Volcano Alert, if it has not previously been done, the ECC Director will conduct a risk and complexity analysis to determine the appropriate management needs (i.e. continue with local management, IMT3, or activate a Type I or II Incident Management Team). The Incident Commander will direct all tactical operations and make decisions on emergency needs. He or she has all the responsibility for the management of assigned resources to effectively accomplish stated objectives and strategies pertaining to an eruptive incident at Mount St. Helens. (See Delegation of Authority Letter).

The Incident Commander reports directly to the VEC Director who acts for, and has full authority from, the Forest Supervisor.

The Incident Commander must have key positions filled as soon as possible to meet all events expected by the incident and subsequent incidents.

An organization chart is shown on page 23 indicating positions needed. The basic organization can be enlarged or scaled down depending upon the event that is expected to occur or has occurred after needs are thoroughly analyzed.

B. UNIFIED COMMAND

Unified Command is a team effort process, allowing all agencies with responsibility for an incident, either geographical or functional, to establish a common set of incident objectives and strategies that all can subscribe to. This is accomplished without losing or abdicating agency authority, responsibility, or accountability.

For a volcano-related incident, Unified Command may be comprised of FEMA, USFS, WA-EMD, Clark, Cowlitz, Lewis and Skamania Counties.

C. AREA COMMAND

Area Command is an organization established to:

1. Oversee the management of multiple incidents that are each being handled by an Incident Command System organization; or

2. To oversee the management of a very large incident that has multiple Incident Management Teams assigned to it.

Area Command is used when there are a number of incidents in a geographic area. These incidents may be vying for the same resources.

If the incidents under the authority of the Area Command are multi-jurisdictional, a Unified Area Command should be established. This allows each jurisdiction to have representation in the Area Command.

D. MAC GROUP

If it is determined by the Cooperating Agencies that a MAC is necessary, then it may be established. It assumes the responsibility for making key decisions regarding the sharing and use of critical resources. It is necessary to use the emergency resources within the region to maximum efficiency possible. The MAC **does not exercise authority over the Incident Commander (or Unified Command)** who has the responsibility for the management of the on-the-ground incident organization.

Under any scenarios, the Forest Supervisor, or his/her delegate (Agency Administration Representative/VEC) must make the administrative decisions for the Forest Service roles in meeting its obligations such as closures and evacuations for the Gifford Pinchot National Forest.

VIII. National Response Plan (reference NRP 2004)

In Homeland Security Presidential Directive (HSPD) – 5, the President directed the development of the National Response Plan (NRP) to align Federal coordination structures, capabilities and resources into a unified, all-discipline and all-hazards approach to domestic incident management. This approach eliminates critical seams and ties together a complete spectrum of incident management activities including prevention, preparedness, response and recovery from major natural disasters and other emergencies.

The NRP is built on the template of the National Incident Management System (NIMS), which provides a consistent doctrinal framework for incident management at all jurisdictional levels, regardless of the cause, size or complexity of the incident. The NRP bases the definition of Incidents of National Significance on situations related to the following four criteria set forth in HSPD-5:

1. A federal department or agency acting under its own authority has requested the assistance of the Secretary of Homeland Security.

2. The resources of State and local authorities are overwhelmed and Federal assistance has been requested by the appropriate State and local authorities. Examples include:
    - Major disasters or emergencies as defined under the Stafford Act; and
    - Catastrophic incidents (NRP 2004; page 43)
3. More than one Federal department or agency has become substantially involved in responding to an incident.
4. The Secretary of Homeland Security has been directed to assume responsibility for managing a domestic incident by the President.

The NRP will be the guiding document should the Governor of Washington or the President declare a volcanic event an emergency or disaster.

IX. REVIEW AND UPDATING

A. REVIEW PROCEDURE

The purpose of this section is to establish a procedure for review of the plan. This plan must be kept as current as possible. An annual volcano contingency plan workday is recommended. Major participants would be ECC Staff (USFS), U.S. Geological Survey, and Mount St. Helens National Volcanic Monument Staff. Expansion to include major cooperators is possible and desirable. The workday discussion would include possible scenarios, range of volcanic activity, and clarification of terms.

It will be the joint responsibility of the U.S. Geological Survey and U.S. Forest Service to plan and hold this annual workday.

B. UPDATING PROCEDURE

Corrections and updating will be accomplished through the use of self-addressed updating form(s) enclosed. Anyone who reads or reviews the document and identifies a correction may fill out the enclosed form and mail it to the ECC Director. Corrected pages will be sent out to cooperating agencies on a quarterly basis, if necessary, to update that organization’s plan. To keep track of changes, an updating form will be placed in the Appendix to track the changes.

The ECC, on a quarterly basis, will also check the phone numbers on the call down list and review the agencies notified for possible revision and/or amendments.

C. UPDATING FORM

See the following page.

