NORTH KING AND SOUTH SNOHOMISH COUNTIES
REGIONAL MITIGATION PLAN
for Natural Hazards

Emergency Services Coordinating Agency
Natural Hazards Mitigation Plan

Prepared by:
Emergency Services Coordinating Agency
(ESCA)

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Special Thanks & Acknowledgements

Thanks to all City Staff who worked on the Mitigation Planning Committee directly or who provided input and assistance during the development and review of this document.

Thanks, too, to the Citizens who read over the document and provided feedback regarding the Plan; and to Julie Deel for her proofing skills.

Cover Photos:
Thanks to the following Public Works Departments for providing photographs of natural hazard events that have occurred within their jurisdictions' limits:

- City of Lynnwood
- City of Mountlake Terrace
- Town of Woodway
- Port of Edmonds

Point of Contact

For information regarding this plan, or to comment on this plan, please contact Emergency Services Coordinating Agency (ESCA):

MAILING ADDRESS:	**ESCA** **2901 228th Street SW, Ste A** **Brier, WA 98036**
TELEPHONE:	**(425) 776-3722**
FAX:	**(425) 775-7153**
EMAIL:	**Jamie@esca1.com**

Record of Changes

CHANGE NO.	SECTION / PAGE NO.	DATE	ENTERED BY

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List of Plan Recipients

Printed and electronic versions of the *North King and South Snohomish Counties Regional Mitigation Plan* – Draft and Final versions – are provided to the following jurisdictions, locations and/or individuals:

	Name / Jurisdiction	Date
1	Brier, City of Nicole Gaudette	
2	Edmonds, City of Noel Miller	
3	Kenmore, City of Nancy Ousley	
4	Lake Forest Park, City of Cheryl Niclai	
5	Lynnwood, City of Kevin Garrett	
6	Mill Creek, City of Christi Amrine	
7	Mountlake Terrace, City of Shane Hope	
8	Mukilteo, City of Larry Waters	
9	Woodinville, City of Justina Tate	
10	Woodway, Town of Terrance Bryant	
11	Edmonds Community College Paul Doherty	
12	Edmonds School District Brian Harding	
13	Olympic View Water and Sewer District Roger Eberhart	
14	Port of Edmonds Bev Borth	
15	ESCA Lyn Gross	
16	ESCA Jamie Gravelle	
17	Washington EMD Beverly O'Dea	
18	Washington EMD	

Final print versions of the *North King and South Snohomish Counties Regional Mitigation Plan* are provided to the following jurisdictions, locations and/or individuals:

	Name / Jurisdiction	**Date**
19	Brier, City of Paula Swisher	
20	Edmonds, City of Gary Haakenson	
21	Kenmore, City of Frederick Stouder	
22	Lake Forest Park, City of David Cline	
23	Lynnwood, City of Don Gough	
24	Mill Creek, City of Timothy Burns	
25	Mountlake Terrace, City of John Caulfield	
26	Mukilteo, City of Joe Marine	
27	Woodinville, City of Richard Leahy	
28	Woodway, Town of Carla Nichols	
29	Edmonds Community College Jack Ohara	
30	Edmonds School District Dr. Nick Brossoit	
31	Olympic View Water and Sewer District	
32	Port of Edmonds Bob McChesney	

Feedback on the draft documents were requested from the following agencies and individuals:

	Name / Jurisdiction	Date
33	King County OEM Rich Tokarzewski	
34	Snohomish County DEM John Pennington	
35	Snohomish Fire District 1 Brad Reading	
36	Snohomish Fire District 7 Janet Jaeger	
37	Northshore Fire District Tom Weathers	
38	Woodinville Fire and Life Safety District Dennis Johnson	

In addition, final electronic versions of the North King and South Snohomish Counties Regional Mitigation Plan were provided for their records.

Final electronic versions of the *North King and South Snohomish Counties Regional Mitigation Plan* are provided to:

	Name / Jurisdiction	Date
39	Brier Public Library	
40	Edmonds Public Library	
41	Kenmore Public Library	
42	Lake Forest Park Public Library	
43	Lynnwood Public Library	
44	Mill Creek Public Library	
45	Mountlake Terrace Public Library	
46	Mukilteo Public Library	
47	Woodinville Public Library	

Promulgation

The following document was promulgated by legal representatives of each participating agency. The original document is on file with ESCA.

THIS DOCUMENT WILL BE REPLACED WHEN THE APPROVAL AND ADOPTION PROCESS IS COMPLETE.

Promulgation

The **North King and South Snohomish Counties Regional Mitigation Plan**, dated June 2004, is hereby adopted this 30th day of June, 2004, as the official natural hazards mitigation plan for the member cities of Kenmore, Brier, Edmonds, Lynnwood, Mill Creek, Mountlake Terrace, and Woodway, and for the Edmonds School District, Olympic View Water and Sewer District, and the Port of Edmonds.

APPROVED:

Stephen L. Anderson, City Manager
Kenmore, WA

Gary Stirk, Mayor
Brier, WA

Gary Haakenson, Mayor
Edmonds, WA

Mike McKinnon, Mayor
Lynnwood, WA

Bob Stowe, City Manager
Mill Creek, WA

Connie Fessler, City Manager
Mountlake Terrace, WA

Bob Schillberg, Mayor Pro-Tem
Woodway, WA

Dr. Wayne Robertson, Superintendent
Edmonds School District

Roger Eberhart, Manager
Olympic View Water & Sewer District

Chris Keuss, Executive Director
Port of Edmonds

How to Use This Plan

Each section of the **North King and South Snohomish Counties Regional Mitigation Plan** provides information to assist participating jurisdictions and agencies in North King and South Snohomish Counties, and the citizens within those jurisdictions and agencies, in understanding the community in which we live and work, and the hazard-related issues facing government, citizens, businesses, and the environment. Combined, the various sections of this plan work together to create a document that guides the mission to reduce vulnerability and minimize loss from future natural hazards.

The structure of this plan enables people to use only that portion of the plan that is of interest to them and/or pertains to their needs. It also allows local government to review and update specific sections as new data becomes available. New data may be easily incorporated, resulting in a natural hazards mitigation plan that remains current and relevant to the needs of the jurisdictions in North King and South Snohomish Counties.

The **North King and South Snohomish Counties Regional Mitigation Plan** is organized into five sections:

Section I contains the introduction, multi-jurisdictional community profile information, and an overview of the planning process.

Section II contains information regarding the various natural hazards that can affect North King and South Snohomish Counties.

Section III contains jurisdiction- and special district-specific information. It identifies local vulnerabilities and mitigation strategies for each jurisdiction participating in the Plan.

Section IV contains an index of mitigation action items by jurisdiction.

Section V contains the lists of critical infrastructure for each jurisdiction. This information is restricted under *RCW 42.17.310(1)(ww)* and is exempt from the Freedom of Information Act. Anyone wishing to obtain this information should apply to the individual jurisdiction.

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Section I : Overview

NOTE:

This section of the Emergency Services Coordinating Agency Regional Natural Hazards Mitigation Plan contains general, multi-jurisdictional information regarding the region as well as a description of the planning process.

The statements regarding natural hazards and historical disaster events as well as the information contained in the multi-jurisdictional community profile depict the average conditions within the region.

Please refer to Section III of this Plan for jurisdiction-specific information for the ten Cities and four Special Purpose Districts in north King County and south Snohomish County participating in this Plan.

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Introduction

The members of the Emergency Services Coordinating Agency (ESCA) have dealt with natural disasters on both a local and regional basis. These have included earthquakes, local flooding, landslides, severe storms, and wildland-urban interface fires. In addition, the region has the potential to be subjected to damage from tsunami or seiche as well as volcano eruption.

During the Inaugural Day Windstorm in 1993, the area experienced winds of more than 40 m.p.h. with gusts of 66 m.p.h. As a result, 225,000 people lost power and were without electricity for a week or more. This affected both personal lives and business operations in the area.

In December 2003, south King County experienced a windstorm that included wind gusts of as much as 80 m.p.h. 180,000 people were without power at least overnight, and about 110,000 would be without power for as much as four days.

While 100-year floods are relatively rare in this area, urban flooding is common among all jurisdictions and occurs on a nearly annual basis. In addition, three jurisdictions include properties on the Puget Sound shoreline and experience occasional shoreline flooding events. Photos of urban flooding from 1996 may be found in Section III, Mountlake Terrace.

Unusually severe urban flooding was experienced in north King and south Snohomish Counties in December 2007. This event occurred in connection with a series of three storms that moved in over the Pacific Northwest between December 1 and 3, 2007.

On December 1st, with cold arctic air already in place over the region, the first storm produced heavy snow in the mountains and low-land snow throughout western Washington. Around Seattle, up-to 1" of snow fell while the “convergent zone” (which includes the ESCA Cities) received over 6" of snow.

On December 2, the snow changed over to rain as temperatures increased along with the wind. Over two days, December 2-3,[1] an entire month’s worth of rain fell in the Puget Sound Area accompanied by wind gusts of over 80 mph along much of the coast and 40 to 50+ mph inland.

While King and Snohomish Counties braced for flooding along the rivers, the resulting flooding broke the normal patterns in the ESCA area.[2] River flooding was minimal in most areas, but the north King and south Snohomish counties

1 NOAA reports that 6-hour and 24-hour precipitation amounts were near 100-year rain frequency levels during this event.

2 Lewis County was most affected, with over $57 million of damage.

area experienced urban flooding where storm water systems were overwhelmed and problems intensified by many of the smaller creeks flooding.

The Nisqually Earthquake, in 2001, caused only minor damage in the north King and south Snohomish Counties area, but it provided a graphic reminder that this region is Earthquake Country and that we must be prepared. It should be noted that the occurrence of one earthquake does not lessen the threat of future earthquakes.

Overall, this area has been very fortunate and has not experienced any major natural disasters in the last twenty years. This does not mean that we are safe from natural hazards, however, and the local governments and special purpose districts are committed to mitigating against natural disasters to the best of their abilities.

What is natural hazard mitigation?

Natural hazard mitigation is the development and implementation of activities designed to reduce or eliminate losses resulting from natural hazards.

Why develop a natural hazards mitigation strategy?

Developing and maintaining a mitigation strategy for the north King and south Snohomish Counties region is another step in the planning process that began with the Cities' Comprehensive Emergency Management Plans (CEMP). These Plans were developed by ESCA and provide consistent and coordinated procedures for the Cities.

The regional overview of this Plan provides a foundation for coordination and collaboration between the ten ESCA Cities and four Special Purpose Districts included in this document. It is the groundwork for identifying mitigation strategies and future mitigation projects as a means to assist in meeting the requirements of various federal assistance programs.

The rising cost of responding to and recovering from natural disasters has resulted in a renewed interest in identifying effective ways to reduce the vulnerability to natural hazards and the disasters these hazards can create. Natural hazard mitigation plans assist communities in identifying the hazards that could impact them, determining the vulnerability of the community to these hazards, and identifying mitigation strategies to prevent or reduce the impacts these hazards pose to the community through a coordinated, multi-jurisdictional approach.

It should be noted, too, that while the Cities and Special Purpose Districts have eight natural hazards in common, and are all likely to be affected during a significant regional disaster, the level of threat for each hazard varies

between the Plan participants. These differences are recognized and are accounted for in the breakouts included in Section III.

What are the benefits of hazard mitigation?

The information contained in this Plan is applicable for the region and serves to provide the framework for natural hazard mitigation among the participants. This is one more step in the emergency management cycle of *planning, response, recovery,* and *mitigation*. It is also consistent with the existing long-term commitment to mutual aid agreements, first responder agreements, and coordinating inter-jurisdictional cooperation in disaster response.

Hazard mitigation planning is intended to:

- **Save lives and property.**
  Communities can save lives and reduce property damage from natural hazards through mitigation actions, such as moving families and their homes out of harm's way, limiting development, and/or regulating the type of construction or structures allowed in certain areas.

- **Reduce vulnerability to future hazards.**
  By having a mitigation strategy in place, communities are better prepared to take proper steps that will permanently reduce the risk of future losses.

- **Facilitate post-disaster funding.**
  By identifying mitigation strategies and projects before the next disaster, communities will be in a better position to obtain post-disaster funding because much of the background work necessary for funding assistance will already be in place.

- **Speed recovery.**
  By developing a mitigation strategy, communities can identify post-disaster mitigation opportunities in advance of a disaster. Further, communities can develop recovery plans and policies to minimize the number of decisions that must be made while under the stress of responding to and recovering from a disaster.

- **Demonstrate commitment to improving community health and safety.**
  Developing a mitigation strategy demonstrates a community's commitment to safeguarding its citizens and protecting its economic and environmental well-being.

- **Demonstrate accountability and regional coordination.**
  Each jurisdiction is responsible for mitigation projects within their scope and boundaries. This includes identifying, prioritizing, funding, completing and evaluating mitigation projects.

  The jurisdictions also have an ongoing commitment to regional cooperation to the greatest extent possible. To this end, the jurisdictions will continue to look for opportunities to action regionally and in partnership with each other. This allows for problem-solving at the regional level and gaining maximum benefit from potential funding sources.

Who does the natural hazards mitigation plan benefit?

The *North King and South Snohomish Counties Regional Mitigation Plan* was developed, written, and adopted as a multi-jurisdictional natural hazards mitigation plan for the benefit of ESCA's member cities, plus Edmonds Community College, Edmonds School District, the Port of Edmonds, and Olympic View Water and Sewer District.

The jurisdictions are all located in close proximity to each other. As a result, the Plan participants have ongoing, working relationships and recognize that they have a vested interest in coordinating mitigation efforts. It is anticipated that this cooperation will continue to develop and improve in the years to come. The results of these cooperative efforts will benefit the Cities and Special Purpose Jurisdictions as well as the citizens served by these agencies.

Each jurisdiction is responsible for identifying, planning, obtaining financing, and completing their own mitigation activities. To the greatest extent possible, the jurisdictions will coordinate efforts through existing interlocal agreements and inter-governmental jurisdictions.

To further the efforts of regional coordination, this Plan was offered to both King and Snohomish Counties for review and consistency.

Natural hazards land use policy in Washington

Planning for natural hazards in Washington has taken shape over the past 35 years, beginning with the State Environmental Policy Act (1971) and the Shorelines Management Act (1971), and followed by the State Building Code Act (1974, 1985), and the Growth Management Act (1991). It is an integral element of Washington's statewide land use planning program which focuses on appropriate land use controls in critical areas that are prone to natural disasters, along with keeping up with the latest technology in construction methods to mitigate potential natural disasters.

Support for natural hazards mitigation

The primary responsibility for the development and implementation of mitigation strategies and policies lies with local jurisdictions. However, local jurisdictions are not alone; partners and resources exist at the state and federal levels to assist local government in the development of mitigation strategies and plans. Within Washington State, the Washington Military Department, Emergency Management Division is the lead agency for providing hazard mitigation planning assistance to local jurisdictions.

Plan Methodology

Because of the similarity in hazards within the north King and south Snohomish County region, the jurisdictions decided to create the *North King and South Snohomish Counties Regional Mitigation Plan* to meet the goals in the following ways:

- The Plan meets the requirements as specified in the Disaster Mitigation Act of 2000.
- The Plan is developed following the process outlined by the Disaster Mitigation Act of 2000.
- The Plan is multi-jurisdictional to promote and enhance regional efforts for emergency response, planning, recovery, and mitigation among the jurisdictions.
- All participating jurisdictions have a Mitigation Plan that is complete, comprehensive, and consistent with other existing emergency management documents.

The *North King and South Snohomish Counties Regional Mitigation Plan* was written using the best possible information obtained from a wide variety of sources. Throughout the planning process, a concerted effort was made to gather information from the ten ESCA Cities, the four participating Special Purpose Districts, and the region's stakeholders: citizens, businesses, other government jurisdictions and agencies.

Among others, information was solicited from regional partners such as Stevens Hospital, SNOCOM, Snohomish Fire District #1, Snohomish Fire District #7, Northshore Fire District, Snohomish County PUD, Alderwood Water District, Puget Sound Energy, and the Washington State Ferry System.

Feedback was also solicited from the neighboring emergency management agencies that included: King County Office of Emergency Management (OEM), Snohomish County Department of Emergency Management (DEM) and Everett Emergency Management.

The natural hazards mitigation strategies contained within this Plan are the result of a lengthy and extensive planning process involving all ESCA Cities, four Special Districts, key partners, and a cross-section of the business community and local citizens.

Establishment of the ESCA Natural Hazards Mitigation Planning Committee

In 2004, the City of Kenmore, applied for a Pre-Disaster Mitigation (PDM) Grant to cover part of the costs of regional mitigation planning.

Upon receipt of the Pre-Disaster Mitigation Planning Grant for all-hazards planning, the ESCA Natural Hazards Mitigation Planning Committee was formed to assist in meeting the planning requirements and to keep the mitigation planning project on schedule. This committee was charged with the following responsibilities:

- Identify Plan development goals and objectives.
- Establish a timeline for Plan completion.
- Ensure that the Plan meets the requirements of the Disaster Mitigation Act of 2000.
- Assist in coordinating local efforts in gathering information for inclusion in the Plan.
- Oversee the public involvement process at the local level.

The Committee completed the first version of the *North King and South Snohomish County Regional Mitigation Plan* and saw it through the review and promulgation process.

While the members have changed in the five years since the first iteration of this Plan, the Committee purpose remains the same. The current Committee has one or more representatives from each of the Cities and Special Districts participating in this 5-year Update.

ESCA Natural Hazards Mitigation Planning Committee – Current Members

- Jim Cutts, City of Brier
- Nicole Gaudette, City of Brier
- Noel Miller, City of Edmonds
- Leslie Harris, City of Kenmore
- Cheryl Niclai, City of Lake Forest Park
- Bill Franz, City of Lynnwood
- Kevin Garrett, City of Lynnwood
- Tom Rogers, City of Mill Creek
- Tom Gathmann, City of Mill Creek
- Shane Hope, City of Mountlake Terrace
- Paula Schwartz, City of Mountlake Terrace
- Justina Tate, City of Woodinville
- Terrance Bryant, Town of Woodway
- Brian Harding, Edmonds School District
- Lisa Skinner, Edmonds School District
- Roger Eberhart, Olympic View Water and Sewer District
- Marla Kempf, Port of Edmonds
- Steve Robinson, Edmonds Community College
- Paul Doherty, Edmonds Community College

The ESCA Natural Hazards Mitigation Planning Committee met as a group in July and September of 2008. Additional meetings between the coordinator and each jurisdiction were held to focus on individual needs and issues. The work concluded in July 2009.

The Committee meetings provided opportunities to gather and share information, assess vulnerabilities, identify critical facilities, and assist in developing mitigation strategies. They also maintained continuity throughout the process to ensure that jurisdiction-specific natural hazards vulnerability information and mitigation strategies were incorporated into the Plan.

Plan Update Responsibilities

Each City and Special Purpose District was responsible for:

- Reviewing breakout information for their jurisdiction
- Identifying out of date data and information
- Providing the updated data and information to the ESCA Project Manager
- Posting legally required notifications according to State Law and local Ordinances

- Providing an on-site opportunity for community members to provide comment on the Plan
- Working with ESCA Project Manager during public input meetings and sessions
- Working with ESCA Project Manager to complete the adoption and promulgation process

The Project Manager was responsible for:

- Developing a planning timeline
- Working with each Jurisdiction to obtain updated information and data; and entering that data into the Plan
- Working with the new Jurisdictions to include them in the planning process and incorporate them into the final document
- Providing guidance, editing and feedback as necessary
- Coordinating with the State Mitigation Strategists to ensure appropriate Plan development
- Updating Section A (Preceding Documents), Section I (Overview) and Section II (HIVA).
- Working with Jurisdictions to conduct public input opportunities
- Printing and submitting the proposed Plan to the State and FEMA for review and approval
- Working with Jurisdictions to complete the adoption and promulgation process

Input from Stakeholders and Citizens

The ESCA Natural Hazards Mitigation Planning Committee held a series of meetings at the local level to solicit input from the stakeholders and citizens of the community.

A regional meeting in an "Open House" format was held during work hours to ensure that community members had adequate opportunity to participate in the process. This was to provide access for businesses, shift workers, and others who are unlikely to attend an evening meeting.

July 22, 2009, 1 to 4 pm
Regional meeting/Open House.
Open to all interested parties.
Location:
ESCA offices
2901 228th Street SW, Ste A
Brier, WA 98036

In addition, late afternoon and evening meetings were held at the local levels.

May 26, 2009 at 7:00 p.m
Woodinville Emergency Preparation Commission
Local meeting, open to public
Location:
Woodinville City Hall
17301-133rd Avenue NE
Woodinville, WA

June 8, 2009 at 7:00 p.m.
Woodinville Emergency Preparation Commission
Local meeting #2, open to public
Location:
Woodinville City Hall
17301-133rd Avenue NE
Woodinville, WA

June 9, 2009 at 7:00 p.m.
Woodinville City Council meeting.
Open to public
Location:
Woodinville City Hall
17301-133rd Avenue NE
Woodinville, WA

June 16, 2009 at 7:00 p.m.
Woodinville City Council meeting.
Location:
Woodinville City Hall
17301-133rd Avenue NE
Woodinville, WA

July 22, 2009; 1:00 – 4:00 p.m.
ESCA "Open House"
Location:
ESCA
2901 228th Street SW, Ste A
Brier, WA

July 27, 2009 at 5:30 p.m.
Woodinville "Open House"
Location:
Woodinville City Hall
17301-133rd Avenue NE
Woodinville, WA

August 10, 2009 at 7:00 p.m.
Mountlake Terrace Planning Commisison meeting
Public Hearing
Location:
Mountlake Terrace City Hall
6100 219th Street SW, Suite 200
Mountlake Terrace, WA

August 24, 2009 at 7:00 p.m.
Lynnwood Council meeting
Public Hearing
Location:
Lynnwood City Hall
19100 44th Ave W
Lynnwood, WA

August 25, 2009 at 7:00 p.m.
Brier Council meeting
Public Hearing
Location:
Brier City Hall
2901 228th Street SW
Brier, WA

September 9, 2009 at 7:00 p.m.
Edmonds Council meeting
Public Hearing
Location:
Edmonds City Hall
121 5th Ave N
Edmonds, WA

September 10, 2009 at 7:00 p.m.
Lake Forest Park Council meeting
Location:
Lake Forest Park City Hall
17425 Ballinger Way NE
Lake Forest Park, WA

September 15, 2009 at 7:00 p.m.
Edmonds Council meeting
Public Hearing
Location:
Edmonds City Hall
121 5th Ave N

Edmonds, WA

September 17, 2009 at 7:00 p.m.
Mill Creek Council meeting
Location:
Mill Creek City Hall
15728 Main Street
Mill Creek, WA

A press release was sent to local and regional newspapers on July 14, 2009. The release provided information regarding the background for the Mitigation Plan, the purpose of the meetings, and a request for public participation and input.

For those individuals who were unable to attend any of the public input meetings, a further opportunity to provide input was provided. ESCA posted background information, a series of questions, and feedback forms on ESCA's website (www.esca1.com). Newspaper articles, jurisdictional postings, and websites maintained by the participating jurisdictions directed interested parties to this information and solicited feedback. Plan participants also maintained printed materials at the front desk of each jurisdiction to provide public access to the information and solicit public input.

It should also be pointed out that the projects identified in the Cities' breakouts are pulled from existing documents (Capital Improvement Plans, annual or bi-annual budgets, etc.). This is significant as it provides additional and independent review opportunities for this – arguably the most important – portion of the Plan.

Hazard-specific Research

During the course of the plan development process, a large amount of information and data was collected for eight natural disasters: drought, earthquake, flood, landslide, severe storm, tsunami and seiche, volcanoes, and wildland-urban interface fire.

Sources for this information included local records, existing Hazard Identification and Vulnerability Assessments (HIVA) and emergency management plans, local agencies, the Internet, emergency management publications, and government agencies at all levels.

Plan Development Process

The Disaster Mitigation Act of 2000

In the past, federal legislation has provided funding for disaster relief, recovery, and hazard mitigation planning. The Disaster Mitigation Act of 2000 is the latest legislation to improve the planning process. It reinforces the importance of mitigation planning and emphasizes planning for disasters *before* they occur.

The Disaster Mitigation Act is intended to facilitate cooperation between state and local authorities and to encourage coordinated efforts between jurisdictions. The Act encourages and rewards local and state pre-disaster planning and promotes sustainability as a strategy for disaster resistance.

To implement the new Disaster Mitigation Act requirements, the Federal Emergency Management Agency (FEMA) prepared an Interim Final Rule, published in the Federal Registry on February 26, 2002, at 44 CFR Parts 201 and 206, which establishes planning and funding criteria for state and local governments.

The primary purpose of hazard mitigation is to identify community policies, actions, and tools for implementation over the long-term that will result in a reduction in risk and potential future losses community-wide. This is accomplished by using a systematic process of learning about the hazards that can affect the community, setting clear goals, identifying appropriate actions, following through with an effective mitigation strategy, and keeping the Plan current.

Mitigation: The development and implementation of activities designed to reduce or eliminate losses.

Planning: The act or process of making or carrying out plans; establishing goals, policies, or procedures for a social or economic unit.

Hazard Mitigation (as defined by the Disaster Mitigation Act of 2000): Any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards.

Local Involvement

Fourteen jurisdictions in north King and south Snohomish Counties participated in this Mitigation Plan. They are: the Cities of Brier, Edmonds, Kenmore, Lake Forest Park, Lynnwood, Mill Creek, Mountlake Terrace, Mukilteo, Woodinville, the Town of Woodway, Edmonds Community College, Edmonds School District, Olympic View Water and Sewer District, and the Port of Edmonds.

Each jurisdiction contributed to plan development through dedicated staff time to oversee the development of the Plan, assist in writing the Plan, and/or compiling jurisdiction-specific information contained in the Plan.

Public Notification

In addition to each jurisdiction posting meeting notices in accordance with local Codes and Ordinances, press releases were sent to local and regional newspapers. These include:

- Edmonds Paper
- Enterprise
- Everett Herald
- Kenmore/Bothell Reporter
- Mill Creek View
- Puget Sound Business Journal
- Seattle P-I, City Desk
- Seattle P-I, North Bureau
- Seattle Times, City Desk
- Seattle Times, North Bureau

Important dates and elements in the plan process

September 9, 2005 – City of Mukilteo joins ESCA
The City of Mukilteo signed the Interlocal Agreement making it the 8th ESCA member.

March 27, 2006 – City of Lake forest Park joins ESCA
The City of Lake Forest Park signed the Interlocal Agreement making it the 9th ESCA member.

July 15, 2008 – Pre-Disaster Mitigation Planning Meeting
The participating jurisdictions met with the Coordinator to discuss the development process and coordinate efforts.

September 9, 2008 – Pre-Disaster Mitigation Planning Meeting
The participating jurisdictions met with the Coordinator to discuss progress and establish next steps in the planning process.

May 16, 2009 – City of Woodinville joins ESCA
The City of Woodinville signed the Interlocal Agreement making it the 10th ESCA member.

June 19, 2009 – Received Letter of Commitment for Disaster Mitigation Planning Project

- Edmonds Community College[3]

July 22, 2009 – Regional Public Input Meeting
This meeting was held at the ESCA offices. Press releases were sent out for this meeting as well as the rest of the meeting schedule. In addition to posting on the ESCA website, individual jurisdictions posted for this meeting in accordance with local codes and ordinances. Staff from each jurisdiction attended, as did ESCA staff.

July 27, 2009 – Woodinville Open House Meeting

DATE TO BE FILLED IN HERE – Promulgated Plan delivered to Washington State Military Department, Emergency Management Division, Camp Murray

[3] Edmonds Community College was participating in the planning process before providing the official letter.

Plan Adoption

Organizations and Decision Making

Each participating jurisdiction is subject to one of four forms of government: Mayor-Council, Council-Manager, Elected Board and appointed Board of Trustees.

Mayor-Council Form of Government[4]

This form of government, also known as a "strong mayor," provides for the direct election of a Mayor by the populace. The Mayor has responsibility for managing day-to-day operations of the City or Town.

The Council, also elected, is the legislative body responsible for setting policy. Issues may be placed on the agenda by either the Council or the Mayor. The issue is presented to the Council body, and an opportunity is provided for public input. After discussion among the Council members, a vote is taken, and the majority decision is implemented.

Of those jurisdictions participating in this Mitigation Planning process, the following Cities and Towns follow the Mayor-Council form of government:

- City of Brier
- City of Edmonds
- City of Lake Forest Park
- City of Lynnwood
- City of Mukilteo
- Town of Woodway

Council-Manager Form of Government[5]

For this form of government, Council members are elected by the citizens, and the Mayor is chosen from among the elected body. The Mayor, in this capacity, does not have any additional authority, but is primarily responsible for the effective operation of Council meetings. The Mayor also acts in a ceremonial capacity and represents the body to sign resolutions and other official documents.

Council sets policy and relies on the City Manager and other staff to carry out that policy. The City Manager is in charge of ensuring the City's day-to-day operations are carried out.

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[4] Municipal Research and Services Center of Washington (MRSC). Available WWW: http://www.mrsc.org.
[5] Ibid.

Policy issues are placed on the agenda by Council members or the City Manager. In most cases, a presentation is made to the Council; an opportunity is presented for public input and Council discussion, followed by a vote. Policy is set based on the outcome of the Council's vote.

Upon policy approval, the Mayor signs a resolution enacting the policy.

Of those participating in this Plan, the following jurisdictions have the Council-Manager form of government:

- City of Kenmore
- City of Mill Creek
- City of Mountlake Terrace
- City of Woodinville

Elected Board[6]

This form of government relies on a Board that is elected by the voters within the jurisdiction's borders. The Board is then responsible for creating policy and directing the organization's executive – General Manager, Director, or Superintendent – to carry out day-to-day operations.

Issues are placed on the agenda by Board members or by the organization's Executive. As in the previous forms of government, a presentation is made to the Board. An opportunity for public input is provided, followed by discussion by the Board. The Board then votes upon the issue, and the Executive acts in accordance with the majority's vote.

The following jurisdictions follow this form of governance:

- Edmonds School District
- Olympic View Water and Sewer District
- Port of Edmonds

President and Board of Trustees[7]

Day-to-day operations are managed by the President, a position hired by the Board of Trustees.

The Board of Trustees is composed of five members appointed by the Governor. Each member serves a five-year term and must reside within the college's district boundaries.

The following jurisdictions follow this form of governance:

- Edmonds Community College

[6] Ibid.
[7] Edmonds Community College. Available WWW: http://edcc.edu/

As identified above, the regional partners for this Plan have differing governance roles and responsibilities.

Each jurisdiction is responsible for meeting legal requirements (i.e., State laws, local ordinances, statutes or regulations) associated with their portion of the Plan's review and adoption.

Review Process

Each City and Special Purpose District actively solicited public review and input on the document in accordance with the local jurisdiction's rules, regulations and requirements.

Each jurisdiction's Council or Board then reviewed the jurisdiction's breakout.

After review and discussion, each Council or Board approved the submission of the Plan to Washington State and FEMA for review and approval.

Agency/Jurisdiction	Date of Approval to Submit
Brier	
Edmonds	
Kenmore	
Lake Forest Park	
Lynnwood	
Mill Creek	
Mountlake Terrace	
Mukilteo	
Woodinville	
Woodway	
Edmonds Community College	
Edmonds School District	
Olympic View Water & Sewer District	
Port of Edmonds	

Once approved by the State and FEMA, each Council and Board is then responsible for adopting the Plan through Resolution.

Adoption

Following the jurisdiction's individual requirements, each City/Town Council or agency Board signed a Resolution formally adopting the North King and South Snohomish Counties Regional Mitigation Plan. This process was done in accordance with individual requirements and in compliance with the type of organization.

Agency/Jurisdiction	Resolution Number	Date of Adoption
Brier		
Edmonds		
Kenmore		
Lake Forest Park		
Lynnwood		
Mill Creek		
Mountlake Terrace		
Mukilteo		
Woodinville		
Woodway		
Edmonds Community College		
Edmonds School District		
Olympic View Water & Sewer District		
Port of Edmonds		

The *North King and South Snohomish Counties Regional Mitigation Plan* was formally promulgated by signature of the Mayors of Brier, Edmonds, Kenmore, Lake Forest Park, Lynnwood, Mill Creek, Mountlake Terrace, Mukilteo, Woodinville and Woodway as well as the Board Chairs of Edmonds Community College, Edmonds School District, Olympic View Water and Sewer District, and the Port of Edmonds.

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Plan Maintenance

Evaluating and Updating the Plan

The *North King and South Snohomish Counties Regional Mitigation Plan* will be evaluated and updated on a five-year cycle to determine the effectiveness of mitigation programs, projects, or other related activities and reflect changes in land development or programs that may affect mitigation priorities and/or strategies. Five-year updates will be delivered to the Washington State Hazard Mitigation Program Manager for review and forwarding to the Federal Emergency Management Agency, Region X Office.

Each jurisdiction will be responsible for reviewing and evaluating their section of the Plan on a regular basis. It is *suggested* that the jurisdictions conduct the evaluation half-way through the five-year cycle to ensure that the Plan is staying on target.

Five-Year Plan Update

Updates to the *North King and South Snohomish Counties Regional Mitigation Plan* shall be conducted on a five-year cycle. At this time, no funding sources are identified for additional ESCA staff time, so each jurisdiction will be responsible for updating their portion of the Plan.

At the end of this Plan cycle, each jurisdiction will receive both a printed and an electronic copy of the Plan. The electronic copy can be used as a template to update the Plan in 2014.

The Mayors of each of the participating municipalities, and the Chairs or Presidents of Edmonds Community College, Edmonds School District, Olympic View Water and Sewer District, and Port of Edmonds, or their designated representatives, shall approve the updated Plan. A copy of the updated Plan shall be submitted to the Washington State Hazard Mitigation Officer no later than July 31st of the update year.

PLAN EVALUATION AND UPDATE SCHEDULE 2010-2014

Date	Required Action to be Taken
September 2013	Jurisdiction(s) should investigate grant options to pay for the 5-year update. Lead agency should be identified to apply for appropriate grant(s).
January 2014	Participating jurisdictions should identify the lead, or coordinating, agency in the update process.
March 2014	Staffs, for each jurisdiction, begin 5-year Plan update process. Each jurisdiction should develop an update of all mitigation activities and/or projects.
March – May 204	Update Plan in cooperation with participating jurisdictions.
June - July 2009	Conduct at least one public meeting regarding the Plan update. Receive comments from community and key stakeholders. Revise Plan as necessary.
July – Sept. 2014	Obtain approval of updated Plan by all participating jurisdictions.
Sept. 30, 2014	Submit updated Plan to Washington State Hazard Mitigation Officer.

Continued Public Involvement

All participating entities are dedicated to the continued involvement of the public in the natural hazards mitigation process.

Copies of the *North King and South Snohomish Counties Regional Mitigation Plan* will be kept and made available for public review at the following locations:

- City/Town Hall
  - City of Mountlake Terrace
  - City of Brier
  - City of Edmonds
  - City of Kenmore
  - City of Lake Forest Park
  - City of Lynnwood
  - City of Mill Creek
  - City of Mukilteo
  - City of Woodinville
  - Town of Woodway

- Special Purpose District Offices
  - Edmonds Community College
  - Edmonds School District
  - Olympic View Water and Sewer District

- Port of Edmonds

- Libraries
  - Brier (Sno-Isle Regional Library)
  - Edmonds (Sno-Isle Regional Library)
  - Kenmore (King County Library System)
  - Lake Forest Park (King County Library System)
  - Lynnwood (Sno-Isle Regional Library)
  - Mill Creek (Sno-Isle Regional Library)
  - Mountlake Terrace (Sno-Isle Regional Library)
  - Mukilteo (Sno-Isle Regional Library)
  - Woodinville (King County Library System)

Contact information for ESCA is included in the Point of Contact information on page *vii* of the Mitigation Plan.

A notice regarding the existence and location of these copies of the *North King and South Snohomish Counties Regional Mitigation Plan* will be publicized in accordance with each jurisdiction's requirements.

A minimum of one public meeting will be held by each jurisdiction as a part of the five-year plan update. The purpose of these meetings is to provide a public forum so that citizens can express concerns, opinions, or ideas about the *North King and South Snohomish Counties Regional Mitigation Plan*.

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Plan Membership / Adding Jurisdictions

The jurisdictions within the North King and South Snohomish Counties area are committed to regional cooperation. To facilitate and expand future cooperation and regional partnerships, the *North King and South Snohomish Regional Mitigation Plan* provides the following process for jurisdictions wishing to join this Plan. There are two options for this addition.

In the first option, a new City, Town or Special Purpose District joins ESCA through signing the Interlocal Agreement. In this case, the new member also commits to regional planning efforts, including the *North King and South Snohomish Regional Mitigation Plan*. A section pertaining to the new jurisdiction will be added at the soonest possible time.

The second option is if a jurisdiction that is *not* an ESCA member wishes to add onto the Plan. In this case:

1. The non-ESCA jurisdiction wishing to join the Plan contacts the Regional Plan Manager (ESCA) with a request to participate.

2. The Regional Plan Manager provides the jurisdiction with a copy of the approved Plan, the local planning requirements and any other pertinent data.

3. The jurisdiction reviews the Regional Mitigation Plan and develops the portions of the Plan that are specific to the jurisdiction and required by the Regional Plan Manager to comply with the Regional Plan. This portion of the Plan must meet the requirements of 44 CFR 201.6 of the Disaster Mitigation Act of 2000 (DMA2K) including a public process.

4. The new jurisdiction submits its portions of the Hazard Mitigation Plan to the Regional Plan Manager for review and compliance with regional planning criteria.

5. The Regional Plan Manager forwards the new jurisdiction's Plan to the State Hazard Mitigation Program Manager for review and compliance with DMA2K. The Regional Plan Manager also sends certification to the State Hazard Mitigation Program Manager that the new jurisdiction meets the Regional Mitigation Plan criteria.

6. The State Hazard Mitigation Program Manager reviews the new jurisdiction's Plan for DMA2K criteria compliance in conjunction with the approved Regional Plan. If the Plan does not meet criteria, the State Hazard Mitigation Program Manager works with the jurisdiction to resolve issues until it does.

7. The State Hazard Mitigation Program Manager forwards the new jurisdiction's Plan to FEMA Region X for review and DMA2K compliance.

8. Upon approval from FEMA Region X, the new jurisdiction is considered part of the Regional Mitigation Plan and will comply with the update schedule, workgroups, planning committee and criteria in the Regional Mitigation Plan as required.

Section II : Multi-Jurisdictional Hazard Identification

NOTE:

This section of the *North King and South Snohomish Counties Regional Mitigation Plan* contains general, multi-jurisdictional information regarding natural hazards within the region.

The statements regarding vulnerability assessment, probability, and risk contained within this section depict the average condition within the region as defined by this Plan's participants.

The contents of this section of the *North King and South Snohomish Counties Regional Mitigation Plan* are based upon the best available information. Probability and risk assessments regarding natural events were made on a subjective basis and with consideration of past events.

Each jurisdiction conducted their own vulnerability assessment and considered the probability and risk associated with each specific natural hazard. Please refer to Section III of this Plan for jurisdiction-specific information regarding vulnerability, probability, and risk associated with natural hazards as well as suggested mitigation strategies proposed by each of the jurisdictions that participated in the development of this Plan.

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Drought

Defining the Hazard

Drought – an extended period of abnormally low precipitation; a condition of climate dryness that is severe enough to reduce soil moisture as well as water and snow levels below the minimum necessary for sustaining plant, animal, and economic systems.

Statutory criteria for drought

- Water supply below 75 percent of normal
- Shortage expected to create undue hardship for some water users

Table 1: Drought Severity Classification

Category	*Description*	*% of Normal Precip*	*Possible Impacts*
D0	Abnormally Dry	<75% for 3 months	Short-term dryness slowing planting, growth of crops or pastures; fire risk above average.
D1	Moderate Drought	<70% for 3 months	Damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent.
D2	Severe Drought	<65% for 6 months	Crop or pasture losses likely; fire risk very high; water shortages common.
D3	Extreme Drought	<60% for 6 months	Major crop/pasture losses; extreme fire danger; widespread water shortages.
D4	Exceptional Drought.	<65% for 12 months	Exceptional and widespread crop/pasture losses; exceptional risk; shortages of water in reservoirs, streams, and wells, creating water emergencies.

Causes of Drought

While drought originates from a deficiency of precipitation over an extended period of time, usually a season or more, drought is also related to the timing and the intensity or number of rainfall events. Other climactic factors such as high temperature, high wind, and low relative humidity are associated with drought in many regions of the world and can significantly aggravate the severity of a drought. Drought differs from aridity, a permanent climactic feature common to regions with low rainfall.

The National Weather Service reports that 2000-01 was the driest winter in Washington since 1976-77. It was also one of the five driest in the past 100 years. Many factors came together to cause drought. For this reason, drought is difficult to predict. The National Drought Mitigation Center provides information on how drought is predicted.

In 1989, the Washington State Legislature gave permanent drought relief authority to the Department of Ecology (DoE) and enabled them to issue orders declaring drought emergencies. (RCW 43.83B.400-430 and Chapter 173-166 WAC).

In Washington State, the statutory criteria for drought is a water supply below 75% of normal and a shortage expected to create undue hardship for some water users.

Drought's Effect on Ground Water and Wells

Five percent of the water on the earth is drinkable. Ninety-five percent of that is in the ground. In Washington, many of us get our drinking water from the ground. In total, about 16,000 drinking water systems in Washington get water from this source. The effects of drought on ground water supplies are usually not felt as quickly as they are for surface water supplies. However, reduced precipitation during a drought means that ground water supplies are not being replenished at a normal rate. This can lead to a reduction in ground water levels and problems such as reduced pumping capacity or - worse yet - wells going dry. Shallow wells are more vulnerable than deep wells.

Most water utilities are aware of this problem and continuously monitor ground water levels, implementing water conservation measures as necessary. For private homeowners with their own wells, the Washington State Department of Ecology, Division of Drinking Water Quality, advises that these citizens practice water conservation. DoE also can provide information on deepening or re-drilling wells if this action becomes necessary.