UPDATING FORM

INSTRUCTIONS:

Please fill out one of these forms and mail it to the ECC Director anytime there are any of the following changes:

1. Change in your organization that affects notification procedures.
2. A need to correct the Contingency plan content.
3. An upgrade in your communication system or procedures.

Organization____

Address____

Name of Previous Contact___________________________ Phone____________

Name of New Contact______________________________ Phone____________

Page Where Changes Were Made_______________________________________

Comments or Amendments:

____

____

____

____

____

Name and Date of Party Making Correction:

_____________________ _____________________ ______________________

Name Title Date

Mail To: Gifford Pinchot National Forest
10600 N.E. 51st Circle,
Vancouver, WA 98682
Attn: Fire Management

X. GLOSSARY

Accretionary lapilli. More or less spherical masses of loosely aggregated ash, mostly between 1mm and 1cm in diameter.

Andesite. A volcanic rock consisting of 53-63 percent silica; has a moderate viscosity when in a molten state.

Ash. Fragments of lava or rock less than 2mm in diameter that are blasted into the atmosphere by volcanic explosions.

Basalt. A volcanic rock consisting of less than 53 percent silica; has a low viscosity when in a molten state.

Caldera. A large volcanic depression, usually circular in map view.

Composite volcano. A steep-sided volcano composed of layers of volcanic rock, usually of high-viscosity lava, and unconsolidated material such as debris-flow and pyroclastic deposits.

Dacite. A volcanic rock composed of 63-68 percent silica; has a high viscosity when in a molten state.

CVO. Cascades Volcano Observatory, Vancouver, WA 98683

Debris flow. A flowing mixture of water and rock debris. Volcanic debris flows are sometimes referred to as volcanic mudflows or lahars (an Indonesian word).

Dome. A steep-sided mound that forms when highly viscous lava piles up near a volcanic vent. Domes are formed by andesite, dacite, and rhyolite lavas.

Earthquake. A sudden motion or trembling in the earth caused by the abrupt release of accumulated strain in rocks.

Lava flow. Molten rock that erupts from a vent or fissure and flows downhill.

Magma. Molten rock, which contains dissolved gas and crystals, formed deep within the Earth. When magma reaches the earth's surface, it is called lava.

Phreatic eruption. A steam explosion that occurs when water comes in contact with hot rocks or ash near a volcanic vent.

Pumice. A light-colored volcanic roc containing abundant trapped gas bubbles formed by the explosive eruption of magma. Because of its numerous vesicles, or bubbles, pumice commonly floats on water.

Pyroclastic flow. A hot, fast-moving, and high-density mixture of ash, pumice, rock fragments, and gas that flows downhill during explosive eruptions.

Seismicity. The phenomenon of earthquakes or earth vibrations.

Silicosis. Fibrosis of the lungs caused by long-term inhalation of silica dust and resulting in a chronic shortness of breath.

Tephra. A general term for airborne rock fragments ejected during explosive eruptions. Tephra consisting of fragments less than 2 mm in diameter is called ash.

Tremor. In relation to volcanoes, a type of seismicity characterized by continuous vibration of the ground. The vibration is related to the transport of fluids and gas within or beneath a volcano.

Volcanic landslide. The down slope movement of soil, rock debris, and sometimes-glacial ice, with or without water, from the flank of a volcano.

Volcano. A vent on the surface of the earth through which magma erupts, and also the landform that is produced by the erupted material.

XI. APPENDICIES

Appendix A

W-8
VOLCANO

PURPOSE: To establish procedures for the Washington State Emergency Operations Officer (SEOO) to respond to volcanic events.

GENERAL INFORMATION:

Washington State counties within the Pacific Northwest, encompass a geologically dynamic region. As a consequence of this dynamic environment, hundreds of volcanoes and volcanic fields have formed in geologic recent (2 million years) history.

Although many of these volcanoes have and will remain dormant for thousands of years, a real threat exists that a volcanic event may take place affecting the lives, property and the environment of the entire region at any given time. Events range from minor steam bursts, avalanches and rock falls to major seismic activity, unanticipated flank-collapse, Lahar, Pyroclastic flow and/or a protracted build up of an eruption.

Atmospheric ash from any of the volcanoes within Washington State could potentially cripple the airways and blanket the landscape.

Known active, or potentially active, Pacific Northwest volcanoes which could affect Washington State are:

Washington State	Oregon State	Canada
Mt Rainier (Pierce County)	Crater Lake	Garabaldi Volcanic Belt (closest in proximity to Washington State)
Mt Baker (Whatcom County)	Mt Hood (closest in proximity to Washington State)	Anahim Volcanic Belt
Mt Adams (Yakima County)	Mt Jefferson	Stikine Volcanic Belt
Mt St. Helens (Skamania County)	Newberry Crater	Wrangell Volcanic Belt
Glacier Peak (Snohomish County)	Three Sisters	

Appendix A

PROCEDURES: Determine the volcano affected and refer to the appropriate procedures below:

TAB W-8A…………..MT. ST. Helens
TAB W-8B…………..MT. Rainier
TAB W-8C…………..MT. Baker/ Glacier Peak
TAB W-8D…………..MT. Adams
TAB W-8E…………..MT Rainier LAHAR Warning System

Attachments:

1. Volcanic Event Definitions
2. Atmospheric Ash Definitions

Appendix B

TAB W-8A
MOUNT ST. HELENS

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PURPOSE: To establish procedures for the Washington State Emergency Operations Officer (SEOO) to respond to volcanic events/incidents at Mount St. Helens.

GENERAL INFORMATION:

Warning information may come from the United States Geologic Survey (USGS), United States Forrest Service (USFS) or the University of Washington, but only USGS has the authority to change alert levels. The USGS, after analyzing the appropriate data, will issue information under 4 response categories: (Information Statement, Volcano Advisory, Volcano Watch, and Volcano Warning).

The level of activity and category dictate the actions of the SEOO. The USFS, by agreement with the Federal Emergency Management Agency (FEMA), USGS, and the National Weather Service (NWS), continue to be responsible for warning of all volcanic events.

RESPONSE CATEGORIES:

The USGS, USFS, Emergency Management, Federal Emergency Management Agency (FEMA), and others have agreed to utilize the following operational strategy that has, as its basis, four levels of response to volcano categories. They are: Information Statement, Volcano Advisory, Volcano Watch, and Volcano Warning).

NOTE: Call may come in at any alert level. ONLY the first call will be verified!

PROCEDURES:

A. **INFORMATION STATEMENTS**

Mount St. Helens has a history of non-emergency but very spectacular events including minor ash falls, which garnered a great deal of media or public attention in the past. Should such an event occur in the future, the USGS and USFS Emergency Coordination Center (ECC) in Vancouver, WA will attempt to verify the nature and extent of the event and then contact the SEOO, 1-800-258-5990, and issue an Information Statement

After receiving the Information Statement, the SEOO will:

1. Confirm the caller's authenticity by having them state their pager or cell phone number. If verified, proceed w/step two. If not notify the USFS/USGS. See Attach 1. PAGER/CELL NUMBERS ARE:

USGS
(360) 414-3025 (pager)
(360) 624-8751 (Scientist-in-Charge)
(360) 993-8999 (USGS Ops – 24hr)

USFS
Forest Duty Officer (360) 896-3473 (24hr)
Mike Matarrese (360) 921-0916 (cell)

TAB W-8A

MOUNT ST. HELENS

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2. Once verified, make conference call with USGS and USFS to coordinate activities and information. (See attachment 1).

3. Annotate information on EM Form 105 and assign incident number.

4. Notify the EMD Emergency Operations Manager and Operations Unit Manager, to discuss notification of the EMD PIO, EMD Director or assistant EMD Director and the Governor's Office.

5. Telephonically notify Clark, Skamania, Cowlitz, Lewis counties and the Yakima State Patrol. Make additional notifications per instructions by chain of supervision.

6. Notify the Washington State Patrol (WSP) Liaison, Department of Transportation (DOT), (Highways) Liaison Department of Natural Resources (DNR) Liaison and Weyerhaeuser security patrol using attachment 2 of this SOP.

7. If ash fall is involved, the National Weather Service may issue transport winds forecast, which will go automatically to all concerned via ACCESS.

B. **NOTICE OF VOLCANIC UNREST**

This category is used when USGS monitoring and evaluation can first confirm changes that may lead to eruptive activity. The USFS, USGS, and EM will not release information to the media until the USGS has consulted and advised key cooperating agencies.

1. Confirm the caller's authenticity by having them state their pager or cell phone number. If verified, proceed w/step two. If not notify the USFS/USGS. See Attach 1. PAGER/CELL NUMBERS ARE:

<u>USGS</u>	<u>USFS</u>
(360) 624-8751 (SIC cell)	Forest Duty Officer (360) 896-3473 (24 hr)
(360) 624-8754 (C. Gardner cell)	Mike Matarrese (360) 921-0916 (cell)

2. Once verified, make conference call with USGS and USFS to coordinate activities and information. (See attachment 1).

3. Annotate information on EM 105 and assign an incident number.

4. Make notifications using NAWAS and ACCESS to all counties, Yakima State Patrol, and neighboring states of Montana, Idaho and Oregon. (Use NAWAS handbook Tab 5, Attachment 9).

TAB W-8A

MOUNT ST. HELENS

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5. Make telephonic notifications to all Indian tribes.

6. Notify the WSP, DOT, F & W, DNR Liaison's (tel 22) and the Weyerhaeuser Communications Center/security patrol using attachment 2.

7. Notify the EMD Emergency Operations Manager and Operations Unit Manager, to discuss notification of the EMD PIO, EMD Director or assistant EMD Director and the Governor's Office.