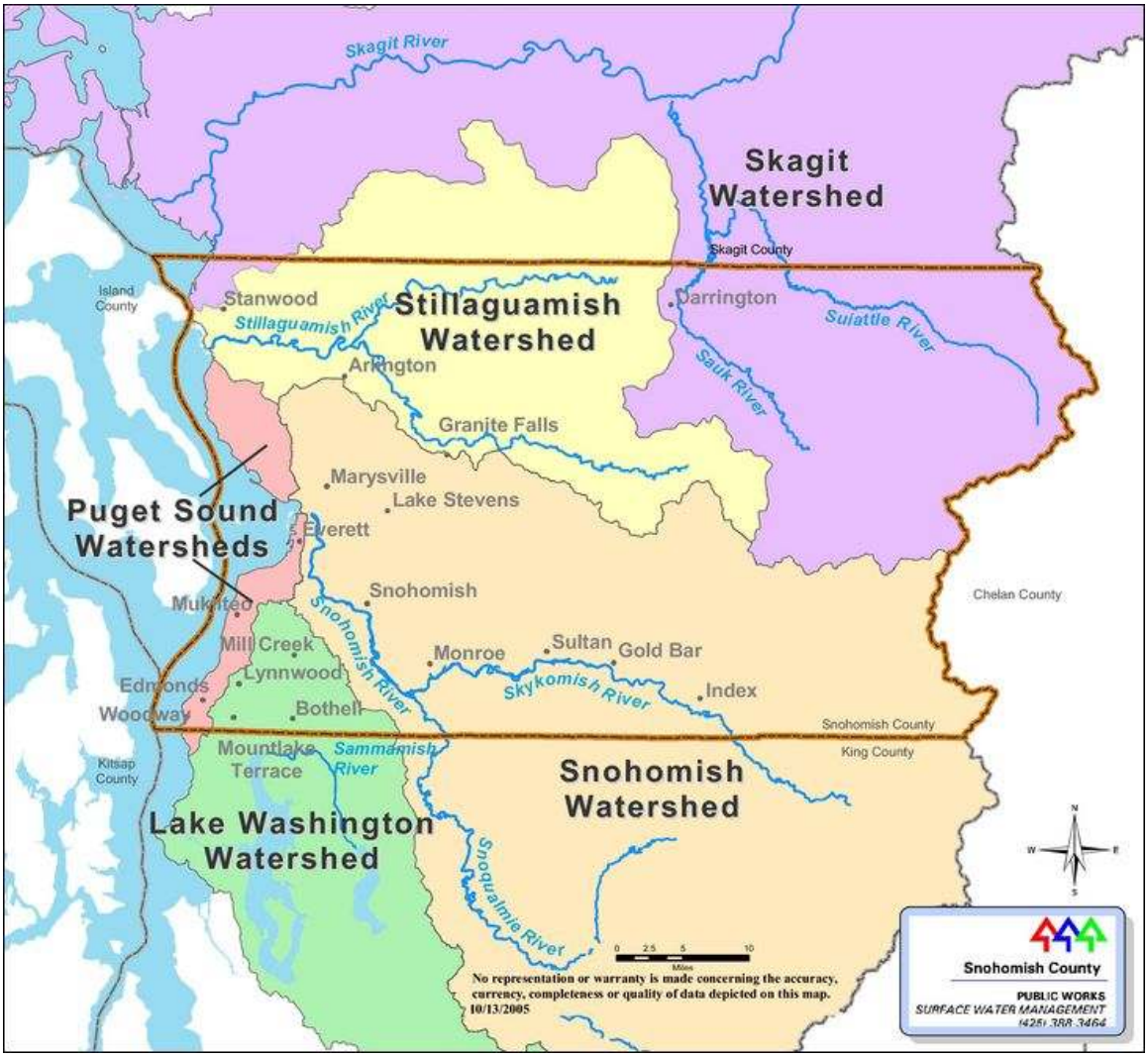
Drought's Effect on Ground Water and Streams

Reduced replenishment of ground water also affects streams. Streams are not fed entirely by runoff from precipitation and melting of the snowpack. Much of the flow in streams comes from ground water, especially in the summer when there is less precipitation. Reduced ground water levels mean that less water will enter streams. Some users of ground water will be affected by low stream flows during a drought – meaning they might legally have to cease withdrawing water.

Figure 1: King County Watersheds

Source: King County Public Works

Figure 2: Snohomish County Watersheds



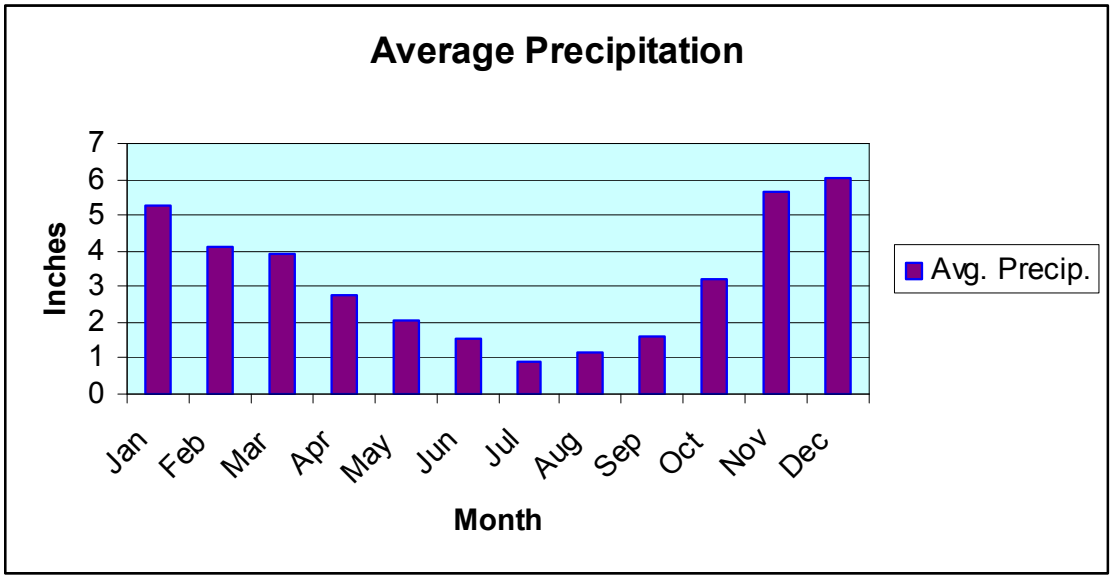
Source: King County Public Works

Regional Drought History

Washington State usually experiences drought during a regional climate event characterized by a period of below-normal precipitation. While the North King and South Snohomish Counties region has experienced some periods of drought in the past, these events are typically low to moderate in severity and relatively short in duration. In addition, the jurisdictions participating in this plan are urban/suburban in nature, and therefore do not experience the same financial hardships as an agricultural region does during drought.

The North King and South Snohomish Counties area averages almost 38.25 inches of precipitation per year over the last 30 years.[1] The following graph indicates average monthly rainfall.

Graph 1: Regional Precipitation Averages[2]



In spite of a generous "average rainfall," droughts are a natural part of the climate cycle. In the last century, there have been a number of drought episodes, including several that have lasted for more that a single season, such as the dry periods between 1928-1932 and 1992-1994. Severe drought episodes occurred in 1977 and 2001. The 1977 event set records for low precipitation, snow-pack, and stream flow totals that still stand today. The 2001 event was the second-worst drought year in state-recorded history.

Rainfall for Western Washington during the 2001 water year was approximately 30% below normal. On March 14, 2001, after several months of record low precipitation, Governor Gary Locke authorized the Department of Ecology (Ecology) to declare a statewide drought emergency. Washington was the first northwest state to make a drought declaration. Due to above-average precipitation in the final two months of the year, the drought emergency formally expired on December 31, 2001. The National Weather Service reported that the winter of 2000-01 was the driest since 1976-1977. It was also one of the five driest in the past 100 years.

Table 2: Washington State Drought Occurrences[3]

Date	Occurrence
July-August 1902	No measurable rainfall in Western Washington.
August 1919	Drought and hot weather occurred in Western Washington.
July-August 1921	Drought in all agricultural sections.
June-August 1922	The statewide precipitation averaged .10 inches.

March-August 1924	Lack of soil moisture retarded germination of spring wheat.
July 1925	Drought occurred in Washington.
July 21-Aug 25, 1926	Little or no rainfall was reported.
June 1928-March 1929	Most stations averaged less than 20 percent of normal rainfall for August and September and less than 60 percent for nine months.
July-August 1930	Drought affected the entire state. Most weather stations averaged 10 percent or less of normal precipitation.
April 1934-March 1937	The longest drought in the region's history – the driest periods were April-August 1934, September-December 1935, and July-January 1936-1937.
May-September 1938	Driest growing season in Western Washington.
1944	Water shortages in Spokane.
1952	Every month was below normal precipitation except June. The hardest hit areas were Puget Sound and the central Cascades.
January-May 1964	Drought covered the southwestern part of the state. Precipitation was less than 40 percent of normal.
Spring, 1966	The entire state was dry.
June-August 1967	Drought occurred in Washington.
January-August 1973	Dry in the Cascades.
October 1976 – September 1977	Below normal precipitation in Olympia, Seattle, and Yakima. Crop yields were below normal and ski resorts closed for much of the 1976-77 ski season.
October 1991 – September 1994	Water supply in Yakima River Basin was 65 percent of normal.
2000 - 2001	Governor Gary Locke authorized the Department of Ecology (Ecology) to declare a statewide drought emergency. National Weather Service reported that the winter of 2000-01 was the driest since 1976-1977. It was also one of the five driest in the past 100 years.

Hazard Identification and Risk Analysis

Hazard Identification

When a drought begins, the agricultural sector is usually the first to be affected because of its heavy dependence on stored water in the soil. Soil water can be rapidly depleted during extended dry periods. If precipitation deficiencies continue, then people dependent on other sources of water will begin to feel the effects of the shortage. Those who rely on surface water (reservoirs and lakes) and subsurface water (ground water), for example, are usually the last to be affected. A short-term drought that persists for 3 to 6 months may have little impact on these sectors, depending on the characteristics of the hydrologic system and water use requirements.

When precipitation returns to normal and meteorological drought conditions have abated, the sequence is repeated for the recovery of surface and subsurface water supplies. Soil water reserves are replenished first, followed by stream-flow, reservoirs and lakes, and ground water.

Drought impacts may diminish rapidly in the agricultural sector because of its reliance on soil water, but linger for months or even years in other sectors dependent on stored surface or subsurface supplies. Ground water users, often the last to be affected by drought during its onset, may be last to experience a return to normal water levels. The length of the recovery period is a function of the intensity of the drought, its duration, and the quantity of precipitation received as the episode terminates.

Vulnerability Assessment

Unlike most natural hazards, drought cannot be viewed as purely a physical phenomenon or natural event. Its impacts on a region's weather, agriculture, and hydrology and on society as a whole result from the interplay between a natural event (less precipitation than expected resulting from natural climatic variability) and the demand people and technology place on a region's water supply. Human beings often exacerbate (or may ameliorate) the impact of drought. Recent droughts in both developing and developed countries, and the resulting economic and environmental impacts and personal hardships, have underscored the vulnerability of societies to this hazard.

In order to define the area's vulnerability to a severe drought, the effects of prolonged dry weather on several systems are important to understand.

Meteorological Impact

Drought's impact is seen first in relation to the day-to-day weather of a region, usually in the degree of dryness (in comparison to some "normal" or average amount of rainfall), and in the duration of the dry period.

Meteorological drought is region-specific, since the atmospheric conditions that result in deficiencies of precipitation are highly variable from one part of the country to another. *The most significant vulnerability for the participating jurisdictions during a prolonged period of dry weather is the elevation of wildland-urban interface fire threat in the area.*[4] Careless smokers, mechanical devices, and lightning storms are just a few of the ways a wildland-urban interface fire may be ignited.

Agricultural Impact

The agricultural community needs an ample and consistent water supply. Within the jurisdictions participating in this Plan, however, there is little agricultural industry. As a result, the north King and south Snohomish Counties region is unlikely to experience direct effects from

an agricultural drought. Instead, the region may be affected through the ripple effect from loss of jobs and increased food prices.

Hydrological Impact

The hydrological effects of drought are associated with the shortfalls of surface or subsurface water supplies (i.e., stream flow, reservoir and lake levels, and groundwater). The frequency and severity of hydrological drought are often defined on a watershed or river basin scale. Although drought originates with precipitation deficiency, hydrologists are more concerned with how this deficiency plays out through the rivers, streams, and groundwater system.

Hydrological drought is often out of phase with, or lags behind, the effects of meteorological and agricultural drought. This complicates the sequence and quantification of effects. Competition for water in these storage systems escalates during drought and conflicts between water users may increase significantly.

Hydrological Drought and Land Use

Although climate is a primary contributor to hydrological drought, other factors such as increases in population, changes in land use (e.g., deforestation or urbanization), land degradation, and the construction of dams all affect the hydrological characteristics of the basin.

The impact of meteorological drought may extend well beyond the borders of the precipitation-deficient area due to the interconnections in hydrologic systems. For example, meteorological drought may severely affect portions of the Canadian Rocky Mountains and spare the Pacific Northwest region of the United States. However, since the Columbia River and its tributaries drain this region to the south, there may be significant hydrologic impacts far downstream.

Similarly, changes in land use upstream may alter a basin's hydrologic characteristics such as infiltration and runoff rates, resulting in more variable stream flow and a higher incidence of hydrologic drought downstream. The Colorado River is a textbook case of evolution in land use creating a demand for water that vastly exceeds supply.

Land use change is one way human actions alter the frequency of water shortages (agricultural or hydrological drought) even when no change in the frequency or severity of meteorological drought has been observed.

Drought Sequence

The sequence of effects associated with meteorological, agricultural, and hydrological drought further emphasizes their differences. When drought begins, early effects are seen in the severity of fire vulnerability

in wildland areas. The agricultural sector is usually affected early in the event because of its heavy dependence on stored soil water. Soil water can be rapidly depleted during extended dry periods. If precipitation shortfalls continue, then people dependent on other sources of water will begin to feel the effects of the shortage. Those who rely on surface water (i.e., reservoirs and lakes) and subsurface water (i.e., ground water) are usually the last to be affected. A short-term drought that persists for 3 to 6 months may have little impact on these users, depending on the characteristics of the hydrologic system and water use requirements.

When precipitation returns to normal and meteorological drought conditions have abated, the drought impact sequence is repeated for the recovery of surface and subsurface water supplies. Soil pore water reserves are replenished first, followed by stream flow, reservoirs and lakes, and finally ground water. Drought impacts may diminish rapidly in the agricultural sector because of its reliance on soil water, but linger for months or even years in other sectors dependent on stored surface or subsurface supplies. Ground water users, often the last to be affected by drought during its onset, will also be last to experience a return to normal water levels. The length of the recovery period is a function of the intensity of the drought, its duration, and the quantity of precipitation received as the episode terminates.[5]

The effects of an extreme, long-term drought could result in inadequate streams flows thereby resulting in the implementation of strict water conservation measures – something that the majority of the population of the north King and south Snohomish Counties region is not familiar with.

According to the Washington State HIVA, three energy curtailments during drought periods prior to 1977 caused temporary unemployment. During a drastic increase in electricity rates in 2001, many large manufacturing plants closed their businesses and laid off employees. A severe, long-term drought would have the same effect on large business and industry that rely on large amounts of electrical power to operate.

As mentioned above, a severe drought could cause reduced stream flows. This, in turn, may cause warmer waters which could have a major impact on local salmon runs. In addition, several residential areas within the region could be at risk from wildland-urban interface fires ignited by lightening as well as either accidental or intentional human actions.

Risk Analysis

Based on historical evidence, there is a moderate probability of a drought occurring in north King and south Snohomish County but a very low risk associated with such an event due to the typically short duration and minor severity of drought events in north King and south Snohomish Counties.

Residents of Woodway and portions of Edmonds and unincorporated Snohomish County receive their water from Olympic View Water and Sewer District. Olympic View purchases most of their supply from Seattle Water. Seattle's water originates in two watersheds: the Cedar River Watershed (located between Snoqualmie Falls and the Cascade foothills) and the South Fork Tolt River Watershed (located in the Cascade foothills). Between the two sources, approximately 1.3 million people are supplied with water on a daily basis.[6] In addition, approximately 40% of Olympic View's annual demand is supplied by a treated surface source located in the Town of Woodway.

Alderwood Water District supplies most of the southwest portion of Snohomish County, including Brier, Lynnwood, Mill Creek, Mountlake Terrace, Woodway, and most of Edmonds. The District purchases the water from the City of Everett. The water comes from the Sultan Basin watershed and originates at Spada Reservoir, located in the Cascade Mountains.

Northshore Water District serves Kenmore and Lake Forest Park in King County. The City of Woodinville gets its water from Woodinville Water District; and both Northshore and Woodinville Water Districts purchase the water supply from Seattle Public Utilities. (Seattle is supplied by the Cedar River Watershed and the Tolt River Watershed.)

These systems should not be seriously affected by a short-term drought, especially if reasonable conservation measures are implemented.[7, 8]

Drought's primary impacts for Olympic View Water and Sewer would be difficulty in meeting water demand and the resulting financial consequences.

A drought lasting for more than one season would most likely reduce the annual snow-pack normally accumulated at high elevations in the Cascade Mountains thereby reducing normal stream flows in local rivers and creeks. A substantial reduction in stream flows could severely impact the generation of electricity from the hydro-electric dams located on the Skagit River, Baker River, White River, and Snoqualmie Falls, thereby affecting the City of Kenmore and other areas served by Puget Sound Energy (PSE).

Other cities participating in this Plan are served by Snohomish County PUD, and are less reliant on locally-generated electricity. With 80% of the PUD's power supplied by Bonneville Power Administration, however, a drought in other parts of the state, or in other states entirely, could impact the supply of local electricity. Specifically, a reduction in hydro-electric generation will result in increased electricity rates and/or reduced supply (brownouts or blackouts) for all residents and businesses in the area.[9]

For cities, the primary concerns will be ensuring adequate supply for fire flow and supplying residents' needs. Of additional concern is the impact on creeks and streams that run through the area.

Drought significantly increases the number of wildland-urban interface fires that occur. It also increases the possibility of landslides once the rains begin. This is due to loss of plant-life from fires or die-off from lack of water. In either case, it leaves the soil unprotected and more vulnerable to landslide or soil displacement activity.

Should a severe, long-term drought occur, it will be vital that local elected officials and governmental agencies work cooperatively with the Washington State Department of Health and the Washington State Department of Ecology to help insure efforts are made to protect public water supplies, aid local industry, and safeguard fish and stream flows.

Mitigation Activities

Existing Mitigation Activities

The following activities are common to the north King and south Snohomish Counties region:

Drought Laws and Regulations

Chapter 43.83B RCW - Water Supply Facilities Law

Gives the Department of Ecology authority to respond to a drought emergency.

- **43.83B.400** defines a "drought condition" as one in which "the water supply for a geographical area or for a significant portion of a geographical area is below seventy-five percent of normal and the water shortage is likely to create undue hardships for various water uses and users."
- **43.83B.405** gives Washington State Department of Ecology the authority, after obtaining the views of certain state and federal agencies and receiving written approval from the governor, to issue orders to address a drought.
- **43.83B.410 (1)** gives DoE specific authority, if certain conditions are met, to issue orders to "authorize emergency withdrawal of public surface and ground waters, including dead storage within reservoirs, on a temporary basis and to authorize associated physical works which may be either temporary or permanent."
- **43.83B.410 (2)** gives DoE authority to approve a "temporary change in purpose, place of use, or point of diversion, consistent with state policy allowing transfer or lease of waters between willing parties…"
- **43.83B.430** created a drought preparedness account in the state treasury. The funds in the account can only be used for activities directly related to drought preparedness.

Chapter 173-166 WAC - Emergency Drought Relief

This regulation was adopted by the Department of Ecology to implement Chapter 43.83B RCW.

- **Section 050** -- Forecast of Drought Conditions
- **Section 060 --** Orders Declaration of Drought Conditions

Emergency Drought Permits / Temporary Transfers:

1. **Ch. 173-166 WAC--Section 040** General eligibility rule
2. **Ch. 173-166 WAC--Section 070** Emergency drought permits
3. **Ch. 173-166 WAC--Section 080** Temporary transfers of water rights

Amendment to Chapter 173-166 WAC - Emergency Drought Relief
This emergency adoption, effective 5/10/01, amends existing regulation by adding a new section (Ch 173-166 WAC, Section (085) to clarify the requirements for filing emergency water right applications during a declared drought emergency and identifies information necessary from applicants who wish to "spread" their water right during a drought.

Chapter 173-167 WAC - Drought Funding Emergency Rule
Drought preparedness funding for agricultural, municipal and utility, and fish and wildlife needs, and for purchasing and leasing water for fish.

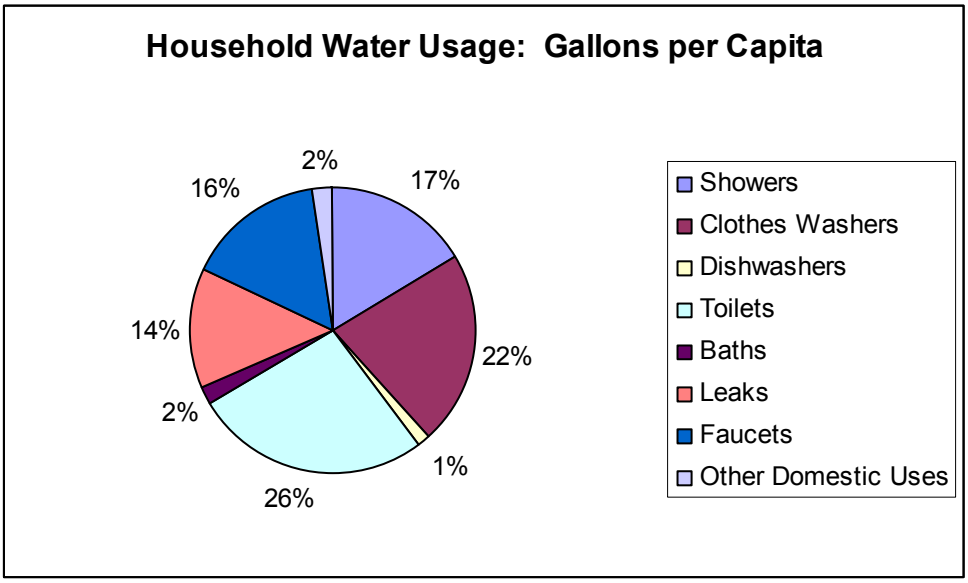
Water Conservation
The following educational information is similar to that disseminated during times of drought by local water districts and cities during times of drought:

Home resident
Individuals can lessen the effects of limited water supplies. Landscape watering and toilets use the largest amount of water in the home.

Here are some things individual homeowners can do:

Consider converting to low-water landscaping, also known as Xeriscape.
Select plants, shrubs, and trees that need minimal water.
Water lawns early in the morning and/or late in the evening (but not too late; that encourages fungal growth). Limit water use to approximately one inch per week, including rainfall. For best results, moisten the soil between 4 and 6 inches deep with each watering. This will encourage growth of a deep root structure that is more drought-resistant. Better yet, "go for the gold" and let the lawn go golden for the summer months.
For owners of older home, converting to water efficient toilets (1.6 gallons per flush), faucets and showerheads (2.5 gallons per minute) can save up to 75 percent over conventional fixtures. Check with the local utility - some offer free low flow shower heads and faucet aerators or rebates toward the purchase of water efficient toilets and washing machines. Take shorter showers.
Don't let the water run when shaving, brushing teeth, or hand washing dishes. Turn on the tap only when necessary. Additionally, don’t use faucets at full pressure. Do not run washing machines or dishwashers without a full load.

Chart 1: Typical Domestic Water Use



Data source: American Water Works Association

Technical assistance

Technical assistance during the current drought emergency is focused on water systems most vulnerable to drought impact. State Department of Health-sponsored activities include educating system operators about water conservation, promoting water audits and leak detection, supporting the development of water shortage response plans, helping identify alternate water sources, helping develop drought ordinances, and ensuring the safe use of emergency sources of water.

Washington State Department of Health is working with the Department of Ecology and other agencies on the emergency funding available for drought response. Water systems most at risk to water shortages will be given priority for financial assistance.

Drought Resource Directory

The following resource directory lists the resources and programs that can assist county communities and organizations. The resource directory will provide contact information for local, county, regional, state and federal programs that deal with natural hazards.

Federal

National Drought Mitigation Center (NDMC)

Helps people and institutions develop and implement measures to reduce societal vulnerability to drought, stressing preparedness and risk management rather than crisis management.

Contact: University of Nebraska – Lincoln
Address: 239 L.W. Chase Hall; P.O. Box 830749; Lincoln, NE 68583-0749
Phone: 402/472-6707
Fax: 402/472-6614
Email: ndmc@drought.unl.edu
Website: http://www.drought.unl.edu

National Oceanic and Atmospheric Administration (NOAA)

NOAA's historical role has been to predict environmental changes, protect life and property, provide decision makers with reliable scientific information, and foster global environmental stewardship.

Contact: National Oceanic and Atmospheric Administration
Address: 14th Street & Constitution Avenue NW, Room 6013, Washington, DC 20230
Phone: (202) 482-6090
Fax: (202) 482-3154
Website: http://www.noaa.gov
Email: answers@noaa.gov

NOAA Northwest River Forecast Center

A general summary of water supply conditions in the Pacific Northwest, including basin summaries for precipitation, temperature, snow, reservoir storage and runoff for the current water year.

Website: http://www.nwrfc.noaa.gov/

National Weather Service, Seattle Bureau

The National Weather Service (NWS) provides weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy. NWS data and products form a national information database and infrastructure, which can be used by other governmental agencies, the private sector, the public, and the global community.

Contact: National Weather Service
Address: 7600 Sand Point Way NE, Seattle, WA 98115
Phone: (206)526-6087
Website: http://www.wrh.noaa.gov

National Resources Conservation Service (NRCS), US Department of Agriculture

NRCS provides a suite of federal programs designed to assist state and local governments and landowners in mitigating the impacts of flood events. The Watershed Surveys and Planning Program and the Small Watershed Program provide technical and financial assistance to help participants solve natural resource and related economic problems on a watershed basis. The Wetlands Reserve Program and the Flood Risk Reduction Program provide financial incentives to landowners to put aside land that is either a wetland resource, or that experiences frequent flooding. The Emergency Watershed Protection Program (EWP) provides technical and financial assistance to clear debris from clogged waterways, restore vegetation, and stabilizing riverbanks. The measures taken under EWP must be environmentally and economically sound and generally benefit more that one property.

Contact: Resource Conservationist
Address: 256 Warner Milne Rd, Oregon City, Oregon 97045-4014
Phone: (503) 655-3144
Website: http://www.nrcs.usda.gov/

U.S. Geological Survey

The USGS website provides current streamflow conditions at USGS gauging stations throughout the Pacific Northwest. The Seattle USGS office is responsible for water-resources investigations, and their office cooperates with local, state, and federal agencies in the area. Cooperative activities include water-resources data collection and interpretive water-availability and water-quality studies.

Contact: USGS Western Region Office
Address: 345 Middlefield Road; Menlo Park, CA 94025
Phone: (650)853-8300
Website: http://www.usgs.gov
USGS Information: 1-888-ASK-USGS or (888)275-8747

USGS Water Resources

This web page offers current US water news; extensive current (including real-time) and historical water data; numerous fact sheets and other publications; various technical resources; descriptions of ongoing water survey programs; local water information; and connections to other sources of water information.

Contact: USGS Water Resources
Website: http://water.usgs.gov
Or: http://water.usgs.gov/public/realtime.html

Bureau of Reclamation

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Contact: Bureau of Reclamation, Pacific Northwest Region
Address: 1150 N. Curtis Road, Boise, ID 83706
Phone: (208) 378-5012
Website: http://usbr.gov/pn

Army Corps of Engineers

The Corps of Engineers administers a permit program to ensure that the nation's waterways are used in the public interest. Any person, firm, or agency planning to work in waters of the United States must first obtain a permit from the Army Corps of Engineers. The Corps is responsible for the protection and development of the nation's water resources, including navigation, flood control, energy production through hydropower management, water supply storage and recreation.

Contact: US Army Corps of Engineers, Floodplain Information Branch
Address: 4735 East Marginal Way South; Seattle, WA 98124-3755
Phone: (206)764-3750
Website: http://www.nws.usace.army.mil/

Office of Hydrology, National Weather Service

The National Weather Service's Office of Hydrology (OH) and its Hydrological Information Center offer information on floods and other aquatic disasters. This site offers current and historical data including an archive of past flood summaries, information on current hydrologic conditions, water supply outlooks, an Automated Local Flood Warning Systems Handbook, Natural Disaster Survey Reports, and other scientific publications on hydrology and flooding.

Contact: Office of Hydrology, National Weather Service
Website: http://www.nws.noaa.gov/oh
Or: http://www.nws.noaa.gov/oh/hic/

Regional

Western Regional Climate Center

Weather-related data for the western states.

Address: 2215 Raggio Parkway; Reno, NV 89512
Phone: 775/674-7010
Fax: 775/674-7106
Email: wrcc@dri.edu
Website: http://www.wrcc.dri.edu/

Water Resource Inventory Area 8 (WRIA 8)

Coordinating regional efforts toward protecting and restoring watersheds and salmon habitat.

Contact: Jane Lamensdorf-Boucher, WRIA 8 Watershed Coordinator
Address: 201 South Jackson Street, Suite 600; Seattle, WA 98104
Phone: (206)296-1907
Email: jane.lamendsdorfboucher@metrokc.gov

State

Interactive Weather Information Network (IWIN)

Current weather information in cooperation with NOAA.

Website: http://iwin.nws.noaa.gov/iwin/main.html
Email: W-IWIN.Webmaster@noaa.gov

Washington Department of Ecology, Northwest Regional Office

Provides technical assistance to local jurisdictions in making sound policy decisions relating to land use, shorelands, and wetlands.

Contact: Washington State Department of Ecology, Northwest Regional Office
Address: 3190 160th Avenue SE, Mail Stop NB-81; Bellevue, WA 98008-5452
Phone: (425)649-7000
Website: http://www.ecy.wa.gov/

Washington Department of Fish and Wildlife

The organization's mission is to protect and enhance Washington's fish and wildlife and their habitats for use and enjoyment by present and future generations. WDFW regulates stream activity and engages in stream enhancement activities.

Contact: Washington Department of Fish and Wildlife
Physical Address: 600 Capitol Way North; Olympia, WA 98501-0191
Mailing Address: 1111 Washington St SE; Olympia, WA 98501
Phone: (360)902-2200
Website: http://wdfw.wa.gov/
Email: wildthing@dfw.wa.gov

Regional Office: Washington Department of Fish and Wildlife
Address: 16018 Mill Creek Blvd.; Mill Creek, WA 98012
Phone: (425)775-1311

Washington Department of Natural Resources

DNR's role is to protect and manage State lands and other natural resources such as water, wildlife, and fish. The Department is also responsible for fire prevention and suppression.

Contact: Washington Department of Natural Resources
Address: 1111 Washington Street SE; Olympia, WA 98504
Mailing Address: PO Box 47000; Olympia, WA 98504-7000
State Phone: (360)902-1000
Regional Info: (800)527-3305
Fax: (360)902-1775
Website: http://www.dnr.wa.gov

Contact: Washington Department of Natural Resources, Northwest Region
Address: 919 N Township Street; Sedro Woolley, WA 98284-9333
Phone: (360)856-3500
Fax: (360)856-2150
Website: http://www.dnr.wa.gov

Publications and Additional Resources

Washington State Hazard Identification and Vulnerability Assessment (HIVA)

The *Washington State Hazard Identification and Vulnerability Assessment (HIVA)* assesses natural and technological (man-made) hazards in Washington State. Assessment is the initial step in the emergency management process that leads to mitigation against, preparedness for, response to, and recovery from hazards. Hazards have the potential of becoming disasters or emergencies that can adversely affect the people, environment, economy, and property of the state.

Contact: Washington State Military Department, Emergency Management Division
Address: Plans Section, Camp Murray, Washington 98430-5122.
Phone: (800)562-6108
Website: http://emd.wa.gov

Washington State Hazard Mitigation Strategy

Contact: Washington State Military Department, Emergency Management Division
Address: Plans Section, Camp Murray, Washington 98430-5122.
Phone: (800)562-6108
Website: http://emd.wa.gov

Washington State Comprehensive Emergency Management Plan

This document establishes emergency management functions and the responsibilities of the Washington State Military Department, Emergency Management Division (EMD), state agencies, commissions, boards, and councils.

Contact: Washington State Military Department, Emergency Management Division
Address: Plans Section, Camp Murray, Washington 98430-5122.
Phone: (800)562-6108
Website: http://emd.wa.gov

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Earthquake

Defining the Hazard

An earthquake is a naturally-induced shaking of the ground. Earthquakes are caused by the fracture and sliding of rock within the earth's crust. The earth's crust is divided into eight major pieces (or plates) and many minor plates. These plates are constantly moving, very slowly, over the surface of the globe. As these plates move, stresses are built up in areas where the plates come into contact with each other. Within seconds, an earthquake releases stress that has slowly accumulated within the rock, in some instances over hundreds of years. Sometimes the release occurs near the surface, and sometimes it comes from deep within the crust.

More than 20,000 earthquakes greater than magnitude 1.0 have been logged in Washington State since 1970. This averages 656 events per year, or approximately two per day. Earthquakes of at least magnitude 2.0 to 3.0 have occurred in almost every county in the state.[10]

Massive earthquakes occur on an irregular basis. In January 1700, a great earthquake with an estimated magnitude of 9.0 affected the region.[11] This quake is credited as the cause of a tsunami that swept across the Pacific Ocean and devastated portions of Japan. Just over 150 years later, the December 14, 1872, North Cascades earthquake ranks as the most widely felt earthquake in the state. This quake is estimated at a 7.4 magnitude. While no major damage is recorded, roofs were reported as cracked, lumber piles were "thrown down," and "people rushed from …houses in terror."[12] Aftershocks were felt for approximately three weeks following the initial quake.

More recent events include a magnitude 7.1 magnitude earthquake near Olympia in 1949 and a magnitude 6.5 earthquake near Seattle-Tacoma Airport in 1965.

The Nisqually earthquake on February 28, 2001, was a deep, magnitude 6.8 earthquake 10 miles northeast of Olympia. One person died of a heart attack, more than 700 people were injured, and various estimates place damage at between $1 billion and $4 billion; exact figures are not available , as insurance claims information is not available.

In combination, these large events in 1949, 1965, and the Nisqually quake in 2001 killed 16 people and caused more than $2 billion (1984 dollars) in property damage.[13] At least 20 damaging earthquakes have occurred in western Washington during the past 125 years.[14]

The USGS provides the following descriptions of the major identified faults that are located within the Puget Sound area (formatting and emphasis added):

Hood Canal fault zone (Class B) No. 552: The northerly striking, Hood Canal fault zone was originally inferred from gravity anomalies and some aeromagnetic data for the Puget Lowlands and the Olympic Mountains directly to the west… The presence of an active fault zone, beneath the southern part of the canal and onland north of the canal, are more speculative and based principally on geophysical anomalies.

Interpretation of seismically imaged stratigraphic relations implies considerable deformation of Tertiary bedrock and complex depositional patterns in Quaternary deposits that have been affected by high-angle faulting. In seismic-reflection profiles, these high-angle faults appear to be principally normal faults associated with some reverse faults. Possible strike-slip offsets along these faults, however, might not be apparent in these profiles, and several regional studies infer from regional relations that this fault zone is principally characterized by right-lateral strike-slip movement.

Some interpretations of regional tectonic relations may also suggest that the most recent movement along faults of this zone is as young as late Holocene in age. Inferences of right-lateral strike-slip movement and the possibility of late Holocene movement along this fault zone are based mostly on the apparent westward termination of the Seattle fault zone [570] near Hood Canal.

Late Holocene activity along the Seattle fault zone is well documented. The age, character, and origin of faults that appear to deform Quaternary sediments beneath Hood Canal, however, are not tightly constrained. For example, some apparent faults and faulted relations imaged from seismic data, might instead reflect inherited Tertiary topography enhanced and modified by multiple episodes of Quaternary glacial erosion and glacial and marine deposition. Possible slip rates and recurrence intervals for this fault zone have not been reported. Consequently, at this time this largely inferred fault zone is classified herein as a Class B structure until more detailed studies and characterization of this zone is reported.

Seattle fault zone (Class A) No. 570: This 4- to 7-km-wide east-trending fault zone extends from the Cascade Range foothills on the east across the Puget Lowland to Hood Canal, crossing Lake Sammamish, Lake Washington, Puget Sound, Bainbridge Island, and the Kitsap Peninsula. Various strands of the fault zone lie largely concealed beneath the major population centers of Seattle, Bellevue, and Bremerton. It forms the northern boundary of a belt of bedrock exposures that cross much of the Puget Lowland. The depth to bedrock north of the fault zone is as much as 1 km...

…These data indicate the zone consists of three or more south-dipping thrust faults that form the structural boundary between the Seattle uplift on the south and the Seattle basin on the north. Blakely and others… have named three of these structures the "frontal fault," the "Blakely Harbor fault," and the "Orchard Point fault." Nelson and others…termed the "frontal fault" the "Seattle fault."

The Seattle fault zone also includes north-dipping reverse or thrust faults, such as the Toe Jam Hill fault…which forms a complex scarp in densely forested terrain on Bainbridge Island. Slip on both south- and north-dipping faults within the zone probably is associated with offset on a south-dipping "master fault" (e.g., Pratt and others, 1997 #4737) at depth.

- Southern Whidbey Island fault zone (Class A) No. 572:

This northwest-trending fault zone extends more than 65 km across Possession Sound, southern Whidbey Island, Admiralty Inlet into the eastern Strait of Juan de Fuca. The fault zone is as wide as 5-7 km, correlates with gravity and magnetic anomalies…and has been interpreted as a complex zone of transpressional deformation…

- Saddle Mountain faults (Class A) No. 575: The Saddle Mountain faults (east and west) are two of four faults described and discussed by…Wilson and others… In a later report, Wilson (1983 #5822) also discussed possible relationships of these faults and earthquakes in the Puget Sound region.

These two northeast-striking faults are present along the southeast flank of the Olympic Mountains and they show evidence for two or more faulting events during the late. Detailed study of the Saddle Mountain faults, which included trenching and isotopic dating, indicates that latest movement along the Saddle Mountain faults is Holocene in age.

Recently acquired lidar topography suggests that scarps related to the Saddle Mountains faults cut across Holocene alluvium and continue about 10 km southwest of the mapped traces of these. The northwest-striking Dow Mountain fault intersects the eastern Saddle Mountain fault and shows evidence for late Quaternary offset. The Dow Mountain fault, however, has a short mapped trace, less than 1 km in length, and is not shown herein for scale reasons.

- Tacoma fault (Class A) No. 581: Prominent geophysical anomalies extend west-northwest across the south-central Puget Lowland from the Tacoma region to Hood.

Local and regional experts are in agreement that the western, east-trending part of the geophysical anomalies are caused by the Tacoma fault, but no consensus exists for the eastern part. We anticipate that ongoing investigations will clarify present uncertainties in the location and geometry of the eastern portion and eastern end of the fault.

Brocher and others (2001 #4718) and Johnson and others (2004 #6235) suggest that the Tacoma fault is a backthrust to the south-dipping Seattle fault [570], and suggest that structural relief increases westward along the Tacoma fault.

Coastal marsh uplift north of the Tacoma fault at Lynch Cove and Burley, and coastal marsh subsidence south of the Tacoma fault at Wollochet Bay, are consistent with a minimum of 2-3 m of up-to-the-north slip along the western part of the Tacoma fault about 1,000 yr ago.

Seismic source characterization

The first step in seismic hazard identification involves answering three questions:

- Where do earthquakes occur?
- How often to earthquakes occur?
- How big can we expect these earthquakes to be?

More than ninety percent of all Pacific Northwest earthquakes occur along the crustal plate boundary between the Juan de Fuca plate and the North American plate. Seismicity catalogs are the fundamental tool used to determine where, how often, and how big earthquakes are likely to be. However, because of the short time (from a geological perspective) that written records have been kept, and the relative infrequency (from a human perspective) of such events, seismicity statistics are necessarily based on historically short catalogs. Therefore, other kinds of data are needed to answer the "where, how often, how big" questions.

The results from examining the historical record, monitoring seismic and geodetic changes, and study of the geologic record are combined to characterize seismic sources. This data is used to identify seismic source zones – the regions of the earth's crust where earthquakes occur. Although there are large uncertainties associated with source characterization (scientists have not yet been able to place instruments in the crust at the depths where earthquakes are generated), the Pacific Northwest has been studied extensively in recent years and some valuable new insights have been developed as a result of this attention. It is now generally agreed that three source zones exist for Puget Sound earthquakes: a *shallow (crustal) zone*; a *deep or intraplate ("Benioff") zone*; and *the Cascadia Subduction Zone*.

Shallow (Crustal Fault) Zone

Crustal fault earthquakes are the most common earthquakes and occur at relatively shallow depths of 6 to 12 miles below the surface.[15] While most crustal fault earthquakes are smaller than magnitude 4 and generally cause little or no damage, they can produce earthquakes of magnitudes up to 7, which cause extensive damage.

Shallow earthquakes of magnitude up to 7.0 or greater can happen anywhere in the Puget Sound region. Such earthquakes have the potential to cause greater loss of life and property in King and Snohomish Counties than any other kind of disaster. Fortunately, great crustal quakes do not seem to happen very often – perhaps no more than once every 1,000 years. In addition to the 1872 North Cascades earthquake, seismologists have found evidence that a devastating crustal quake occurred on a fault near Seattle approximately 1,100 years ago.

Several known major fault zones cross Whidbey Island and run east to southeast. Seismologists have recently identified a near-surface fault zone near Darrington. This fault, the Darrington Seismic Zone - Devil's Mountain Fault - North Whidbey Fault complex, is estimated to be capable of generating at least a 6.0 to 7.0 earthquake. The Duvall Fault, near Lake Margaret on the King-Snohomish boarder, has produced two 5.3 quakes in the last 70 years (1932 and 1996).

Crustal earthquakes are the least predictable of Puget Sound's seismic threats and are the most likely to be followed by significant aftershocks. Following a 7.0 crustal quake, one of the greatest dangers to human life is that buildings or other structures damaged in the initial shock, but still in use and believed to be safe, could collapse in a strong aftershock.

Deep or Intraplate Zone

Occurring at depths from 25 to 40 miles below the earth's surface in the subducting oceanic crust, deep intraplate earthquakes can reach up to magnitude 7.5.[16] The Nisqually earthquake on February 28, 2001, was a deep intraplate earthquake. It produced a rolling motion that was felt from Vancouver, British Columbia, to Coos Bay, Oregon, and east to Salt Lake City, Utah. As a result of this quake, there were more than 400 reported injuries (a dozen of them serious), and one fatal, trauma-induced heart attack.[17] A 1965 magnitude 6.5 intraplate earthquake centered south of Seattle-Tacoma International Airport caused seven deaths.[18]

Strong shaking during the Olympia earthquake lasted about 20 seconds. For the Nisqually quake, duration of shaking in Snohomish County varied from about 30 seconds to "more than 2 minutes" up-river from Sultan. Since 1870, there have been seven deep earthquakes in the Puget Sound basin with measured or estimated magnitudes of 6.0 or larger. The epicenters of all these events have been located within about 80 kilometers of each other between Olympia and just north of Tacoma. Scientists estimate the recurrence interval for this type of earthquake to be 30 to 40 years for magnitude 6.5, and 50 to 70 years for magnitude 7.0. Because of their depth, intraplate earthquakes are least likely to produce significant aftershocks.