C. **VOLCANO WATCH**

This category is used when USGS monitoring and evaluation indicate that processes are underway that could culminate in eruptive activity or abnormal hydrologic activity but when the evidence does not indicate that a life or property-threatening event is imminent. This category is used to emphasize heightened potential hazard.

1. Confirm the caller's authenticity by having them state their pager or cell phone number. If verified, proceed with step two. If not, notify the USFS/USGS. See Attach 1. PAGER/CELL NUMBERS ARE:

USGS	USFS
(360) 414-3025 (pager)	Forest Duty Officer (360) 896-3473 (24 hr) Mike Matarrese (360) 921-0916 (cell)

2. Once verified, make conference call with USGS and USFS to coordinate activities and information. (See attachment 1).

3. Annotate information on EM Form 105 and assign incident number.

4. Make notifications using NAWAS and ACCESS to all counties, Yakima State Patrol, and neighboring states of Montana, Idaho and Oregon. Use NAWAS handbook Tab 5, Attachment 9.

5. Make telephonic notifications to all tribes

6. Make telephonic notifications to key agencies using attachment 2.

7. If the volcanic event involves a release of ash or an imminent release of ash, request the National Weather Service, Portland, using NAWAS or by calling (503) 326-3720 to send a transport winds forecast, to be transmitted on the NOAA weather wire (ACCESS) as soon as possible.

TAB W-8A

MOUNT ST. HELENS

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8. Notify the EMD Operations Manager, EMD Operations Unit Manager or the EMD assistant Director to make notifications to:

   a. EMD PIO
   b. Governor's Office and EMD Director
   c. Other EMD staff for Emergency Operations Center (EOC) activation or standby status as appropriate
   d. Possible Emergency Alert System (EAS) use
   e. Possible EOC activation

9. Notify the following state agencies:

___	Natural Resources	24 hrs-a-day
___	Military	24 hrs-a-day
___	Labor & Industries	0800-1700 weekdays
___	Licensing	24 hrs-a-day
___	DOT Aviation	24 hrs-a-day
___	DOT	24 hrs-a-day
___	WSP	24 hrs-a-day
___	Ecology	24 hrs-a-day
___	Department of Health	24 hrs-a-day
___	Agriculture	0800-1700 weekdays
___	Employment Security	24 hrs-a-day
___	Indian Affairs	24 hrs-a-day
___	Parks & Recreation	24 hrs-a-day
___	GA (off-campus)	24 hrs-a-day
___	GA (on-campus)	24 hrs-a-day
___	Fish & Wildlife	24 hrs –a-day

D. **VOLCANO WARNING**

This category is used when USGS monitoring and evaluation indicate that precursory events have escalated to the point where a volcanic or hydrologic event threatening to life and property appears imminent or is underway.

1. Confirm the caller's authenticity by having them state their pager or cell phone number. If verified, proceed w/step two. If not notify the USFS/USGS. See Attach 1.

Appendix B

TAB W-8A

MOUNT ST. HELENS

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PAGER/CELL NUMBERS ARE:

USGS	USFS
(360) 993-8999 (USGS Ops 24hr)	Forest Duty Officer (360) 896-3473 (24 hr)
(360) 624-8754 (C.Gardner cell)	Mike Matarrese (360) 921-0916
(360) 624-8751 (Acting SIC cell)	

2. Once verified, make a conference call with USGS and USFS to coordinate activities and information. (See attachment 1).

3. Annotate information on EM Form 105 and assign an incident number.

4. Make notifications using NAWAS and ACCESS to all counties, Yakima State Patrol, and neighboring states of Montana, Idaho and Oregon. Use NAWAS handbook Tab 5, Attachment 9.

5. Make telephonic notifications to all Indian tribes.

6. Make telephonic notifications to key agencies using Attachment 2.

7. If the volcanic event involves the release of ash, call the National Weather Service Portland over NAWAS or by telephone at: (503) 326-3720 and request they send a transport winds forecast over the NOAA weather wire via ACCESS as soon as possible.

8. Notify the EMD Operations Manager, Operations Unit Manager or the assistant EMD Director to discuss notifications to:

   a. EMD PIO and EMD Director
   b. Governor's office
   c. Other EMD staff for EOC activation or standby status as appropriate
   d. Possible EAS use
   e. Possible EOC activation (see SOP G-7 if required)

9. Notify the following state agencies:

___	Natural Resources	24 hrs-a-day
___	Military	24 hrs-a-day
___	Labor & Industries	0800-1700 weekdays
___	Licensing	24 hrs-a-day
___	DOT Aviation	24 hrs-a-day
___	DOT	24 hrs-a-day

TAB W-8A

MOUNT ST. HELENS

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___	WSP	24 hrs-a-day
___	Ecology	24 hrs-a-day
___	Department of Health	24 hrs-a-day
___	Agriculture	0800-1700 weekdays
___	Employment Security	24 hrs-a-day
___	Indian Affairs	24 hrs-a-day
___	Parks & Recreation	24 hrs-a-day
___	GA (off-campus)	24 hrs-a-day
___	GA (on-campus)	24 hrs-a-day
___	Fish & Wildlife	24 hrs-a-day