Cascadia Subduction Zone

The world's greatest earthquakes are observed at subduction zone boundaries. These 8.0 to 9.5 thrust-type subduction quakes occur from time to time as two converging plates slide over each other.

The Pacific Northwest is located at a convergent plate boundary, where the Juan de Fuca and North American tectonic plates meet.

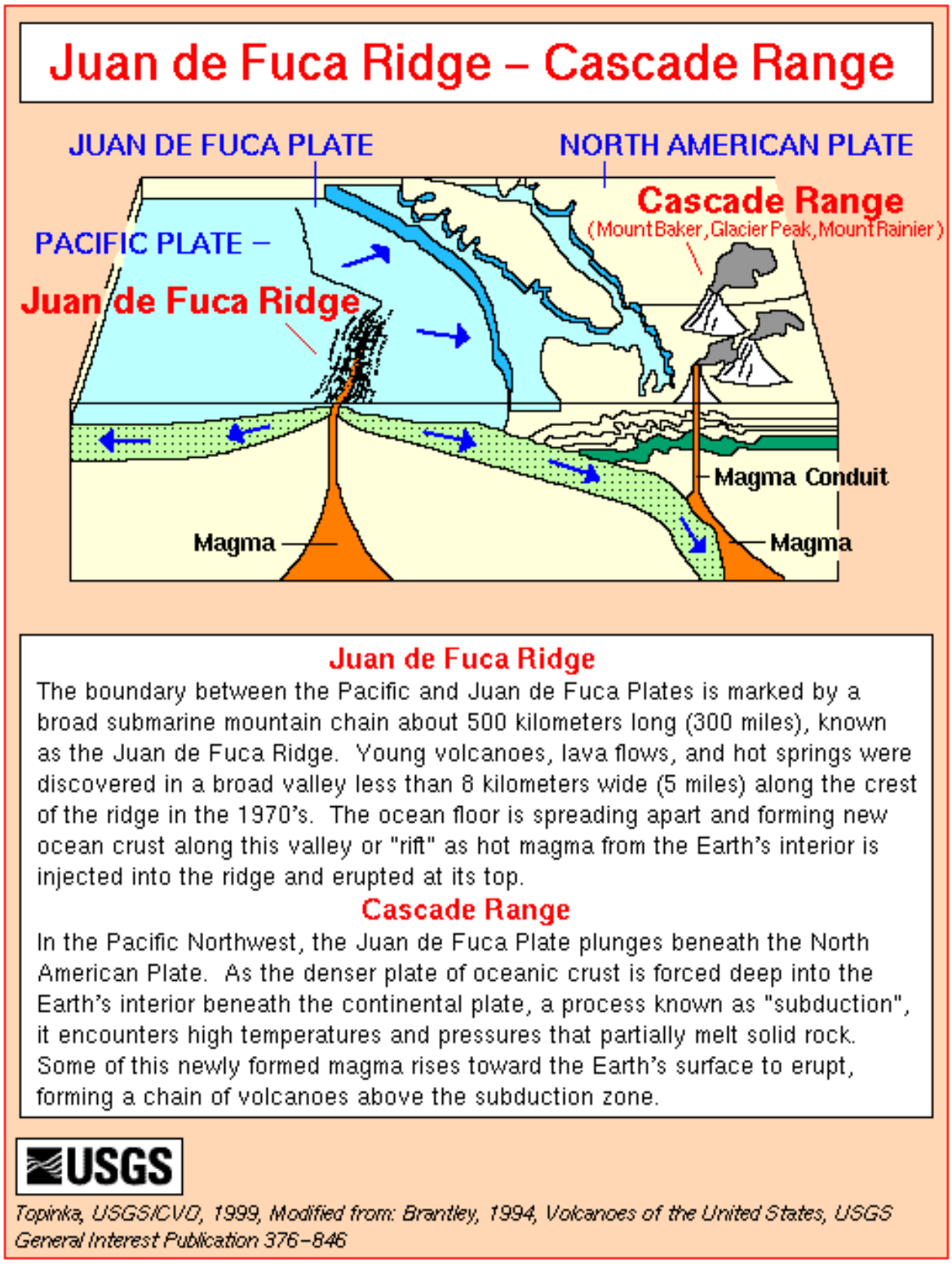
The two plates are converging at a rate of about 3 to 4 centimeters per year.[19] This boundary is called the Cascadia Subduction Zone. It extends from British Columbia to northern California. Subduction zone earthquakes are caused by the abrupt release of slowly accumulated stress.[20]

While there are no reports of such earthquakes in the Cascadia Subjection Zone off the Washington-Oregon coast since the first written records of permanent occupation by Europeans in 1833, paleoseismic evidence suggests that there may have been as many as five of these devastating energy releases in the past 2,000 years, with a very irregular recurrence interval of 150 to 1,100 years. Written tsunami records from Japan, correlated with studies of partially-submerged forests in coastal Washington and Oregon, give a probable date for the most recent of these huge quakes as January 26, 1700.

In addition, subduction zones similar to the Cascadia Subduction Zone have produced earthquakes with magnitudes of 8 or larger. Historic subduction zone earthquakes include the 1960 Chile (magnitude 9.5) and the 1964 southern Alaska (magnitude 9.2) earthquakes.[21]

The following diagram, provided by the United States Geological Survey, shows the two subduction zones in the Pacific Northwest.

Figure 3: Puget Sound Subduction Zones [22]



History of Major Earthquakes

As discussed in previous sections, Washington State has earthquakes on a regular basis, averaging about two per day. The north King and south Snohomish County region frequently feels the shocks and aftershocks of significant quakes and may suffer considerable damages.

Table 3: Washington State Significant Earthquakes.[23]

Washington State Significant Earthquakes					
Date	**Time (PST)**	**Latitude Longitude**	**Depth (Km)**	**Mag**	**Location**
December 14, 1872	2140	48°48' 121°24'	shallow	7.4	North Cascades
December 12, 1880	2040	47°30' 122°30'		5.5	Puget Sound
April 30, 1882	2248	47°00' 123°00'	deep	6.0	Olympia area
November 29, 1891	1521	48°00' 123°30'		5.0	Puget Sound
January 3, 1896	2215	48°30' 122°48'		5.7	Puget Sound
March 16, 1904	2020	47°48' 123°00'		5.3	Olympics eastside
January 11, 1909	1549	48°42' 122°48'	deep	6.0	Puget Sound
August 18, 1915	0605	48°30' 121°24'		5.6	North Cascades
January 23, 1920	2309	48°36' 123°00'		5.5	Puget Sound
July 17, 1932	2201	47°45' 121°50'	shallow	5.2	Central Cascades
November 12, 1939	2346	47°24' 122°36'	deep	5.7	Puget Sound
April 29, 1945	1216	47°24' 121°42'		5.5	Central Cascades
February 14, 1946	1914	47°18' 122°54'	40	6.3	Puget Sound
April 13, 1949	1155	47°06' 122°42'	54	7.1	Puget Sound
August 5, 1959	1944	47°48' 120°00'	35		Northwest Cascades
April 29, 1965	0728	47°24' 122°24	63	6.5	Puget Sound
April 13, 1990	2133	48°51' 122°36'	5	5.0	Deming
January 28, 1995	1911	47°23' 122°21'	16	5.0	17.6 km NNE of Tacoma
May 2, 1996	2104	47°46' 121°57'	7	5.3	10.2 km ENE of Duvall
June 23, 1997	1113	47°36' 122°34'	7.4	4.9	5.5 km NE of Bremerton
July 2, 1999	1743	47°05' 123°28'	41	5.1	8.2 km N of Satsop
February 28, 2001	1054	47° 09' 122° 43'	52.4	6.8	17.6 km NE of Olympia

As previously mentioned, the most recent significant earthquake, the Nisqually earthquake, occurred on February 28, 2001. It was a deep, 6.8 magnitude earthquake located 17.6 kilometers northeast of Olympia in the Puget Sound area. One person died of a heart attack, over 400 people were injured, and damages were upward of $1 billion as a result of the earthquake.[24]

Immediately following the Nisqually quake, six counties, including King and Snohomish Counties, were declared a disaster area. By the time FEMA completed the damages tally, a total of thirteen counties were eligible for disaster relief funds, and all counties in Washington State were approved for disaster mitigation funds.

To put the threat of a major earthquake event into perspective, research conducted in 1999 suggests that the Cascadia Subduction Zone is capable of producing earthquakes exceeding magnitude 9.0 on the Richter scale. Potential losses in the Cascadia region alone could exceed $12 billion, with over 30,000 destroyed buildings, and 8,000 lives lost in the event of a magnitude 8.5 Cascadia Subduction Zone earthquake.[25]

In the last ten years, since the Oregon Department of Geology and Mineral Industries (DOGAMI) pushed the report, populations and building density have increased, building values have gone up, and the threat of earthquake has not diminished. The reality is that the potential for significant damage has increased with time.

Hazard Assessment and Risk Analysis

Hazard Identification

Ground shaking, landslides, liquefaction, and amplification are the specific hazards associated with earthquakes. The severity of these hazards depends on several factors, including soil and slope conditions, proximity to the fault, earthquake magnitude, and the type of earthquake.

Ground Shaking

Ground shaking is the motion felt on the earth's surface caused by seismic waves generated by the earthquake. It is the primary cause of earthquake damage. The strength of ground shaking depends on the magnitude of the earthquake, the type of fault, and the distance from the epicenter (where the earthquake originates). Buildings on poorly consolidated and thick soils will typically see more damage than buildings on consolidated soils and bedrock.

Earthquake-Induced Landslides

Earthquake-induced landslides are secondary earthquake hazards that occur from ground shaking. They can destroy the roads, buildings, utilities, and other critical facilities necessary to respond to, and recover from, an earthquake. Many communities in Washington have a high likelihood of encountering such risks, especially in areas with steep slopes.[26]

Liquefaction

Liquefaction is a process by which sediments below the water table temporarily lose strength and behave as a viscous liquid rather than a solid. The types of sediments most susceptible are clay-free deposits of sand and silts; occasionally, gravel liquefies. The actions in the soil which produce liquefaction are as follows: seismic waves, primarily shear waves, passing through saturated granular layers, distort the granular structure, and cause loosely packed groups of particles to collapse. These collapses increase the pore-water pressure between the grains if drainage cannot occur. If the pore-water pressure rises to a level approaching the weight of the overlying soil, the granular layer temporarily behaves as a viscous liquid rather than a solid. Liquefaction has occurred.

In the liquefied condition, soil may deform with little shear resistance; deformations large enough to cause damage to buildings and other structures are called ground failures. The ease with which a soil can be liquefied depends primarily on the looseness of the soil, the amount of cementing or clay between particles, and the amount of drainage restriction. The amount of soil deformation following liquefaction depends on the looseness of the material, the depth, thickness, and areal extent of the liquefied layer, the ground slope, and the distribution of loads applied by buildings and other structures.[27]

Amplification

Soils and soft sedimentary rocks near the earth's surface can modify ground shaking caused by earthquakes. One of these modifications is amplification. Amplification increases the magnitude of the seismic waves generated by the earthquake. The amount of amplification is influenced by the thickness of geologic materials and their physical properties. Buildings and structures built on soft and unconsolidated soils can face greater risk.[28] Amplification can also occur in areas with deep sediment-filled basins and on ridge tops.

Vulnerability Assessment

Earthquake damage occurs because humans have built structures that cannot withstand severe shaking. Buildings, airports, schools, ferry

terminals, and lifelines (highways and utilities lines) suffer damage in earthquakes and can cause death or injury to humans.

The welfare of homes, major businesses, and public infrastructure is very important for purposes of safety, social and economic wellbeing, response, and recovery. Addressing the reliability of buildings, critical facilities, and infrastructure, and understanding the potential costs to government, businesses, and individuals as a result of earthquake, are challenges faced by the region.

Buildings

The built environment is susceptible to damage from earthquakes. Buildings that collapse can trap and bury people. Lives are at risk and the cost of cleaning up the damages is great. In the north King and south Snohomish Counties area, many buildings were built before 1993 when building codes were not as strict. In addition, retrofitting is not required except under certain conditions and can be expensive. Therefore, the number of buildings at risk remains high.

In any effort dealing with losses from natural hazards, the existing inventory of man-made structures and lifeline infrastructure must be established. Most of the participating cities are developing building inventory datasets using individual GIS systems. In the future, the building inventory will include tax lot data and be used to conduct risk assessment analyses for each city. It will take several years for the cities working on these projects to complete their inventories, and this will continue to be an ongoing concern.

Infrastructure and Communication

Residents in north King and south Snohomish Counties commute frequently by automobiles and public transportation such as buses. An earthquake can greatly damage bridges and roads, hampering the movement of people and goods. Damaged infrastructure strongly affects the economy of the community by disconnecting people from work, school, food, and leisure, and separates business from their customers and suppliers.

Bridge Damage

Even modern bridges can sustain damage during earthquakes, leaving them unsafe for use. Some bridges have failed completely due to strong ground motion. Bridges may be closed after an earthquake until they can be inspected and deemed safe by structural engineers.

Bridges are a vital transportation link – with even minor damages making some areas inaccessible. Because bridges vary in size, materials, siting, and design, any given earthquake will affect them

differently. Bridges built before the mid-1970's have a significantly higher risk of suffering structural damage during a moderate to large earthquake compared with those built after 1980 when design improvements were made.

Much of the interstate highway system was built in the mid- to late-1960's. The bridges in the north King and south Snohomish Counties area are state, city, or privately owned. A state-designated inspector must inspect all state, county, and city bridges every two years, and the inspections are rigorous, looking at everything from seismic capability to erosion and scour. However, private bridges are not inspected and damage and vulnerabilities may not be recognized after an earthquake.

One year after the Nisqually earthquake, Washington State Department of Transportation had identified $16.5 million of necessary transportation-related repairs statewide. In the five-county region that makes up the Northwest Region of WSDOT (King, Snohomish, Skagit, Whatcom and Island), the approximate cost of repairing damage was just over $6 million. Over 1,200 signals, 400 bridges and dozens of facilities were inspected within 24 hours of the quake. The cost of the initial and ongoing inspections totaled close to $300,000, the majority of which was paid for by federal Emergency Relief (ER) Funds. Some of the damage was minimal and maintenance crews completed repairs fairly quickly after the quake.[29]

Damage to Lifelines

Lifelines are the connections between communities and outside services. They include water and gas lines, transportation systems, electricity, and communications networks. Ground shaking and amplification can cause pipes to break open, power lines to fall, roads and railways to crack or move, and radio and telephone communication to cease. Disruption to transportation makes it especially difficult to bring in supplies or services. Lifelines need to be useable after an earthquake to allow for rescue, recovery, and rebuilding efforts and to relay important information to the public.

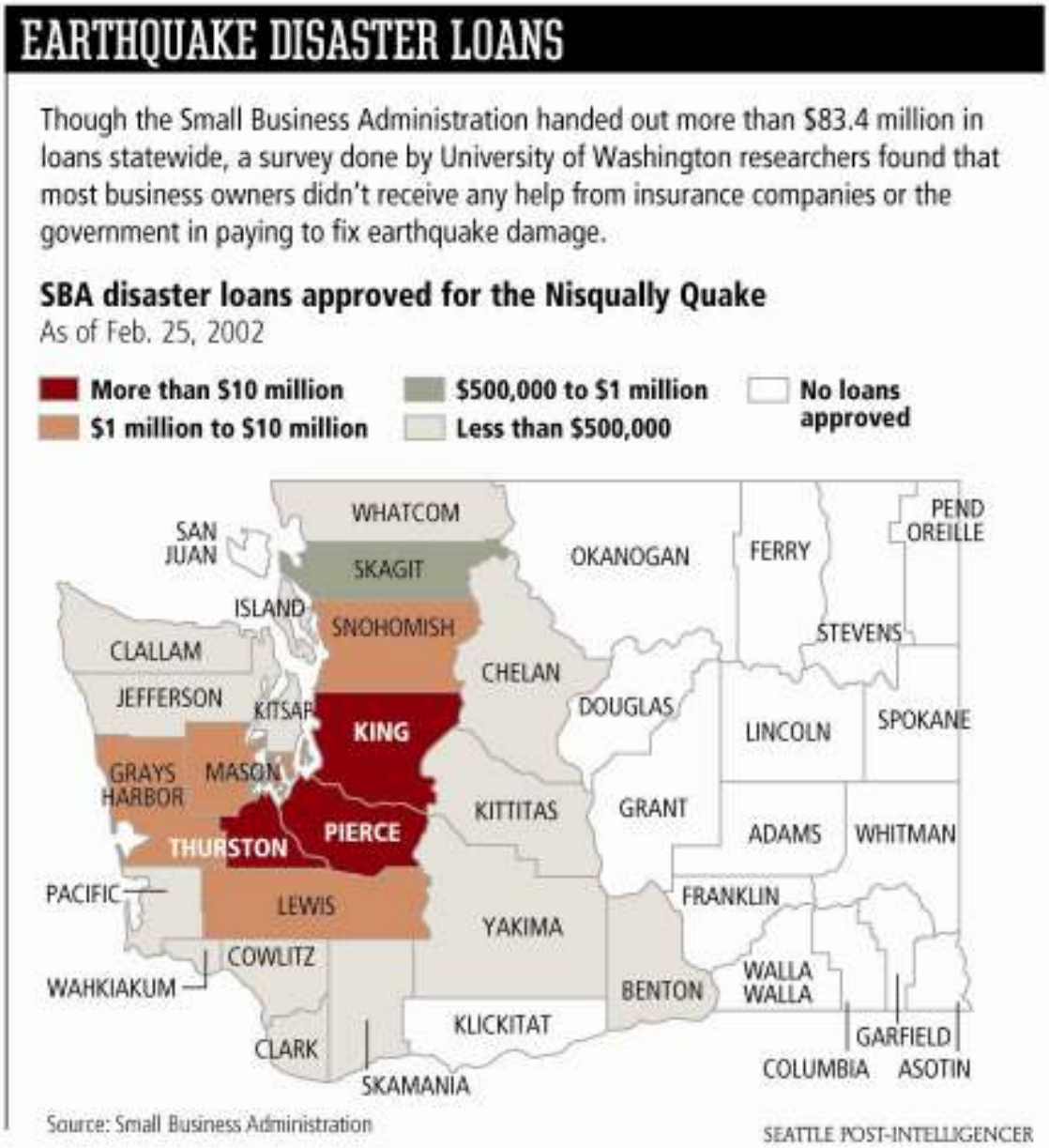
Disruption of Critical Services

Critical facilities include police stations, fire stations, hospitals, shelters, and other facilities that provide important services to the community. These facilities and their services need to be functional after an earthquake event. Many critical facilities are housed in older buildings that are not up to current seismic codes.

Businesses

Seismic activity can cause great loss to businesses; both large-scale corporations and small retail shops. When a company is forced to stop production for just a day, the economic loss can be tremendous, especially when its market is at a national or global level. Seismic activity can create economic loss that presents a burden to large and small shop owners who may have difficulty recovering from their losses.

Figure 4: Earthquake Disaster Loans. [30]



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Death and Injury

Death and injury can occur both inside and outside of buildings due to collapse, falling equipment, furniture, debris, and structural materials. Downed power lines and broken water and gas lines can also endanger human life.

Fire

Downed power lines or broken gas mains can trigger fires. When fire stations suffer building or lifeline damage, quick response to extinguish fires is less likely.

Debris

After damage to a variety of structures, much time is spent cleaning up brick, glass, wood, steel, or concrete building elements, office and home contents, and other materials. Developing strong debris management strategies can assist in post-disaster recovery.

Risk Analysis

Risk analysis involves estimating the damage and costs likely to be experienced in a geographic area over a period of time.[31] Factors included in assessing earthquake risk include population and property distribution in the hazard area, the frequency of earthquake events, landslide susceptibility, buildings, infrastructure, and disaster preparedness of the region. This type of analysis can generate estimates of the damages to the area due to an earthquake event in a specific location.

FEMA's software program, HAZUS, uses mathematical formulas and information about building stock, local geology, the location and size of potential earthquakes, economic data, and other information to estimate losses from a potential earthquake.

At this time, the participating cities are not using HAZUS due to both financial and personnel constraints. The larger cities may be able to consider the use of HAZUS in the future as they continue building data in GIS systems.

Earthquake Mitigation

Existing Mitigation Activities

Mitigation activities include existing programs and activities that are being implemented by county, regional, state, or federal agencies or organizations. These include:

City Codes

Implementation of earthquake mitigation policy often takes place at the local government level. Each city is responsible for adopting and enforcing zoning and building codes pertaining to earthquake hazards, usually by adopting the State's standard by reference. Generally, these codes seek to discourage development in areas that could be prone to natural disasters such as flooding, landslide, wildfire, and/or seismic hazards. This minimizes threats to life and property. Developers wishing to build in potential hazard-prone areas are required to retain a professional engineer to evaluate the level of risk onsite and to recommend mitigation measures.

In 2004, Washington State adopted, by reference in statute, the International Building Code (IBC). The State Building Code Council (SBCC) updates the editions. The IBC uses site-specific designations for seismic design factors, a change from the numeric seismic zones in the UBC, resulting in a more accurate design guide for earthquake resistant construction.[32]

The participating cities adopted the IBC to coincide with the State's effective date. This maintains consistency with the State and within the region.

Businesses/Private Sector

Natural hazards have a devastating impact on businesses. In fact, of all businesses which close following a disaster, more than 43% never reopen, and an additional 29% close for good within the next two years.[33] The Institute of Business and Home Safety has developed "Open for Business", a disaster planning toolkit to help guide businesses in preparing for and dealing with the adverse affects of natural hazards. The kit integrates protection from natural disasters into the company's risk reduction measures to safeguard employees, customers, and the investment itself. The guide helps businesses secure human and physical resources during disasters, and helps to develop strategies to maintain business continuity before, during, and after a disaster occurs.

Legislation

WAC Title 51-04: Department of Community, Trade and Economic Development (Building Code Council)

The building Code Council adopts and maintains the state building code. The primary objective of the council is to encourage consistency in the building code throughout the state of Washington and to maintain the building code consistent with the state's interest as provided in RCW 19.27.020.

Earthquake Education

The Pacific Northwest Seismograph Network (PNSN) is centered at the University of Washington's Department of Earth and Space Sciences. The PNSN is operated jointly by the University of Washington, the University of Oregon, and Oregon State University. It is funded by the U.S. Geological Survey, U.S. Department of Energy, and the State of Washington. PNSN data help scientists understand Pacific Northwest earthquake hazards, predict volcanic eruptions at Mount St. Helens, and determine the location of faults and volcanic magma chambers.

PNSN computers automatically determine earthquake locations and magnitudes, and rapidly provide essential information. The Rapid Alert for Cascadia Earthquakes (RACE) system broadcasts earthquake location, magnitude, and shaking estimates within minutes to sites throughout the region via pagers attached to PC mapping packages. The earthquake alert information is also available immediately on the PNSN WEB pages: **http://www.ess.washington.edu/SEIS/PNSN/**

Individual Preparedness

Because the potential for earthquake occurrences and earthquake-related property damage is relatively high, increasing individual preparedness is a significant need. Strapping down heavy furniture, waterheaters, and expensive personal property, as well as being earthquake insured, and anchoring buildings to foundations are just a few steps individuals can take to prepare for an earthquake.

Earthquake Resource Directory

The following resource directory lists the resources and programs that can assist county communities and organizations. The resource directory will provide contact information for local, county, regional, state and federal programs that deal with natural hazards.

Federal Resources

US Geological Survey (USGS)

The USGS is an active seismic research organization that also provides funding for research. (For an example of such research, see the seismic publications at the end of the Earthquake Resource section.)

Contact: USGS, National Earthquake Information Center
Address: Box 25046; DFC, MS 967; Denver, CO 80225
Phone: (303) 273-8500
Fax: (303) 273-8450
Website: http://neic.usgs.gov
Website: http://usgs.gov

Building Seismic Safety Council (BSSC)

The Building Seismic Safety Council (BSSC) established by the National Institute of Building Sciences (NIBS), deals with complex regulatory, technical, social, and economic issues and develops and promotes building earthquake risk mitigation regulatory provisions for the nation.

Address: 1090 Vermont Avenue, NW, Suite 700, Washington, DC 20005
Phone: (202) 289-7800
Fax: (202) 289-109
Website: http://www.bssconline.org/

Natural Resource Conservation Service (NRCS)

The NRCS produces soil surveys. These may be useful to local governments who are assessing areas with potential development limitations including steep slopes and soil types. They operate many programs dealing with the protection of natural resources.

Contact: National Resources Conservation Service – Renton Service Center (King County)
Address: 935 Powell Ave SW, Ste C; Renton, WA 98055-2992
Phone: (206)764-3325, ext 3
Fax: (206)764-6677
Website: http://www.nrcs.usda.gov

Contact: National Resources Conservation Service – Lake Stevens Service Center (Snohomish County)
Address: 528 91st Ave NE, Ste C; Lake Stevens, WA 98258
Phone: (425)334-2828
Fax: (425)335-5024
Website: http://www.nrcs.usda.gov

Federal Emergency Management Agency (FEMA)

FEMA's mission is to reduce loss of life and property and protect the nation's critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management program of mitigation, preparedness, response and recovery. FEMA Region X serves the northwestern states of Alaska, Idaho, Oregon, and Washington.

Contact: FEMA, Federal Regional Center, Region 10
Address: 228th St. SW, Bothell, WA 98021-9796
Phone: (425) 487-4678
Website: http://www.fema.gov

To obtain FEMA publications:
Phone: (800) 480-2520

Regional Resources

Cascadia Region Earthquake Workgroup (CREW)

The Cascadia Region Earthquake Workgroup provides information on regional earthquake hazards, facts, and mitigation strategies for homes and businesses. CREW is a non-profit coalition of private and public representatives working together to improve the ability of Cascadia Region communities to reduce the effects of earthquake events. Members are from Oregon, Washington, California, and British Columbia. CREW's goals are to:

- Promote efforts to reduce the loss of life and property;
- Conduct education efforts to motivate key decision makers to reduce risks associated with earthquakes; and
- Foster productive linkages between scientists, critical infrastructure providers, businesses, and governmental agencies in order to improve the viability of communities after an earthquake event.

Contact: CREW, Executive Director Bob Freitagg
Address:3110 Portage Bay Pl E, Slip G, Seattle, WA 98102
Phone: (206) 328-2533
Fax: (206) 328-2533 call first
Website: http://www.crew.org

Western States Seismic Policy Council Earthquake Program Information Center (WSSPC)

WSSPC is a regional earthquake consortium primarily funded by FEMA. Its website is a great earthquake resource, with information clearly categorized - from policy to engineering to education.

Contact: Western States Seismic Policy Council
Address: 125 California Avenue, Suite D201, #1, Palo Alto, CA 94306
Phone: (650) 330-1101
Fax: (650) 326-1769
E-mail: wsspc@wsspc.org
Website: http://www.wsspc.org/home.html

Earthquake Engineering Research Institute

The Earthquake Engineering Research Institute (EERI) is a national, nonprofit, technical society of engineers, geoscientists, architects, planners, public officials, and social scientists. EERI members include researchers, practicing professionals, educators, government officials, and building code regulators.

The organization's objective is to reduce earthquake risk by advancing the science and practice of earthquake engineering, by improving understanding of the impact of earthquakes on the physical, social, economic, political and cultural environment, and by advocating comprehensive and realistic measures for reducing the harmful effects of earthquakes.

Contact: 499 14th Street, Suite 320, Oakland, California 94612-1902
Phone: (510) 451-0905
Fax: (510) 451-5411
Website: http://www.eeri.org/

State Resources

Pacific Northwest Seismograph Network (PNSN)

Regional earthquake research

Contact: University of Washington, Dept. of Earth and Space Sciences
Address: Box 351310; Seattle, WA, 98195-1310
Phone: (206) 543-7010
Email: (seis_info@ess.washington.edu)
Website: http://www.pnsn.org

University of Washington, Earth & Space Sciences

The University of Washington conducts research and prepares inventories and reports for communities throughout Washington relating to earthquakes, landslides, and tsunamis. The department uses a multi-disciplinary approach to provide a basis for making accurate predictions of future conditions.

Contact: University of Washington, Earth & Space Sciences
Physical Address: Johnson Hall, Room 070; Seattle, WA 98195
Mailing Address: Box 351310; Seattle, WA 98195
Phone: (206)543-1190
Website: http://www.geophys.washington.edu

Publications and Additional Resources

Public Assistance Debris Management Guide, Federal Emergency Management Agency (July 2000).

The *Debris Management Guide* was developed to assist local officials in planning, mobilizing, organizing, and controlling large-scale debris clearance, removal, and disposal operations. Debris management is generally associated with post-disaster recovery. While it should be compliant with local and county emergency operations plans, developing strategies to ensure strong debris management is a way to integrate debris management within mitigation activities. The Public Assistance Debris Management Guide is available in hard copy or on the FEMA website.

Contact: FEMA Distribution Center
Address: 130 228th Street, SW, Bothell, WA 98021-9796
Phone: (800) 480-2520
Fax: (425) 487-4622
Website: http://www.fema.gov

Washington State Hazard Identification and Vulnerability Assessment (HIVA)

The *Washington State Hazard Identification and Vulnerability Assessment (HIVA)* assesses natural and technological (man-made) hazards in Washington State. Assessment is the initial step in the emergency management process that leads to mitigation against, preparedness for, response to, and recovery from hazards. Hazards have the potential of becoming disasters or emergencies that can adversely affect the people, environment, economy, and property of the state.

Contact: Washington State Military Department, Emergency Management Division
Address: Plans Section, Camp Murray, Washington 98430-5122.
Phone: (800)562-6108
Website: http://emd.wa.gov

Washington State Hazard Mitigation Strategy

Contact: Washington State Military Department, Emergency Management Division
Address: Plans Section, Camp Murray, Washington 98430-5122.
Phone: (800)562-6108
Website: http://emd.wa.gov

Washington State Comprehensive Emergency Management Plan

This document establishes emergency management functions and the responsibilities of the Washington State Military Department, Emergency Management Division (EMD), state agencies, commissions, boards, and councils.

Contact: Washington State Military Department, Emergency Management Division
Address: Plans Section, Camp Murray, Washington 98430-5122.
Phone: (800)562-6108
Website: http://emd.wa.gov

Washington State Earthquake Hazards,
Noson, Linda Lawrance, Anthony Qamar, and Gerald W. Thorson. Washington Division of Geology and Earth Resources. Information Circular 85 (1988).

Contact: Washington Division of Geology and Earth Resources
Address: PO Box 47007; Olympia, WA 98504-7007
Phone: (360) 902-1450
Website:
http://www.geophys.washington.edu/SEIS/PNSN/info_general/nqt/welcome.html

Land Use Planning for Earthquake Hazard Mitigation: A Handbook for Planners,
Wolfe, Myer R. et. al., (1986) University of Colorado, Institute of Behavioral Science, National Science Foundation. This handbook provides techniques that planners and others can utilize to help mitigate for seismic hazards. It provides information on the effects of earthquakes, sources on risk assessment, and effects of earthquakes on the built environment. The handbook also gives examples on application and implementation of planning techniques to be used by local communities.

Contact: Natural Hazards Research and Applications Information Center
Address: University of Colorado, 482 UCB, Boulder, CO 80309-0482
Phone: (303) 492-6818
Fax: (303) 492-2151
Website: http://www.colorado.edu/UCB/Research/IBS/hazards

Using Earthquake Hazard Maps: A Guide for Local Governments in the Portland Metropolitan Region; Evaluation of Earthquake Hazard Maps for the Portland Metropolitan Region Spangle Associates (1998/1999)
Urban Planning and Research, Portola Valley, California.
These two publications are useful for local governments concerned with land use in earthquake hazard areas. The proximity of Clackamas County to Portland and their interactive communities make these guides applicable to the county. The publications are written in clear and simplistic language and address issues such as how to apply earthquake hazard maps for land use decisions.

Contact: DOGAMI
Address: 800 NE Oregon St., Suite 965, Portland, Oregon 97232
Phone: (503) 731-4100
Fax: (503) 731-4066
Website: http://www.OregonGeology.com

King County HIVA
This document identifies natural and technological hazards in the King County region.

Contact: King County Emergency Management Division
Address: King County Airport/Boeing Field; 7300 Perimeter Road South, Rm 128; MS KCA-EM; Seattle, WA 98108-3848
Phone: (206)296-3829
Fax: (206)296-3838
Website: http://metrokc.gov/prepare/

Snohomish County HIVA

This document identifies natural and technological hazards in the Snohomish County region.

Contact: Snohomish County Department of Emergency Management
Address: 3509 109th Street SW; Everett, WA 98204
Phone: (425)423-7635
Fax: (425)423-9152
Website: http://www1.co.snohomish.wa.us/Departemts/Emergency_Management

Washington State Comprehensive Emergency Management Plan

This document establishes emergency management functions and the responsibilities of the Washington State Military Department, Emergency Management Division (EMD), state agencies, commissions, boards, and councils.

Contact: Washington State Military Department, Emergency Management Division
Address: Plans Section, Camp Murray, Washington 98430-5122.
Phone: (800)562-6108
Website: http://emd.wa.gov

Flood

Defining the Hazard

From 1956 to 1998 there have been 27 Presidential Major Disaster Declaration floods in Washington State. Since 1971, every Washington State county has received a Presidential Disaster Declaration for flooding. See the following table for a list of floods in Washington State.[34]

Table 4: Flood Occurrences, 1948- 1998

Date	Occurrence
May-June 1948	Snowmelt flooding broke lake and river records in Eastern Washington and along the Columbia River. Vancouver, Camas, Kalama, and Longview suffered flooding.
February 1956	Flooding occurred in Adams, Benton, and Franklin Counties. Federal Disaster Number 50 was assigned for the event.
March 1957	Flooding affected Douglas, Grant, and Lincoln Counties. Federal Disaster Number 70 was assigned for the event.
March 1963	Flooding occurred in the counties of Columbia, Garfield, Grant, Whitman, and Spokane. Federal Disaster Number 146 was assigned for the event.
December 1964	Flooding and heavy rains affected Asotin, Benton, Columbia, Cowlitz, Garfield, Grays Harbor, King, Kittitas, Klickitat, Lewis, Mason, Pacific, Pierce, Skamania, Snohomish, Wahkiakum, Walla Walla, Whitman, and Yakima Counties. Federal Disaster Number 185 was assigned for the event.
January 1971	Flooding, heavy rains, melting snow affected the counties of Columbia, Garfield, Grays Harbor, Lewis, Skagit, Whatcom, and Yakima. Federal Disaster Number 300 was assigned for the event.
January 1972	Flooding and severe storms affected Asotin, Cowlitz, Grays Harbor, Lewis, Skagit, Whatcom, and Yakima Counties. Federal Disaster Number 332 was assigned for the event.
February 1972	Flooding and heavy rains occurred in King, Pierce, and Thurston Counties. Federal Disaster Number 328 was assigned for the event.
May-June 1972	Snow melt in North Central Washington counties of Chelan, Douglas, and Okanogan, combined with heavy rains, produced major flooding on the Okanogan and Methow Rivers in Okanogan County and the Entiat River in Chelan County. All three rivers reached record stages. Federal Disaster Number 334 was assigned for the event.
January 1974	Flooding, severe storms, and snowmelt affected Asotin, Benton, Columbia, Ferry, Kitsap, Klickitat, Lewis, Mason, Pend Oreille, Stevens, Thurston, Whitman, and Yakima Counties. Federal Disaster Number 414 was assigned for the event.
December 1975	Heavy rain and high freezing levels caused major flooding on rivers in Benton, Cowlitz, Grays Harbor, King, Kittitas, Lewis, Mason, Pierce, Skagit, Snohomish, Thurston, Whatcom, and Yakima. The flooded rivers included the Cowlitz, Chehalis, Skykomish, Snoqualmie, Snohomish, Stillaguamish, Skagit, and Nooksack. Federal Disaster Number 492 was assigned for the event.
December 1977	Heavy rain, mild temperatures, and snow melt runoff caused major flooding on the Nisqually, Skykomish, Snoqualmie, and Snohomish Rivers. Affected counties included Benton, Clark, Cowlitz, Garfield, Grays Harbor, King, Kittitas, Klickitat, Lewis, Pacific, Pierce, Snohomish, Thurston, Wahkiakum, Whitman, and Yakima. Federal Disaster Number 545 was assigned for the event.
December 1979	Flooding, storms, mudslides, and high tides affected Clallam, Grays Harbor, Jefferson, King, Mason, Skagit, Snohomish, and Whatcom Counties. Federal Disaster Number 612 was assigned for the event.
December 1982	Flooding, severe storm, and high tide affected Whatcom County. Federal Disaster Number 676 was assigned for the event.
January 1986	Flooding and severe storms affected Clallam, Jefferson, and King Counties. Federal Disaster Number 757 was assigned for the event.
February 1986	Flooding, heavy rains, and mudslides occurred in Cowlitz County. Federal Disaster Number 762 was assigned for the event.

Date	Occurrence
November 1986	Heavy rain, mild temperatures, and snow melt runoff generated major floods on the Chehalis, Skookumchuck, Skykomish, Snoqualmie, and Snohomish Rivers. Less severe flooding occurred on the Satsop, Skokomish, Cedar, Stillaguamish, Skagit, and Nooksack Rivers. Flooding occurred in Cowlitz, King, Lewis, Pacific, Snohomish, and Wahkiakum Counties. Federal Disaster Number 784 was assigned for the event.
March 1989	Flooding and heavy rains affected Douglas, Okanogan, Stevens, and Whitman Counties. Federal Disaster Number 822 was assigned for the event.
January 1990	Flooding occurred on the Chehalis, Skookumchuck, and Deschutes Rivers as heavy rain and severe storms affected the counties of Benton, Grays Harbor, King, Lewis, Pierce, Thurston, and Wahkiakum. Federal Disaster Number 852 was assigned for the event.
November 1990	Floods and severe storms occurred in the counties of Chelan, Clallam, Grays Harbor, Island, Jefferson, King, Kitsap, Kittitas, Lewis, Mason, Pacific, Pierce, San Juan, Skagit, Snohomish, Thurston, Wahkiakum, Whatcom, and Yakima. Rivers with major flooding were the Skagit and Nooksack Rivers. The Thanksgiving weekend floods set record stages on the Naselle, Willapa, Hoh, Calawah, Dungeness, Skokomish, Cedar, Skykomish, Snoqualmie, Snohomish, Stillaguamish, Chiwawa, Wenatchee, Elwha, and Klickitat Rivers. Major floods occurred on the Skagit, Nooksack, and Yakima Rivers. During this event 2 people died and the Interstate 90 Lake Washington floating bridge sank. Federal Disaster Number 883 was assigned for the event.
December 1990	Floods, storms, and high winds affected the counties of Island, Jefferson, King, Kitsap, Lewis, Pierce, San Juan, Skagit, Snohomish, and Whatcom. Federal Disaster Number 896 was assigned for the event.
December 1994 - February 1995	Heavy rain, combined with high freezing levels and low level snow melt produced floods. The Skokomish River flooded repeatedly driving residents from their homes on four occasions. Mudslides in the area, caused traffic problems and damage to highways. Floods occurred on the Willapa, Naselle, Chehalis, Satsop, and Deschutes Rivers in December 1994. In February 1995, the Snoqualmie River reached its highest level since the November 1990 flood.
November – December 1995	Flooding and wind in the counties of Chelan, Clallam, Clark, Cowlitz, Grays Harbor, Island, Jefferson, King, Kittitas, Lewis, Mason, Pacific, Pierce, Skagit, Snohomish, Thurston, Wahkiakum, Whatcom, and Yakima. Federal Disaster Number 1079 was assigned for the event.
February 1996	Heavy rains caused flooding in the counties of Adams, Asotin, Benton, Clark, Columbia, Cowlitz, Garfield, Grays Harbor, King, Kitsap, Kittitas, Klickitat, Lewis, Lincoln, Pierce, Skagit, Skamania, Snohomish, Spokane, Thurston, Wahkiakum, Walla Walla, Whitman, and Yakima and the Yakima Indian Reservation. Snowfall beginning January 26, 1996, followed by heavy rain in February, mild temperatures, and mountain snow melt caused severe flooding throughout the entire northwest. Three people died in Washington. Mudslides occurred throughout Washington. Traffic flow both east and west, north and south along major highways were shut down for several days. Snow closed Interstate 90 at Snoqualmie Pass. Mudslides and flooding closed Interstate 5 in Lewis County. Record floods occurred on the Columbia, Snoqualmie, Cedar, Chehelis, Nisqually, Skookumchuck, Klickitat, Skokomish, Cowlitz, Yakima, Naches, Palouse, Walla Walla Rivers, and Latah Creek. Federal Disaster Number 1100 was assigned for the event.
December 1996 - January 1997	Rain, ice, and snow caused flooding. Federal disaster number 1159 was assigned for counties of Adams, Asotin, Benton, Chelan, Clallam, Clark, Columbia, Cowlitz, Douglas, Ferry, Franklin, Garfield, Grant, Grays Harbor, Island, Jefferson, King, Kitsap, Kittitas, Klickitat, Lewis, Lincoln, Mason, Okanogan, Pacific, Pend Oreille, Pierce, San Juan, Skagit, Skamania, Snohomish, Spokane, Stevens, Thurston, Walla Walla, Whatcom, and Yakima.
March 1997	Heavy rain and mountain snowmelt caused flooding in counties of Grays Harbor, Jefferson, King, Kitsap, Lincoln, Mason, Pacific, Pierce, Pend Oreille, and Stevens. Federal Disaster Number 1172 was assigned for event.
April 1997	Heavy rain and mountain snowmelt caused flooding in Pend Oreille County. Federal Disaster Number 1182 was assigned for event.

Date	Occurrence
May 1998	Heavy rain caused flooding in Ferry and Stevens Counties. Federal Disaster Number 1252 was assigned for the event.
November 2003	Severe storms and heavy rains caused flooding in Chelan, Clallam, Grays Harbor, Island, Jefferson, King, Kitsap, Mason, Okanogan, Pierce, San Juan, Skagit, Snohomish, Thurston and Whatcom counties.
January 27 - February 4, 2006	Washington State experienced severe storms, flooding, tidal surge, landslides and mudslides. Eleven counties receive Presidential Disaster Declaration: Clallam, Grays Harbor, Island, Jefferson, Kitsap, Mason, Pacific, Pend Oreille, San Juan, Snohomish and Wahkiakum. Other counties sustained damage but did not meet thresholds.
November 2-11, 2006	Severe storms, flooding, landslides and mudslides result in Presidential Declaration for Clark, Cowlitz, Grays Harbor, King, Lewis, Pierce, Skagit, Skamania, Snohomish, Thurston, and Wahkiakum counties.
December 14-15, 2006	Severe Winter Storm, Landslides, and Mudslides. Affected counties: Chelan, Clark, Clallam, Grant, Grays Harbor, Island, King, Klickitat, Lewis, Mason, Pacific, Pend Oreille, Pierce, San Juan, Skagit, Skamania, Snohomish, Thurston, and Wahkiakum.
December 1 - 17, 2007	Clallam, Grays Harbor, King, Kitsap, Lewis, Mason, Pacific, Snohomish, Thurston and Wahkiakum Counties experienced severe storms and flooding.
January 6-16, 2009	Severe winter storms caused flooding, mudslides and landslides in Benton, Clallam, Cowlitz, Grays Harbor, Kittitas, King, Lewis, Mason, Pacific, Pierce, Skagit, Snohomish, Thurston, Wahkiakum, and Whatcom Counties. Public Assistance levels top $17 million with the event still active as of June 2009.
December 12, 2008 to January 5, 2009	Severe Winter Storm and Record and Near Record Snow. Clallam, Clark, Columbia, Cowlitz, Ferry, Garfield, Grays Harbor, Island, Jefferson, King, Klickitat, Lewis, Lincoln, Mason, Pacific, Pend Oreille, Skagit, Skamania, Snohomish, Spokane, Stevens, Thurston, Wahkiakum, Walla Walla, Whatcom and Whitman counties receive Disaster Declarations. More than $13 million in disaster relief funds designated. Event still active as of June 2009.