Attachments

1 Mount St. Helens USGS, USFS, University of Washington Telephone List
2 Key Agency Telephone List

Appendix B

MOUNT ST. HELENS

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Mount St. Helens USGS-USFS-UW Telephone List

U.S FOREST SERVICE Emergency Coordination Center*

Sunday-Saturday 0730-1800 (May-Oct)
Monday-Friday 0800-1630 (Nov-Apr) (360) 891-5140
After Hours and Weekends (Answering Service) (360) 896- FIRE (3473)

	Office	
Primary – Mike Matarrese	(360) 891-5146	Fax (360) 891-5145
Secondary – Ron Freeman	(360) 891-5156	

*U.S FOREST SERVICE GENERAL OFFICES, VANCOUVER (360) 891-5000

U.S GEOLOGICAL SURVEY

Monday-Friday 0800-1630 (360) 993-8900 (General Office #)

	Office
Cynthia Gardner	(360) 993-7693
Willie Scott	(360) 993-8942

Cynthia Gardner has a beeper. This beeper is capable of displaying a call-back number. Call the beeper number and after it answers, punch in your telephone number (1-800-258-5990), press the # and hang up. Cynthia Gardner should call back shortly. **NOTE: ONLY WORKS WITH PUSH BUTTON PHONE.**

	Page Number
Primary – Cynthia Gardner	(360) 414-3025
Fax	(360) 993-8900

UNIVERSITY OF WASHINGTON – PACIFIC NORTHWEST SEISMOGRAPH NETWORK

Hotline (not for public release) (preprogrammed on duty officer telephone)	(206) 685-2068
EOS Line	(206) 685-2068
Warmline (for press/media/local EM's)	(206) 685-2255

CALL-DOWN LIST

Monument Manager	Tom Mulder	(360) 449-7810 Home (360) 449-0490 Cell (360) 253-1328
Deputy Monument Manager	Maggie Dowd	(360) 449-7843 Home (360) 687-4310
Supervisory Law Enforcement Officer	Chris Lynch	(360) 891-5135 Pager (360) 690-3085
Cowlitz Valley Ranger District	Kristie Miller	(360) 497-1105 Home (360) 497-7746
Mount Adams Ranger District	Nancy Ryke	(509) 395-3401 Home (509) 395-0028
Federal Aviation Administration (FAA) – Seattle		(253) 351-3520
National Weather Service (NWS) – Portland	Emergency Line Forecaster	(503) 326-2340
Portland Water Bureau	24-hour Emergency Number	(503) 823-1560
Army Corps of Engineers	24-hour Emergency Number	(503) 808-4400
Yakima Indian Nation	24-hour Emergency Number Tribal Police	(509) 865-6653
Northwest Coordination Center	24-hour Emergency Number	(503) 808-2720

Appendix D

VOLCANIC HAZARDS

(Prepared by U.S. Geological Survey, 1992)

Future Eruptive Activity

Mount St. Helens is virtually certain to erupt again, but its behavior in the past has been sufficiently varied that we have no well-established basis for forecasting the exact timing or nature of its next eruptive activity. For example, the Kalama eruptive period, which began in the late 15th century and lasted approximately 3 centuries, was preceded by a dormant interval of 600-700 years, whereas the dormant interval between the Kalama period and the Goat Rocks period, which began in A.D. 1800 and continued for nearly 6 decades, was apparently less than 30 years. Approximately 12 decades separated the Goat Rocks period from the eruptions of 1980-86. We do not know whether the interval between the 1980-86 eruptions and the next eruption will last years, decades, or longer.

Several lines of evidence indicate that magma for the eruptions of 1980-86 was supplied to the surface through a relatively narrow conduit from a reservoir whose top is about 7km below the present crater floor. The inferred reservoir volume greatly exceeds the volume of magma erupted during 1980-86; thus, we believe that a large volume of magma still remains in storage.

Several different processes, including addition of new magma, magma mixing, and crystallization, operate in the reservoir to affect the composition, temperature, volatile content, homogeneity, and buoyancy of the magma. Although study of the volcano’s past eruptive products shows that these processes have all acted in the past, we know little of the rates or the constancy at which they occur. Owing to appreciable uncertainty about the composition and physical properties of magma in the reservoir, we cannot confidently assess the eruptibility and potential explosiveness of the stored magma, and it is unclear whether the 1980-86 eruptions represent a complete but brief eruptive period or an early stage of a more prolonged eruptive period.

Among the possibilities for onset of renewed eruptive activity are resumption of dome growth, eruption of basaltic or andesitic tephras and lava flows, or explosive eruptions of dacitic tephra and pyroclastic flows in volumes that could be as large as, or appreciably larger than, the volume erupted in 1980. Because of the length of time since the last dome-building eruption in October 1986, crystallization of magma in the conduit beneath the dome has probably formed a plug. The pressure necessary to overcome this blockage may exceed that of any eruption since May 18, 1980, and so resumption even of small dome eruptions may be initially explosive owing simply to the blockage of the conduit. Several scenarios for renewed eruptive activity notwithstanding, a conservative approach to hazards assessment requires us to assume that a substantial quantity of low-density, volatile-rich, and potentially explosive magma is either available now or could become available in the near future.

Appendix D

Monitoring and Warnings

The U.S. Geological Survey and the University of Washington carefully monitor Mount St. Helens. Our experience since early 1980 indicates that the monitoring is sufficient for us to detect the ascent of fresh magma that must take place before renewed magma tic eruption. As in the past, interpretation of phenomena related to magma ascent will enable us to provide warnings and updated assessments of hazards. An exception may be fairly small gas-release explosions driven by penetration of groundwater into still-hot dome and conduit rocks or by release of vapor generated through continued crystallization of magma remaining in conduit. At least six such explosions occurred during the winter months from December 1989 through February 1991; although these explosions took place during a prolonged period of slightly elevated seismicity beneath the volcano, no explicit precursors to the individual explosions were recognized. Numerous similar explosions occurred in 1981-86 when the present dome was growing.

Volcanic Hazards

Tephra Fall

Volcanic ash and larger fragments (collectively called tephra) are ejected upward from a vent by explosive eruptions. Large fragments fall close to the vent; smaller particles drift downwind, eventually falling and forming a lobe-shaped blanket that becomes thinner and finer-grained with increasing distance from the vent. The volume of the tephra and its effects range widely depending on the size of the event that produces it. The relatively small explosions from the dome during the winters of 1989-90 and 19990-91 produced dilute plumes of ash and steam that ascended up to about 25,000 feet, dusted the outer flanks of the volcano with fine ash, and deposited only traces of ash beyond the volcano. Large magmatic eruptions of Mount St. Helens, on the other hand, can produce dense tephra-rich plumes that rise high into the stratosphere and produce thick deposits of tephra over large areas. For example, tephra layer Wn, deposited in the late 15th century at the onset of the Kalama eruptive period, is as much as 150 cm thick at the distance of 10 km, 10 cm at 100 km, and 3 cm at 200 km from Mount St. Helens.

Prevailing winds at Mount St. Helens range from southwesterly to northwesterly; thus tephra is most likely to be distributed northeast, east, or southeast. However, there is appreciable variability. Whereas tephra from the relatively large May 18, 1980 eruption was transported primarily eastward, tephra from smaller eruptions on May 25 and June 12, 1980 was distributed over a broad arc extending south, west and northwest from Mount St. Helens. Indeed on May 25,1980, nearly a centimeter of ash accumulated at Chehalis, about 80 km northwest of Mount St. Helens.

Tephra falls are not of themselves generally life threatening, although exposure to atmospheric tephra particles causes eye irritation or respiratory problems for some people. A significant potential danger is collapse of insufficiently braced buildings under the weight of heavy tephra accumulation, particularly if the weight has been increased because of saturation of rain. Visibility can be drastically reduced by falling tephra or when fine dry tephra particles are remobilized by passing motor vehicles; such reduced visibility was probably responsible for hundreds of accidents on Interstate 5 between Kelso and Olympia after less than a centimeter of tephra had fallen in that area on May 25, 1980. Thus, one should anticipate hazardous, if not impossible driving conditions during or after periods of tephra fall.

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Explosive Ejection of Rock Fragments

Volcanic explosions can impel dense rock fragments, for example from disrupted domes, on ballistic trajectories that may be counter or oblique to the wind direction. The relatively small vapor-driven explosions of 1989-91 threw hundreds of blocks, some as large as a meter, for distances of as much as 1 km within the crater. A blast related to emplacement of the Sugarbowl dome on the north flank of Mount St. Helens about 1,200 years ago propelled ballistic fragments as far as 10 km from the vent.

Pyroclastic Flows

Pyroclastic flows are fluidized avalanches of hot, dry pyroclastic debris and gases that descend a volcano's flanks and beyond at speeds of 10 to hundreds of meters per second. A flow is composed typically of two parts: (1) a ground-hugging dense basal flow that is the pyroclastic flow proper, and (2) an overriding turbulent ash-cloud surge of ash winnowed from the flow. Owing to their mass, high temperature, high velocity and great mobility, pyroclastic flows and related pyroclastic surges and great mobility, pyroclastic flows and related pyroclastic surges pose grave hazards from asphyxiation, burial, incineration, and impact. Because of their high velocities, pyroclastic flows and surges are generally impossible to escape. Evacuation must take place before such events occur.