A flood is the inundation of normally dry land resulting from the rising and overflow of a body of water. It is a natural geologic process that shapes the landscape, provides habitat, and creates rich agricultural lands. Human activities and settlements tend to occur on floodplains, frequently interfering with the natural processes and suffering inconvenience or catastrophe as a result. Human activities encroach upon floodplains, affecting the distribution and timing of drainage, and thereby increasing flood problems. The built environment creates localized flooding problems outside natural floodplains by altering or confining drainage channels. This increases flood potential in two ways: it reduces the stream's capacity to contain flows and increases flow rates downstream.

All the Pacific coastal counties, as well as some inland coastal counties and counties at the mouth of the Columbia River, are susceptible to wind and barometric tide floods. Much of the recent development in Washington State occurs in or near flood plains. This development increases the likelihood of flood damages in two ways:

New developments near a flood plain add structures and people in flood areas.
New construction alters surface water flows by diverting water to new courses or increases the amount of water that runs off impermeable pavement and

roof surfaces. This second effect diverts waters to places previously safe from flooding.

Flood plains, or areas at risk for flooding, make up approximately 7.5 percent of the state's total land area. These areas contain an estimated 100,000 households. All the homes and citizens that live in them are vulnerable to flood damage. Only about 22 percent of the homes in flood plains are insured against flood losses. Uninsured homeowners face greater financial liability than they realize. *During a typical 30-year mortgage period, a home in a mapped flood plain has about a 26 percent chance of being damaged by a 100-year flood event. The same structure only has about a one-percent chance of being damaged by fire.*

Most cities and counties in Washington participate in the National Flood Insurance Program and have developed local ordinances to better regulate and direct development in flood plain areas. These local ordinances regulate planning, construction, operation, maintenance, and improvements - private or public. Ordinances ensure that work is properly planned, constructed, operated, and maintained to avoid adversely influencing the regimen of a stream or body of water or the security of life, health, and property against damage by floodwater.

Flood Terminology

While people often think of flooding in relation to a large river overflowing its banks, in reality there are different types of flooding. The following definitions provide a rough description of concepts pertaining to flood.

Rising Flood

A risking flood occurs because of heavy, prolonged rain, melting snow, or both. This type of flood may have an impact on rural, suburban, and urban areas of King and Snohomish Counties.

Flash Flood

Flash floods are characterized by the quick rise and fall of flood levels.

Wind-Driven Flood Tides

This type of flood occurs when high winds and high tides occur at the same time, causing tide waters to flood coastal areas.

Floodplain

A floodplain is a land area adjacent to a river, stream, lake, estuary, or other body of water that is subject to flooding. This area, if left undisturbed, acts to store excess floodwater. The floodplain is made up of two sections: the floodway and the flood fringe.

100-Year Flood

The 100-year flooding event is the flood having a one percent chance of being equaled or exceeded in magnitude in any given year. Contrary to popular belief, it is not a flood occurring once every 100 years. The 100-year floodplain is the area adjoining a river, stream, or watercourse covered by water in the event of a 100-year flood.

100-year floodplain maps for each city are included in the Jurisdiction-Specific section of this document.

Floodway

The floodway is one of two main sections that make up the floodplain. Floodways are defined for regulatory purposes. Unlike floodplains, floodways do not reflect a recognizable geologic feature. For NFIP purposes, floodways are defined as the channel of a river or stream, and the overbank areas adjacent to the channel. The floodway carries the bulk of the floodwater downstream and is usually the area where water velocities and forces are the greatest. NFIP regulations require that the floodway be kept open and free from development or other structures that would obstruct or divert flood flows onto other properties. The NFIP floodway definition is "the channel of a river or other watercourse and adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot. Floodways are not mapped for all rivers and streams but are generally mapped in developed areas.

Flood Fringe

The flood fringe refers to the outer portions of the floodplain, beginning at the edge of the floodway and continuing outward. This is the area where development is most likely to occur, and where precautions to protect life and property need to be taken.

Development

For the purposes of this document, development is broadly defined to mean "any manmade change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations located within the area of special flood hazard." The definition of development for floodplain purposes is generally broader and includes more activities than the definition of development used in other sections of local land use ordinances.

Base Flood Elevation (BFE)

The term "Base Flood Elevation" refers to the elevation (normally measured in feet above sea level) that the base flood is expected to

reach. Base flood elevations can be set at levels other than the 100-year flood. Some communities choose to use higher frequency flood events as their base flood elevation for certain activities, while using lower frequency events for others. For example, for the purpose of storm water management, a 25-year flood event might serve as the base flood elevation, while the 500-year flood event may serve as base flood elevation for the tie down of mobile homes. The regulations of the NFIP focus on development in the 100-year floodplain. (See definition above.) The 100-year floodplain is the area adjoining a river, stream, or watercourse covered by water in the event of a 100-year flood.

Flood Risk Factors

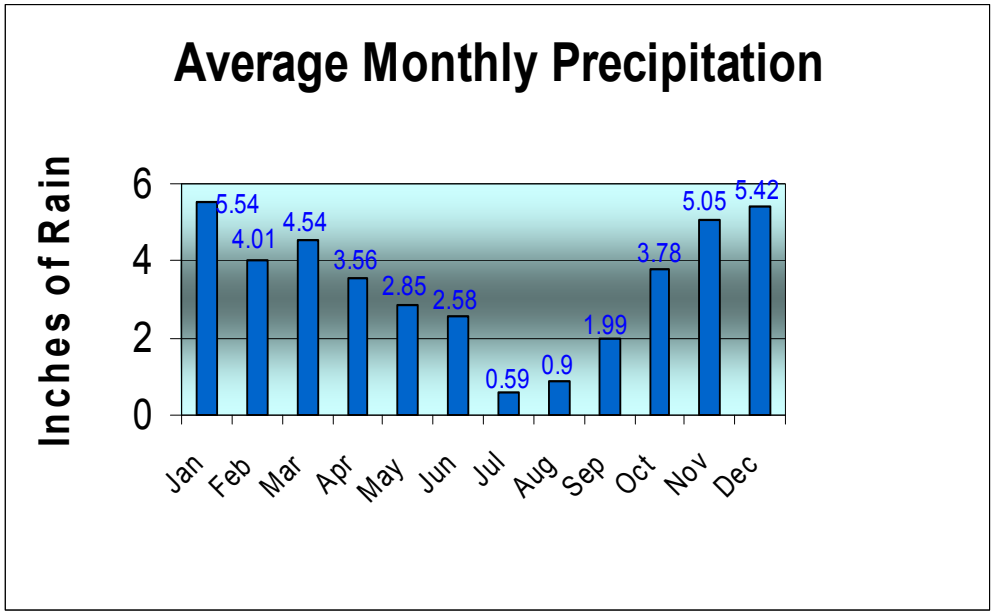
Flooding occurs when climate or weather patterns, geology, and hydrology combine to create conditions where water flows outside of its usual course. In north King and south Snohomish Counties, geography and climate combine to create occasional flooding conditions.

Precipitation

The north King and South Snohomish Counties area lies in the heart of the Puget Sound region. Marine air from the Pacific Ocean is a moderating influence on temperatures in the area and is responsible for generally mild winters and summers.

The amount of rainfall received is heavily affected by the geographic relationship of Puget Sound, the Olympic Peninsula, and the Cascade Mountain Range. As a result, the area receives an average rainfall of 40 inches per year. Approximately 65- to 75% of the rainfall occurs in the timeframe between November and March. The north King and south Snohomish Counties area lies in a convergence zone and may receive more precipitation than areas to the north and south.

Graph 2: Regional Precipitation Averages[35]



Geography and Geology

The north King and south Snohomish Counties area is geologically diverse. The region has a mix of gentle or rolling hills, broad terraces, floodplains, wetlands, ravines, and steep slopes. The area has multiple creeks, streams, and lakes; and two jurisdictions have Puget Sound shoreline. There are also seven drainage basins within the region.

Characteristics of Flooding

Four types of flooding have the potential to affect the north King and south Snohomish Counties region: urban flooding, riverine flooding, dam failure flooding, and flood tides. In addition, any low-lying area has the potential to flood. The flooding of developed areas may occur when the amount of water generated from rainfall and runoff exceeds a storm water system's (ditch or sewer) capability to remove it.

Urban Flooding

As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Urbanization of a watershed changes the hydrologic systems of the basin. Heavy rainfall collects and flows faster on impervious concrete and asphalt surfaces. The water moves from the clouds, to the ground, and into streams at a much faster rate in urban areas. Adding these elements to the hydrological systems can result in floodwaters that rise very rapidly and peak with violent force.

By definition, the ten cities participating in this plan are incorporated. In addition, Edmonds Community College, Edmonds School District and the Port of Edmonds fall within incorporated areas.

While about 25% of Olympic View Water District is in unincorporated county, the area is, for the most part, made up of developed lots. This results in a high concentration of impermeable surfaces that either collect water, or concentrate the flow of water in unnatural channels. During periods of urban flooding, streets can become swift moving rivers and basements can fill with water. Storm drains often back up with vegetative debris causing additional, localized flooding.

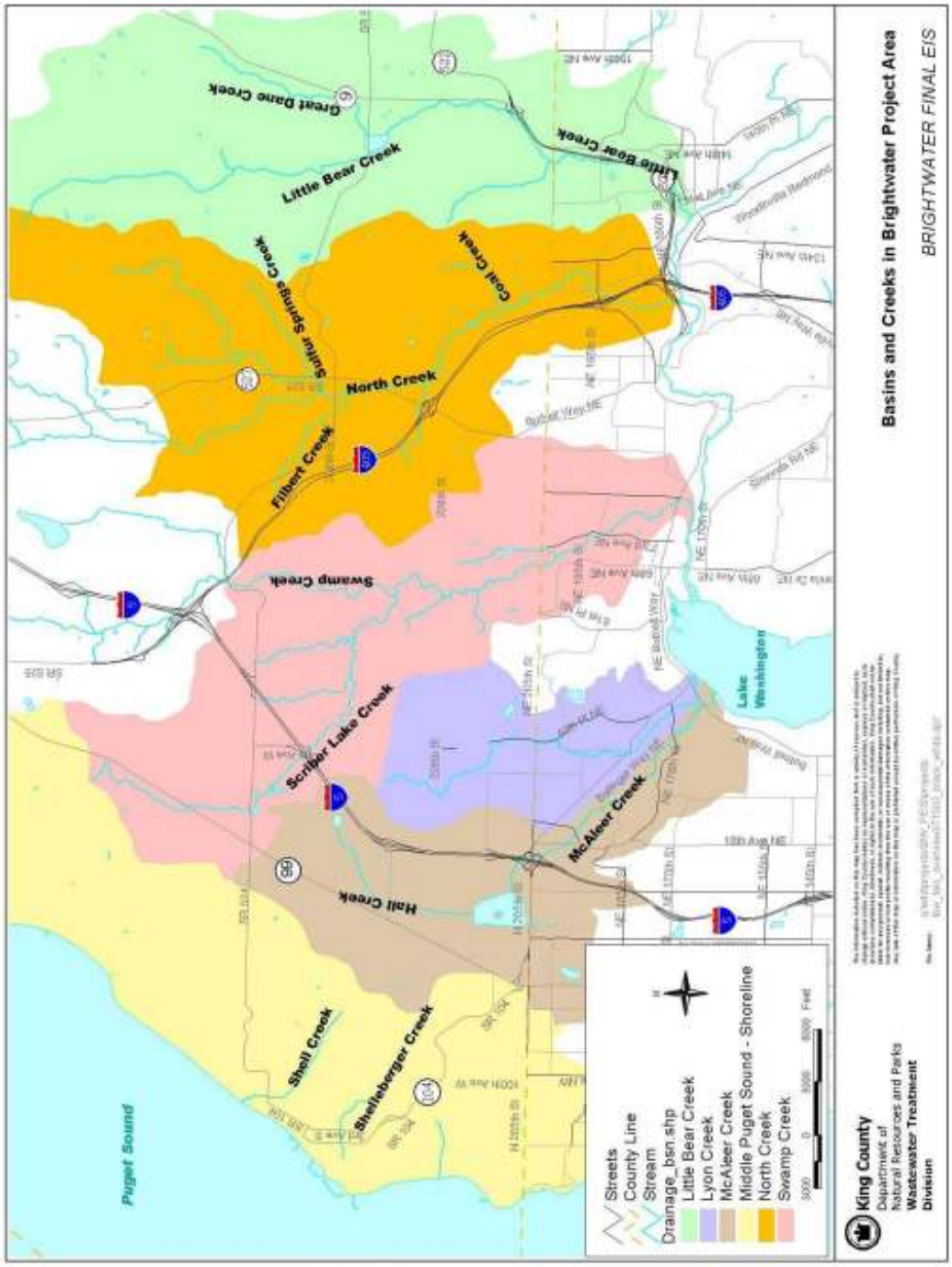
Halls Creek in Mountlake Terrace.
Source: Mountlake Terrace Public Works Department.

Riverine Flooding

Riverine flooding is the overbank flooding of rivers and streams. The natural processes of riverine flooding add sediment and nutrients to floodplain areas. Flooding in large river systems typically results from large-scale weather systems that generate prolonged rainfall over a wide geographic area, causing flooding in hundreds of smaller streams, which then drain into the major rivers.

Shallow area flooding is a special type of riverine flooding. FEMA defines shallow flood hazards as areas that are inundated by the 100-year flood with flood depths of only one to three feet. These areas are generally flooded by low velocity sheet flows of water.

Figure 5: King and Snohomish Counties Water Basins



Source: King County Brightwater Project.

Dam Failure Flooding

Loss of life and damage to structures, roads, and utilities may result from a dam failure. Because dam failure can have severe consequences, FEMA requires that all dam owners develop Emergency Action Plans (EAP) for warning, evacuation, and post-flood actions.

For more detailed information regarding dam failure flooding, and potential flood inundation zones for a particular dam in the county, refer to the Mountlake Terrace Emergency Action Plan.

Tide Floods

As mentioned in the Definitions section, the combination of high winds and high tides may cause flooding in coastal areas. This is a primarily a potential hazard for the City of Edmonds and the Town of Woodway as these jurisdictions have significant waterfront property.

What is the Effect of Development on Floods?

When structures or fill are placed in the floodway or floodplain, water is displaced. Development raises the river levels by forcing the river to compensate for the flow space obstructed by the inserted structures and/or fill. When structures or materials are added to the floodway or floodplain and no fill is removed to compensate, serious problems can arise. Floodwaters may be forced away from historic floodplain areas. As a result, other existing floodplain areas may experience floodwaters that rise above historic levels.

Displacement of only a few inches of water can mean the difference between no structural damage occurring in a given flood event, and the inundation of many homes, businesses, and other facilities. Careful attention should be given to development that occurs within the floodway to ensure that structures are prepared to withstand base flood events.

In highly urbanized areas, increased paving can lead to an increase in volume and velocity of runoff after a rainfall event, exacerbating the potential flood hazards. Care should be taken in the development and implementation of storm water management systems to ensure that these runoff waters are dealt with effectively.[36]

How are Flood-Prone Areas Identified?

Flood maps and Flood Insurance Studies (FIS) are often used to identify flood-prone areas. The NFIP was established in 1968 as a means of providing low-cost flood insurance to the nation's flood-prone communities. The NFIP also reduces flood losses through regulations that focus on building codes and "sound floodplain management. NFIP regulations (44 Code of Federal Regulations [CFR] Chapter 1, Section

60.3) require that all new construction in floodplains must be elevated at or above base flood level.

Flood Insurance Rate Maps (FIRM) and Flood Insurance Studies (FIS)

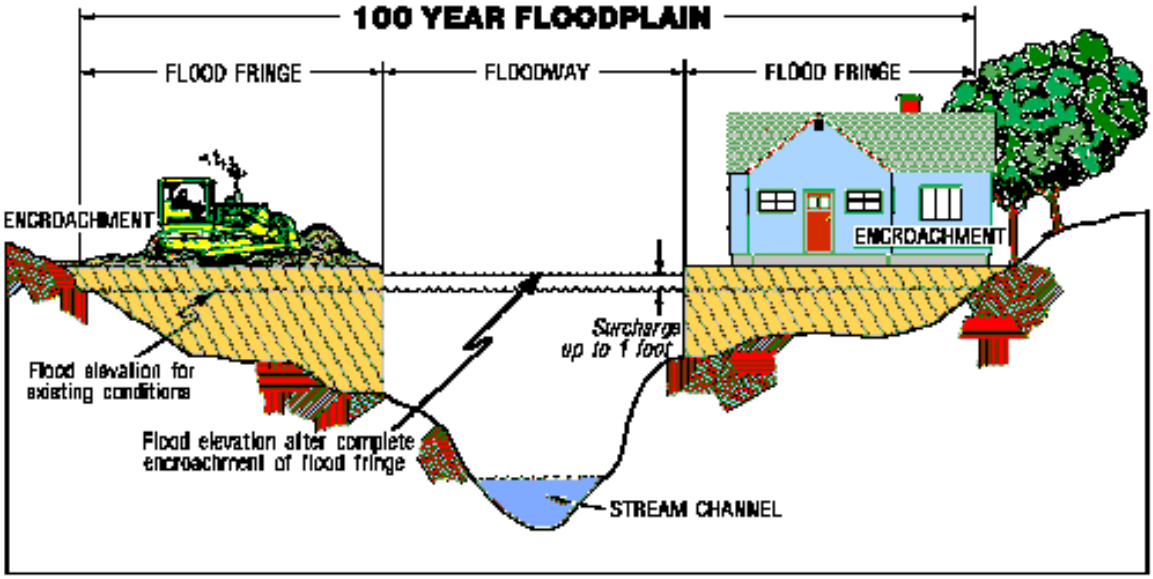
Floodplain maps are the basis for implementing floodplain regulations and for delineating flood insurance purchase requirements. A Flood Insurance Rate Map (FIRM) is the official map produced by FEMA, which delineates SFHA in communities where NFIP regulations apply. FIRMs are also used by insurance agents and mortgage lenders to determine if flood insurance is required and what insurance rates should apply.

Water surface elevations are combined with topographic data to develop FIRMs. FIRMs illustrate areas that would be inundated during a 100-year flood, floodway areas, and elevations marking the 100-year-flood level. In some cases they also include base flood elevations (BFEs) and areas located within the 500-year floodplain.[37]

Flood Insurance Studies and FIRMs produced for the NFIP provide assessments of the probability of flooding at a given location. FEMA conducted many Flood Insurance Studies in the late 1970s and early 1980s. These studies and maps represent flood risk at the point in time when FEMA completed the studies.

FEMA flood maps are not entirely accurate. These studies and maps represent flood risk at the point in time when FEMA completed the studies, and does not incorporate planning for floodplain changes in the future due to new development. Man-made and natural changes to the environment have changed the course of many of the rivers in the Puget Sound region, as well as their associated floodplain boundaries.

Figure 6: Floodplain Schematic[38]



Flood Mapping Methods and Techniques

Although many communities rely exclusively on FIRMs to characterize the risk of flooding in their area, there are some flood-prone areas that are not mapped but remain susceptible to flooding. These areas include locations next to small creeks, local drainage areas, and areas susceptible to manmade flooding.

The use of GIS (Geographic Information System) is becoming an important tool for flood hazard mapping. FIRM maps can be imported directly into GIS, which allows for GIS analysis of flood hazard areas. Communities may find it particularly useful to overlay flood hazard areas on tax assessment parcel maps. This allows a community to evaluate the flood hazard risk for a specific parcel during review of a development request. Coordination between FEMA and local planning jurisdictions is the key to making a strong connection with GIS technology for the purpose of flood hazard mapping.

FEMA and the Environmental Systems Research Institute (ESRI), a private company, have formed a partnership to provide multi-hazard maps and information to the public via the Internet. ESRI produces GIS software, including ArcView© and ArcInfo©. The ESRI web site has information on GIS technology and downloadable maps. The hazards maps provided on the ESRI site are intended to assist communities in evaluating geographic information about natural hazards. Flood information for most Washington communities is available on the ESRI web site. Visit http://www.esri.com for more information.

History of Flooding in North King and South Snohomish Counties

There are many feeders and water systems that flow through the North King-South Snohomish region into the Lake Washington Drainage Basin. They include:

- Deer Creek
- Halls Creek
- Little Bear Creek
- Lyons Creek
- McAleer Creek
- Mill Creek South
- Nickel Creek
- North Creek
- Penney Creek
- Sammamish River
- Scriber Creek
- Shell Creek
- Swamp Creek
- Woodin Creek
- Halls Lake
- Lake Ballinger
- Scriber Lake

Hazard Assessment and Risk Analysis

Hazard Identification

Hazard identification is the first phase of flood-hazard assessment. Identification is the process of estimating:

(1) the geographic extent of the floodplain (i.e., the area at risk from flooding);
(2) the intensity of the flooding that can be expected in specific areas of the floodplain; and
(3) the probability of occurrence of flood events.

This process usually results in the creation of a floodplain map. Floodplain maps provide detailed information that can assist jurisdictions in making policies and land-use decisions.

Data Sources

FEMA mapped several of the cities' 100-year and 500-year floodplains through the Flood Insurance Study (FIS) in conjunction with the United States Army Corps of Engineers (USACE). The mappings dates are as follows:[39]

Community	Initial Flood Hazard Boundary Map Date	Flood Insurance Rate Map Effective Date	Flood Insurance Rate Map Revision Date
Brier	Jan. 24, 1975	Sept. 24, 1984	Sept. 16, 2005
Edmonds	Jul. 26, 1974	Aug. 8, 1978	Sept. 16, 2005
Kenmore	Jan. 17, 1975	Mar. 30, 1998	Apr. 19, 2005
Lake Forest Park	Jun. 26, 1974	Feb. 15, 1980	Apr. 19, 2005
Lynnwood	Jun. 28, 1975	Jun. 5, 1985	Sept. 16, 2005
Mill Creek	--	Nov. 8, 1999	Sept. 16, 2005
Mountlake Terrace	Jun. 28, 1974	Aug. 19, 1985	Sept. 16, 2005
Mukilteo	Jul. 11, 1975	Aug. 19, 1985	Sept. 16, 2005
Woodinville	--	May 16, 1995	Apr. 19, 2005
Woodway	Dec. 13, 1977	Mar. 15, 1984	Sept. 30, 1992

Vulnerability Assessment

Vulnerability assessment is the second step of flood-hazard assessment. It combines the floodplain boundary, generated through hazard identification, with an inventory of the property within the floodplain. Understanding the population and property exposed to natural hazards will assist in reducing risk and preventing loss from future events.

Because site-specific inventory data and inundation levels given for a particular flood event (10-year, 25-year, 50-year, 100-year, and 500-year) are not readily available, calculating a community's vulnerability to flood events is not straightforward. The amount of property in the floodplain, as well as the type and value of structures on those properties, should be calculated to provide a working estimate for potential flood losses.

Each jurisdiction provides an assessment of individual vulnerabilities in the breakouts in Section III.

Life and Private Property

The largest impact on communities from flood events is the loss of life and property. During certain years, property losses resulting from flood damage are significant but not widespread. Development in the floodplains of the north King and south Snohomish Counties will continue to be at risk from flooding because flood damage occurs on a regular basis throughout the area.

The type of property damage caused by flood events depends on the depth and velocity of the floodwaters. Faster moving floodwaters can wash buildings off their foundations and sweep cars downstream. Pipelines, bridges, and other infrastructure can be damaged when high waters combine with flood debris.

The volumes of water that flow through the creek systems in this area, even during a flood, are neither heavy nor swift enough to carry away housing structures. The most likely scenario for the participating jurisdictions in north King and south Snohomish counties is damage in connection with urban flooding.

It is highly unlikely that the region will experience floodwaters with the speed or volume to wash away structures. For the same reason, loss of life due to flooding is unlikely. The most common type of flooding is urban in nature.

Homes

Extensive damage can be caused by basement flooding and landslide damage related to soil saturation from flood events. Seepage into basements or daylight basements is common during flood events, not only in or near floodplains, but also on hillsides and other areas that are far removed from floodplains. Most flood damage is caused by water saturating materials susceptible to loss (e.g., wood, insulation, wallboard, fabric, furnishings, floor coverings, and appliances).

Homes in frequently flooded areas can experience damage to septic systems and drain fields. Although mostly urban and suburban in nature, some of the participating jurisdictions may have pockets where private sewage treatment systems (septic systems) are still in use.

In many cases, flood damage to homes renders them unlivable.

Manufactured Homes

Manufactured homes have a lower level of structural stability than stick-built homes, and must be anchored to provide additional structural stability during flood events.

Business/Industry

Flood events impact businesses by damaging property and by interrupting business. Flood events can cut off customer access to a business as well as close a business for repairs. A quick response to the needs of businesses affected by flood events can help a community maintain economic vitality in the face of flood damage. Responses to business damages can include funding to assist owners in elevating or relocating flood-prone business structures.

Public Infrastructure

Publicly owned facilities are a key component of daily life for all citizens of the region. Damage to public water and sewer systems, transportation networks, flood control facilities, emergency facilities, and offices can hinder the ability of the government to deliver services.

Government can take action to reduce risk to public infrastructure from flood events, as well as craft public policy that reduces risk to private property from flood events. There are a variety of drinking water, surface water, and wastewater service providers throughout the region. During flooding events, the infrastructure that supports the water service providers in the area can be damaged and sometimes destroyed.

Buildings

Of particular importance during flood events are facilities located in flood hazard areas that are critical to government response and recovery activities. Each jurisdiction will address this issue in their individual breakouts in Section III.

Roads

During natural hazard events, or any type of emergency or disaster, dependable road connections are critical for providing emergency services. Roads systems in the north King and south Snohomish Counties region are maintained by multiple jurisdictions. Federal, state, county, and city governments all have a stake in protecting roads from flood damage. Road networks often traverse floodplain and floodway areas. Transportation agencies responsible for road maintenance are typically aware of roads at risk from flooding.

Bridges

Bridges are key points of concern during flood events because they are important links in road networks, watercourse crossings, and they can be obstructions in watercourses, inhibiting the flow of water during flood events. The State of Washington has approximately 7,400 bridges in its inventory. About 3,180 are owned by the state, a handful owned by railroads, and the balance owned by cities and counties.

The bridges in the north King and south Snohomish Counties area are state, county, city, or privately owned. With a few exceptions, a state-designated inspector must inspect all state, county, and city bridges every two years, but private bridges are not inspected, and can be very dangerous. The state inspections are rigorous, looking at everything from seismic capability to erosion and scour. Upon inspection, the bridges are subject to a sufficiency score. As a result of the inspection outcome, the bridges are ranked throughout the State. The state then prioritizes the bridge repair according to each score.

Approximately 400 bridges are inspected on a 4-year cycle in accordance with an agreement with the Federal Highway Administration. Additionally, a few bridges are inspected annually if they are a critical structure or are being monitored for a specific issue.

It should be noted that all inspections and State policies must meet the Federal Highway Administration's guidelines.

Bridge repairs and replacements are funded through a variety of mechanisms with the "owning" agency having primary responsibility for the expense. The State receives 20% of the Federal gas taxes back to support the repair and replacement of bridges. Of that 20%, the State keeps 60%, and the other 40% is distributed to cities and counties based on the direction of the Bridge Replacement Advisory Committee.

Storm Water Systems

Local drainage problems are common throughout the region. Several communities have drainage master plans and/or stormwater plans, and local public works staff members are often aware of local drainage threats. The problems are often present where open ditches enter culverts or go underground into storm sewers. In addition, high water tables in some areas can mean wet crawl spaces, yards, and basements after storms because the accumulated water does not drain quickly into a stream or storm sewer. Filled ditches and swales near buildings can inhibit or prevent the flow of water and compound these problems. Inadequate maintenance, especially following leaf accumulation in the fall, can also contribute to the flood hazard in urban areas.

Water/Wastewater Treatment Facilities

There are four sanitary districts in the North King and South Snohomish Counties region, three surface water management districts, and five sewage treatment facilities. There are also two water service districts that operate within the participating jurisdictions.

The districts work with local Cities to ensure service is maintained and operational at all times.

Risk Analysis

Risk analysis is the third and most advanced phase of a hazard assessment. It builds upon the hazard identification and vulnerability assessment.

A flood risk analysis for the north King and south Snohomish Counties region should include two components: (1) the life and value of property that may incur losses from a flood event (defined through the vulnerability assessment); and (2) the number and type of flood events expected to occur over time. Within the broad components of a risk analysis, it is possible to predict the severity of damage from a range of events.

Flow velocity models can assist in predicting the amount of damage expected from different magnitudes of flood events. The data used to develop these models is based on hydrological analysis of landscape features. Changes in the landscape, often associated with human development, can alter the flow velocity and the severity of damage that can be expected from a flood event.

Using GIS technology and flow velocity models, it is possible to map the damage that can be expected from flood events over time. It is also possible to pinpoint the effects of certain flood events on individual properties. At the time of publication of this plan, data was insufficient to conduct a risk analysis for flood events in the north King and south Snohomish Counties area, and the participating cities have neither the staff nor budget to provide a full-scale GIS analysis.

From past experience, however, the participating jurisdictions recognize that certain areas within their boundaries are prone to urban flooding, particularly during winters with unusually high levels of precipitation and/or periods of heavy snowfall followed by quick thaws.

Flood Mitigation

Each jurisdiction participating in this Plan works to mitigate problems regarding flood issues when they arise. However, funding, time and manpower are often unavailable, causing the problems to go unresolved.

The jurisdictions participating in this Plan have documented the problem areas within the community. These are listed in the Jurisdiction-Specific portion of this document in the appropriate areas.

Existing Flood Mitigation Activities

Flood mitigation activities listed here include current mitigation programs and activities that are being implemented by north King and south Snohomish County agencies or organizations.

Codes

The cities participating in this Mitigation Plan use building codes, zoning codes, and various planning strategies to address development restrictions in areas of known hazards and apply appropriate safeguards.

- Mitigation Requirements: All habitable floors must be 1 foot above floodplain in accordance with NFIP.
- Affected Properties: All development in the floodplain.

Acquisition and Protection of Open Space in the Floodplain

Current efforts to maintain and/or increase public open space in the area have been paired with the need to restore and preserve natural systems that provide wildlife habitat and help to mitigate flood events. Public parks and publicly owned open spaces can provide a buffer between flood hazards and private property.

Preserved open space in the floodplain can help mitigate flood impacts by reducing the amount of allowable development in flood hazard areas. Preserving natural wetlands systems can assist in absorbing water during flood events and providing storage for treated effluent from wastewater treatment plants.

Water Districts

Water districts and Cities in the area are in the process of replacing old pipes with more ductile iron pipes, which will be more resilient in disaster situations. During a disaster, water districts in the region work together to provide water for north King and south Snohomish County citizens.

Natural Systems

Maintaining and restoring natural systems help to mitigate the impact of flood events on the built environment. Flooding changes the natural environment and hydrology of an affected area. High water can be beneficial to the natural processes within a floodplain, and can benefit riparian areas. The best flood control techniques work to control water using the natural features such as wetlands that assist in water storage and bank stability.

Riparian Areas

Riparian areas are important transitional areas that link water and land ecosystems. Vegetation in riparian areas is dependent on stream processes, such as flooding, and often is composed of plants that require large amounts of water, such as willows and cottonwood trees. Healthy vegetation in riparian buffers can reduce streamside erosion. During flood events, high water can cause significant erosion.

Population growth and development have strained the land and water. In response to state legislation as well local needs, the community has responded by supporting various improvement projects through WRIA 8, a regional organization established to identify and develop effective actions to address regional problems. The goal of the organization is to develop a basin wide strategy to protect and restore river, habitat and riparian areas. Well-managed riparian areas can reduce the amount of erosion and help to protect water quality during flood events.

Wastewater Management

There are a variety of wastewater service providers in the north King and south Snohomish Counties area. Working cooperatively, the Cities and service providers operate and maintain the infrastructure that helps to keep the waters of the region clean and pure.

Wetlands

Many floodplain and stream-associated wetlands absorb and store storm water flows, which reduces flood velocities and stream bank erosion. Preserving these wetlands reduces flood damage and the need for expensive flood control devices such as levees. When the storms are over, many wetlands augment summer stream flows by slowly releasing the stored water back to the stream system.[40] Wetlands are highly effective at removing nitrogen, phosphorous, heavy metals, and other pollutants from water. For this reason, artificial wetlands are often constructed for cleaning storm water runoff and for tertiary treatment (polishing) of wastewater.

Wetlands bordering streams and rivers, and those that intercept runoff from fields and roads, provide this valuable service free of charge.[41] In north King and south Snohomish Counties, most of the streams run into the Lake Washington Drainage Basin.

Cities and counties in the Puget Sound area are working together to resolve water system issues including stormwater, runoff, and the listing of salmon as an endangered species. To this end, the jurisdictions have organized around watersheds, water basins, and drainage basins to plan and act regionally to the greatest degree possible.

Stormwater Systems

In compliance with State and Federal requirements, each city has a Stormwater Management Plan.

Legislation

- **Federal Executive Order 11988** – Floodplain Management
- **Federal Executive Order 11990** – Protection of Wetlands
- **Shoreline Management Act** – Amended March 2002

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Flood Resource Directory

The following resource directory lists the resources and programs that can assist county communities and organizations. The resource directory will provide contact information for local, county, regional, state and federal programs that deal with natural hazards.

Federal Resources

Federal Emergency Management Agency (FEMA)

FEMA provides maps of flood hazard areas, various publications related to flood mitigation, funding for flood mitigation projects, and technical assistance. FEMA also operates the National Flood Insurance Program. FEMA's mission is to reduce loss of life and property and protect the nation's critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management program of mitigation, preparedness, response and recovery. FEMA Region X serves the northwestern states of Alaska, Idaho, Oregon, and Washington.

Contact: FEMA, Federal Regional Center, Region 10
Address: 228th St. SW, Bothell, WA 98021-9796
Phone: (425) 487-4678
Website: http://www.fema.gov

To obtain FEMA publications:
Phone: (800) 480-2520

To obtain FEMA maps, contact: Map Service Center
Address: P.O. Box 1038, Jessup, Maryland 20794-1038
Phone: (800) 358-9616
Fax: (800) 358-9620

National Flood Insurance Program (NFIP)

Flood insurance is available to citizens in communities that adopt and implement NFIP building standards. The standards are applied to development that occurs within a delineated floodplain, a drainage hazard area, and properties within 250 feet of a floodplain boundary. These areas are depicted on federal Flood Insurance Rate Maps available through the county.

Contact: National Flood Insurance Program
Website: http://www.fema.gov/nfip/

The Community Rating System (CRS)

The Community Rating System (CRS) recognizes community floodplain management efforts that go beyond the minimum requirements of the NFIP. Property owners would receive reduced NFIP flood insurance premiums if the jurisdictions implements floodplain management practices that qualify it for a CRS rating.

Contact: National Flood Insurance Program
Website: http://www.fema.gov/nfip/crs.htm

NOAA Northwest River Forecast Center

A general summary of water supply conditions in the Pacific Northwest, including basin summaries for precipitation, temperature, snow, reservoir storage and runoff for the current water year.

Website: http://www.nwrfc.noaa.gov

National Weather Service Seattle

Water supply outlook, snowpack data.

Website: http://www.wrh.noaa.gov

Office of Hydrology, National Weather Service

The National Weather Service's Office of Hydrology (OH) and its Hydrological Information Center offer information on floods and other aquatic disasters. This site offers current and historical data including an archive of past flood summaries, information on current hydrologic conditions, water supply outlooks, an Automated Local Flood Warning Systems Handbook, Natural Disaster Survey Reports, and other scientific publications on hydrology and flooding.

Contact: Office of Hydrology, National Weather Service
Website: http://www.nws.noaa.gov/oh
Or: http://www.nws.noaa.gov/oh/hic/

National Resources Conservation Service (NRCS), US Department of Agriculture

NRCS provides a suite of federal programs designed to assist state and local governments and landowners in mitigating the impacts of flood events. The Watershed Surveys and Planning Program and the Small Watershed Program provide technical and financial assistance to help participants solve natural resource and related economic problems on a watershed basis. The Wetlands Reserve Program and the Flood Risk Reduction Program provide financial incentives to landowners to put aside land that is either a wetland resource, or that experiences frequent flooding. The Emergency Watershed Protection Program (EWP) provides technical and financial assistance to clear debris from clogged waterways, restore vegetation, and stabilizing riverbanks. The measures taken under EWP must be environmentally and economically sound and generally benefit more that one property.

Contact: National Resources Conservation Service – Renton Service Center (King County)
Address: 941 Powell Ave SW, Ste 102; Renton, WA 98057
Phone: (425)277-5580, ext 3
Fax: (425)277-5588
Website: http://www.nrcs.usda.gov

Contact: National Resources Conservation Service – Farm Service Agency
Lake Stevens Service Center (Snohomish County)
Address: 528 91st Ave NE, Ste C; Lake Stevens, WA 98258
Phone: (425)334-2828
Fax: (425)335-5024
Website: http://www.nrcs.usda.gov

United States Geological Survey (USGS)

The USGS website provides current streamflow conditions at USGS gauging stations throughout the Pacific Northwest. The Seattle USGS office is responsible for water-resources investigations, and their office cooperates with local, state, and federal agencies in the area. Cooperative activities include water-resources data collection and interpretive water-availability and water-quality studies.

Contact: USGS Western Region Office
Address: 345 Middlefield Road; Menlo Park, CA 94025
Phone: (650)853-8300
Website: http://www.usgs.gov
USGS Information: (888)ASK-USGS
(888)275-8747

USGS Water Resources

This web page offers current US water news; extensive current (including real-time) and historical water data; numerous fact sheets and other publications; various technical resources; descriptions of ongoing water survey programs; local water information; and connections to other sources of water information.

Contact: USGS Water Resources
Website: http://water.usgs.gov
Or: http://water.usgs.gov/public/realtime.html

Bureau of Reclamation

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Contact: Bureau of Reclamation, Pacific Northwest Region
Address: 1150 N. Curtis Road, Boise, ID 83706
Phone: (208) 378-5012
Website: http://www.pn.usbr.gov/contact/index.html

Army Corps of Engineers

The Corps of Engineers administers a permit program to ensure that the nation's waterways are used in the public interest. Any person, firm, or agency planning to work in waters of the United States must first obtain a permit from the Army Corps of Engineers. The Corps is responsible for the protection and development of the nation's water resources, including navigation, flood control, energy production through hydropower management, water supply storage and recreation.

Contact: US Army Corps of Engineers
Address: 4735 East Marginal Way South; Seattle, WA 98124-3755
Phone: (206) 764-3750
Website: http://www.nws.usace.army.mil/

Regional Resources

Water Resource Inventory Area 8 (WRIA 8)

A group of 27 jurisdictions in King and Snohomish Counties making coordinated regional efforts toward protecting and restoring watersheds and salmon habitat.

Contact: Jane Lamensdorf-Boucher, WRIA 8 Watershed Coordinator
Address: 201 South Jackson Street, Suite 600; Seattle, WA 98104
Phone: (206)296-1907
Email: jane.lamendsdorfboucher@metrokc.gov

State Resources

Shoreland and Environmental Assistance Program (SEA)

Part of Washington State's Department of Ecology. This department provides information about managing shorelands and wetlands. It focuses primarily on state and local responsibilities in administering state laws and federally-delegated laws.

Contact: Washington State Department of Ecology;
Shorelands and Environmental Assistance Program
Address: P.O. Box 47600; Olympia, WA 98504-7600
Phone: (360)407-6600
Website: http://www.ecy.wa.gov/programs/sea/shorelan.html

Washington Department of Fish and Wildlife

The organization's mission is to protect and enhance Washington's fish and wildlife and their habitats for use and enjoyment by present and future generations. WDFW regulates stream activity and engages in stream enhancement activities.

Contact: Washington Department of Fish and Wildlife
Physical Address: 600 Capitol Way North; Olympia, WA 98501-0191
Mailing Address: 1111 Washington St SE; Olympia, WA 98501
Phone: (360)902-2515
Website: http://wdfw.wa.gov
Email: wildthing@dfw.wa.gov

Regional Office: Washington Department of Fish and Wildlife
Address: 16018 Mill Creek Blvd.; Mill Creek, WA 98012
Phone: (425)775-1311

Interactive Weather Information Network (IWIN)

Current weather information in cooperation with NOAA.

Website: http://iwin.nws.noaa.gov/main.html
Email: W-IWIN.Webmaster@noaa.gov

Washington Department of Ecology, Northwest Regional Office

Provides technical assistance to local jurisdictions in making sound policy decisions relating to land use, shorelands, and wetlands.

Contact: Washington State Department of Ecology, Northwest Regional Office
Address: 3190 160th Avenue SE, Mail Stop NB-81; Bellevue, WA 98008-5452
Phone: (425)649-7000
Website: http://www.ecy.wa.gov/

Washington Department of Natural Resources

DNR's role is to protect and manage State lands and other natural resources such as water, wildlife, and fish. The Department is also responsible for fire prevention and suppression.

Contact: Washington Department of Natural Resources
Address: 1111 Washington Street SE; Olympia, WA 98504
Mailing Address: PO Box 47000; Olympia, WA 98504-7000
State Phone: (360)902-1000
Regional Info: (800)527-3305
Fax: (360)902-1775
Website: http://www.dnr.wa.gov

Contact: Washington Department of Natural Resources, Northwest Region
Address: 919 N Township Street; Sedro Woolley, WA 98284-9333
Phone: (360)856-3500
Fax: (360)856-2150
Website: http://www.dnr.wa.gov

Publications and Additional Resources

The Floodplain Management Association

The Floodplain Management website was established by the Floodplain Management Association (FMA) to serve the entire floodplain management community. It includes full-text articles, a calendar of upcoming events, a list of positions available, an index of publications available free or at nominal cost, a list of associations, a list of firms and consultants in floodplain management, an index of newsletters dealing with flood issues, a section on the basics of floodplain management, a list of frequently asked questions (FAQs) about the Website, and a catalog of Web links.