Pyroclastic flows have been observed to form from the gravitational collapse of high vertical eruption columns, from low fountains of erupting pyroclastic material that appear to "boil over" from the vent, and from gravitational or explosive disruption of hot lava domes. The first two mechanisms operated during the explosive eruptions of 1980 at Mount St. Helens and are likely again should eruptive activity be resumed. The third mechanism, disruption of a hot lava dome, has operated at numerous times in the past but would be significant at Mount St. Helens only if new dome growth should be established.

Although the present shape of the volcano, with its crater open to the north, will favor distribution of pyroclastic flows into the valley of the North Fork of the Toutle River, all flanks of the volcano are subject to pyroclastic-flow hazard during a large eruption. Because pyroclastic-flows are density currents, they seek topographically low into the valleys. Within the past 4,500 years, pyroclastic flows are known to have traveled at least as far as 13km from the volcano summit.

Pyroclastic Surges

Pyroclastic surges are turbulent, relatively low density, gas-solid mixtures that flow above the ground surface at high velocities. Hot pyroclastic surges are generated by many of the same processes that form pyroclastic flows and, in addition, they are generated from the pyroclastic flows themselves as preceding or overriding ash clouds.
Because they are less dense, pyroclastic surges are less constrained by topography than are pyroclastic flows, and surges may climb or surmount valley walls, affecting areas well beyond the limits of pyroclastic flows. Hazards resulting from pyroclastic surges include destruction by high-velocity ash-laden clouds, impact by rock fragments, burial by surge deposits, incineration, exposure to noxious gases, and asphyxiation.

The presence of water-saturated sediments beneath the crater floor raises the potential for hydro volcanic explosions that could be generated by intrusion of magma into the water-bearing sediments. Such explosions may produce relatively low-temperature pyroclastic surges that would or could flow at high speeds through the crater breech and down the volcano's north flank.

Laterally Directed Blasts

Large laterally directed blasts are complex phenomena that share characteristics of both pyroclastic flows and pyroclastic surges. They may have a significant initial low-angle component and can affect broad sectors of a volcano up to 180 degrees and outward for tens of kilometers. Previous lateral blasts are known in two contexts at Mount St. Helens: (1) blasts generated by abrupt landslide-induced decompression of a shallow magma body and the hydrothermal system surrounding it within a volcano; (2) explosions originating from sudden release of gases at growing lava domes.

A massive landslide abruptly removed the volcano's summit, and the resulting decompression of shallow magma and the hydrothermal system that enveloped it initiated the highly destructive lateral blast of May 18, 1980. The profound change in the volcano's shape—removal of the summit and formation of the crater—has appreciably reduced the potential for reoccurrence, at the onset of renewed eruptive activity, of a similar massive landslide that could abruptly unroof a magma body and pressurized hydrothermal system. Consequently a massive lateral blast like that of May 18, 1980, is unlikely at a future resumption of eruptive activity.

Smaller lateral blasts could ensue if dome growth recurs. Explosions related to emplacement of the Sugarbowl dome about 1200 years ago generated pyroclastic flows that extended several kilometers and impelled rock fragments at least 10 km from the vent. Lateral blasts that might occur from a new dome growing within the crater would be directed northward. Addition of a 50 percent safety factor to the 10-km range identified for ballistic fragments from the Sugarbowl blasts suggests that hazard from rock projectiles might extend 15 km northward from the crater in laterally directed explosions from a growing dome. A comparable laterally directed explosion could result from abrupt failure of the plug blocking the 1980-86 conduit under elevated pressure related to renewed magmatic activity.

Lava Flows

Elongate lava flows have issued several times from Mount St. Helens. Basalt flows that issued about 2,000 years ago extended about 12 km from the volcano's summit. Andesite flows erupted in the 16th and possibly early 17th centuries and also in the 19th century were less fluid and extended about half as far. Lava flows issuing from vents on the outer flank of the volcano are less likely than one from a vent within the existing crater. Lava flows are directed by the topography; they flow downhill, becoming channeled into river valleys if they extend far enough. Thus, a lava flow from a vent in the present crater would be directed down the north flank of Mount St. Helens and possibly into the upper part of the valley of the North Fork of the Toutle River. Lava flows are destructive but generally not life-threatening because they normally advance so slowly that people can walk away from them.

Appendix D

Lahars and Floods

Lahars are rapidly flowing mixtures of soil, pyroclastic and other rock debris, and water that originate on the slope of volcanoes. The necessary water may be produced by such processes as rapid melting of snow and ice by hot eruption products—
Especially pyroclastic flows, abrupt release of water from storage behind natural dams, and rainfall. Lahars are able to incorporate sediment as they flow and can achieve sediment to water ratio as large as 3:1. Such "bulking" greatly increases their volumes, bulk densities, yield strengths, and apparent viscosities. Velocities of lahars in 1980 at Mount St. Helens ranged from about 1 m/sec along low-gradient reaches to as much as 40 m/sec on steep slopes near the volcano. Lahars are dangerous and destructive because of their high velocities and bulk densities. However, like floods, they are confined to valleys. With addition of water or removal of sediment lahars commonly transform downstream to sediment-rich water floods. Lahars and floods are capable of inundation of low-lying flood plains and terraces. This represents a pervasive hazard as transportation corridors commonly follow or cross-valleys subject to lahars or floods.