Contact: Floodplain Managers Association
Website: http://www.floodplain.org
Email: admin@floodplain.org

The Association of State Floodplain Managers

The Association of State Floodplain Managers is an organization of professionals involved in floodplain management, flood hazard mitigation, the National Flood Insurance Program, and flood preparedness, warning, and recovery. ASFPM fosters communication among those responsible for flood hazard activities, provides technical advice to governments and other entities about proposed actions or policies that will affect flood hazards, and encourages flood hazard research, education, and training. The ASFPM Web site includes information on how to become a member, the organization's constitution and bylaws, directories of officers and committees, a publications list, information on upcoming conferences, a history of the association, and other useful information and Internet links.

Contact: The Association of State Floodplain Managers
Address: 2809 Fish Hatchery Road, Madison, WI 53713
Phone: (608) 274-0123
Website: http://www.floods.org

Northwest Regional Floodplain Managers Association (NORFMA)
This site is a resource for floodplains, fisheries, and river engineering information for the Northwest. This site provides technical information, articles, and Internet links in the field of floodplain and fisheries management.
Contact: Northwest Regional Floodplain Managers Association
Website: http://www.norfma.org/

FEMA's List of Flood Related Websites
This site contains a long list of flood related Internet sites from "American Heritage Rivers" to "The Weather Channel," and is a good starting point for flood information on the Internet.
Contact: Federal Emergency Management Agency.
Phone: (800) 480-2520
Website: http://www.fema.gov/nfip/related.htm

Revised Washington State Flood Damage Reduction Plan,
Washington State ***Emergency Management Division and Washington State Department of Community Development (July 1995).***
This is a flood-specific planning and mitigation resource for Washington cities and counties. It provides hazard-specific resources and plan evaluation tools. The document was written for local government employees and officials.
Contact: Washington State Emergency Management Division (EMD)
Address: Camp Murray; Tacoma, WA 98430-5000
Phone: (360)512-8000
Website: http://www.emd.wa.gov

NFIP Community Rating System Coordinator's Manual.
FEMA/NFIP. Indianapolis, IN.
This informative brochure explains how the Community Rating System works and what the benefits are to communities. It explains in detail the CRS point system, and what activities communities can pursue to earn points. These points then add up to the "rating" for the community, and flood insurance premium discounts are calculated based upon that "rating." The brochure also provides a table on the percent discount realized for each rating (1-10). Instructions on how to apply to be a CRS community are also included.
Contact: NFIP Community Rating System
Phone: (800) 480-2520 or (317) 848-2898
Website: http://www.fema.gov/nfip/crs.htm

Floodplain Management: A Local Floodplain Administrator's Guide to the NFIP
FEMA- Region 1, Bothell, WA.
This document discusses floodplain processes and terminology. It contains floodplain management and mitigation strategies, as well as information on the NFIP, CRS, Community Assistance Visits, and floodplain development standards.
Contact: National Flood Insurance Program
Phone: (800) 480-2520
Website: http://www.fema.gov/nfip/

Flood Hazard Mitigation Planning: A Community Guide (June 1997)
Massachusetts Department of Environmental Management.
This informative guide offers a 10-step process for successful flood hazard mitigation. Steps include: map hazards, determine potential damage areas, take an inventory of facilities in the flood zone, determine what is or is not being done about flooding, identify gaps in protection, brainstorm alternatives and actions, determine feasible actions, coordinate with others, prioritize actions, develop strategies for implementation, and adopt and monitor the plan.

Contact: Massachusetts Flood Hazard Management Program
Phone: (617) 626-1250
Website: http://www.magnet.state.ma.us/dem/programs/mitigate

Reducing Losses in High Risk Flood Hazard Areas: A Guidebook for Local Officials (February 1987)
FEMA-116.
This guidebook offers a table on actions that communities can take to reduce flood losses. It also offers a table with sources for floodplain mapping assistance for the various types of flooding hazards. There is information on various types of flood hazards with regard to existing mitigation efforts and options for action (policy and programs, mapping, regulatory, non-regulatory). Types of flooding which are covered include alluvial fan, areas behind levees, areas below unsafe dams, coastal flooding, flash floods, fluctuating lake level floods, ground failure triggered by earthquakes, ice jam flooding, and mudslides.

Contact: Federal Emergency Management Agency
Phone: (800) 480-2520
Website: http://www.fema.gov

Public Assistance Debris Management Guide,
Federal Emergency Management Agency (July 2000).
The Debris Management Guide was developed to assist local officials in planning, mobilizing, organizing, and controlling large-scale debris clearance, removal, and disposal operations. Debris management is generally associated with post-disaster recovery. While it should be compliant with local and county emergency operations plans, developing strategies to ensure strong debris management is a way to integrate debris management within mitigation activities. The Public Assistance Debris Management Guide is available in hard copy or on the FEMA website.

Contact: FEMA Distribution Center
Address: 130 228th Street, SW, Bothell, WA 98021-9796
Phone: (800) 480-2520
Fax: (425) 487-4622

Washington State Hazard Identification and Vulnerability Assessment (HIVA)

The *Washington State Hazard Identification and Vulnerability Assessment (HIVA)* assesses natural and technological (man-made) hazards in Washington State. Assessment is the initial step in the emergency management process that leads to mitigation against, preparedness for, response to, and recovery from hazards. Hazards have the potential of becoming disasters or emergencies that can adversely affect the people, environment, economy, and property of the state.

Contact: Washington State Military Department, Emergency Management Division
Address: Plans Section, Camp Murray, Washington 98430-5122.
Phone: (800)562-6108
Website: http://emd.wa.gov

Washington State Hazard Mitigation Strategy

A state-wide plan designed to identify, prioritize, and prevent or minimize natural and technical (man-made) hazards.

Contact: Washington State Military Department, Emergency Management Division
Address: Plans Section, Camp Murray, Washington 98430-5122.
Phone: (800)562-6108
Website: http://emd.wa.gov

Washington State Comprehensive Emergency Management Plan

This document establishes emergency management functions and the responsibilities of the Washington State Military Department, Emergency Management Division (EMD), state agencies, commissions, boards, and councils.

Contact: Washington State Military Department, Emergency Management Division
Address: Plans Section, Camp Murray, Washington 98430-5122.
Phone: (800)562-6108
Website: http://emd.wa.gov

Landslide and Soil Displacement

Defining the Hazard

Landslides are a serious geologic hazard to almost every state in America. Nationally, landslides cause 25 to 50 deaths each year.[42] The best estimate of direct and indirect costs of landslide in the United States range from $1 to $2 billion annually.[43] In Washington, a significant number of locations are potentially subject to landslides, and this includes locations within the ten ESCA Cities. In addition to damage to public and private property, landslides also pose a serious threat to human life.

Landslide is the sliding movement of masses of loosened rock and soil down a hillside or slope. Landslide causes depend on rock type, precipitation, seismic shaking, land development and zoning practices, soil composition, moisture, and slope steepness.[44]

Landslides range from shallow debris flows to deep-seated slumps. These take lives, destroy homes, businesses, and public buildings, undermine bridges, derail railroad cars, cover clam and oyster beds, interrupt transportation infrastructure, and damage utilities.[45] [46] Sinkholes affect roads and utilities. Losses often go unrecorded because of no claims to insurance companies, no report to emergency management, no media coverage, or because transportation damages are recorded as maintenance.[47]

Due to population density and the desire of people to have a home with a view, an increasing number of structures are built on top of or below slopes subject to land sliding. The public is not well-educated with the risk associated in building in potentially vulnerable areas. Additionally, land is not stable indefinitely. People believe that if a bluff has remained stable for the last 50 years, it will remain so for the next 50 years regardless of the development or maintenance.[48]

In addition to landslide, the region may experience soil displacement where soil is eroded beneath the road or ground surfaces. Sinkholes may occur as a result of this erosion. Additionally, streambanks may be undercut resulting in the banks crumbling and/or washing away.

While soil displacement remains a concern, most of the focus of this section will be directed towards the issue of landslide.

<u>Landslide Characteristics</u>

Landslides are downhill movement of rock, debris, or soil mass that cannot be absolutely predicted with current technology. The best design and construction measures are still vulnerable to slope failure. The

amount of protection, usually correlated to cost, is proportional to the level of risk reduction. Debris and vegetation management is integral to prevent landslide damages. Corrective measures help, but the property remains vulnerable to risk.[49]

The size of a landslide usually depends on the geology and the initial cause of the landslide. Landslides vary greatly in their volume of rock and soil, the length, width, and depth of the area affected, frequency of occurrence, and speed of movement. Some characteristics that determine the type of landslide are the slope of the hillside, moisture content, and the nature of the underlying materials.

The following examples may be indicative of a landside hazard area:[50]

- Bluff retreat caused by sloughing of bluff sediments, resulting in a vertical bluff face with little vegetation.
- Pre-existing landside area.
- Tension or ground cracks along or near the edge of the top of a bluff.
- Structural damage caused by settling and cracking of building foundations and separation of steps from the main structure.
- Toppling, bowed or jack-sawed trees.
- Gullying and surface erosion.
- Mid-slope ground water seepage from a bluff face.

Landslides are given different names, depending on the type of failure and their composition and characteristics. Types of landslides in north King and south Snohomish Counties include slides, rock falls, and earth flows.

Slides

Slides move in contact with the underlying surface. These movements include rotational slides where sliding material moves along a curved surface, and translational slides where movement occurs along a flat surface. These slides are generally slow moving and can be deep. Slumps are small rotational slides that are generally shallow. Slow-moving landslides can occur on relatively gentle slopes and can cause significant property damage, but are far less likely to result in serious injuries than rapidly moving landslides.

Washouts caused by erosion are also relatively common in the area. These occur when ditches are culverts beneath hillside roads become blocked with debris. If the ditches are blocked, run-off from slopes is inhibited during periods of precipitation. This causes the run-off water to collect in soil, and in some cases, cause a slide. Usually the slides are small (100 to 1,000 cubic yards), but they can be larger.

Rock falls

Rock falls occur when blocks of material come loose on steep slopes. Weathering, erosion, or excavations, such as those along highways, can cause falls where the road has been cut through bedrock. They are fast moving with the materials free falling or bouncing down the slope. In falls, material is detached from a steep slope or cliff. The volume of material involved is generally small, but large boulders or blocks of rock can cause significant damage.

Earth flows

Earth flows are plastic or liquid movements in which earth masses (e.g., soil and rock) breaks up and flows during movement. Earthquakes often trigger flows. Debris flows normally occur when a landslide moves downslope as a semi-fluid mass scouring, or partially scouring soils from the slope along its path. Flows are typically rapid moving and also tend to increase in volume as they scour out the channel. Flows often occur during heavy rainfall, can occur on gentle slopes, and can move rapidly for large distances.

Landslide Conditions

Landslides are typically triggered by periods of heavy rainfall or rapid snowmelt. Earthquakes, volcanic activity, and excavations may also trigger landslides. Certain geologic formations are more susceptible to landslides than others. Human activities, including locating development near steep slopes, can increase susceptibility to landslide events. Landslides on steep slopes are more dangerous because movements can be rapid.

Although landslides are a natural geologic process, the incidence of landslides and their impacts on people can be exacerbated by human activities. Grading for road construction and development can increase slope steepness. Grading and construction can decrease the stability of a hillslope by lading weight to the top of the slope, removing support at the base of the slope, and increasing water content. Other human activities affecting landslides include: excavation, drainage and groundwater alterations, and changes in vegetation.

Natural Conditions

Natural processes can cause landslides or re-activate historical landslide sites. The removal or undercutting of shoreline-supporting materials along bodies of water by currents and waves produces countless numbers of small slides each year. Seismic tremors can trigger landslides on slopes historically known to have landslide movement. Earthquakes can also cause additional failure (lateral spreading) that can occur on gentle slopes above steep streams and

riverbanks. Landslides are particularly common along stream banks, reservoir shorelines, large lakes, and seacoasts. Steep, concave-shaped slopes with larger drainage areas appear to be more susceptible to landslides than other landforms. All soil types can be affected by landslide triggering conditions.

Particularly Hazardous Landslide Areas

Locations at risk from landslides or debris flows include areas with one or more of the following conditions:

- On or close to steep hills;
- Steep road-cuts or excavations;
- Existing landslides or places of known historic landslides (such sites often have tilted power lines, treats tilted in various directions, cracks in the ground; and/or irregular-surfaced ground);
- Steep areas where surface runoff is channeled, such as below culverts, V-shaped valleys, canyon bottoms, and steep stream channels; and
- Fan-shaped areas of sediment and boulder accumulations at the outlet of canyons.

Impacts of Development

Although landslides are a natural occurrence, human impacts can substantially affect the potential for landslide failures. Proper planning can be exercised to reduce the threat to people, property, and infrastructure.

Excavation and Grading

Slope excavation is common in the development of home sites or roads on sloping terrain. Grading these slopes can result in some slopes that are steeper than the pre-existing natural slopes. Since slope steepness is a major factor in landslides, these steeper slopes can be at an increased risk for landslides. The added weight of fill placed on slopes can also result in an increased landslide hazard. Small landslides can be fairly common along roads, in either the road cut or the road fill. Landslides occurring below new construction sites are indicators of the potential impacts stemming from excavation.

Drainage and Groundwater Alterations

Water flowing above or through the ground is often the trigger for landslides. Any activity that increases the amount of water flowing into landslide-prone slopes can increase landslide hazards. Broken or leaking water or sewer pipes can be especially problematic, as can water retention facilities that direct water onto slopes. However, even lawn irrigation and minor alterations to small streams in landslide-prone areas can result in damaging landslides. Ineffective storm water management and excess runoff can also cause erosion and increase

the risk of landslide hazards. Drainage can be affected naturally by the geology and topography of an area. Development that results in an increase in impervious surface impairs the ability of the land to absorb water and may redirect water to other areas. Channels, streams, ponding, and erosion on slopes all indicate potential slope problems.

Road and driveway drains, gutters, downspouts, and other constructed drainage facilities can concentrate and accelerate flow. Ground saturation and concentrated velocity flow are major causes of slope problems and may trigger landslides.[51]

Changes in Vegetation

Removing vegetation from very steep slopes can increase landslide hazards. The Storm Impacts Study conducted by the Oregon Department of Forestry found that landslide hazards in three out of four steeply sloped areas were highest for a period of roughly ten years after timber harvesting.[52] Areas that have experienced wildfire and land clearing for development may have long periods of increased landslide hazard. In addition, woody debris in stream channels (both natural and man-made) may cause the impacts from debris flows to be more severe.[53]

History of Landslides in North King and South Snohomish Counties

From November 1996 through March 1997, a series of wet winter storms delivered snow, freezing rain, and warm rain, producing floods and landslides. Prior to the storms, the late autumn months had above normal precipitation, building soil moisture, and heavy snow packs. The combination of pre-existing soil moisture, heavy rain, and rapid snow melt brought soils to saturation. On the gentler plains, perching of water and emergence of ground water from shallow aquifers caused flooding in low lying areas. In the steep bluffs that border Puget Sound, Lake Washington, and larger river valleys, lateral movement of ground water toward the free faces caused water pressures that triggered hundreds of landslides.[54]

On January 15, 1997, Woodway experienced a landslide that cut the bluff back by 50 to 60 feet in places and dropped chunks of soil the size of small cars to the beach below.[55] The landslide was of such a magnitude that it not only covered the beach area, but it pushed a freight train off the tracks and into Puget Sound.

In January and February of 2006, and again in November and December of 2006 (resulting in a total of three Presidential Declarations), the Puget Sound area experienced multiple mud- and landslides between Everett and Seattle

in association with severe storms and flooding. This scenario was repeated again in January 2009 with an additional Declaration.

Hazard Assessment and Risk Analysis

Hazard Identification

Some landslides move slowly and cause damage gradually, while others move so rapidly that they can destroy property and take lives suddenly and unexpectedly. Debris flows, sometimes referred to as mudslides, mudflows, lahars, or debris avalanches, are common types of fast-moving landslides. These flows generally occur during periods of intense rainfall or rapid snowmelt. They usually start on steep hillsides as shallow landslides that liquefy and accelerate to speeds that are typically about 10 mph, but can exceed 35 mph. The consistency of debris flows range from watery mud to thick, rock mud that can carry large items such as builders, trees, and cars. Debris flows from many different sources can combine in channels where their destructive power may be greatly increased. They continue flowing down hills and through channels, growing in volume with the addition of water, sand, mud, buildings, trees, and other materials. When the flows reach canyon mouths or flatter ground, the debris spreads over a broad area, sometimes accumulating in thick deposits that can wreak havoc in developed areas.

Areas that have experienced landslides in the past tend to be most susceptible to future landslides, especially during wet weather. Because these areas consist of broken materials and frequently involve disruption of ground water flow, these dormant sites can be more vulnerable to slides caused by construction activities than adjacent, undisturbed soil.

As houses and roads are built on steeper slopes, landslide hazards become an increasingly serious threat to life and property. In addition, wildland-urban interface fires, clear-cutting trees, and land clearing for housing developments may cause soils to become less stable and thereby increasing the threat of slides, debris flows, and soil displacement.

Other factors may cause, or contribute to, a landslide. These include slide erosion from stream or wave action, intense or prolonged rainfall, rapid snowmelt, freezing and thawing of soil, and/or sharp fluctuations in groundwater levels. Shocks or vibrations caused by earthquakes, passing trains, large explosions, or construction activity can also lead to landslides.

As previously mentioned, an increasing number of structures are built on top of or below slopes subject to land sliding. This is due to a variety of factors, one being the desire by many homeowners for a “view property.” Another factor is the relative scarcity of undeveloped or under-developed property in this area. Combined with the overall increase in property values over the last two decades, and properties once deemed

"unbuildable" or "too expensive" to develop have become too valuable to let sit empty.

Landslides in these areas can take lives, destroy homes and businesses, undermine bridges, derail railroad cars, cover fish habitat and oyster beds, interrupt transportation infrastructure, and damage utilities.

Vulnerability Assessment

Lives may be at risk from a landslide, and safety is the highest priority. In addition, landslides and ground displacement can affect utility services, transportation systems, and critical lifelines. During a landslide or soil displacement event, communities may suffer immediate damages and loss of critical services.

Disruption of infrastructure, roads, and critical facilities may have a long-term effect on the economy. Utilities, including potable water, wastewater, telecommunications, natural gas, and electric power are all essential to the community. Loss of electricity has the greatest impact on other utilities and on the community as a whole. Natural gas pipes may be at risk of breakage from landslide movements.

Lives and Property

Certain homes are particularly vulnerable to landslide and soil displacement. As mentioned previously, houses built on "view property" atop or below bluffs or steep slopes are particularly vulnerable to land movement.

In the past, some buildings have been damaged by debris and mudflow coming down upon them. Others have had the bluff give way from beneath them leaving them unsupported. In each of these situations, the house is generally rendered unsafe for habitation.

While property damage is of concern, the greater issue is the safety of the people who live or work in these properties. Lives have been lost from landslides.

Roads and Bridges

Several cities participating in this plan have incurred losses from landslides. Roads have been damaged or endangered from landslides that have buried roads to varying degrees. Other losses have occurred when roadways have been destabilized due to soil displacement. In this situation, the soil is eroded away leaving the road unsupported and therefore vulnerable to collapse.

In most cases, recovery includes a combination of soil removal or restoration, road repairs, and bank stabilization measures.

Lifelines and Critical Facilities

Many roads and bridges are critical to hospitals and other emergency facilities and should be kept open and accessible if possible. Therefore, inspection and repair of critical transportation facilities and routes is essential and should receive high priority.

Loss of utility services is another potential consequence of landslide or soil displacement events. Heavy rains may accelerate soil erosion in hillside areas, resulting in loss of soil support beneath high voltage transmission towers or communication towers on hillsides. Gas lines may also be damaged or broken from a soil shift of only one to two inches, thereby adding the danger of fire to the event.

In the Puget Sound area, railroad tracks run along the coastline, often beneath bluffs with steep slopes. These tracks are at risk of being damaged by landslides

Risk Analysis

All jurisdictions are concerned about interruption of critical services. For two of the jurisdictions, Edmonds and Woodway, an additional concern is the disruption of train service running along the shoreline of Puget Sound. The tracks lie at the base of steep bluffs overlooking Puget Sound.

If a landslide occurs in any of the participating jurisdictions, it is most likely to cause damage to private property. In the overall scheme of things, however, landslide and soil displacement is not a major threat in the north King and south Snohomish Counties area.

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Landslide Mitigation

Landslide mitigation begins with building code development, adoption, and enforcement. Additional activities to actively improve slope stability include surface and ground water control improvements, retaining structures, soil reinforcement, grading, and cachement or diversionary structures.

Public education regarding landslides is another key aspect of mitigation, and property owners should be encouraged to take additional actions to reduce damages. These include:

- Seeking the advice of a geotechnical expert to evaluate the property for landslide or mudslide hazards and design corrective techniques to reduce the risk of slippage.
- Diverting, containing, and safely discharging water around and away from unstable slopes and structures and into road gutters, storm drains, and stream channels.
- Using interruptor drains to redirect groundwater flow away from vulnerable areas.
- Planting low-growing groundcover vegetation to improve slope stability.
- Installing flexible fittings on pipe and conduit to avoid gas, water, and sewer leaks and damage to underground electrical lines.

Existing Landslide Mitigation Activities

Each jurisdiction maintains current Building Codes and has identified and mapped Critical Areas within their boundaries.

See Section III for jurisdiction-specific descriptions of mitigation activities.

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Landslide Resource Directory

The following resource directory lists the resources and programs that can assist county communities and organizations. The resource directory will provide contact information for local, county, regional, state and federal programs that deal with natural hazards.

Federal Resources and Programs

Natural Resource Conservation Service (NRCS)

The NRCS produces soil surveys. These may be useful to local governments who are assessing areas with potential development limitations including steep slopes and soil types. They operate many programs dealing with the protection of natural resources.

Contact: National Resources Conservation Service – Renton Service Center (King County)
Address: 941 Powell Ave SW, Ste 102; Renton, WA 98055-2992
Phone: (425) 277-5580 x3
Fax: (425) 277-5580
Website: http://www.nrcs.usda.gov

Contact: National Resources Conservation Service – Lake Stevens Service Center (Snohomish County)
Address: 528 91st Ave NE, Ste C; Lake Stevens, WA 98258-1538
Phone: (425)334-2828
Fax: (425)335-5024
Website: http://www.nrcs.usda.gov

US Geological Survey, National Landslide Information Center (NLIC)

The NLIC website provides good information on the programs and resources regarding landslides. The page includes information on the National Landslide Hazards Program Information Center, a bibliography, publications, and current projects. USGS scientists are working to reduce long-term losses and casualties from landslide hazards through better understanding of the causes and mechanisms of ground failure both nationally and worldwide.

Contact: National Landslide Information Center
Phone: (800) 654-4966
Website: http://landslides.usgs.gov/nlic/contact.php

US Geological Survey (USGS) - Coastal and Marine Geology Program (CMGP)

Multi-disciplinary scientific research in the coastal and offshore areas of California, Oregon, Washington, Alaska, Hawaii, and other US Pacific Islands; and in other waterways in the United States. The broad goals of the Program are to collect information, monitor conditions, and distribute findings about geologic hazards, environmental conditions, habitats, geologic processes, and energy and mineral resources. Its activities help the Department of Interior and other government managers make informed decisions about the use and protection of our coastal and marine resources.

Contact: US Geological Survey Coastal and Marine Geology Program
Address: 345 Middlefield Road, MS 999; Menlo Park, CA 94025
Phone: (650)853-8300
Website: http://marine.usgs.gov

Federal Emergency Management Agency (FEMA), Landslide Fact Sheet

FEMA's website contains information on strategies to reduce risk and prevent loss from landslides and debris flows.

Contact: Federal Regional Center, Region 10
Address: 130-228th St. SW, Bothell, WA 98021-9796
Phone: (425) 487-4678
Website: http://www.fema.gov/hazard/landslide/index.shtm

Coastal Training Program

A national initiative, funding through NOAA's National Estuarine Reserves Division and implemented in the State of Washington by the Padilla Bay Reserve. Padilla Bay Reserve is part of Washington Department of Ecology's Shoreline and Environmental Assistance Program.

Contact: Cathy Angell, CTP Coordinator
Address: 10441 Bayview-Edison Rd; Mt. Vernon, WA 98273
Phone: (360)428-1558
Website: http://www.coastaltraining-wa.org/

Regional Resources

Nature of the Northwest

The Oregon Department of Geology and Mineral Industries and the USDA Forest Service jointly operate the Nature of the Northwest Information Center. The Center offers a selection of maps and publications from state, federal, and private agencies.

Contact: The Nature of the Northwest Information Center
Address: 800 NE Oregon Street, Suite 177, Portland, Oregon 97232
Phone: (503) 872- 2750
Fax: (503) 731-4066
Website: http://www.naturenw.org
Email: Nature.of.Northwest@state.or.us

State Resources

New Name: Washington State Department of Commerce.

The State Building Code Council was created to provide independent analysis and objective advice to the legislature and Governor's Office on state building code issues. The Council establishes the minimum building, mechanical, fire, plumbing and energy code requirements necessary to promote the health, safety, and welfare of the people of the state of Washington, by reviewing, developing, and adopting the state building code.

Contact: Washington State Building Code Council
Physical Address: 906 Columbia St. SW; Olympia, WA 98504
Mailing Address: PO Box 42525mpia, WA 98504-8300
Phone: (360)724-4000
Fax: (360)586-9383
Website: http://www.cted.wa.gov/
Email: sbcc@cted.wa.gov

Washington Department of Natural Resources

DNR's role is to protect and manage State lands and other natural resources such as water, wildlife, and fish. The Department is also responsible for fire prevention and suppression.

Contact: Washington Department of Natural Resources
Address: 1111 Washington Street SE; Olympia, WA 98504
Mailing Address: PO Box 47000; Olympia, WA 98504-7000
State Phone: (360)902-1000
Regional Info: (800)527-3305
Fax: (360)902-1775
Website: http://www.dnr.wa.gov

Contact: Washington Department of Natural Resources, Northwest Region
Address: 919 N Township Street; Sedro Woolley, WA 98284-9333
Phone: (360)856-3500
Fax: (360)856-2150
Website: http://www.dnr.wa.gov

Washington Department of Ecology, Northwest Regional Office

Provides technical assistance to local jurisdictions in making sound policy decisions relating to land use, shorelands, and wetlands.

Contact: Washington State Department of Ecology, Northwest Regional Office
Address: 3190 160th Avenue SE, Mail Stop NB-81; Bellevue, WA 98008-5452
Phone: (425)649-7000
Website: http://www.ecy.wa.gov/

Shoreland and Environmental Assistance Program (SEA)

Part of Washington State's Department of Ecology. This department provides information about managing shorelands and wetlands. It focuses primarily on state and local responsibilities in administering state laws and federally-delegated laws.

Contact: Washington State Department of Ecology;
Shorelands and Environmental Assistance Program
Address: P.O. Box 47600; Olympia, WA 98504-7600
Phone: (360)407-6600
Website: http://www.ecy.wa.gov/programs/sea/shorelan.html

University of Washington, Earth & Space Sciences

The University of Washington conducts research and prepares inventories and reports for communities throughout Washington relating to earthquakes, landslides, and tsunamis. The department uses a multi-disciplinary approach to provide a basis for making accurate predictions of future conditions

Contact: University of Washington, Earth & Space Sciences
Physical Address: Johnson Hall, Room 70; Seattle, WA 98195
Mailing Address: Box 351310; Seattle, WA 98195
Phone: (206)543-1190
Website: http://www.geophys.washington.edu

Southwest Washington Coastal Erosion Study (SWCES)

Washington Department of Ecology

A Federal – State – Local cooperate research projected conducted by the U.S. Geological Survey Coastal and Marine Geology Program and the Washington Department of Ecology – Coastal Monitoring and Analysis Program. The SWCES was initiated to examine the coastal evolution, processes, geology, and hazards of the Columbia River littoral cell. The project involves fundamental and applied research aimed at developing a regional-scale understanding of the costal processes and their associated shoreline changes over a variety of time scales. Research efforts are directed toward developing an understanding of the littoral cell morphology and dynamics to facilitate land use planning and resource management decisions into the future.

Website: http://www.ecy.gov/programs/sea/swces/index.htm

Publications and Other Resources

Olshansky, Robert B. Planning for Hillside Development (1996).

American Planning Association.

This document describes the history, purpose, and functions of hillside development and regulation and the role of planning, and provides excerpts from hillside plans, ordinances, and guidelines from communities throughout the US.

Landslide Brochure
Oregon's Department of Geology and Mineral Industries (DOGAMI) developed a landslide public outreach brochure in cooperation with several other state agencies. Forty thousand copies were printed in November 1997 and were distributed widely to building codes officials, county planners, local emergency managers, field offices of natural resource agencies, banks, real estate companies, insurance companies, and other outlets. The landslide brochure is available from DOGAMI, OEM, ODF, and the Department of Land Conservation and Development (DLCD).

Contact: Department of Geology and Mineral Industries
Address: 800 NE Oregon Street, Suite 965**,** Portland, Oregon 97232
Phone: (971) 673-1555
Fax: (971) 673-1562
Website: http://www.oregongeology.com

Olshansky, Robert B. & Rogers, J. David. Unstable Ground: Landslide Policy in the United States (1987)
Ecology Law Quarterly
A state-wide plan designed to identify, prioritize, and prevent or minimize natural and technical (man-made) hazards.

Public Assistance Debris Management Guide (July 2000).
Federal Emergency Management Agency.
The Debris Management Guide was developed to assist local officials in planning, mobilizing, organizing, and controlling large-scale debris clearance, removal, and disposal operations. Debris management is generally associated with post-disaster recovery. While it should be compliant with local and county emergency operations plans, developing strategies to ensure strong debris management is a way to integrate debris management within mitigation activities. The Guide is available in hard copy or on the FEMA website.

Contact: FEMA Distribution Center
Address: 130 228th Street, SW, Bothell, WA 98021-9796
Phone: (800) 480-2520
Website: http://www.fema.gov

USGS Landslide Program Brochure.
National Landslide Information Center (NLIC), United States Geologic Survey.
The brochure provides good, general information in simple terminology on the importance of landslide studies and a list of databases, outreach, and exhibits maintained by the NLIC. The brochure also includes information on the types and causes of landslides, rock falls, and earth flows.

Contact: USGS- MS 966, Box 25046
Address: Denver, Federal Center, Denver, CO 80225
Phone: (800) 654-4966
Web: http://geohazards.cr.usgs.gov/

Managing Washington's Coastline: Washington State's Coastal Zone Management Program (Pub. 00-06-029)

Washington State of Ecology

This document describes the Department of Ecology's Coastal Zone Management Program. Participating states are required to describe their coastal zone management programs and submit those descriptive documents to the National Oceanic and Atmospheric Administration (NOAA) for approval.

Contact: Washington State Department of Ecology
Physical Address: 300 Desmond Dr. SE; Lacey, WA 98504
Mailing Address: P.O. Box 47600; Olympia, WA 98504-7600
Phone: (360)407-6600
Website: http://www.ecy.wa.gov/

Enforcing the Shoreline Management Act: Guidance for Local Government Administrators (Pub. 95-101)

Washington State of Ecology

This reference manual provides technical assistance for local governments on how to enforce the Shoreline Management Act.

Contact: Washington State Department of Ecology
Physical Address: 300 Desmond Dr. SE; Lacey, WA 98504
Mailing Address: P.O. Box 47600; Olympia, WA 98504-7600
Phone: (360)407-6600
Website: http://www.ecy.wa.gov/

Spiker, Elliott C. and Paula L. Gori. National Landslide Hazards Mitigation Strategy – A Framework for Loss Reduction (Circular 1244).

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

This circular outlines the key elements of a comprehensive and effective national strategy for reducing losses from landslides nationwide and provides an assessment of the status, needs, and associated costs of this strategy.

Contact: National Landslide Information Center
Phone: (800) 654-4966
Website: http://landslide.usgs.gov

Harp, Edwin L. et al. Landslides and Landslide Hazards in Washington State Due to February 5-9, 1996 Storm.

U.S. Geologic Survey

Contact: National Landslide Information Center
Phone: (800) 654-4966
Website: http://landslide.usgs.gov

Severe Storm

Defining the Hazard

Severe winter storms pose a significant risk to life and property in north King and south Snohomish Counties by creating conditions that disrupt essential regional systems such as public utilities, telecommunications, and transportation routes. Severe winter storms can produce rain, freezing rain, ice, snow, cold temperatures, and wind. Ice storms accompanied by high winds can have destructive impacts, especially to trees, power lines, and utility services.

Windstorms

Power and communication outages frequently result when windstorms topple trees across power and telephone lines. The fallen tree may also make roadways impassable, damage or destroy residences, cars and public facilities, and may endanger human life. The downed power lines become a separate danger in and of themselves.

Snowstorms and Icestorms

While sleet and hail can create hazards for motorists when it accumulates, freezing rain can cause the most dangerous conditions within a community. Ice buildup can bring down trees, communication towers, and power lines creating hazards for property owners, motorists, and pedestrians alike.

History of Severe Storms

Windstorms batter the area frequently with steady winds that reach more than 50 miles per hour, and gust up to 77 miles per hour. These annual events have resulted in significant damage in the north King and south Snohomish Counties area. They leave a trail of destruction in their paths with toppled trees, downed power lines, and widespread power outages.

The following table was provided by Snohomish County Public Utility District (PUD) and documents some of the effects of windstorms in the last ten years. It should be noted that while the spreadsheet provides for an "*Average* Customer Outage Duration," there were some incidents where customers were without power for several days. Some people went without power for as long as a week while crews worked to resolve the problem.

Table 5: Power Outages, as reported by Snohomish County Public Utility District

Year	Dates	Event	Wind Speed	Number of Customers Impacted	Average Customer Outage Duration	Cost
2002	Dec. 27	Wind	60 MPH	76,000	83 Min.	$680,000
2001	Oct. 22	Wind	34 MPH	36,000	51 Min.	$617,000
2000	Dec.15	Wind	40 MPH	167,000	132 Min.	$1,689,000
2000	Jan. 16	Wind	50 MPH	131,000	113 Min.	$833,000
1999	Oct. 27	Wind	25 MPH	15,000	175 Min.	$589,000
1999	Mar. 3	Wind	44 MPH	200,000	154 Min.	$1,351,000
1998	Nov. 24	Wind	53 MPH	99,000	102 Min.	$1,049,000
1997	Mar.30	Wind	52 MPH	89,000	123 Min.	$862,000
1996	Dec. 29	Wind	47 MPH	59,000	92 Min.	$1,096,000
1995	Dec. 12	Wind	77 MPH	159,000	226 Min.	$3,299,000
1995	Dec. 4	Wind	51 MPH	149,000	229 Min.	$1,815,000
1995	Nov. 18	Wind	61 MPH	70,000	196 Min.	$511,000
1993	Jan. 20	Wind	66 MPH	225,000	1255 Min.	$3,914,000

Over a ten-year period, more than 1.5 million households lost power during windstorms. During the same period, the Snohomish County PUD spent more than $19 million for restoration and repairs.

Anytime winds reach speeds of 40 mph or greater, the region can expect to experience power outages in varying degrees. Communities may take days, or even weeks, to recover from a major storm.

While snow is relatively rare in the north King and south Snohomish County area, aberrations in weather patterns do occur, and the region has been hit with the occasional snowstorm or icestorm.

When these storms occur, the region is often shut down. Local jurisdictions are overwhelmed with safety issues such as clearing the streets of snow and sanding for ice. The number of traffic accidents increases, and local resources are strained even further.

The snowstorm or icestorm may bring about power outages as limbs break under the weight of the snow or ice and take out power lines. In addition, when the snow melts, it may cause flooding and secondary damage to the region.

An example of snowstorm damage occurred on November 19, 1996, when up to 12 inches of snow fell in a 24-hour period and knocked out power to 82,000 Snohomish County PUD customers. While the average customer was without power for 96 minutes, some homes were without power for more than a week. This single event cost Snohomish County PUD $771,000 to effect repairs and restore power.

Hazard Assessment and Risk Analysis

Hazard Identification

A severe winter storm is generally a prolonged event, frequently involving snow or ice. The characteristics of severe winter storms are determined by the amount and extent of snow or ice, air temperature, wind speed, and event duration. Severe storms can affect the north King and south Snohomish Counties area. When they occur, they may cause prolonged power outages over widespread areas.

Vulnerability Assessment

Factors included in assessing severe winter storm risk include population and property distribution in the hazard area, the frequency of severe winter storm events, and information on trees, utilities, and infrastructure that may be impacted by severe winter storms.

The area included in this Mitigation Plan – ten Cities and four Special Purpose Districts in the north King and south Snohomish Counties area – are, by definition, incorporated areas and have a relatively dense population ratio.

In fact, eight of the ten Cities fall within the top 20% of population densities. As a combined population, these ten Cities incorporate more than 186,000 people, making it the fourth largest "city" in the State. Only Seattle, Spokane and Tacoma have greater populations.

A regional event will impact a greater number of individuals just by fact of the greater density in this area.

Table 6: Population, Land Area and Density for Cities and Towns[56]

	Population					Density	
Municipality	**Total**	**Rank**		**Land in Square Miles**		**Population Per Sq. Miles**	**Rank**
Brier	6,485	99		2.19		2,961.53	37
Edmonds	40,760	22		9.04		4,507.84	7
Kenmore	20,220	45		6.10		3,314.75	27
Lake Forest Park	12,810	65		3.68		3,480.01	24
Lynnwood	35,680	29		10.03		3,558.49	21
Mill Creek	17,770	50		4.62		3,844.95	17
Mountlake Terrace	20,930	43		3.98		5,255.30	3
Mukilteo	20,050	46		6.14		3,267.82	29
Woodinville	10,560	72		6.13		1,723.22	103
Woodway	1,180	188		1.04		1,134.62	169

While the area is densely population, much of the area still has many trees surrounding residential communities and in greenbelts. Cities and Towns are providing mitigation when new power- and telephones lines are installed by requiring an underground installation. However, most of the lines were installed many years before this requirement and continue to operate aboveground.

Life & Property

Winter storms are deceptive killers. Many of the deaths that occur are indirectly related to the actual storm, including deaths resulting from traffic accidents on icy roads, heart attacks while shoveling snow, hypothermia from prolonged exposure to the cold, and contact with downed power lines.

Property is at risk due to flooding (see *Section II, Flood*) and landslides (see *Section II, Landslide*) resulting from heavy snow melt. Trees, power lines, telephone lines, and television and radio antennas can be impacted by ice, wind, snow, and falling trees and limbs. Saturated soil can cause trees to lose their ability to stand and fall on houses, cars, utilities, and other property.

Icy streets make it difficult for emergency personnel to travel and may pose a secondary threat to life if police, fire, and medical personnel cannot respond to calls quickly.

Roads and Bridges

Snow and ice events resulting in icy road conditions can lead to major traffic accidents. Roads blocked by fallen trees during a windstorm may have tragic consequences for people who need access to emergency services. The ability to travel after a natural hazard event is a priority issue for county residents, organizations, and providers of essential services such as hospitals and utilities.

Power Lines

Historically, falling trees have been the major cause of power outages resulting in interruption of services and damaged property. In addition, falling trees can down electric power lines resulting in the potential for lethal electric shock. Snow and ice can damage utility lines and cause prolonged power outages.

Rising population growth and new infrastructure in the county creates a higher probability for damage to occur from severe winter storms as more lives and property are exposed to risk.

Water Lines

The most frequent water system problem related to cold weather is a break in water mains. Breaks may occur during severe freeze events, as well as during extreme cooling periods during the months of October, November, and December.

Another common problem during severe freeze events is the failure of commercial and residential water lines. Inadequately insulated potable water and fire sprinkler pipes can rupture and cause extensive damage to property.

Risk Analysis

The region is vulnerable to severe storms with the most regularly occurring event being that of windstorms. While the storms are likely to cause damage to individual properties, the larger impact will be that of power or water outages caused by severe weather. If a power outage occurred that affected all 36 square miles of land covered by the seven cities, it would affect a population 133,000 people.

Other major concerns include:

- An increased calls for assistance to traffic accidents
- A rise in the number of house fires caused by the use of candles during a power outage
- A significantly slower response time by fire and police due to road conditions and/or downed trees, limbs, and power lines
- 9-1-1 system overload

Severe Storm Mitigation

Existing Severe Storm Mitigation Activities

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

Utilities

Alderwood Water District

Alderwood Water District has a regular maintenance and repair program to maintain infrastructure and complies with all State and Federal requirements. They have a series of interlocal agreements and memoranda of understanding (MOU's) with other water districts to ensure that water service will be provided regionally if a major event should occur. Additionally, Alderwood Water District is developing a mitigation plan in cooperation with the other water districts in the area.

Snohomish County Public Utility District (PUD)

Snohomish County PUD has a regular schedule for trimming and removing branches and vegetation that could potentially damage power lines during severe weather. This schedule is part of the Snohomish County Public Utility Department Business Continuity Plan, adopted in 2002.

Snohomish County PUD also has a Capital Improvement Plan and other components for planning and mitigation purposes. The PUD will be developing and adopting a Mitigation Plan for their organization.

Federal

National Weather Service

The Seattle Office of the National Weather Service issues severe winter storm watches and warnings when appropriate to alert government agencies and the public of possible or impending weather events. The watches and warnings are broadcast over NOAA weather radio and the Emergency Alert System.

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Severe Storm Resource Directory

The following resource directory lists the resources and programs that can assist county communities and organizations. The resource directory will provide contact information for local, county, regional, state and federal programs that deal with natural hazards.

Federal Resources

Federal Emergency Management Agency (FEMA)

FEMA provides a variety of booklets on thunderstorms, winter storms and their secondary effects. FEMA's mission is to reduce loss of life and property and protect the nation's critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management program of mitigation, preparedness, response and recovery. FEMA Region X serves the northwestern states of Alaska, Idaho, Oregon, and Washington.

Contact: FEMA, Federal Regional Center, Region 10
Address: 228th St. SW, Bothell, WA 98021-9796
Phone: (425) 487-4678
Website: http://www.fema.gov

To obtain FEMA publications:
Phone: (800) 480-2520

National Oceanic and Atmospheric Administration (NOAA)

NOAA's historical role has been to predict environmental changes, protect life and property, provide decision makers with reliable scientific information, and foster global environmental stewardship.

Contact: National Oceanic and Atmospheric Administration
Address: 14th Street & Constitution Avenue NW, Room 6013, Washington, DC 20230
Phone: (202) 482-6090
Fax: (202) 482-3154
Website: http://www.noaa.gov
Email: answers@noaa.gov

National Weather Service, Seattle Bureau

The National Weather Service (NWS) provides weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy. NWS data and products form a national information database and infrastructure, which can be used by other governmental agencies, the private sector, the public, and the global community.