A growing volume of snow and ice is accumulating between the 1980-86 dome and the crater walls. The present estimated volume (1992) of snow and ice is about 40 million cubic meters of water (equivalent to approximately 30 million cubic meters of water), and the average rate of accumulation as determined from measurements made through 1988 is about 4 million cubic meters of snow per year. Renewed eruptive activity in the crater has the potential for disrupting and rapidly melting all or part of the accumulating fill of snow and ice, triggering a significant lahar in the North Fork Toutle valley and flooding farther downstream.

Emplacement of pyroclastic flows on the outer flanks of the volcano when thick winter snow pack is present could trigger lahars or floods in drainages heading on the east, south, and west flanks of Mount St. Helens. Such flows could be as large or larger than those of May 18, 1980 in the same areas.

Lahars can be generated by surface runoff over deposits of unconsolidated fragmental volcanic materials during or long after and eruption; rainfall leading to rapid erosion of thick, fine-grained tephra or pyroclastic-flow deposits is a common source of lahars. Enhanced runoff from an unusually severe storm over the denuded or partly revegetated hill slopes of the North Fork Toutle valley drainage basin or from release of on of the avalanche-dammed lakes has the potential to generate lahars by mobilizing large volumes of sediment from the 1980 debris-avalanche deposit on the valley floor (only and estimated 10 percent of that deposit has been eroded so far). Under the current conditions (1992) two of the three avalanche-dammed lakes (Spirit Lake and Coldwater Lake) are considered stable, and the third (Castle Lake) marginally stable. Runoff generated by heavy winter rains could degrade the stability of these natural dams over time, and high water tables seasonally reduce the stability of the Castle Lake blockage. A breakout of any of these avalanche-dammed lakes would probably cause a large lahar and flood down valley. Continued monitoring of drainage from the crater, of lake levels in the Toutle Valley, of discharge in the North Fork of the Toutle River, and of conditions at the Castle Lake blockage should serve to detect events that might lead to production of a large runoff-generated lahar.

Appendix D

Hazard Zonation

The accompanying hazard-zonation map shows areas potentially threatened by a large eruption of Mount St. Helens. The map is largely derived from earlier maps published both before (Crandell and Mullineaux, 1978; Miller, Mullineaux, and Crandell, 1981, fig. 454) and after (Miller, Mullineax, and Crandell, 1981, fig. 455) the 1980 eruptions. Such maps are founded on the assumption that the geologic record of a volcano's past activity is the best guide for estimating hazards related to future activity. Thus the mapped hazard zones reflect both evaluations of deposits of previous eruptions of Mt. St. Helens and experience with recent volcanic eruptions at Mount St. Helens and elsewhere. The map portrays zonation for three classes of volcanic hazard: (1) combined flowage hazards including pyroclastic flows, pyroclastic surges, lava flows, and lahars and floods; (2) pyroclastic surges; and (3) lahars and floods.

Pyroclastic flows from an eruption no larger than the May 18, 1980 eruption would be likely to affect only the steep flanks of the volcano and the Spirit Lake Basin-upper Toutle Valley region. However, the eruption of May 18, 1980, was a relatively small one for Mount St. Helens. For example, geologic evidence indicates that an eruption 500 years ago was about 5 times as large and an eruption about 3,500 years ago was approximately 10 times as large as the 1980 eruption. Because we have no evidence that the next eruption of Mount St. Helens will be a small one, the hazard-zonation map portrays hazards anticipated from a large eruption.

Hazard-zone boundaries are approximate. The extents of future lava flows, pyroclastic flows, pyroclastic surges, lahars, and laterally directed blasts will depend upon several variables, including volume, mobility, velocity, and flow transformations, which are all different to forecast. Therefore, the boundaries of hazard zones shown on the hazard-zonation map are imprecise; one must not assume that hazard-zone boundaries mark well-defined limits beyond which there is little or no volcanic hazard.

Zones of lahar and flood hazard extend far to the west of the areas depicted on the hazard-zonation map: along the Kalama River valley to the Columbia River and along the Toutle River valley to the lower part of the Cowlitz River valley and then to the Columbia River. Low-lying areas along and near these drainages are subject to flowage hazards and inundation and, except for the valley of the North Fork of the Toutle River below the Corps of Engineers debris dam, are subject to heavy deposition of sediment from lahars.

Tephra-fall hazard may affect any sector around the volcano, depending upon wind-direction, and may extend tens to hundreds of kilometers downwind.

Appendix D

Additional Sources of Information

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