Contact: National Weather Service
Address: 7600 Sand Point Way NE, Seattle, WA 98115
Phone: (206)526-6087
Website: http://www.wrh.noaa.gov

Regional Resources

Western Regional Climate Center

Weather-related data for the western states.

Address: 2215 Raggio Parkway; Reno, NV 89512
Phone: 775/674-7010
Fax: 775/674-7106
Email: wrcc@dri.edu
Website: http://wrcc.sage.dri.edu/

State Resources

Interactive Weather Information Network (IWIN)

Current weather information in cooperation with NOAA.

Website: http://iwin.nws.noaa.gov/iwin/wa/wa/html
Or: http://iwin.nws.noaa.gov/main.html
Email: W-IWIN.Webmaster@noaa.gov

New Name: Washington State Department of Commerce.

The State Building Code Council was created to provide independent analysis and objective advice to the legislature and Governor's Office on state building code issues. The Council establishes the minimum building, mechanical, fire, plumbing and energy code requirements necessary to promote the health, safety, and welfare of the people of the state of Washington, by reviewing, developing, and adopting the state building code.

Contact: Washington State Building Code Council
Physical Address: 906 Columbia St. SW; Olympia, WA 98504
Mailing Address: PO Box 48300; Olympia, WA 98504-8300
Phone: (360)725-2969
Fax: (360)586-9383
Website: http://cted.wa.gov
Email: sbcc@cted.wa.gov

Publications and Additional Resources

Public Assistance Debris Management Guide,

Federal Emergency Management Agency (July 2000).

The Debris Management Guide was developed to assist local officials in planning, mobilizing, organizing, and controlling large-scale debris clearance, removal, and disposal operations. Debris management is generally associated with post-disaster recovery. While it should be compliant with local and county emergency operations plans, developing strategies to ensure strong debris management is a way to integrate debris management within mitigation activities. The Public Assistance Debris Management Guide is available in hard copy or on the FEMA website.

Contact: FEMA Distribution Center
Address: 130 228th Street, SW, Bothell, WA 98021-9796
Phone: (800) 480-2520
Fax: (425) 487-4622
Website: http://www.fema.gov

Washington State Hazard Identification and Vulnerability Assessment (HIVA)

The *Washington State Hazard Identification and Vulnerability Assessment (HIVA)* assesses natural and technological (man-made) hazards in Washington State. Assessment is the initial step in the emergency management process that leads to mitigation against, preparedness for, response to, and recovery from hazards. Hazards have the potential of becoming disasters or emergencies that can adversely affect the people, environment, economy, and property of the state.

Contact: Washington State Military Department, Emergency Management Division
Address: Plans Section, Camp Murray, Washington 98430-5122.
Phone: (800)562-6108
Website: http://emd.wa.gov

Washington State Hazard Mitigation Strategy

A state-wide plan designed to identify, prioritize, and prevent or minimize natural and technical (man-made) hazards.

Contact: Washington State Military Department, Emergency Management Division
Address: Plans Section, Camp Murray, Washington 98430-5122.
Phone: (800)562-6108
Website: http://emd.wa.gov

Washington State Comprehensive Emergency Management Plan

This document establishes emergency management functions and the responsibilities of the Washington State Military Department, Emergency Management Division (EMD), state agencies, commissions, boards, and councils.

Contact: Washington State Military Department, Emergency Management Division
Address: Plans Section, Camp Murray, Washington 98430-5122.
Phone: (800)562-6108
Website: http://emd.wa.gov

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Tsunamis and Seiches

Defining the Hazard

Tsunami – A Japanese word that means harbor wave; a sea wave of local or distant origin that results from large-scale seafloor displacements associated with large earthquakes, major submarine slides, or exploding volcanic islands.

Seiche – A series of standing waves (sloshing action) of an enclosed body or partially enclosed body of water caused by earthquake shaking. Seiche action can affect harbors, bays, lakes, rivers, canals, and sounds.

Background[57]

Tsunami

The phenomenon we call "tsunami" (soo-NAH-mee) is a series of traveling ocean waves of extremely long length. A tsunami can be generated when there is significant vertical movement of the seafloor over a large area, typically caused by large earthquakes occurring below or near the ocean floor. Earthquakes occurring at plate boundaries beneath the ocean, especially subduction earthquakes are particularly effective in generating tsunamis.

Underwater volcanic eruptions and landslides can also generate tsunamis. Large Pacific Ocean tsunamis typically have wave crest to wave crest distances of 60 miles and can travel about 600 miles per hour in the open ocean. A tsunami can traverse the entire 12,000 to 14,000 miles of the Pacific Ocean in 24 hours, striking land with great force. In the deep ocean, the length from wave crest to wave crest may be a hundred miles or more but with a wave height of only a few feet or less. They cannot be felt aboard ships nor can they be seen from the air in the open ocean.

A tsunami becomes a hazard as the wave or waves approach land and the ocean depths decease causing the wave or waves to “feel bottom” and “grow in height” above the surface of the ocean as they reach shore. Tsunamis 10 to 20 feet high have the potential to be very destructive and cause damage to structures as well as injuries or deaths; large tsunamis have been known to rise over 100 feet in height.

Seiche

In the majority of instances, earthquake-induced seiches do not occur close to the epicenter of an earthquake, but hundreds of miles away. This is due to the fact that earthquake shockwaves close to the epicenter consist of high-frequency vibrations, while those at much greater distances are of lower frequency. These low frequency vibrations can enhance the rhythmic movement in a body of water; the largest seiches

develop when the period of ground shaking matches the frequency of oscillation of the body of water.

History of Tsunamis and Seiches

Tsunami

There is no written historical record of a damaging tsunami or seiche occurring in the north King and south Snohomish Counties area.

Geologic evidence of tsunamis has been found at Cultus Bay on Whidbey Island and at West Point in Seattle. Researchers believe these tsunami deposits are evidence of earthquake activity along the Seattle Fault or other shallow crustal faults located in the Puget Sound area. It is estimated that these events occurred around A.D. 900 – 930.[58]

The 1964 Alaska Earthquake generated multiple tsunamis that were recorded throughout the Pacific. The most disastrous tsunami to hit the west coast of the contiguous United States and British Columbia, Canada was from this earthquake. A wave height of approximately 200 feet was recorded in Valdez Inlet (the wave height at Ocean Shores, Washington was approximately 10 feet) and a total of 123 people were killed as a result of the tsunami in Alaska, British Columbia, Oregon, and California. While Washington received minor damage as a result of this tsunami, damages totaled $84 million in Alaska, $10 million in British Columbia, $700,000 in Oregon, and $10 million in California.

From 1992 to 1996, over 2,000 people were killed by tsunamis occurring in Nicaragua, Indonesia, Japan, the Philippines, and Peru with property damage totaling nearly one billion U.S. dollars.

The largest recorded earthquake (magnitude 9.5 Richter) struck just off the coast of Chile in May 1960. This earthquake generated a tsunami that caused destruction throughout the Pacific Ocean including Japan and Hawaii. Much of the damage occurred in Hilo, Hawaii where 61 people were killed and damages totaled over $23 million. This earthquake occurred along a subduction fault where the ocean floor is being pushed beneath the continental land mass. It is important to note that this same plate tectonic setting is found off the coast of southern British Columbia, Washington, Oregon, and northern California.

Historically, tsunamis originating in the northern Pacific and along the west coast of South America have caused more damage on the west coast of the United States than tsunamis originating in Japan and the southwest Pacific.

Seiche

Puget Sound has experienced seiches at various times in the past. In 1891, an earthquake near Port Angeles caused an 8-foot seiche in Lake Washington. Seiches generated by the 1949 Queen Charlotte Islands earthquake were reported on Lake Union and Lake Washington. The 1964 Alaska Earthquake created seiches on 14 inland bodies of water in Washington State.

More recently, a 7.9 magnitude earthquake that occurred on November 3, 2002 near Denali National Park in Alaska created minor seiche action on Lake Union in Seattle causing minor damage to several houseboat dock moorings.

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Hazard Assessment and Risk Analysis

Hazard Identification

While there is no written historical record of a tsunami occurring in the north King and south Snohomish Counties region, scientists have stated that it might be possible for a tsunami to impact the area given the right set of circumstances. These include local earthquakes or large submarine slides.[59]

In addition to the direct impact of a tsunami, such an event could produce extensive seiche action of nearby waters resulting in additional damage to nearby shoreline areas not directly impacted by the tsunami.

The first warning sign of a coming tsunami generated from the Cascadia Subduction Zone may be a large magnitude 8 mega-thrust earthquake with ground shaking possibly lasting as long as 3 minutes. An earthquake of this magnitude would present all of the typical problems associated with a large earthquake but these problems could be compounded in low-lying shoreline areas of King and Snohomish Counties due to tsunami and/or seiche action. Furthermore, studies indicate that about a dozen very large earthquakes with magnitudes of 8 or more have previously occurred in the Cascadia Subduction Zone off the coast of Washington. Computer models indicate that tsunami waves from such an event could be up to 30 feet in height and could affect the entire coast of Washington. Such a tsunami would most likely impact the Pacific coastal areas of Washington but inlets like the Strait of Juan de Fuca, could receive a “wall of water”.

Computer models indicate that locally induced tsunamis from the Cascadia Subduction Zone could generate waves of 6 to 60 feet in height along the Washington Coast. Of particular concern is the possibility of a tsunami generated by a subduction zone earthquake in which the triggering fault could be located at a sufficient distance (i.e., offshore from northern California or northern British Columbia) that Washington coastal residents and tourists would not feel ground shaking. Tsunamis generated by a quake of this size and location may have travel times of an hour or less, and could arrive unannounced.

In addition to damaging homes, businesses, property, and the environment, a tsunami or seiche event in the north King and south Snohomish Counties area could potentially result in damage to the following:

- Washington State ferry dock in Edmonds;
- Washington State ferry dock in Mukilteo;
- Port of Edmonds facilities;
- Marinas and marine-related businesses located in Edmonds;

- Coastal railroad tracks; and
- Waterfront bulkheads, public and private.

Even with prior notification of a potential event, evacuation of low-lying coastal areas would be very difficult due to the unfamiliarity of such events in the area.

Vulnerability Assessment

While the Pacific coastline is most vulnerable to tsunamis generated either at a distance or by a local subduction or crustal zone (shallow) earthquake, the inland waters on the Strait of Juan de Fuca are also vulnerable to tsunamis. People and property on or near beaches or located in low-lying areas of coastal towns and cities, near tidal flats or near mouths of rivers draining into the ocean are most vulnerable to the impacts of a large tsunami. In addition to the tremendous hydraulic force of the tsunami waves themselves, floating debris carried by a tsunami can endanger human lives and damage structures. Ships and boats moored at piers and in harbors may be swamped and sunk or left battered and stranded high on the shore.

Breakwaters and piers could collapse due to the sheer impact of the waves or because of severe scouring actions that sweep away their foundation materials. Railroad lines situated near shorelines are particularly vulnerable to the impacts of tsunami and seiche.

Local rail transportation may be severely impacted due to the fact that the Burlington Northern railroad lines are typically located along shoreline areas throughout much of the Puget Sound region. Large fires fueled by large amounts of flammable liquids from damaged facilities such as marinas can cause additional, secondary damage.

Port and other public utilities facilities as well as marinas are frequently the backbone of the economy of areas impacted by tsunami and seiche and these are the very resources that generally receive the most severe damage. Until debris can be cleared, wharves and piers rebuilt, and utilities restored, communities may find themselves without tourist revenue and employment.

While most of these areas are primarily residential in nature, the numerous port and marina facilities as well as the downtown commercial areas of Edmonds and Woodway would be especially vulnerable to any tsunami or severe seiche action.

The tsunami generated by the 1964 Alaska Earthquake that struck Hilo, Hawaii washed every house on the main street facing Hilo Bay across the street smashing them against the buildings on the opposite side of the

street. Houses were overturned, railroads ripped from their roadbeds, coastal highways buried, and beaches washed away. The waters off the island were dotted with floating houses, debris, and people. Property damage in Hawaii was $26 million (in 1964 dollars) as a result of this tsunami.

Risk Analysis

Considering that there have been no recorded damaging tsunami events within Puget Sound, and no serious damage as a result of recorded seiche events in or around north King or south Snohomish County, there is a very low probability of a tsunami or seiche event impacting the area and therefore, there is a very low risk to persons and/or property due to tsunami events.

The participating jurisdictions are more likely to be affected by a seiche event due to a large underwater landslide or a local, shallow crustal earthquake that causes severe ground shaking than from a damaging tsunami.

Should a tsunami or seiche event impact the North King and South Snohomish Counties area, shoreline and nearby low-lying areas would be most seriously impacted. Alaska averages a tsunami every 1.75 years and a damaging event every 7 years. The west coast of the United States experiences a damaging tsunami about every 18 years.

Geologic evidence shows that the Cascadia Subduction Zone has generated great earthquakes in the past, the most recent about 300 years ago. Large earthquakes also occur at the southern terminus of the Cascadia Subduction Zone in Northern California and near the Oregon border. Any large earthquake has the capability to generate a tsunami or severe seiche action.

Recent studies regarding the potential for a great subduction zone earthquake off the Washington, Oregon, and Northern California coastlines indicate that local tsunami waves may reach nearby coastal communities within minutes of the earthquake thereby giving little or no time to issue warnings.

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Tsunami and Seiche Mitigation

Existing Mitigation Activities

At this time, the Washington State Department of Natural Resources Department of Geology and Earth Resources is working to develop new models for locally-originating tsunamis in the Puget Sound region. At this time, the modeling and mapping is scheduled to be developed in Federal FY 2006-2007.

Local jurisdictions will maintain contact with the Department of Geology and Earth Resources to obtain new information as it is developed and will incorporate the models into future mitigation planning.

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Tsunami and Seiche Resource Directory

The following resource directory lists the resources and programs that can assist county communities and organizations. The resource directory will provide contact information for local, county, regional, state and federal programs that deal with natural hazards.

Federal Resources

US Geological Survey (USGS)

The USGS is an active seismic research organization that also provides funding for research. (For an example of such research, see Recommended Seismic Publications below).

Contact: USGS, National Earthquake Information Center
Address: Box 25046; DFC, MS 967; Denver, CO 80225
Phone: (303) 273-8500
Fax: (303) 273-8450
Website: http://usgs.gov

Coastal Training Program

A national initiative, funding through NOAA's National Estuarine Reserves Division and implemented in the State of Washington by the Padilla Bay Reserve. Padilla Bay Reserve is part of Washington Department of Ecology's Shoreline and Environmental Assistance Program.

Contact: Cathy Angell, CTP Coordinator
Address: 10441 Bayview-Edison Rd; Mt. Vernon, WA 98273
Phone: (360)714-1982
Website: http://www.ecy.wa.gov/programs

National Oceanic and Atmospheric Administration (NOAA)

NOAA's historical role has been to predict environmental changes, protect life and property, provide decision makers with reliable scientific information, and foster global environmental stewardship.

Contact: National Oceanic and Atmospheric Administration
Address: 14th Street & Constitution Avenue NW, Room 6013,
Washington, DC 20230
Phone: (202) 482-6090
Fax: (202) 482-3154
Website: http://www.noaa.gov
Email: answers@noaa.gov

National Weather Service, Seattle Bureau

The National Weather Service (NWS) provides weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy. NWS data and products form a national information database and infrastructure, which can be used by other governmental agencies, the private sector, the public, and the global community.

Contact: National Weather Service
Address: 7600 Sand Point Way NE, Seattle, WA 98115
Phone: (206)526-6087
Website: http://www.wrh.noaa.gov

US Geological Survey (USGS)
Coastal and Marine Geology Program (CMGP)

Multi-disciplinary scientific research in the coastal and offshore areas of California, Oregon, Washington, Alaska, Hawaii, and other US Pacific Islands; and in other waterways in the United States. The broad goals of the Program are to collect information, monitor conditions, and distribute findings about geologic hazards, environmental conditions, habitats, geologic processes, and energy and mineral resources. Its activities help the Department of Interior and other government managers make informed decisions about the use and protection of our coastal and marine resources.

Contact: US Geological Survey Coastal and Marine Geology Program
Address: 345 Middlefield Road, MS 999; Menlo Park, CA 94025
Phone: (650)853-8300
Website: http://marine.usgs.gov

Regional Resources

Cascadia Region Earthquake Workgroup (CREW)

The Cascadia Region Earthquake Workgroup provides information on regional earthquake hazards, facts, and mitigation strategies for homes and businesses. CREW is a non-profit coalition of private and public representatives working together to improve the ability of Cascadia Region communities to reduce the effects of earthquake events. Members are from Oregon, Washington, California, and British Columbia. CREW's goals are to:

- Promote efforts to reduce the loss of life and property;
- Conduct education efforts to motivate key decision makers to reduce risks associated with earthquakes; and
- Foster productive linkages between scientists, critical infrastructure providers, businesses, and governmental agencies in order to improve the viability of communities after an earthquake event.

Contact: CREW, Executive Director c/o Bob Freitagg
Address: 3110 Portage Bay Pl E, Slip G, Seattle, WA 98102
Phone: (206) 328-2533
Fax: Same, but call first
Website: http://www.crew.org

Western States Seismic Policy Council Earthquake Program Information Center (WSSPC)

WSSPC is a regional earthquake consortium primarily funded by FEMA. Its website is a great earthquake resource, with information clearly categorized - from policy to engineering to education.

Contact: Western States Seismic Policy Council
Address: 125 California Avenue, Suite D201, #1, Palo Alto, CA 94306
Phone: (650) 330-1101
Fax: (650) 326-1769
E-mail: wsspc@wsspc.org
Website: http://www.wsspc.org

State Resources

Pacific Northwest Seismograph Network (PNSN)

Regional earthquake research.

Contact: University of Washington, Dept. of Earth and Space Sciences
Address: Box 351310; Seattle, WA, 98195-1310
Phone: (206) 543-7010
Email: (seis_info@ess.washington.edu
Website: http://www.pnsn.org

Shoreland and Environmental Assistance Program (SEA)

Part of Washington State's Department of Ecology. This department provides information about managing shorelands and wetlands. It focuses primarily on state and local responsibilities in administering state laws and federally-delegated laws.

Contact: Washington State Department of Ecology;
Shorelands and Environmental Assistance Program
Address: P.O. Box 47600; Olympia, WA 98504-7600
Phone: (360)407-6600
Website: http://www.ecy.wa.gov/programs/sea/shorelan.html

University of Washington, Earth & Space Sciences

The University of Washington conducts research and prepares inventories and reports for communities throughout Washington relating to earthquakes, landslides, and tsunamis. The department uses a multi-disciplinary approach to provide a basis for making accurate predictions of future conditions

Contact: University of Washington, Earth & Space Sciences
Physical Address: Johnson Hall, Room 070; Seattle, WA 98195
Mailing Address: Box 351310; Seattle, WA 98195
Phone: (206)543-1190
Website: http://www.geophys.washington.edu

Publications

Public Assistance Debris Management Guide, Publication 325

Federal Emergency Management Agency (July 2000).

The *Debris Management Guide* was developed to assist local officials in planning, mobilizing, organizing, and controlling large-scale debris clearance, removal, and disposal operations. Debris management is generally associated with post-disaster recovery. While it should be compliant with local and county emergency operations plans, developing strategies to ensure strong debris management is a way to integrate debris management within mitigation activities. *The Public Assistance Debris Management Guide* is available in hard copy or on the FEMA website.

Contact: FEMA Distribution Center
Address: 130 228th Street, SW, Bothell, WA 98021-9796
Phone: (800) 480-2520
Fax: (425) 487-4622
Website: http://www.fema.gov/government/grant/pa/demagde.shtm

King County HIVA

This document identifies natural and technological hazards in the King County region.

Contact: King County Office of Emergency Management
Address: 3511 NE 2nd Street, Renton, WA 98056
Phone: (206)296-3830
Toll Free: 800-523-5044
Fax: 206-205-4056
website: ecc.kc@kingcounty.gov

Snohomish County HIVA

This document identifies natural and technological hazards in the Snohomish County region.

Contact: Snohomish County Department of Emergency Management
Address: 3509 109th Street SW; Everett, WA 98204
Phone: (425)388-5060
Fax: (425)423-9152
Website: http://www1.co.snohomish.wa.us/Departments/Emergency_Management

Washington State Comprehensive Emergency Management Plan

This document establishes emergency management functions and the responsibilities of the Washington State Military Department, Emergency Management Division (EMD), state agencies, commissions, boards, and councils.

Contact: Washington State Military Department, Emergency Management Division
Address: Plans Section, Camp Murray, Washington 98430-5122.
Phone: (800)562-6108
Website: http://emd.wa.gov

Washington State Hazard Identification and Vulnerability Assessment (HIVA)

The *Washington State Hazard Identification and Vulnerability Assessment (HIVA)* assesses natural and technological (man-made) hazards in Washington State. Assessment is the initial step in the emergency management process that leads to mitigation against, preparedness for, response to, and recovery from hazards. Hazards have the potential of becoming disasters or emergencies that can adversely affect the people, environment, economy, and property of the state.

Contact: Washington State Military Department, Emergency Management Division
Address: Plans Section, Camp Murray, Washington 98430-5122.
Phone: (800)562-6108
Website: http://emd.wa.gov

Washington State Hazard Mitigation Strategy

Contact: Washington State Military Department, Emergency Management Division
Address: Plans Section, Camp Murray, Washington 98430-5122.
Phone: (800)562-6108
Website: http://emd.wa.gov

Managing Washington's Coastline: Washington State's Coastal Zone Management Program (Pub. 00-06-029)

Washington State of Ecology

This document describes the Department of Ecology's Coastal Zone Management Program. Participating states are required to describe their coastal zone management programs and submit those descriptive documents to the National Oceanic and Atmospheric Administration (NOAA) for approval.

Contact: Washington State Department of Ecology
Physical Address: 300 Desmond Dr. SE; Lacey, WA 98504
Mailing Address: P.O. Box 47600; Olympia, WA 98504-7600
Phone: (360)407-6000 Info & Reception
Website: http://www.ecy.wa.gov/

Enforcing the Shoreline Management Act: Guidance for Local Government Administrators (Pub. 95-101)

Washington State of Ecology

This document is a reference manual and provides technical assistance for local governments on how to enforce the Shoreline Management Act.

Contact: Washington State Department of Ecology
Physical Address: 300 Desmond Dr. SE; Lacey, WA 98504
Mailing Address: P.O. Box 47600; Olympia, WA 98504-7600
Phone: (360)407-6000
Website: http://www.ecy.wa.gov/

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Volcanoes

Defining the Hazard[60]

The following terminology and definitions are used to describe volcanic activity:

Composite Volcano – typically steep-sided, symmetrical cones of large dimension built of alternating layers of lava flows, volcanic ash and tephra. Typical features include a crater at the summit, which contains a central vent or a clustered group of vents connected to a conduit system through which magma from a reservoir deep in the Earth's crust rises to the surface; sometimes called stratovolcanoes.

Debris Flow – fast-moving slurry of rock, mud, and water that looks and behaves like flowing wet concrete; similar to but *coarser* and *less cohesive* than a mudflow.

Lahar – an Indonesian word describing mudflows and debris flows that originate from the slope of a volcano; pyroclastic flows can generate lahars by rapidly melting snow and ice.

Lava – molten rock or magma that erupts, or oozes onto the Earth's surface.

Lava Dome – a mound of hardened lava that forms when viscous lava is erupted slowly and plies up over the vent rather than moving away as a lava flow.

Lava Flow – streams of molten rock or magma that erupt relatively non-explosively from a volcano and move slowly downslope.

Magma – molten rock located below the surface of the Earth.

Mudflow – a fast-moving slurry of rock, mud, and water that looks and behaves like flowing wet concrete; similar to but *less coarse* and *more cohesive* than a debris flow.

Pyroclastic Flow – a hot, fast-moving avalanche of ash, rock fragments and gas that moves down the sides of a volcano during explosive eruptions or when the steep edge of a dome breaks apart and collapses.

Tephra – large fragments of rock and natural glass that are blasted from a volcano during a violent eruption and then falls to Earth.

USGS – United States Geological Survey

Volcanic Ash – small fragments of rock and natural glass that are blasted from a volcano during a violent eruption and then falls to Earth. During large events, volcanic ash can travel hundreds of miles.

Volcano – a vent in the earth's crust through which magma (molten rock), rock fragments, gases, and ashes are ejected from the earth's interior. A volcanic mountain is created over time by the accumulation of these erupted products on the earth's surface.

Background Information[61]

The Cascade Range extends more than 1,000 miles forming an arc-shaped band extending from Southern British Columbia to Northern California lying roughly parallel to the Pacific coastline and includes 14 major volcanic centers. The Cascade Range is made up of a band of thousands of very small, short-lived volcanoes that have built a platform of lava and volcanic debris. Rising above this volcanic platform are a few strikingly large volcanoes that dominate the landscape. The Cascades volcanoes define the Pacific Northwest section of the "Ring of Fire", a fiery array of volcanoes that rim the Pacific Ocean.

Many of these volcanoes have erupted in the recent past and will most likely be active again in the future. Given an average rate of two eruptions per century during the past 12,000 years, these disasters are not part of our everyday experience. Mount St. Helens reminded us with the 1980 eruption, however, that though the state's volcanoes are usually quiet, they are not to be ignored. Geologic evidence indicates that both Mount Baker and Glacier Peak have erupted in the past and will no doubt erupt again in the foreseeable future. Due to the topography of the region and the location of drainage basins and river systems, eruption events on either Mount Baker or Glacier Peak resulting in pyroclastic flows, tephra or ash fall, and lava flows could severely impact portions of the north King and south Snohomish Counties region.

Regional History of Volcanoes[62]

Eruptions in the Cascades have occurred at an average rate of 1-2 per century during the past 4,000 years, and future eruptions are certain. Seven volcanoes in the Cascades have erupted within the past 225 years. Four of those eruptions would have caused considerable property damage and loss of life if they had occurred today without warning – the next eruption in the Cascades could affect hundreds of thousands of people.

The most recent volcanic eruption events within the Cascade Range occurred at Mount Saint Helens in Washington (1980-1986) and at Lassen Peak in California (1914-1917).

Mount Baker[63]

Mount Baker is located about 31 miles due east of the City of Bellingham in Washington State. After Mount Rainier, it is the most heavility glaciated of the Cascade volcanoes: the volume of snow and ice on Mount Baker (about 0.43 cubic miles) is greater than all of the other Cascades volcanoes (except Rainier) combined.

Geologic evidence in the Mount Baker area reveals a flank collapse near the summit on the west side of the mountain. The displaced soil transformed into a lahar that is estimated to have been approximately 300 feet deep in the upper reaches of the Middle Fork of the Nooksack River and could have been up to 25 feet deep 30 miles downstream. A huge hydrovolcanic (water mixed with magma) explosion occurred near the site of present day Sherman Crater, triggering a second collapse of the flank just East of the Roman Wall. This collapse also became a lahar that 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. Geologic evidence shows lahars large enough to reach Baker Lake have occurred at various times in the past.

Historical activity at Mount Baker includes several explosions during the mid-19th century, which were witnessed from the Bellingham area. Sherman Crater (located just South of the summit) probably originated with a large hydrovolcanic explosion. In 1843, explorers reported a widespread layer of newly fallen rock fragments and rivers south of the volcano were clogged with ash. 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 water level at least 10 feet.

In 1975, increased fumarolic activity in the Sherman Crater area caused concern that an eruption might be imminent. Additional monitoring equipment was installed and several geophysical surveys were conducted to try to detect the movement of magma. The level of the present day Baker Lake reservoir (located to the east and south of the mountain) was lowered and people were restricted from the area due to concerns that an eruption-induced debris avalanche or debris flow might enter Baker Lake and displace enough water to either cause a wave to overtop the Upper Baker Dam or cause complete failure of the dam. However, few anomalies other than the increased heat flow were recorded during the surveys nor were any other precursory activities observed to indicate that magma was moving up into the volcano. This volcanic activity gradually declined over the next two years but stabilized at a higher level than before 1975. Several small lahars formed from material ejected onto the surrounding glaciers and acidic water was discharged into Baker Lake for many months.[64]

Glacier Peak

Unlike Mount Baker, Glacier Peak is not prominently visible from any major city, though it lies only 70 miles northeast of Seattle. With an elevation of 10,541 feet, it is the next-to-shortest of the major Washington volcanoes. Its small size belies a violent past. Glacier Peak has produced larger and more explosive eruptions in post-glacial time than any other Washington volcano with the exception of Mount St. Helens. During this time period, Glacier Peak has erupted multiple times during at least six separate episodes, most recently about 300 years ago.

Glacier Peak and Mount Saint 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 magma they produce which is too viscous to flow easily out of the eruptive vent and must be pushed out under high pressure. As the magma approaches the surface, expanding gas bubbles within the magma burst and break into countless fragments of tephra and ash. The largest of these eruptions occurred about 13,000 years ago and ejected more than five times as much tephra as the May 18, 1980, eruption of Mount Saint Helens.

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. Deposits from ash clouds mantle ridges East of the summit.

There is definite evidence that pyroclastic flows have mixed with melted snow and glacial ice to form lahars that have severely affected river valleys that head on Glacier Peak. Approximately 13,000 years ago, dozens of eruption-generated lahars descended down the White Chuck, Suiattle, and Sauk Rivers, inundating valley floors. Geologic evidence indicates that lahars flowed down both the North Fork Stillaguamish (then an outlet of the upper Sauk River) and the Skagit River to Puget Sound. These lahars deposited more than seven feet of material as far away as 60 miles from Glacier Peak. The Sauk River's course via the Stillaguamish was abandoned and the Sauk River began to drain only into the Skagit River as it still does today.[65]

Figure 7: Aerial Photo of Glacier Peak

Mount St. Helens

Mount St. Helens is located in Skamania County in the eastern part of the Cascade Range. It lies within 50 miles of two other volcanoes: Mount Adams and Mount Rainier.

On May 18, 1980, after nearly two months of local earthquakes and steam eruptions, Mount St. Helens erupted for the first time since 1857. The event began with a major explosive eruption directed first northward and then upward. The lateral blast, which lasted only the first few minutes of a 9-hour continuous eruption, devastated more than 150 square miles of forest and recreation area, killed countless animals, and left about 60 persons dead or missing. The 9-hour eruption, the huge debris avalanche that immediately preceded it, and the intermittent eruptions during the following three days removed about 4 billion cubic yards (0.7 cubic mile) of new magmatic material and, on the upper and northern parts of the mountain, included about 170 million cubic yards (0.03 cubic mile) of glacial snow and ice.

The eruption caused pyroclastic flows and many mudflows, the largest of which produced deposits so extensive and voluminous that they reached and blocked the shipping channel of the Columbia River about 70 river miles from the volcano. The May 18 eruption blew volcanic ash, consisting of pulverized

old rock from the mountain's core as well as solidified new lava, more than 15 miles into the air. Winds carried the ash generally eastward across the United States and, in trace amounts, around the world. The ash, which fell in troublesome amounts as far east as western Montana, severely disrupted travel, caused economic loss, and resulted in other problems.

Figure 8: Mount St. Helens, before the 1980 eruption

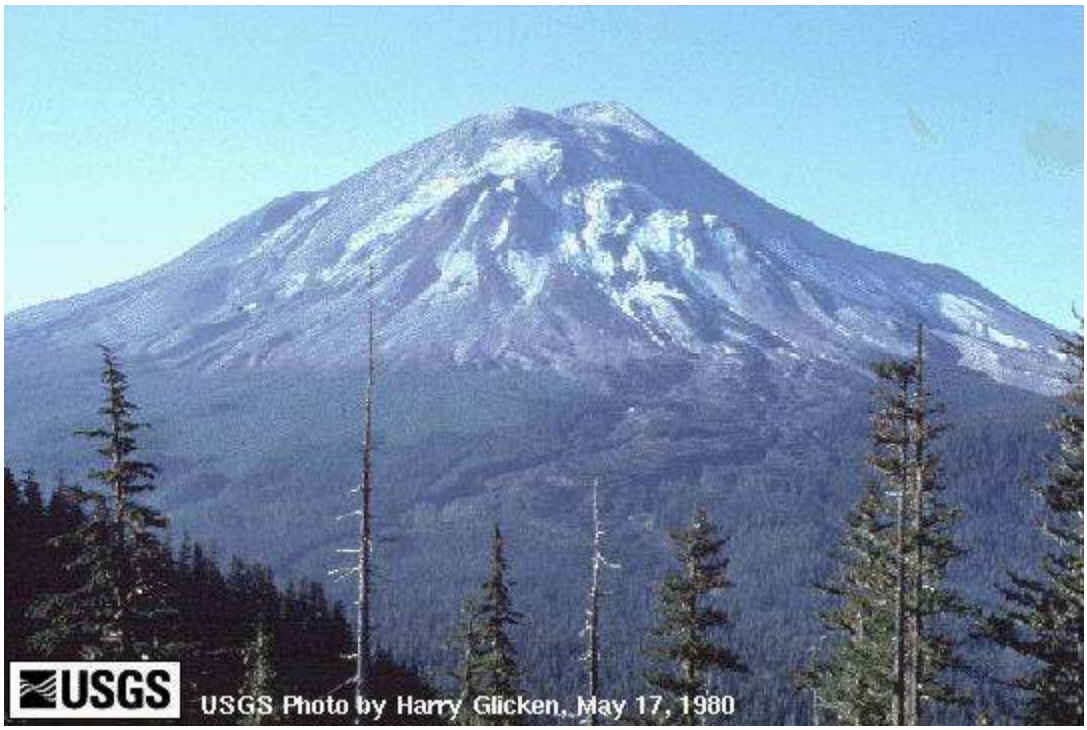


Figure 9: Mount St. Helens, approximately 4 months after the eruption

Mount Adams[66]

Mount Adams, one of the largest volcanoes in the Cascade Range, dominates the Mount Adams volcanic field in Skamania, Yakima, Klickitat, and Lewis counties and Yakima Indian Reservation of south-central Washington. The nearby Indian Heaven and Simcoe Mountains volcanic fields lie west and southeast, respectively, of the 1,250 square kilometers Adams field. Although Mount Adams has been less active during the last few thousand years than neighboring Mounts St. Helens, Rainier, and Hood, it will assuredly erupt again. Future eruptions will probably occur more frequently from vents on the summit and upper flanks of Mount Adams than from vents scattered in the volcanic fields beyond. Large landslides and lahars that need not be related to eruptions probably pose the most destructive, far-reaching hazard of Mount Adams.

In 1921, about 5 million cubic yards of altered rock fell from the head of Avalanche Glacier on the southwest flank of the volcano and traveled almost four miles down Salt Creek valley. The debris avalanche contained or acquired sufficient water to partly transform into small lahars.

Ancient debris avalanches of much larger size have also occurred at Mount Adams, and these formed lahars that traveled far down the White Salmon and other valleys. An avalanche of roughly 90 million cubic yards of debris initiated the largest of these lahars about 6,000 years ago. This lahar inundated the Trout Lake lowland and continued down the valley of the White Salmon River at least as far as Husum, more than 35 miles from Mount Adams. The lahar deposit left in the lowland varies from 3 to 65 feet thick and is clearly visible today as a sediment layer in the banks of the White Salmon River and as isolated blocks (some more than 16 feet in diameter) that protrude from fields and meadows.

Mount Rainier[67] [68]

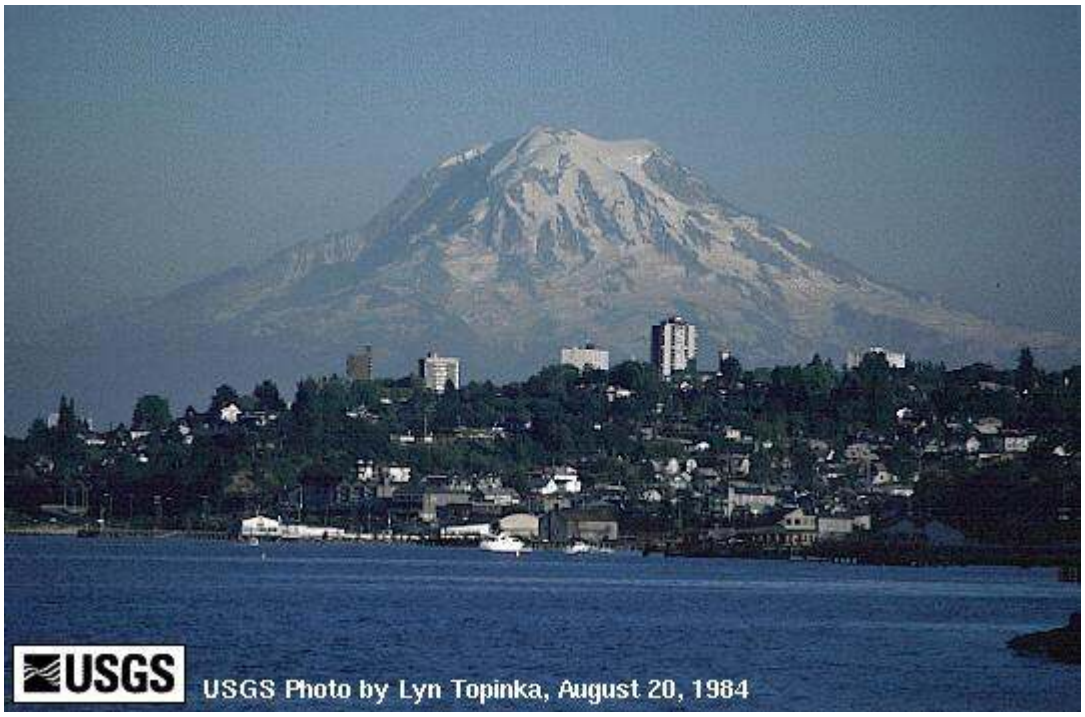
Mount Rainier is the highest peak in the Cascade Range and forms a dramatic backdrop to the Puget Sound region. It stands nearly three miles higher than the lowlands to the west and 1.5 miles higher than the surrounding mountains. The volcano's base spreads over an area of about 100 square miles, and lava flows that radiate from the base of the cone extend to distances of as much as 9 miles. The flanks of Mount Rainier are drained by five major rivers and their tributaries.

Mount Rainier is potentially the most dangerous volcano in the Cascades because it is very steep, covered in large amounts of ice and snow, and near a large population that lives in lowland drainages. Numerous debris avalanches have started on the volcano. The largest debris avalanche traveled more than 60 miles to Puget Sound.

Mount Rainier is known to have erupted as recently as the 1840's, and large eruptions took place around 1,000 and 2,300 years ago.

While Mount Rainier and other similar volcanoes in the Cascade Range erupt much less frequently than the Hawaiian volcanoes, their eruptions are vastly more destructive. Hot lava and rock debris from Rainier's eruptions have melted snow and glacier ice and triggered debris flows (mudflows) – with a consistency of churning wet concrete – that have swept down all of the river valleys that head on the volcano. Debris flows have also formed by collapse of unstable parts of the volcano without accompanying eruptions. Some debris flows have traveled as far as the present margin of Puget Sound, and much of the lowland to the east of Tacoma and the south of Seattle is formed of pre-historic debris from Mount Rainier.

Figure 10: Mount Rainier, with City of Tacoma in the foreground.



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Hazard Assessment and Risk Analysis

Hazard Identification

We know from geological evidence that Mount Baker and Glacier Peak have produced numerous volcanic events in the past. Volcanic hazards from Mount Baker and Glacier Peak result from two main eruptive phenomena: ash fall and tephra fall.

Lahars

Lahars, also called volcanic mudflows or debris flows, are slurries of volcanic rock, sediment, and ash mixed with water that rush down stream and river valleys leading away from a volcano. They can travel more than 60 miles downstream, commonly reaching speeds between 20 and 35 miles per hour (the fastest lahars on Mount Saint Helens traveled over 70 miles per hour).

Lahars may obtain depths of several hundred feet in canyons near their point of origin but spread out over valleys and low ridges downstream. Close to the volcano, lahars have the power to destroy entire forests and demolish large buildings and bridges. Further downstream, they entomb everything in mud. A very large lahar could overtop or destroy a dam.

In addition to damaging or destroying transportation routes, homes, and farmland, lahars can restrict or block river channels, and increase the occurrence and/or severity of flood events for years or decades due to filled stream channels. In some cases, very large lahars may cause river courses to be significantly altered, flooding some areas and leaving other areas without water flow.

Though the risk is low, the north King and south Snohomish Counties area could potentially be affected the secondary affects of lahar. This would occur through flooding caused by altered river courses.

Lava Flows

Lava flows from Cascade Range volcanoes tend to be small and slow moving due to the viscosity of the magma. Due to the distance between the region's volcanoes and the jurisdictions participating in this Mitigation Plan, lava is not likely to be a direct hazard. It is possible that the region could feel secondary effects from lava flow if rivers and streamflows are diverted from existing paths.

Pyroclastic Flows

High-speed avalanches of hot ash, rock fragments, and gas can move down the slopes of volcanoes during an explosive eruption or when the dome breaks apart and collapses. Pyroclastic flows can reach temperatures up to 1,000 degrees Celsius and travel at speeds up to 100 miles per hour and are capable of capable of knocking down and burning everything in their path. The May 18, 1980 eruption of Mount Saint Helens generated a lateral pyroclastic blast that destroyed an area of approximately 450 square miles with an estimated initial velocity in excess of 500 miles per hour.

There is some potential for damage or destruction if Glacier Peak erupted. Due to the rare occurrence of these events, however, the overall risk is extremely low.

Steam and Gas Explosions

Explosions of steam and other gases, containing suspended, pulverized fragments of older rocks as well as newly erupted lava bombs or blocks may occur at any time hot magma or other material comes in contact with water, glacial ice, or snow.

Tephra and Ash

Not all volcanic eruptions involve the extrusion of large amount of magma. In some cases (as with Glacier Peak and Mount Saint Helens) eruption events may be preceded by an extreme build-up of pressure within the volcano and conclude with such a violent and explosive release of tephra and ash particles into the air. Particles may range in size from microscopic ash to boulders 36 inches in diameter. As the ash falls to Earth, it forms a layer that covers broad areas downwind from the volcano, generally decreasing in thickness and particle size as distance from the source increases. Heavy ashfall can blot out sunlight.

Most injuries and fatalities from tephra occur miles away where ash-sized fallout from the eruption accumulates thickly on roofs and other human-made structures and causes structural collapse - especially when the ash is wet. Even dry, a layer of ash four inches thick weighs 120 to 200 pounds per square yard.[69]

Ash may clog watercourses, cause electrical short circuits, and make driving hazardous or impossible; aircraft are particularly vulnerable to ash. Because winds and air currents easily carry it, ash deposits usually remain a hazard to all types of machinery and transportation for many months following an eruption.

Ash can be a health hazard. It can clog and/or restrict breathing passages and may even cause death; however, a short period of exposure has not

been found to be harmful to persons in normal health. When an ash cloud mixes with rain, sulfur dioxide combines with water to form diluted sulfuric acid that may cause minor (but painful) burns to skin, eyes, nose, throat, and mucous membranes. Acid rains may also affect water supplies.

Volcanic Earthquakes

Volcanic earthquakes are usually centered within or beneath the volcano and are generally categorized as: pre-eruption earthquakes caused by explosions of steam or underground magma movements; eruption earthquakes caused by explosions and/or collapse of interior crater walls; post-eruption earthquakes caused by magma retreat and interior structural collapse of the volcano.

Volcanic Landslides

Avalanches of glacial ice or rock debris may be set in motion without warning by volcanic explosions, earthquakes, flank collapses, or heat-induced melting snow and ice. These landslides may not become a full-fledged mudflow but can cause considerable damage in valleys and drainages close to the slopes of the mountain.

Vulnerability Assessment

The degree of volcanic hazard from the volcanoes of the Cascade Range depends upon the type, size, and origin of the eruption. While the possibility of a large volcanic eruption exists, these types of events are typically separated by several hundred to a few thousand years and it is unlikely that we will see such an event in our lifetimes. People, property, and infrastructure closest to the volcano at the time of the eruption are most vulnerable. The distance between the volcanoes and the jurisdictions participating in this Mitigation Plan helps minimize the direct threat from an eruption.

Should a Saint Helens-type event occur at either Mount Baker or Glacier Peak, large portions of the Skagit River floodplain could be severely impacted by flooding, ash fall, or lahar. While the north King and south Snohomish Counties region is not directly affected by the Skagit River as it now lies, volcanic activity could change the flow of the river and impact the area in unforeseen ways.

Tephra and Ash Fall

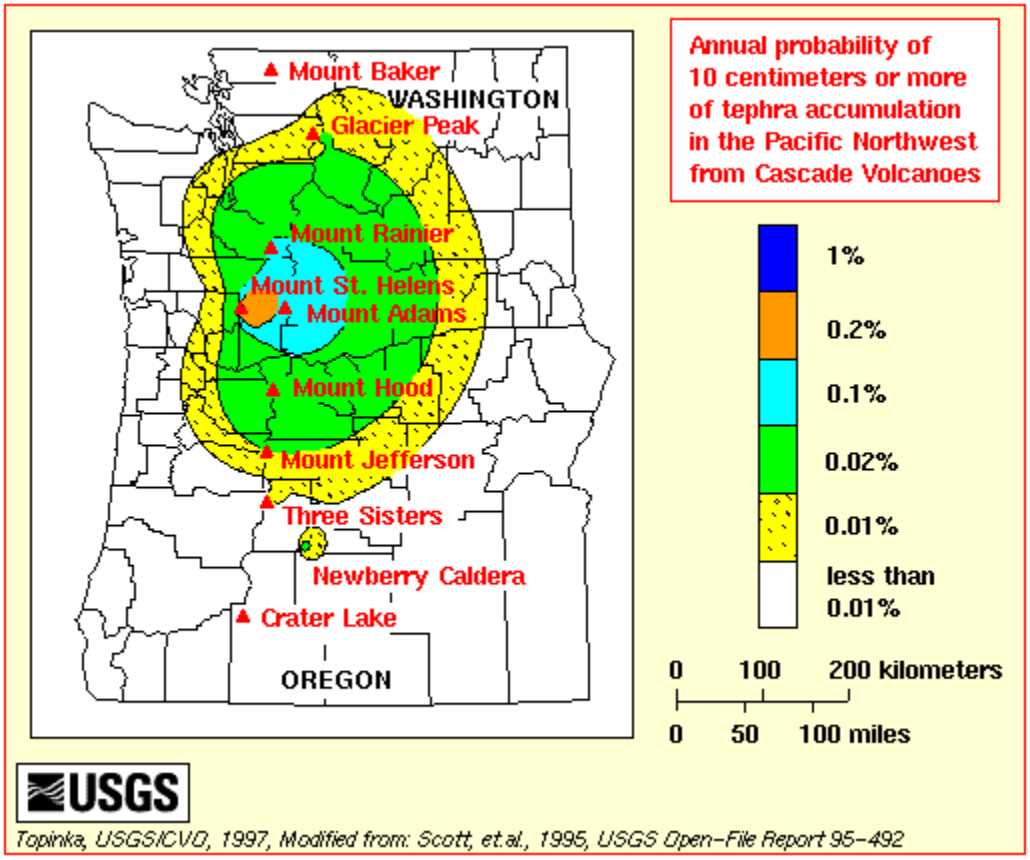
Because of the location of Mount Baker and Glacier Peak and the flow direction of prevailing winds, the majority of airborne ash would most likely be carried to the northeast or east and away from population centers in the north King and south Snohomish Counties region should an ash eruption occur. Regardless of wind direction, there would still be

considerable amount of ash fall in the immediate vicinity of the volcano during and immediately flowing an explosive tephra and ash eruption.

The 1980 eruption of Mount Saint Helens produced enough ash fall to reduce the maximum flow capacity of the Cowlitz River from 76,000 cubic feet per second to less than 15,000 cubic feet per second and also reduced the channel depth of portions of the Columbia River from 40 feet to 14 feet.

The good news is that the US Geologic Survey Cascades Volcano Observatory projects that the north King and south Snohomish counties region has only about one-hundredth of one percent (0.01%) probability of accumulating 10 centimeters or more of tephra in any given year.

Figure 11: Cascade Range Volcanoes -- Ash Accumulation of 10cm or more



Pyroclastic Flows

As mentioned in the *Hazard Identification* section, there is a slight potential for pyroclastic flows from Glacier Peak to affect the north King

and south Snohomish Counties area. This risk is due to the relatively short distance (70 miles) between Glacier Peak and the participating jurisdictions and the destructive capacity of an explosive eruption.

This is an extremely low risk to the area due to the rare occurrence of a volcanic event.

Secondary Effects

Lahar

The river valleys and associated floodplains of the Baker River, Skagit River, Sauk River, and Suiattle River along with their associated tributaries are all especially vulnerable to the effects of large-scale lahars and associated flooding that will no doubt result from a large lahar.

As demonstrated during the 1980 Mount Saint Helens eruption, the hydraulic power of fast-moving lahars and debris flows is astonishing. Sandbags and other "normal" flood fight measures will not be effective to provide any type of protection for such an event. Furthermore, problems related to lahar debris could last for years and even decades because of the tremendous volume of loose rock and ash that has could potentially have been added to the ground surface near the volcano. This debris could provide a source of material that would no doubt flow downstream during flood events for many years following the eruption event.

Refugees

A secondary effect of a volcanic eruption would be the influx of refugees from the areas surrounding the volcano. Should there be an eruption, thousands of people will be displaced from their homes and communities, and they will need food and shelter. Depending on how much advanced warning was available, they may need to replace medication and clothing.

Critical Services

Hospitals and other medical providers will be called upon to provide services to a larger-than-normal population.

Roads are likely to be overloaded resulting in traffic jams. This, in turn, could affect the ability of fire and police to respond to calls and result in longer response times.

The overloaded systems will be further aggravated by the fact that some local medical, fire, and police personnel will be called upon to assist in response closer to the eruption.

The increased population will create greater demand for utility services such as water and electricity. Cell phone service is also likely to be taxed beyond its capacity.

In the short run, virtually all critical services and infrastructure is likely to be overwhelmed by the influx of people.

Risk Analysis

Because of the historical infrequency of such events, it is unlikely that we will see a volcanic eruption in our lifetimes.

As previously stated, ash fall presents the greatest volcanic hazard to the north King and south Snohomish Counties region resulting from activity at either Mount Baker or Glacier Peak. Therefore, there is a *Low Probability* of such an event occurring but a *Moderate Risk* to persons, property, and the environment in the area should an eruption occur from either Mount Baker or Glacier Peak.

Based on past events and especially the 1980 eruption of Mount Saint Helens, future eruptions from either Mount Baker or Glacier Peak will almost certainly be preceded by an increase in seismic (earthquake) activity, and possibly by measured swelling of the volcano and emission of volcanic gases. The University of Washington Geophysics Program, in cooperation with the USGS, monitors seismic activity at Mount Baker and other Cascade Range volcanoes that could signal a possible future eruption. In addition, the USGS monitors gas emissions from Sherman Crater on Mount Baker to detect possible changes in the volcano's interior "plumbing system" that may be a warning of impending magma activity or an increase in hydro-volcanic activity in an effort to predict the likelihood of an eruption event. This ability to monitor seismic and other types of activity at Mount Baker and Glacier Peak provides a warning system of sorts for volcanic eruptions that could impact the region.

Furthermore, the 1980 Mount Saint Helens eruption made it clear that preparing for and responding to a large-scale volcanic eruption must involve a wide variety of agencies and jurisdictions. For this reason, emergency managers from Snohomish, Skagit, and Whatcom Counties, the State of Washington, and the Province of British Columbia, as well as personnel from the United States Forest Service developed the *Mount Baker-Glacier Peak Coordination Plan*. The plan was adopted in April 2001, and provides a tool to coordinate the actions that various agencies must take to minimize loss of life and damage to property before, during, and after a hazardous geologic

event occurring at either volcano. The plan also includes the necessary legal authorities in addition to statements of responsibilities of County, State, and Federal agencies in the United States as well as Provincial and Federal agencies in Canada.

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Volcano Mitigation

Existing Mitigation Activities

NOTE: There are no specific mitigation activities identified for this hazard at this time.

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Volcano Resource Directory

The following resource directory lists the resources and programs that can assist county communities and organizations. The resource directory will provide contact information for local, county, regional, state and federal programs that deal with natural hazards.

Federal Resources

USGS Cascades Volcano Observatory

Website: http://usgs.gov/

USGS Volcano Hazards Program

Email: GS-CVO-WEB@usgs.gov
Website: http://vocanoes.usgs.gov/

State Resources

University of Washington, Volcano Systems Center
University of Washington, Earth & Space Sciences

The University of Washington conducts research and prepares inventories and reports for communities throughout Washington relating to earthquakes, landslides, and tsunamis. The department uses a multi-disciplinary approach to provide a basis for making accurate predictions of future conditions.

Contact: University of Washington, Earth & Space Sciences
Physical Address: Johnson Hall, Room 63; Seattle, WA 98195
Mailing Address: Box 351310; Seattle, WA 98195
Phone: (206)543-1190
Email: volc_info@ess.washington.edu
Website: http://ess.washington.edu
Website: http://www.geophys.washington.edu

Washington State Department of Natural Resources

The Geology and Earth Resources Division is Washington's geological survey. It is an excellent reference source for information about the geology and mineral resources of Washington.

Contact: Washington State Department of Natural Resources
Mailing Address: P.O. Box 47001; Olympia, WA 98504-7001
Phone: (360)902-1000
Fax: (360)902-1775
Email: information@wadnr.gov
Website: http://dnr.wa.gov/

Publications and Additional Resources

Public Assistance Debris Management Guide,

Federal Emergency Management Agency (July 2000).

The *Debris Management Guide* was developed to assist local officials in planning, mobilizing, organizing, and controlling large-scale debris clearance, removal, and disposal operations. Debris management is generally associated with post-disaster recovery. While it should be compliant with local and county emergency operations plans, developing strategies to ensure strong debris management is a way to integrate debris management within mitigation activities. The Public Assistance Debris Management Guide is available in hard copy or on the FEMA website.

Contact: FEMA Distribution Center
Address: 130 228th Street, SW, Bothell, WA 98021-9796
Phone: (800) 480-2520
Fax: (425) 487-4622
Website: http://www.fema.gov

Washington State Hazard Identification and Vulnerability Assessment (HIVA)

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Washington State Comprehensive Emergency Management Plan

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Wildland-Urban Interface Fire

Defining the Hazard

Fires are a natural part of the ecosystem, but they present a substantial hazard to life and property in communities. The north King and south Snohomish Counties region has the potential for losses from two types of fire threats: structure fires and wildland-urban interface fires.

While both types are defined below, only wildland-urban interface fires will be addressed in this Plan.

Structure Fire

A fire of natural or human-caused origin that results in the uncontrolled destruction of homes, businesses, and other structures in populated, urban or suburban areas.

Structure fires do not typically pose a great threat to the community except when the fire spreads to other nearby structures and quickly expands to a size that could threaten large numbers of people and overwhelm local fire resources.

Wildland-Urban Interface

A fire of natural or human-caused origin that occurs in forest or grassland areas *where isolated homes, subdivisions, and small communities are also located*.

Wildland-Urban Interface Fire History

Although this region typically has numerous fires that occur wildland-urban interfaces each year, almost all of these fires are extremely small (less than 2 acres in size) and remain so due to the relatively high moisture content in fire fuels. The majority of these fires involve minimal resources and response costs are typically less than $500 per fire.

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Hazard Assessment and Risk Analysis

Hazard Identification

Unlike other disaster events, the direct effects of even a large fire are generally limited to the immediate area where the fire occurred. However, the community's normal as well as emergency services may be affected as large numbers of agencies and individual responders focus their efforts on the fire. Adjacent fire agencies may be asked for assistance in one form or another and access to a city's business district may be restricted or closed and the influx of sightseers and media personnel can further add to the disruption.

Evacuation of a fire zone is one of the first tasks that may need to be undertaken by emergency responders. Depending upon the size of the fire zone, the population density of the area, and the number of persons needing emergency shelter, evacuation efforts may have a significant effect on other parts of the community. The fire season can begin as early as mid-May and continue through October though unusually dry periods can extend the fire season. The possibility of a wildland-urban interface fire depends on fuel availability, topography, the time of year, weather, and activities such as debris burning, land clearing, camping, and recreation. In Washington State, wildland-urban interface fires start most often in lawns, fields or other open areas, along transportation routes, and forested areas.

Due to their size and complexity, large fires can put a tremendous strain on a wide variety of agencies and jurisdictions within the area that the fire occurs and local resources could be quickly overwhelmed in dealing with the impacts of a large fire.

Those persons living or doing business in the area of a large fire could be affected in several ways. Access to the area will probably be controlled or entry may be denied entirely. In many cases, evacuations may be necessary if the fire directly threatens residential or commercial areas or in the event health issues could result from heavy volumes of smoke associated with large fires.

All areas of the north King and south Snohomish Counties region are susceptible to wildland-urban interface fires caused by lightning strikes, fireworks, sparks from equipment, and/or human recklessness. The level of risk will vary depending on weather conditions, woodland fuels, and topography.

Vulnerability Assessment

People living in interface areas are vulnerable to wildland-urban interface fires.

In the region participating in this plan, more than 90% of the land is incorporated. Pockets of undeveloped land, wetlands, and greenbelt areas exist within these cities' boundaries. In addition, some cities have taken great pride in maintaining a "green" community and have retained large numbers of mature trees. These areas may be vulnerable to wildland-urban interface fires.

Life and Property

Loss of life is possible but not likely in this regional setting. Injury is a more probable hazard in connection with firefighting efforts, both by professionals and individuals attempting to save their property. An additional difficulty may be an increase in illnesses (asthma or breathing distress) from the resulting smoke and air pollution.

Buildings in the area may be damaged or destroyed if the fire is not contained quickly. People may need to be evacuated and not allowed to return to their homes. Due to limitations in the size of the wildland-urban interface in the area, the timeframe is more likely to be hours instead of days, but the disruption impacts lives and creates difficulties.

Habitat

If a large wildland-urban interface fire should occur in the area, the effects of such an event would not be limited to just the loss of residences and businesses, but would also damage valuable wildlife habitat, and recreational areas. The loss of large amounts of trees, shrubbery, and grasses on steep slopes would increase the risk of landslides and mudslides during the winter months and would potentially lead to large deposits of mud and debris in streams and river channels. These deposits could threaten valuable fish habitat for many years. In addition, the loss of plant life would severely impact the Lake Washington – Cedar - Sammamish watershed and could drastically increase the vulnerability to flooding downstream for many years.

Roads and Bridges

Roads and bridges could be damaged from high temperatures caused by fires in close proximity to this infrastructure. Depending on the extent of the damage, it could take months to complete necessary repairs.

Power Lines

Power lines and power stations may be damaged or destroyed by fire leaving businesses and residences without electricity for days.

Water

The demand for water for firefighting purposes may be greater than system capacity is set up to handle. As a result, residents may be asked to conserve water to allow water tanks to be refilled. Conservation efforts include taking shorter showers, not watering lawns and gardens, and waiting to do laundry among other actions. Carnation, Washington was forced to make this request of its citizens during a 30-acre wildland-urban interface fire that occurred on August 21, 2003.

Risk Analysis

The region covered in this plan is made up of ten Cities and four Special Purpose Districts. The cities are mostly developed with some areas of in-fill still to be completed. Several of the cities have unincorporated areas at their borders that may be annexed in the future. One special purpose district, Olympic View Water and Sewer District, encompasses a small amount of unincorporated area, and this land is already moderately developed.

Should a wildland-urban interface fire occur, the impacts of the fire would vary greatly with the size and location of the fire, fuel sources, weather conditions, and topography. It is unlikely that a major wildland-urban interface fire would seriously impact the region as a whole. In the event of a large wildland-urban interface fire, additional resources could be requested through activation of interlocal and mutual aid agreements in addition to other state and federal fire resources.

According to the United States Bureau of Land Management, the north King and south Snohomish Counties region would be considered “Category C,” an “Occluded Community.” This is a situation where the wildland is contained in parks or open land occur within cities.[70]

Over the last twenty years, the open land between the cities in the north King and south Snohomish Counties region has filled in significantly, and there is little land that is undeveloped. As the population continues to grow and fill in the remaining pockets of undeveloped or under-developed land, the risk of wildland-urban interface fires will continue to decrease. In the meantime, there is a Moderate Probability of this type of event occurring in the north King and south Snohomish Counties area, with a Low to Moderate Risk to persons, property and the environment if it should occur.

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Wildland-Urban Interface Fire Mitigation

Existing Mitigation Activities

- Maintain right-of-way to minimize dry grasses and undergrowth.
- Restrict or ban use of fireworks within city limits.

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Wildland-Urban Interface Fire Resource Directory

The following resource directory lists the resources and programs that can assist county communities and organizations. The resource directory will provide contact information for local, county, regional, state and federal programs that deal with natural hazards.

Federal

United States Fire Administration

As an entity of the Department of Homeland Security and the Federal Emergency Management Agency, the mission of the USFA is to reduce life and economic losses due to fire and related emergencies, through leadership, advocacy, coordination, and support.

Contact: United States Fire Administration
Address: 16825 South Seton Avenue; Emmitsburg, MD 21727
Phone: (301)447-6771
Website: http://www.usfa.fema.gov

National Interagency Fire Center Publications Management System

The National Interagency Fire Center (NIFC) in Boise, Idaho, is the nation's support center for wildland firefighting. Seven federal and state agencies call NIFC home and work together to coordinate and support wildland fire and disaster operations. These agencies include the Bureau of Indian Affairs, Bureau of Land Management, Forest Service, Fish and Wildlife Service, National Park Service, National Association of State Foresters, National Weather Service, and Office of Aircraft Services.

Contact: National Interagency Fire Center Publications Management System
Address: 3833 South Development Avenue; Boise, ID 83705
Phone: (208)387-5512
Website: http://www.nifc.gov

United States Bureau of Land Management

The Bureau of Land Management, an agency within the U.S. Department of the Interior, administers 261 million surface acres of America's pubic lands, located primarily in 12 Western States. The BLM sustains the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

Contact: Bureau of Land Management, Office of Public Affairs
Address: 1849 C Street, Room 406-LS; Washington DC 20240
Phone: (202)452-5125
Fax: (202)452-5124
Website: http://www.blm.gov

USDA Forest Service – Pacific Northwest Region

The Forest Service provides resources for the protection of wildland resources.

Contact: USDA Forest Service – Pacific Northwest Region
Physical Address: 333 SW First Ave.; Portland, OR 97208
Mailing Address: PO Box 3623; Portland, OR 97208-3623
Phone: (503)808-2971
Website: http://www.fs.fed.us/r6

USGS Water Resources

This web page offers current US water news; extensive current (including real-time) and historical water data; numerous fact sheets and other publications; various technical resources; descriptions of ongoing water survey programs; local water information; and connections to other sources of water information.

Contact: USGS Water Resources
Website: http://water.usgs.gov
Or: http://water.usgs.gov/public/realtime.html

Federal Emergency Management Agency (FEMA)

FEMA provides maps of flood hazard areas, various publications related to flood mitigation, funding for flood mitigation projects, and technical assistance. FEMA also operates the National Flood Insurance Program. FEMA's mission is to reduce loss of life and property and protect the nation's critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management program of mitigation, preparedness, response and recovery. FEMA Region X serves the northwestern states of Alaska, Idaho, Oregon, and Washington.

Contact: FEMA, Federal Regional Center, Region 10
Address: 228th St. SW, Bothell, WA 98021-9796
Phone: (425) 487-4678
Website: http://www.fema.gov
To obtain FEMA publications:
Phone: (800) 480-2520

State

Washington State Department of Natural Resources, Fire Prevention Program

Responsible for wildfire protection of the State's 12 million acres of private and state forest land.

Contact: Washington State Department of Natural Resources, Fire Prevention Program Coordinator
Address: P.O. Box 47037, Olympia, WA 98504-7037
Phone: (360)902-1754
Fax: (360)902-1757
Email: fire_prevention@wadnr.gov
Website: http://www.dnr.wa.gov/htdocs/rp/prevent.htm

Washington State Department of Natural Resources, Backyard Forest Stewardship

A program designed to provide wildfire safety information to people living in the Wildland-Urban Interface areas.

Contact: Washington State Department of Natural Resources, Backyard Forest Stewardship
Address: P.O. Box 47037, Olympia, WA 98504-7037
Phone: (360)902-1754
Fax: (360)902-1757
Website: http://www.dnr.wa.gov/htdocs/rp/stewardship/bfs/

Washington Department of Fish and Wildlife

The organization's mission is to protect and enhance Washington's fish and wildlife and their habitats for use and enjoyment by present and future generations. WDFW regulates stream activity and engages in stream enhancement activities.

Contact: Washington Department of Fish and Wildlife
Physical Address: 600 Capitol Way North; Olympia, WA 98501-0191
Mailing Address: 1111 Washington St SE; Olympia, WA 98501
Phone: (360)902-2515
Website: http://wdfw.wa.gov
Email: wildthing@dfw.wa.gov

Regional Office: Washington Department of Fish and Wildlife
Address: 16018 Mill Creek Blvd.; Mill Creek, WA 98012
Phone: (425)775-1311

Washington Department of Natural Resources

DNR's role is to protect and manage State lands and other natural resources such as water, wildlife, and fish. The Department is also responsible for fire prevention and suppression.

Contact: Washington Department of Natural Resources
Address: 1111 Washington Street SE; Olympia, WA 98504
Mailing Address: PO Box 47000; Olympia, WA 98504-7000
State Phone: (360)902-1000
Regional Info: (800)527-3305
Fax: (360)902-1775
Website: http://www.dnr.wa.gov

Contact: Washington Department of Natural Resources, Northwest Region
Address: 919 N Township Street; Sedro Woolley, WA 98284-9333
Phone: (360)856-3500
Fax: (360)856-2150
Website: http://www.dnr.wa.gov

Fire Prevention Program, Washington Department of Natural Resources

Providing assistance and best practices information for the purposes of protecting lives, the forest ecosystem, and property.

Contact: Fire Prevention Program, Washington Department of Natural Resources
Address: 1111 Washington Street SE; Olympia, WA 98504
Mailing Address: PO Box 47037; Olympia, WA 98504-7037
State Phone: (360)902-1757
Fax: (360)902-1757
Website: http://www.dnr.wa.gov

Urban and Community Forestry, Washington Department of Natural Resources

A Federal-supported program providing organizational and technical urban forestry assistance to communities.

Contact: Urban and Community Forestry, Washington Department of Natural Resources
Address: 1111 Washington Street SE; Olympia, WA 98504
Mailing Address: PO Box 47012; Olympia, WA 98504-7012
State Phone: (360)902-1400
Fax: (360)902-1757
Website: http://www.dnr.wa.gov

Interactive Weather Information Network (IWIN)

Current weather information in cooperation with NOAA.

Website: http://iwin.nws.noaa.gov/iwin/wa/wa/html
Or: http://iwin.nws.noaa.gov/main.html
Email: W-IWIN.Webmaster@noaa.gov

Publications and Additional Resources

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The *Washington State Hazard Identification and Vulnerability Assessment (HIVA)* assesses natural and technological (man-made) hazards in Washington State. Assessment is the initial step in the emergency management process that leads to mitigation against, preparedness for, response to, and recovery from hazards. Hazards have the potential of becoming disasters or emergencies that can adversely affect the people, environment, economy, and property of the state.

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[1] The Weather Channel. Available WWW: http://www.weather.com/weather/climatology/monthly/USWA0395
[2] Ibid.
[3] Washington State Emergency Management Division. Available WWW: http://emd.wa.gov/.
[4] Snohomish County Department of Emergency Management. *Hazard Identification and Vulnerability Analysis* (January 2002).
[5] Snohomish County Department of Emergency Management. *Hazard Identification and Vulnerability Analysis* (January 2002).
[6] Seattle Public Utilities. *Drinking Water Quality Annual Report* (May 2003).
[7] Snohomish County Department of Emergency Management. *Hazard Identification and Vulnerability Analysis* (January 2002).
[8] Alderwood Water and Wastewater District. *Annual Water Quality Report*. (June 2003).
[9] Ibid.
[10] Washington State Emergency Management Division. Hazard Mitigation Survey Team Report.
[11] The Pacific Northwest Seismograph Network. Earthquake Hazards in Washington and Oregon: Three Source Zones. Available WWW: http://www.geophys.washington.edu/SEIS/PNSN/CascadiaEQs.pdf
[12] Coombs, H.A., et al. "Report of the Review Panel on the December 14, 1872 earthquake", Appendix D: Selected Supporting Information (December 1976).
[13] Washington State Emergency Management Division. Hazard Mitigation Survey Team Report.
[14] Washington State Emergency Management Division. *Washington State Hazard Identification and Vulnerability Assessment* (HIVA) (April 2001).
[15] Madin, Ian P. and Zhenming Wang. *Relative Earthquake Hazard Maps Report* (1999), DOGAMI
[16] *Planning for Natural Hazards: The Oregon Technical Resource Guide*, Department of Land Conservation and Development (July 2000). Ch. 8, pp. 8.
[17] Washington State Emergency Management Division. Hazard Mitigation Survey Team Report.
[18] "A region at risk." March 4, 2001. The Oregonian.
[19] *Washington* Washington State Emergency Management Division. *Washington State Hazard Identification and Vulnerability Assessment* (HIVA) (April 2001).
[20] *Questions and Answers on Earthquakes in Washington and Oregon* (February 2001) Available WWW: www.geophys.washington.edu/seis/pnsn/info_general/faq.html.
[21] "A region at risk." March 4, 2001. The Oregonian.
[22] United States Geological Survey. Volcanoes of the United States, USGS General Interest Publication 376-846 (1999). Available WWW: http://neic.usgs.gov.
[23] Washington State Emergency Management Division. *Washington State Hazard Identification and Vulnerability Assessment* (HIVA) (April 2001).
[24] Ibid.
[25] Wang, Yumei and Clark, J.L. *Earthquake damage in Oregon: Preliminary estimates of future earthquake losses* (1999), DOGAMI, Special Paper 29.
[26] *Planning for Natural Hazards: The Oregon Technical Resource Guide*, Department of Land Conservation and Development (July 2000). Ch. 8, pp. 7.
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Section III: Multi-Jurisdictional Breakouts

Section III provides individualized information for each jurisdiction. It includes a brief description of each City or Special Purpose District. Additionally, each jurisdiction has individually rated the risk from all eight identified natural hazards.

Once each jurisdiction identified local risks, they developed a schedule of mitigation action-items to be implemented within their borders. These action items were developed with consideration of existing documents such as budgets and Capital Improvement Plans (CIP), public input, internal policies, local knowledge, and staff expertise.

Additionally, each jurisdiction recognizes the necessity for regional cooperation in both day-to-day activities as well as regional mitigation efforts.

The jurisdictions participating in this plan are committed to developing regional projects as necessary and appropriate, and as funds are available.

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Multi-Jurisdictional / Multi-Hazard Mitigation

The pages in Section III provide the individual breakouts for each jurisdiction.

Each breakout contains the following sections:

- A brief summary or description of the City or Special Purpose District. It includes information such as population, area covered, and other features or concerns unique to the jurisdiction.
- A hazard rating score and description of the identified vulnerabilities.
- A list of some mitigation projects that have been completed in the past or are currently in process.
- A summary of the Mitigation Action Items identified for future efforts.

Local Hazard Identification and Vulnerability Analysis (HIVA)

While each jurisdiction has some potential exposure to each of the natural hazards identified in Section II of this document, the levels of risk and vulnerability may widely vary between the jurisdictions. As a result, each jurisdiction addresses these issues individually with a brief description of the local concerns.

Hazard Ratings

In 2003, the State of Washington provided 20/20 software to the counties to provide a consistent rating system for natural hazards. The North *King and South Snohomish Counties Regional Mitigation Plan* adapted the rating criteria into a spreadsheet and used this tool to rate local hazards. There was no effort made to duplicate all the functions of the 20/20 software. Instead, the intent was to ensure that the rating system was consistent with that being used by the counties.

Based on the description of this software, and using the same basic criteria as derived from the 20/20 software, the following spreadsheet was developed:

Criteria for Scoring Natural Hazards
(Based on 20/20 software)

Impacted Areas	*Rating*	*"Areas impacted by the hazard"*
	1	Less than 25% of developed areas
	2	Less than 50% of developed areas
	3	Less than 75% of developed areas
	4	More than 75% of developed areas

Health and Safety	*Rating*	*"Probability of persons killed or injured"*
	1	Few injuries/illnesses
	2	Few fatalities, but many injuries/illnesses
	3	Numerous fatalities

Property	*Rating*	*"Probability of property damaged or destroyed"*
	1	Few properties destroyed/damaged
	2	Few destroyed/many damaged -- OR -- Many destroyed, few damaged
	3	Many properties destroyed and damaged

Environment	*Rating*	*"Probability of environmental damage"*
	1	Resources damaged with short-term recovery
	2	Resources damaged with long-term recovery
	3	Resources damaged beyond recovery

Economic	*Rating*	*"Probability of economic disruption"*
	1	Low direct and/or low indirect costs
	2	High direct and low indirect costs -- OR -- Low direct and high indirect costs
	3	High direct and high indirect costs

Probability of Occurrence	*Rating*	*"Probability or frequency of occurrence"*
	1	Unknown but rare occurrence
	2	Unknown but anticipated
	3	100 years or less
	4	25 years of less
	5	Once per year or more

Using the criteria as defined above, members filled out the following form, with one section provided for each of the eight natural hazards identified for the North King and South Snohomish Counties region.

Drought

	Rating Scale	***Risk Categories***
	(1-4)	Areas impacted by the hazard
	(1-3)	Probability of persons killed or injured
	(1-3)	Probability of property damaged or destroyed
	(1-3)	Probability of environmental damage
	(1-3)	Probability of economic disruption
0	***Sum of Risk Categories***	
	(1-5)	Probability or frequency of occurrence
0	***Natural Hazard Rating***	
	(Sum of Risk Categories x Probability or frequency of occurrence)	

Earthquake

	Rating Scale	***Risk Categories***
	(1-4)	Areas impacted by the hazard
	(1-3)	Probability of persons killed or injured
	(1-3)	Probability of property damaged or destroyed
	(1-3)	Probability of environmental damage
	(1-3)	Probability of economic disruption
0	***Sum of Risk Categories***	
	(1-5)	Probability or frequency of occurrence
0	***Natural Hazard Rating***	
	(Sum of Risk Categories x Probability or frequency of occurrence)	

The rating scales varied from "1 to 3" to "1 to 5," with six criteria being considered independently. The first five criteria were rated and subtotaled. These were:

Impacted Areas	(scale of 1 – 4)
Health and Safety	(scale of 1 – 3)
Property	(scale of 1 – 3)
Environment	(scale of 1 – 3)
Economic	(scale of 1 – 3)

Once these ratings were established, they were multiplied by the "Probability of Occurrence" (scale of 1- 5). The maximum score possible was 80 points.

For continuity purposes, the same tool was used in this 5-year update.

Mitigation Goals

The natural hazard mitigation goals listed in this portion of the plan are intended to help guide the direction of and prioritize future natural hazard mitigation activities at the local level aimed at reducing risk and preventing loss from natural hazards.

1. Protect Life and Property
   - Implement mitigation activities that will assist in protecting lives and property by making homes, businesses, infrastructure, and critical facilities more resistant to natural hazards. In addition to large-scale projects, this may include items such as:
     - Continuing the ESCA Community Emergency Response Team (C.E.R.T.) Program to provide citizens from the north King and south Snohomish Counties area with the information and tools they need to help themselves, their families, and their neighbors in the hours and days immediately following an emergency or disaster event.
     - Encouraging homeowners and businesses to purchase insurance coverage for damages caused by natural hazards.
     - Encouraging homeowners and businesses to take preventative actions in areas that are especially vulnerable to natural hazards.

2. Increase Public Awareness
   - Develop and implement additional education and outreach programs to increase public awareness of the risks associated with natural hazards.

3. Encourage Partnerships
   - Strengthen inter-jurisdiction and inter-agency communication and coordination and partnering of jurisdictions and agencies to foster the establishment and implementation of natural hazard mitigation strategies and/or projects designed to benefit multiple jurisdictions.

4. Provide for Emergency and Critical Services
   - Encourage the establishment of policies at the local level to help insure mitigation strategies and/or projects are designed, prioritized, and implemented, to benefit critical/essential facilities, services, and infrastructure.

5. Facilitate Continuity and Recovery
   - Minimize the disruption of services and enable swift recovery after a natural disaster.

6. Protect Natural Systems
   - Restore damaged environments and minimize future damage or destruction.

Multiple-Hazard Mitigation Actions

For the purpose of this plan, multiple-hazard action items are those strategies and/or activities that pertain to more than one hazard, as described in the hazard identification section of this plan.

The action items included in this section of the plan may be short-term (ST) or long-term (LT). Some actions may include activities that jurisdictions may implement with existing resources and authorities. Other, more complex, actions may require new or additional resources and authorities as well as multi-agency and/or multi-jurisdictional partnering.

Timeframes are tentative and are intended to be guidelines as opposed to hard commitments. The completion of these projects is contingent upon identifying and obtaining additional resources.

Each item has an individual "code' or identifier. The conventions are as follows:

- Expected timeframe
  - LT = Long-term
  - ST = Short-term
- Number
  - Progressive numbering
- Hazard abbreviation
  - MH = Multi-Hazard
  - D = Drought
  - E = Earthquake
  - F = Flood
  - L = Landslide
  - S = Severe Storm
  - T = Tsunami and/or Seiche
  - V = Volcano
  - W = Wildland-Urban Interface Fire
- Jurisdiction abbreviation
  - BR = Brier, City of
  - ED = Edmonds, City of
  - KM = Kenmore, City of
  - LFP = Lake Forest Park, City of
  - LW = Lynnwood, City of
  - MC = Mill Creek, City of
  - MT = Mountlake Terrace, City of
  - MK = Mukilteo, City of

- WV = Woodinville, City of
- WW = Woodway, Town of
- ECC = Edmonds Community College
- ESD = Edmonds School District
- OF = Olympic View Water and Sewer District
- PE = Port of Edmonds

Prioritizing Mitigation Actions

Because this plan is multi-jurisdictional, each jurisdiction will develop mitigation priorities at the local level with the direct involvement of the governing body and other participating agencies and organizations.

Due to budget constraints, most of the mitigation measures incorporated into this plan are dependent upon local jurisdictions receiving outside funding; as a general rule, local funding is not available. As a result, local jurisdictions are unsure when many of these mitigation measures will be implemented and the conditions and/or requirements under which implementation may occur.

Unless stated otherwise within an individual entity's break-out, each jurisdiction participating in this plan should prioritize their proposed mitigation projects based on the following factors:

- Mitigation action items that have a benefit-to-cost review rating of "2" or greater.
- Mitigation action items that reduce or eliminate repetitive loss properties.
- Mitigation action items that are multi-jurisdictional and/or multi-agency in nature.
- Mitigation action items that provide the greatest good for the greatest number.
- Mitigation action items that have broad-based public and/or elected official support.
- Mitigation action items that have previously-secured funding sources.
- Mitigation action items that qualify for alternate and/or matching funding.

While it is highly recommended that each of the jurisdictions participating in this plan use the factors listed above in prioritizing mitigation measures, it is recognized that final prioritization is determined by each jurisdiction's Council or Board. A change in local elected officials, changing environmental requirements, public acceptance of a project, or the occurrence of an actual disaster event may dramatically affect the priority ranking of mitigation actions at the local level.

(Note: A description and example of the benefit-to-cost review rating process is included at the beginning of each jurisdiction's Mitigation Action Items section.)

If federal funding is involved in the implementation of a hazard mitigation project, the City or Special Purpose District will conduct a cost-benefit analysis based on guidelines provided by the United States Department of Homeland Security (FEMA) and the Washington State Military Department, Emergency Management Division on how to determine cost-effectiveness of mitigation projects and how to calculate the cost-benefit ratio.

The purpose of the cost-benefit analysis is to determine if the benefits of the project exceed the federal costs of the project. Both the Hazard Mitigation Grant Program and the Pre-Disaster Mitigation Grant Program require a cost-benefit ratio of at least 1.0 for a project to be considered for funding.

While it may be important to emphasize a positive cost-benefit analysis in the prioritizing of mitigation actions, it is also important to recognize the influence of local political factors, community needs, local values, historic properties, and habitat/environmental issues upon the selection of specific mitigation actions.

Implementing Mitigation Actions

Mitigation measures are already in place at the jurisdiction level through existing plans, codes, and ordinances as well as programs such as the Community Emergency Response Team (C.E.R.T.). Current and ongoing programs are funded through existing and established budgets.

The implementation of new and/or additional mitigation measures is dependent upon the approval of the local elected body as well as obtaining funding from outside sources that have not been secured at this time. As a general rule, local funds are not available for implementation of new mitigation measures. Funding for mitigation measures is largely dependent upon individual entities applying for and receiving federal and/or State hazard mitigation grant funding.

For each action item listed and described in this plan, every effort has been made to identify the lead agency and/or community partners, current or possible funding sources, and an estimated timeline for planning and implementation.

It should be noted that **short-term** action items and/or mitigation measures are those activities that are expected to be completed in less than two years from the receipt of funding by the jurisdiction. **Long-term** action items and/or mitigation measures are those activities that are expected to take more than two years to complete from the receipt of funding by the local entity, or it is expected that it will take more than two years to obtain funding for the project. Action items and/or mitigation measures that are **current and ongoing** have been identified as such.

The jurisdictions participating in the North King and South Snohomish Counties Regional Mitigation Plan have a variety of local, state, and federal resources available to support implementing and administering the mitigation actions. Each jurisdiction will continue to identify additional resources to support implementing action items.

Local Funding Sources

Local implementation sources vary based on each jurisdiction's scope of function(s), authorities, and operational capability and capacity. They may include:

- Use of zoning ordinances and building codes.
- Enforcement of sensitive or critical areas ordinances.
- Incorporation into local emergency response plan(s).
- Incorporation into local economic development plan(s).
- Use and support of existing local personnel (planners, city engineers, GIS specialists, and/or emergency managers).
- Capital improvement project funding.
- Authority to levy taxes and special bonds.
- Fees for services.
- Other sources yet to be identified.

The current economic condition and funding level of the participating jurisdictions drastically limits the use of local resources. State or federal funding will be needed to accomplish many of the action items and mitigation measures referenced in this plan.

State Funding Sources

- State-administered Hazard Mitigation Grant Program, Flood Mitigation Act, and Pre-Disaster Mitigation Program
- Department of Ecology Flood Control Assistance Account Program (FCAAP)
- Department of Transportation Emergency Relief Program
- Office of Community Development Block Grants
- Programs administered by the Washington State Transportation Improvement Board

- Other sources yet to be identified

NOTE: An extensive listing of state funding opportunities is available at the following website: http://www.infrafunding.wa.gov.

Federal Funding Sources

- Stafford Act, Section 406 – Public Assistance Program Mitigation Grants
- Stafford Act, Section 404 – Hazard Mitigation Grant Program
- Disaster Mitigation Act of 2000 – Pre-Disaster Mitigation Program Competitive Grants
- United States Fire Administration – Assistance to Firefighters Grants
- United States Small Business Administration – Pre- and Post-Disaster Mitigation Grants
- United States Department of Economic Development Administration Grants
- United States Department of Housing and Urban Development Grants, such as the Community Development Block Grant Program
- United States Army Corps of Engineers
- United States Department of the Interior, Bureau of Land Management
- Federal Highway Administration
- Other sources yet to be identified

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Edmonds

The City of Edmonds is located in the southwest corner of Snohomish County, about 14 miles north of Seattle. It has a population of about 40,760[1] people residing on about 8.9 square miles, or 5,717 acres, of land.

The City is about 95% developed. Of the remaining undeveloped land, about 75% is designated for single-family residential use.

Edmonds' commercial activity is concentrated in two areas: the Downtown/Waterfront and the Highway 99 corridor. The latter includes Stevens Hospital and the medical facilities affiliated with the Hospital. This Hospital region provides critical facilities, and restoring routes to and from the Hospital will be a priority in any disaster.

The City of Edmonds is a key link in the region's transportation routes. The City has three state routes that connect the region to both the Port of Edmonds and the site of the Edmonds-Kingston Ferry Terminal. The former provides mooring for approximately 1,000 boats and watercraft. The latter is located in the Downtown/Waterfront core and provides a steady stream of vehicles and ferry-commuters into the area.

The Burlington-Northern Railroad runs adjacent to the City's shoreline and links Everett to Edmonds to the north and Seattle to the south. The rail line is currently used for freight and AMTRAK passenger rail service; approximately 35 trains pass through the City each day. Conflict between north-south rail traffic and east-west access to the waterfront and its regional facilities (ferry, port, and parks) is an ongoing concern for its potential effect on response and recovery activities in emergency situations.

For a list of critical facilities located in Edmonds, see *Annex B*.

Hazard Identification

The City of Edmonds uses a GIS system, but is currently limited in the information and functions available within that system. County base information is included in the City's GIS system, plus local zoning and Comprehensive Plan information.

GIS development is an ongoing project and will be expanded in the future as funds for training and personnel allow. At some point in the future, the City plans to incorporate HAZUS as well, but resources have not been identified for this project within the foreseeable future.

Based on past experience, GIS data, and hazard maps from the Department of Natural Resources and FEMA, Edmonds rates its risk of natural hazards as follows:

HAZARD	RATING (out of 80 possible)
Drought	07
Earthquake	45
Flood	
100-year	12
Urban	12
Landslide	14
Severe Storm	48
Tsunami & Seiche	08
Volcano	08
Wildland Urban Interface Fire	05

Drought

Rating: 7

Drought is not considered to be a high-risk hazard for Edmonds. The City's potable water is supplied by the Cities of Seattle and Everett via Alderwood Water District and is relatively stable for short-term (one season) droughts. Citizens may be asked to take conservation measures and limit lawn watering, but the City will still receive adequate potable water for its needs.

At greater risk are Lake Ballinger and the streams running through the City of Edmonds. Even a short-term drought is likely to reduce water levels in Lake Ballinger and the City's streams. Reduced water levels lead to higher water temperatures which, in turn, may make the streams uninhabitable for salmon and other aquatic organisms downstream. With several species of salmon listed as "endangered" or "threatened," this could delay recovery efforts.

The City of Edmonds considers the threat of drought to be EXTREMELY LOW.

Earthquake

Rating: 45

Edmonds is located in Seismic Zone 3, between several fault lines, and earthquakes are therefore considered to be a significant risk for the City.

As discussed in this document's HIVA, earthquakes occur in Washington State on an almost daily basis. While most quakes are minor, seismologists tell us that we can expect a deep or intraplate earthquake at a magnitude of 7.0 about every 70 years and an 8.0 or greater subduction quake every 150 to 1,100 years.

Based on this information, when a major earthquake occurs in the region, the City can expect significant damage, injuries, and possibly deaths. This is due in part to the relatively dense concentration of both buildings and people in about 8.9 square miles.

Secondary effects of an earthquake can include tsunami or seiche as well as landslides and soil displacement. The Edmonds waterfront which includes the Port of Edmonds facilities, two major restaurants, and the Senior Center are potentially vulnerable to damages and loss of life.

Edmond's risk from earthquake is MODERATE.

Flood

Rating: 12

The City contains the following creeks and watersheds within the City limits:

Body of Water	Description
Shell Creek	753 acre watershed, plus 527 acres of overflow in the winter months.
Willow Creek	434 acres
Shellabarger Creek	354 acres
Northstream Creek	248 acres
Fruitdale	243 acres
Hindley Creek	178 acres
Perrinville Creek	805 acres
Goodhope Pond	474 acre watershed
Lake Ballinger	Shared with the City of Mountlake Terrace

In addition, a portion of the city is located on Puget Sound. As a result, the City of Edmonds experiences floods from three separate types of events: 100-year flooding, urban flooding, high tides, and shoreline flooding.

100-Year

Flood Insurance Rate Maps (FIRMs), with an effective date of November 8, 1999, were developed for the City. These include panel

numbers 1285, 1305, and 1575. These maps identify areas along the shoreline as "Zone AE," and establishes base flood elevations. Other areas, further inland, are identified as "Zone A," recognized as part of the 100-year floodplain, but no base flood elevations are established. Additionally, the maps identify several areas as part of the 500-year floodplain.

Approximately 90 lots, encompassing 129.6 acres, lie within the 100-year floodplain. The affected property is valued at approximately $43,987,080.

No critical buildings are located in the affected area.

The City of Edmonds has incorporated the information as provided by the FIRMs in the development of the City's Comprehensive Plan. As a result, the City restricts building in these areas.

Urban

Urban flooding is a semi-regular occurrence in the City of Edmonds. This is caused by excessive rainfall or snowmelt which overwhelms the stormwater system, wetlands, lake, and streams. In general, urban flooding is intensified by the increasing amount of impervious surface as surrounding jurisdictions and areas upstream develop and Edmonds continues to in-fill.

Shoreline

Shoreline properties may experience flooding as part of the 100-year or urban flooding events. In addition, storm events are often accompanied by significant wave action, and this can intensify the flooding experienced along the Edmonds shoreline if this coincides with high tide cycles.

The City is in good standing with the NFIP and has no findings.

Edmond's overall hazard rating for flooding is LOW.

Landslide and Soil Displacement

Rating: 14

The City of Edmonds has several areas with steep slopes and one designated landslide hazard area. These are the primary areas that may experience landslide.

To mitigate for this hazard, the City has enacted a very strict ordinance that governs development, enforces current building codes, and requires soil testing and soil stabilization techniques as necessary. Nevertheless, it is still possible for soil saturation or liquefaction to cause a landslide to occur with the right combination of factors and circumstances.

Edmonds could also experience soil displacement in conjunction with the creeks that run through the City. In the case of a heavy or excessive stream-flow, it is possible that the movement of the water could erode and destabilize portions of the creek banks.

Excessive rainfall or snowmelt or a major earthquake are possible contributors to a landslide or soil displacement event.

Having identified the hazard and assessed the possible risks, Edmonds considers landslide to be a LOW risk.

Severe Storm

Rating: 48

The City of Edmonds is subjected to severe storms on a regular basis. Windstorms occur nearly every winter, and rainstorms are not unusual. While rarer, the City has also experienced heavy snows and freezing rains.

Winds and snow or ice regularly cause tree branches to break and/or trees to fall. This may cause power outages or damage buildings. As mentioned in the discussion of floods (above), severe rain or snowstorms can also be associated with and compound the severity of flood events.

The Inaugural Day Storm in 1993 had winds of 66 mph. This storm interrupted power to the City for more than three days. Branches and trees were downed and laid across streets, roads, and yards. City facilities were relatively unscathed, but fences were blown over, and houses received damage from both branches and the wind itself. Since

the majority of damage occurred on private property, damage totals are not available.

In the winter of late 1996/early 1997, the City and region experienced a significant snowfall following by drenching rain. This resulted in mudslides and required the City of Edmonds Public Works crews to plow snow and remove mud and debris. Funds in the amount of $83,685 were approved by FEMA for clean-up and debris removal as a result of this storm event.

In early December 2007, the City experienced a significant rainfall event that produced 5 inches of rainfall in a 36 hour period of time. During the peak of the heavy rains, there was also a high tide and consequently there was nowhere for the storm water to go and it backed up, flooding homes, streets and any low-lying areas. The volume of water also soaked into hillsides, causing many landslides. The some of the most significant damage occurred on Olympic View Drive near 76th Avenue West in the Perrinville neighborhood where a culvert failed and a large sinkhole developed. In addition, damage also occurred on 76th Ave West which required significant road repair work. The total combined repair costs for these two projects amounted to $639,295.93.

The level of risk from Severe Storms is 48, or MODERATELY-HIGH.

Tsunami & Seiche

Rating: 8

As mentioned in the Earthquake section, the South County Senior Center may be occupied by as many as 300 people at any given time. In addition, the Edmonds waterfront has two large restaurants and a marina which may be occupied by several hundred more people. These facilities are located directly on the Puget Sound waterfront, making them a prime concern during a tsunami event.

Another area of concern is the Edmonds Ferry Terminal. This facility handles two state ferries that run up to 28 ferry trips each day. During periods of heavy traffic volume, the dock could be fully loaded with 60 vehicles, and the ferry's passenger waiting lanes may have as many as 300 additional vehicles within a mile of the dock. During peak traffic periods, as many as 600 walk-on passengers may be in the dock area.

Located on the Puget Sound coast, Edmonds is potentially vulnerable to tsunami, though the likelihood of this occurring is EXTREMELY LOW on the rating scale.

Volcano

Rating: 8

The City of Edmonds is unlikely to suffer direct damage from a volcano eruption. In the event of an eruption, Edmonds may experience ashfall, which can interfere with the operation of motor vehicles and back-up generators, require expensive clean-up efforts by the City, and cause respiratory distress to the citizens. The City is highly unlikely to experience any lava flow, lahar activity, or any of the other risks associated with volcanoes.

A secondary effect of a volcano eruption is the influx of refugees into the area. This may be an issue to the City, and the region as a whole, as resources are overwhelmed by numbers of people that the infrastructure is not designed to handle. This includes everything from roads and highways, water and electric utilities, to the regional hospital.

Overall, the level of risk from a volcanic eruption is EXTREMELY LOW.

Wildland-Urban Interface Fire

Rating: 5

Wildland-urban interface fire is a concern to Edmonds due to the parks, wetlands, greenbelts, and undeveloped land parcels that are scattered throughout the City. The threat is in inverse proportion to the amount of rainfall in the region. When rain is scarce, the fire threat increases.

During the summer of 2003, new records were set for number of days without rain. As a result, Edmonds and the north King and south Snohomish Counties region experienced several fires next to the freeway (I-5) that were caused by improperly extinguished cigarettes or sparks from machinery being operated next to dry grass. These fires were quickly contained and suppressed, but the close proximity of houses to these wildland areas, and the relative density of the housing units and wood shake roofs, makes wildland-urban interface fires a risk during periods of drought or excessive dryness.

Offsetting the risk of fire, the region is very well developed and has adequate infrastructure to address this hazard. Fire stations are placed strategically, and are within a 4-minute average response time anywhere in the area. Additionally, interlocal agreements are in place with the surrounding jurisdictions to allow for the nearest available unit to respond to any call for fire suppression.

The City of Edmonds considers the level of risk from wildland-urban interface fire to be EXTREMELY LOW.

Mitigation

Existing and Ongoing Mitigation Activities

The City of Edmonds is taking the following actions in ongoing efforts to mitigate for natural hazards and to maintain public safety.

All Hazards

- The City of Edmonds is a member of the Emergency Services Coordinating Agency (ESCA). As a member, Edmonds receives emergency management planning, coordination, and response services.

  As part of its preparation and mitigation services, ESCA provides education in the form of Community Emergency Response Team (CERT) training. This training is provided to the citizens of the member Cities and Towns. The goal is to prepare people to be self-sufficient for as much as three days after a major disaster until safety personnel can get to them. CERT also provides the students with suggestions and training for personal mitigation projects such as securing water heaters and attaching tall, heavy furniture to the wall.

- The City updated the fire alarm system for City Hall in 1996.

- The South County Senior Center received a new fire alarm system in 2006.

- Edmonds rebuilt the public safety buildings to meet current building code requirements in 1999.

- The City completely upgraded the electrical wiring at the Francis Anderson center in 2002.

- An emergency generator for backup electrical power was installed for City Hall in 2007.

- Installed a new HVAC system for City Hall.

- The Frances Anderson Center, the City's primary recreation center was structurally reinforced to withstand a major earthquake in 2008.

Codes and Plans

The City of Edmonds		
Name of Document	**Purpose**	**Review Schedule***
Edmonds Ordinance No. 2224: Emergency Services – Disaster Coordination Chapter 6.60 of the Edmonds Municipal Code	Govern disaster preparedness and disaster response in the City.	Adopted August 1981
State Environmental Policy Act – City Environmental Policy (SEPA)	Implement procedures and policies to improve and coordinate plans, functions, programs, and resources consistent with state and county policies for environmental protection.	Adopted 1983
Shoreline Master Program Critical Areas Ordinance	Protect against adverse effects to the public health, the land and its vegetation and wildlife by managing shorelines. Protect the public from damages from landslides, subsidence erosion and flooding.	Adopted 2000 (last amended in 1984) Adopted 1996 Updated 2005
Stormwater Comprehensive Plan	Provide guidance on the estimation and control of stormwater runoff quantity and quality.	Adopted May 2003
International Building Code	Construct to the highest standards available.	Adopted July 2007
International Fire Code	Construct to the highest standards available.	Adopted July 2007.
International Mechanical Code	Construct to the highest standards available.	Adopted July 2007
Uniform Plumbing Code	Construct to the highest standards available.	Most recent version Adopted July 2007
National Electric Code	Construct to the highest standards available.	Most recent version Adopted July 1, 1998
Edmonds Comprehensive Plan	Contains community's vision of the City's future, provides a statement of long-range goals and policies.	Adopted 1995 Updated annually
Water Comprehensive Plan	Proves the City's water utility with long-term planning strategies for a twenty-year period.	June 2002 Scheduled for update in 2009
6-Year Capital Facilities Plan 20-Year Capital Facilities Plan 6-Year Capital Improvement Plan	Ongoing plans for the replacement and upgrade of infrastructure and critical facilities.	2008 – 2014 Updated annually

The City of Edmonds		
Name of Document	**Purpose**	**Review Schedule***
Edmonds Environmentally Sensitive Areas Map	Identifies sensitive areas in the Edmonds Shoreline area.	N/A
National Flood Insurance Program		Most recent version Adopted July 1,1998
Community Assistance Visit (NFIP)		Completed May 13, 2008

Other Jurisdictions' Plans	
Edmonds School District No. 15 Capital Facilities Plan	Adopted annually 2008
Edmonds-Woodway High School Master Plan	--
Port of Edmonds Master Plan	Adopted May 2001
Stevens Memorial Hospital Master Plan	October 1994
Washington State Ferry's Safety Management System	--

Drought

- Encourage water conservation.
- Edmonds' Water Conservation Program is consistent with the conservation programs developed by the two entities that provide water to the City: the Cities of Everett and Seattle.

Earthquake

- Edmonds' City Hall was retrofitted for seismic reinforcement in 1997.
- Edmonds recreation center, the Frances Anderson Center was structurally retrofitted for major earthquakes in 2008. This project was partially funded through a FEMA hazard mitigation project grant.
- The City of Edmonds encourages voluntary seismic upgrade to properties.
- The City of Edmonds is aware of and supports the Washington State Ferry System's emergency management protocols: the *Safety Management System*. This system establishes:
  - "Drop, cover, and hold" policies during an earthquake.
  - As soon as the shaking stops, ferry vessels are moved away from the docking areas and taken ½ to 1 mile away from the beach.
  - Cars and foot passengers are evacuated from the dock and directed to move uphill and away from the shore.

- Personnel and passengers wait a minimum of half an hour – longer if a threat of tsunami is established – before anyone is allowed back into the dock area.
- Before ferry operations are resumed, trained staff conduct a safety inspection of the docks and associated facilities. If there is no damage, operations may resume.

Flood

- The City of Edmonds restricts development in the floodway. These restrictions are codified in ECDC 19.75.050C.
  - Evaluated and set elevation requirements for new residential and non-residential structures in the floodplain area.
  - Identify alternatives to reduce development in the floodplain.
- The City of Edmonds is primarily vulnerable to urban flooding. To minimize damage from this hazard, Edmonds has several City-owned and –operated stormwater outfalls with tidal gate systems to provide drainage control. The City also has several open detention ponds and a number of stormwater infiltration systems to manage stormwater flows.

Landslide

- To mitigate for landslide, the City of Edmonds relies on the adoption and enforcement of current building codes. In addition, the City has established building requirements to mitigate for Meadowdale landslide hazards.
- The City maintains the drainage system in the Meadowdale landslide area to minimize build-up of water that could erode the embankments.
- The Critical Areas Ordinance provides guidelines for, and places restrictions on, development in hazard-prone areas.

Severe Storm

- The City of Edmonds has completed a series of projects to restore and replace bulkhead on the waterfront to minimize damage from wave action during a severe storm.
- The Comprehensive Stormwater Plan and Capital Improvement Plan are maintained in accordance with State guidelines and are used both to develop policies and as a financial management tool. The City uses these plans to maintain and enhance stormwater systems in order to minimize the effects of severe storms and the secondary effects of these storms: flooding and landslide.
- As part of the Comprehensive Stormwater Plan and Capital Improvement Plan, culverts have been inventoried and mapped. Drainage problems are identified and included in the Capital Improvement Plan for future work.

- Edmonds rebuilt the waterfront bulkheads to replace deteriorated wood. This reduces wave damage and shoreline erosion.

Tsunami and Seiche

- As discussed above, the City of Edmonds is aware of and supports the Washington State Ferry System's emergency management protocols: the *Safety Management System*. If a tsunami was expected, the Washington Ferry System's personnel would:
  - Move the vessel(s) away from the docking areas and take the ferries ½ to 1 mile away from the beach.
  - Evacuate cars and foot passengers from the dock areas and direct all traffic to move uphill and away from the shore.
  - Before ferry operations are resumed, trained staff will conduct a safety inspection of the docks and associated facilities. If there is no damage, operations may resume.

Volcano

- None at this time.

Wildland-Urban Interface Fire

- Maintain right-of-way to minimize dry grasses and undergrowth.
- Ban the use of fireworks within the City.

Mitigation Action Items

The Mitigation Plan identifies short- and long-term action items developed through data collection, research, and the public participation process. Mitigation Plan activities may be considered for funding through federal and state grant programs and when other funds are made available through the budgeting process or the passage of bonds.

Action items address multi-hazard (MH) or hazard-specific issues. Upon implementation, the coordinating organizations may look to partner organizations for resources and technical assistance.

To help ensure activity implementation, each action item includes several pieces of information in the description. These include:

- *Coordinating Organization*
  The coordinating organization is that which is willing and able to organize resources, find appropriate funding, or oversee activity implementation, monitoring and evaluation. The coordinating organizations may be local or regional agencies. Organizations written in *italics* are not participating in this Plan but have an established relationship with this jurisdiction.

- *Timeline*
  Action items include both long- and short-term activities. Each action item includes an estimate of the timeline for implementation. *Short-term* action items (ST) are activities that organizations may implement with existing resources and authorities within one to two years. *Long-term* action items (LT) may require new or additional resources or authorities, and may take between two and five years to implement.

- *Ideas for Implementation*
  Each action item includes ideas for implementation. This may be individual steps for one project, or it may be several related projects that address the natural hazard.

- *Plan Goals Addressed*
  The plan goals are identified to monitor and evaluate how well the Mitigation Plan is achieving its goals once implementation begins.

- *Benefit-to-Cost Review*
  Due to limitations in staff time, and because project priorities may shift based on changes in funding options and local events, a generalized benefit-to-cost review is used. The steps associated with prioritizing the mitigation projects are as follows:

1. The jurisdiction rates the project cost as “high,” “medium,” or “low” in relation to budget and previous projects, and each rating is assigned a numerical value.
2. The project outcome is then rated as “low,” “medium,” or “high,” and each of these ratings is assigned a numerical value.
3. The two values are added together, and the total provides the cost-benefit and the priority.

Example:

If a project has a *medium approximate cost*, and is considered to be *highly effective*, the boxes would be marked as shown below.

Approx Cost +	Effectiveness	=	Priority
[ ] 1 – High	[ ] 1 – Low		[ ] 2 – Lowest
[**X**] 2 – Medium	[ ] 2 – Medium		[ ] 3
[ ] 3 – Low	[**X**] 3 – High		[ ] 4
			[**X**] 5
			[ ] 6 – Highest

The priority ratings with the highest numbers are considered to be the highest priorities. As always, however, these are subject to financial realities and may not be carried out in the exact order indicated.

MULTI-HAZARD Mitigation Actions (MH)

<u>ST-01-MH-ED</u>: Replace water mains to maintain and/or enhance critical functions; minimize damage or breakage from natural hazards such as earthquakes or landslides; and ensure adequate water pressure to be effective in fire suppression.

Ideas for implementation:

- The City of Edmonds is replacing steel line water mains with ductile iron pipe mains. This replacement cycle will be completed by 2008.
- Beginning in 2008-2009, the City will begin replacing cast iron water mains with ductile iron or as required by current codes or technology.
- The 138 miles of water mains are scheduled to be replaced at a rate of 1% per year.

Coordinating Organization:	Edmonds Public Works
Estimated Price:	$1,990,000
Funding Source:	Water Utility Fund
Timeline:	Ongoing
Plan Goals Addressed:	Protect Life and Property; Provide for Emergency & Critical Services; Facilitate Continuity and Recovery
Benefit-to Cost Review:	4

Approx Cost +	Effectiveness	=	Priority
[**X**] 1 – High	[ ] 1 – Low		[ ] 2 – Lowest
[ ] 2 – Medium	[ ] 2 – Medium		[ ] 3
[ ] 3 – Low	[**X**] 3 – High		[**X**] 4
			[ ] 5
			[ ] 6 – Highest

DROUGHT Mitigation Actions (D)

<u>ST-02-D-ED</u>: Work with Alderwood Water District to educate consumers about drought impacts and ways to minimize water waste.

Ideas for implementation:

- Insert water conservation information in utility bills.
- Work with schools to educate young people on the importance of water conservation and the impact of drought on watersheds.
- The City loans out a Car Wash kit that removes pollutants from the water and this comes with a brochure for water conservation.

Coordinating Organization:	Edmonds Public Works; Edmonds Administration; Alderwood Water District
Estimated Price:	$10,000
Funding Source:	Storm Utility Fund
Timeline:	Ongoing
Plan Goals Addressed:	Increase Public Awareness; Encourage Partnerships
Benefit-to Cost Review:	4

Approx Cost +	Effectiveness	=	Priority
[ ] 1 – High	[**X**] 1 – Low		[ ] 2 – Lowest
[ ] 2 – Medium	[ ] 2 – Medium		[ ] 3
[**X**] 3 – Low	[ ] 3 – High		[**X**] 4
			[ ] 5
			[ ] 6 – Highest

EARTHQUAKE Mitigation Actions (E)

<u>ST-03-E-ED</u>: Integrate new earthquake hazard mapping data for the City of Edmonds and improve technical analysis of earthquake hazards.

Ideas for implementation:

- Update GIS system data.
- Install and train on HAZUS software; conduct HAZUS analysis.

Coordinating Organization:	Edmonds Development Services
Estimated Price:	$100,000
Funding Source:	General Fund/Grants
Timeline:	5 years
Plan Goals Addressed:	Protect Life & Property; Increase Public Awareness; Provide for Emergency & Critical Services; Facilitate Continuity & Recovery
Benefit-to Cost Review:	5

Approx Cost +	Effectiveness	=	Priority
[ ] 1 – High	[ ] 1 – Low		[ ] 2 – Lowest
[**X**] 2 – Medium	[ ] 2 – Medium		[ ] 3
[ ] 3 – Low	[**X**] 3 – High		[ ] 4
			[**X**] 5
			[ ] 6 – Highest

ST-04-E-ED: Conduct non-structural retrofit activities.

Ideas for implementation:

- Strap down and secure computers and other office equipment and machinery.
- Secure shelves, lockers, and furniture to walls.
- Conduct walk-throughs to ensure that heavy items are not stored overhead. Secure in place or move to safer locations.
- Mount computer servers on seismic isolation platforms, or use other appropriate technology to secure servers.
- Ensure facility water heaters are strapped securely to wall studs in accordance with current requirements.
- Secure ceiling tiles and light fixtures with wires.
- Secure the back-up generator and HVAC equipment for City Hall (Completed).
- Secure ducts and piping.
- Use plastic sleeves on fluorescent lighting tubes.
- Secure artwork.
- Replace untempered glass with tempered glass, or install polyester shatter-resistant film over existing glass.
- Install child-proof latches on drawers and cabinets in appropriate locations.

Coordinating Organization:	Edmonds Public Works
Estimated Price:	$150,000
Funding Source:	General Fund/Grants
Timeline:	5 years, ongoing
Plan Goals Addressed:	Protect Life & Property; Provide for Emergency & Critical Services; Facilitate Continuity & Recovery
Benefit-to Cost Review:	5

Approx Cost +	Effectiveness	=	Priority
[ ] 1 – High	[ ] 1 – Low		[ ] 2 – Lowest
[**X**] 2 – Medium	[ ] 2 – Medium		[ ] 3
[ ] 3 – Low	[**X**] 3 – High		[ ] 4
			[**X**] 5
			[ ] 6 – Highest

<u>ST-05-E-ED</u>: Encourage reduction of nonstructural and structural earthquake hazards in homes, schools, businesses, and government offices.

Ideas for implementation:

- Provide information to all Edmonds School District, City and government departments and school facility managers and teachers on securing bookcases, filing cabinets, light fixtures, and other objects that can cause injuries and block exits.
- Explore partnerships to provide retrofitting classes for homeowners, renters, building professionals, and contractors.

Coordinating Organization:	Edmonds School District; Edmonds Development Services
Estimated Price:	$20,000
Funding Source:	General Fund/Grants
Timeline:	Ongoing
Plan Goals Addressed:	Protect Life & Property; Increase Public Awareness; Encourage Partnerships
Benefit-to Cost Review:	5

Approx Cost +	Effectiveness	=	Priority
[ ] 1 – High	[ ] 1 – Low		[ ] 2 – Lowest
[ ] 2 – Medium	[**X**] 2 – Medium		[ ] 3
[**X**] 3 – Low	[ ] 3 – High		[ ] 4
			[**X**] 5
			[ ] 6 – Highest

<u>ST-06-E-ED</u>: Identify public buildings and infrastructure that require structural retrofitting.

Ideas for implementation:

- Conduct a seismic survey of all public buildings and infrastructure.
- Coordinate with State to identify transportation infrastructure in Edmonds that requires seismic retrofits.

Coordinating Organization:	Edmonds Public Works; Edmonds Development Services
Estimated Price:	$5,000
Funding Source:	General Fund
Timeline:	2 years & ongoing
Plan Goals Addressed:	Protect Life and Property; Encourage Partnerships; Provide for Emergency or Critical Services; Facilitate Continuity and Recovery
Benefit-to Cost Review:	5

Approx Cost +	Effectiveness	=	Priority
[ ] 1 – High	[ ] 1 – Low		[ ] 2 – Lowest
[ ] 2 – Medium	[**X**] 2 – Medium		[ ] 3
[**X**] 3 – Low	[ ] 3 – High		[ ] 4
			[**X**] 5
			[ ] 6 – Highest

<u>ST-07-E-ED</u>: Identify funding sources for structural and nonstructural retrofitting of structures that are identified as seismically vulnerable.

Ideas for implementation:

- Provide information for property owners, small businesses, and organizations on sources of funds (loans, grants, etc.).

Coordinating Organization:	*Edmonds Chamber of Commerce;* Edmonds Development Services
Estimated Price:	$5,000
Funding Source:	Grants
Timeline:	Ongoing
Plan Goals Addressed:	Increase Public Awareness; Encourage Partnerships
Benefit-to Cost Review:	4

Approx Cost +	Effectiveness	=	Priority
[ ] 1 – High	[**X**] 1 – Low		[ ] 2 – Lowest
[ ] 2 – Medium	[ ] 2 – Medium		[ ] 3
[**X**] 3 – Low	[ ] 3 – High		[**X**] 4
			[ ] 5
			[ ] 6 – Highest

FLOOD Mitigation Actions (F)

<u>LT-01-F-ED</u>: Enhance data and mapping for floodplain information within the city, and identify and map flood-prone areas outside of designated floodplains.

Ideas for implementation:

- Apply for FEMA's cooperative technical partnership using the 2-foot contour interval floodplain mapping data in the City of Edmonds's GIS system.
- Update flood plain maps in the Comprehensive Plan.
- Use mapping data to update the flood-loss estimates for the City of Edmonds.

Coordinating Organization:	Edmonds Development Services
Estimated Price:	**$**40,000
Funding Source:	Grants
Timeline:	5 years (as funding allows)
Plan Goals Addressed:	Protect Life & Property; Increase Public Awareness; Encourage Partnerships; Provide for Emergency & Critical Services; Facilitate Continuity & Recovery; Protect Natural Systems
Benefit-to Cost Review:	5

Approx Cost +	Effectiveness	=	Priority
[ ] 1 – High	[ ] 1 – Low		[ ] 2 – Lowest
[ ] 2 – Medium	[**X**] 2 – Medium		[ ] 3
[**X**] 3 – Low	[ ] 3 – High		[ ] 4
			[**X**] 5
			[ ] 6 – Highest

<u>LT-02-F-ED</u>: Develop acquisition and management strategies to preserve opens space for flood mitigation, fish habitat, and water quality in the floodplain.

Ideas for implementation:

- Continue to implement and require conservation easements for the Shell Creek Corridor by acquiring and managing floodplain open space in the City of Edmonds.
- Explore funding for property acquisition from federal (e.g., FEMA's Hazard Mitigation Grant Program), state, regional, and county governments, as well as private and non-profit organizations, trails programs, fish programs, as well as options for special appropriations.
- Develop a regional partnership between flood mitigation, fish habitat, and water quality enhancement organizations and programs to improve educational programs.
- Identify sites where environmental restoration work can benefit flood mitigation, fish habitat, and water quality.
- Work with landowners to develop flood management practices that provide healthy fish habitat.
- Identify existing watershed education programs and determine which programs would support a flood education component.

Coordinating Organization:	Edmonds Public Works; Edmonds Executive Department; *Adopt-A-Stream Foundation*
Estimated Price:	$108,500
Funding Source:	Storm Water Utility/General Fund/Grant
Timeline:	2 years (as funding allows)
Plan Goals Addressed:	Protect Life & Property; Increase Public Awareness; Encourage Partnerships; Provide for Emergency & Critical Services; Facilitate Continuity & Recovery; Protect Natural Systems
Benefit-to Cost Review:	5

Approx Cost +	Effectiveness	=	Priority
[ ] 1 – High	[ ] 1 – Low		[ ] 2 – Lowest
[**X**] 2 – Medium	[ ] 2 – Medium		[ ] 3
[ ] 3 – Low	[**X**] 3 – High		[ ] 4
			[**X**] 5
			[ ] 6 – Highest

LANDSLIDE Mitigation Actions (L)

<u>ST-08-L-ED</u>: Improve knowledge of landslide hazard areas and understanding of vulnerability and risk to live and property in hazard-prone areas.

Ideas for implementation:

- Incorporate landslide information into GIS mapping, and planning and the City of Edmonds Comprehensive Plan.
- Develop public information to emphasize economic risk when building on potential or historical landslide areas.
- Develop or attain public information brochures to educate the community on how to maintain and enhance slope stability.

Coordinating Organization:	Edmonds Development Services
Estimated Price:	**$**25,000
Funding Source:	Grants/General Fund
Timeline:	3 years
Plan Goals Addressed:	Protect Life & Property; Increase Public Awareness; Encourage Partnerships; Provide for Emergency & Critical Services; Facilitate Continuity & Recovery; Protect Natural Systems
Benefit-to Cost Review:	6

Approx Cost +	Effectiveness	=	Priority
[ ] 1 – High	[ ] 1 – Low		[ ] 2 – Lowest
[ ] 2 – Medium	[ ] 2 – Medium		[ ] 3
[**X**] 3 – Low	[**X**] 3 – High		[ ] 4
			[ ] 5
			[**X**] 6 – Highest

<u>ST-09-L-ED</u>: Encourage construction and subdivision design by professional planning staff that can be applied to steep slopes to reduce the potential adverse impacts from development.

Ideas for implementation:

- Continue to implement the City's Comprehensive Plan and Municipal Code that encourages the retention of natural features of the land and minimizes impacts to steep slopes.
- Work with the City of Edmonds Planning Commission and City Council to develop guidelines to mitigate and prevent landslides.

Coordinating Organization:	Edmonds Development Services
Estimated Price:	$369,086
Funding Source:	General Fund
Timeline:	1 year (Completed with adoption of new critical areas regulations)
Plan Goals Addressed:	Protect Life & Property; Increase Public Awareness; Encourage Partnerships; Provide for Emergency & Critical Services; Facilitate Continuity & Recovery; Protect Natural Systems
Benefit-to Cost Review:	5

Approx Cost +	Effectiveness	=	Priority
[ ] 1 – High	[ ] 1 – Low		[ ] 2 – Lowest
[**X**] 2 – Medium	[ ] 2 – Medium		[ ] 3
[ ] 3 – Low	[**X**] 3 – High		[ ] 4
			[**X**] 5
			[ ] 6 – Highest

<u>ST-10-L-ED</u>: Limit activities in identified potential and historical landslide areas through regulation and public outreach.

Ideas for implementation:

- Analyze existing regulations regarding development in landslide prone areas. (Completed)
- Identify existing mechanisms for public outreach (e.g., watershed councils, etc.).

Coordinating Organization:	Edmonds Development Services
Estimated Price:	$200,000
Funding Source:	General Fund
Timeline:	Ongoing
Plan Goals Addressed:	Protect Life & Property; Public Awareness; Encourage Partnerships
Benefit-to Cost Review:	5

Approx Cost +	Effectiveness	=	Priority
[ ] 1 – High	[ ] 1 – Low		[ ] 2 – Lowest
[**X**] 2 – Medium	[ ] 2 – Medium		[ ] 3
[ ] 3 – Low	[**X**] 3 – High		[ ] 4
			[**X**] 5
			[ ] 6 – Highest

SEVERE STORM Mitigation Actions (S)

ST-11-S-ED: Enhance public safety strategies for severe storm events.

Ideas for implementation:

- Develop coordinated management strategies for accident prevention through de-icing roads, plowing roads, clearing roads of fallen trees, and clearing debris from public and private property.
- Enact management strategies.

Coordinating Organization:	Edmonds Public Works
Estimated Price:	$50,000
Funding Source:	Street Maintenance Fund
Timeline:	Ongoing
Plan Goals Addressed:	Protect Life & Property; Provide for Emergency & Critical Services; Facilitate Continuity & Recovery
Benefit-to Cost Review:	6

Approx Cost +	Effectiveness	=	Priority
[ ] 1 – High	[ ] 1 – Low		[ ] 2 – Lowest
[ ] 2 – Medium	[ ] 2 – Medium		[ ] 3
[**X**] 3 – Low	[**X**] 3 – High		[ ] 4
			[ ] 5
			[**X**] 6 – Highest

<u>ST-12-S-ED</u>: Develop and implement programs to coordinate maintenance and mitigation activities to reduce risk to public infrastructure from severe storms.

Ideas for implementation:

- Partner with responsible agencies and organizations to design and implement programs that reduce risk to life, property, and utility systems.
- Develop partnerships between utility providers and City public works agencies to document known hazard areas.

Coordinating Organization:	Edmonds Public Works; *Alderwood Water District; Snohomish County PUD; Puget Sound Energy*
Estimated Price:	$25,000
Funding Source:	Utility Fund/Grants
Timeline:	Ongoing
Plan Goals Addressed:	Protect Life & Property; Encourage Partnerships; Provide for Emergency & Critical Services
Benefit-to Cost Review:	5

Approx Cost +	Effectiveness	=	Priority
[ ] 1 – High	[ ] 1 – Low		[ ] 2 – Lowest
[ ] 2 – Medium	[**X**] 2 – Medium		[ ] 3
[**X**] 3 – Low	[ ] 3 – High		[ ] 4
			[**X**] 5
			[ ] 6 – Highest

<u>ST-13-S-ED</u>: Increase public awareness of severe storm mitigation activities.

Ideas for implementation:

- Collect information on public education materials for protecting life, property, and the environment from severe storm events.
- Distribute educational materials to residents and public and private sector organizations regarding evacuation routes during road closures.
- Target the vulnerable or at-risk populace for disseminating preparedness information (seniors, medically fragile, etc.).

Coordinating Organization:	Edmonds Fire Department; Edmonds Police Department; Edmonds School District; *Snohomish County PUD; Puget Sound Energy; ESCA*
Estimated Price:	$30,000
Funding Source:	Utility Fund/General Fund/Grants
Timeline:	Ongoing
Plan Goals Addressed:	Protect Life & Property; Increase Public Awareness; Encourage Partnerships
Benefit-to Cost Review:	5

Approx Cost +	Effectiveness	=	Priority
[ ] 1 – High	[ ] 1 – Low		[ ] 2 – Lowest
[ ] 2 – Medium	[**X**] 2 – Medium		[ ] 3
[**X**] 3 – Low	[ ] 3 – High		[ ] 4
			[**X**] 5
			[ ] 6 – Highest

<u>ST-14-S-ED</u>: Develop and implement programs to keep trees from threatening lives, property, and public infrastructure during severe storm events.

Ideas for implementation:

- Partner with responsible agencies and organizations to design and disseminate education information to property owners to reduce risk from tree failure to life, property, and utility systems.
- Develop partnerships between utility providers and local public works agencies to document known hazard areas.
- Continue to identify potentially hazardous trees in urban areas.

Coordinating Organization:	Edmonds Public Works; *Snohomish County PUD*
Estimated Price:	$10,000
Funding Source:	Street Maintenance Fund
Timeline:	Ongoing
Plan Goals Addressed:	Protect Life & Property; Increase Public Awareness; Encourage Partnerships; Provide for Emergency & Critical Services; Facilitate Continuity & Recovery; Protect Natural Systems
Benefit-to Cost Review:	5

Approx Cost +	Effectiveness	=	Priority
[ ] 1 – High	[ ] 1 – Low		[ ] 2 – Lowest
[ ] 2 – Medium	[**X**] 2 – Medium		[ ] 3
[**X**] 3 – Low	[ ] 3 – High		[ ] 4
			[**X**] 5
			[ ] 6 – Highest

<u>LT-03-S-ED</u>: Require electrical utilities to use underground construction methods where possible to reduce power outages from severe storms.

Ideas for implementation:

- Continue to require the use of underground utilities where possible to be consistent with the City of Edmonds Municipal Code.

Coordinating Organization:	Edmonds Development Services; *Snohomish County PUD*
Estimated Price:	$50,000
Funding Source:	General Fund
Timeline:	Ongoing
Plan Goals Addressed:	Protect Life & Property; Encourage Partnerships; Provide for Emergency & Critical Services; Facilitate Continuity & Recovery
Benefit-to Cost Review:	6

Approx Cost +	Effectiveness	=	Priority
[ ] 1 – High	[ ] 1 – Low		[ ] 2 – Lowest
[ ] 2 – Medium	[ ] 2 – Medium		[ ] 3
[**X**] 3 – Low	[**X**] 3 – High		[ ] 4
			[ ] 5
			[**X**] 6 – Highest

TSUNAMI & SEICHE Mitigation Actions (T)
None identified at this time.

VOLCANO Mitigation Actions (V)

LT-04-V-ED: Collaborate to develop ash fall models that are specific to the north King and south Snohomish Counties area.

Ideas for implementation:
- Determine critical activities that must be implemented for varying degrees of ash fall.

Coordinating Organization:	Edmonds Development Services; *Washington State Department of Natural Resources*; *ESCA*
Estimated Price:	To be determined (low to medium cost)
Funding Source:	Grants
Timeline:	5 years
Plan Goals Addressed:	Protect Life & Property; Increase Public Awareness; Encourage Partnerships
Benefit-to Cost Review:	3

Approx Cost +	Effectiveness	=	Priority
[ ] 1 – High	[**X**] 1 – Low		[ ] 2 – Lowest
[**X**] 2 – Medium	[ ] 2 – Medium		[**X**] 3
[ ] 3 – Low	[ ] 3 – High		[ ] 4
			[ ] 5
			[ ] 6 – Highest

LT-05-V-ED: Develop and implement policy for maintaining stock of filters for key vehicles and pieces of equipment.

Ideas for implementation:

- Identify key vehicles and equipment such as: back-up generators, fire and police vehicles, HVAC and/or other large or unusual equipment requiring filters.
- Establish policy and budget to maintain spare filters.

Coordinating Organization:	Edmonds Executive Department; Edmonds Public Works; Edmonds Fire Department; Edmonds Police Department
Estimated Price:	To be determined
Funding Source:	General fund
Timeline:	5 years
Plan Goals Addressed:	Protect Life & Property; Provide for Emergency & Critical Services; Facilitate Continuity and Recovery
Benefit-to Cost Review:	4

Approx Cost +	Effectiveness	=	Priority
[ ] 1 – High	[ ] 1 – Low		[ ] 2 – Lowest
[**X**] 2 – Medium	[**X**] 2 – Medium		[ ] 3
[ ] 3 – Low	[ ] 3 – High		[**X**] 4
			[ ] 5
			[ ] 6 – Highest

WILDLAND-URBAN INTERFACE FIRE Mitigation Actions (W)

<u>LT-06-W-ED</u>: Enhance outreach and education programs aimed at mitigating wildland-urban interface fire hazards and reducing or preventing the exposure of citizens, public agencies, private property owners, and businesses to natural causes.

Ideas for implementation:

- Visit neighborhoods and conduct education and outreach activities.
- Conduct specific community-based demonstration projects of fire prevention and mitigation in the urban interface.
- Establish neighborhood "drive-through" activities that pinpoint site-specific mitigation activities. Fire crews can give property owners personal suggestions and assistance.
- Perform public outreach and information outreach by holding open houses at fire stations. Allow the public to visit, see the equipment, and discuss wildland-urban interface fire mitigation with the crews.

Coordinating Organization:	Edmonds Fire Department
Estimated Price:	To be determined
Funding Source:	General fund and grants
Timeline:	4 years
Plan Goals Addressed:	Protect Life & Property; Increase Public Awareness; Encourage Partnerships; Provide for Emergency & Critical Services; Facilitate Continuity & Recovery; Protect Natural Systems
Benefit-to Cost Review:	4

Approx Cost +	Effectiveness	=	Priority
[ ] 1 – High	[ ] 1 – Low		[ ] 2 – Lowest
[**X**] 2 – Medium	[**X**] 2 – Medium		[ ] 3
[ ] 3 – Low	[ ] 3 – High		[**X**] 4
			[ ] 5
			[ ] 6 – Highest

<u>LT-07-W-ED</u>: Increase communication, coordination, and collaboration between wildland-urban interface property owners, city planners, fire prevention crews, and city officials to address risks, existing mitigation measures, and federal assistance programs.

Ideas for implementation:

- Encourage all residences to practice fire plans and evacuation routes.
- Encourage a standard for the State Fire Marshall to evaluate fire plans and emergency plans.
- Require fire department notification of new business applications to ensure that appropriate fire plans have been developed.
- Have the City Planners and Planning Commission work closely with those who choose to build in the wildland-urban interface area to identify and mitigate conditions that aggravate fire hazards, including:
  - Limited access for emergency equipment due to width and grade of roadways.
  - Poor turn-around for emergency equipment.
  - Inadequate water supplies.
  - Spacing, consistency, and species of vegetation around structures.
  - Inadequate fuel breaks, or lack of defensible space.
  - Highly flammable construction materials.
  - Building lots and subdivisions that are not in compliance with state and local land use and fire protection regulations.
  - Inadequate entry/escape routes.
- Encourage all new homes and major remodels located in the interface to have fire-resistant roofs and residential sprinkler systems.

Coordinating Organization:	Edmonds Fire Department
Estimated Price:	To be determined
Funding Source:	General Fund and Grants as available
Timeline:	Ongoing
Plan Goals Addressed:	Protect Life & Property; Increase Public Awareness; Encourage Partnerships; Provide for Emergency & Critical Services; Facilitate Continuity & Recovery
Benefit-to Cost Review:	4

Approx Cost +	Effectiveness =	Priority
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[**X**] 2 – Medium	[**X**] 2 – Medium	[ ] 3
[ ] 3 – Low	[ ] 3 – High	[**X**] 4
		[ ] 5
		[ ] 6 – Highest

[1] Washington Office of Financial Management, Forecasting Division.

Edmonds Community College

Edmonds Community College is located within the boundaries of the City of Lynnwood, approximately 15 miles north of Seattle. The campus encompasses a total of 51.7 acres of land and includes 31 buildings that have more than 600,000 square feet.

Edmonds Community College, its lands and buildings, is owned and controlled by the State of Washington. Governance is provided by the Washington State Board of Community and Technical Colleges.

Edmonds Community College has an average of 10,700 students attending each quarter, with nearly 3,900 students attending full-time. The staff includes 141 full-time instructors, 320 part-term instructors and another 590 support staff. Additionally, the facility hosts a day care that provides services to an average of 110 children on a daily basis.

Because the school provides both day and evening classes, and is frequently used as a meeting facility for community groups and organizations, it is very likely that the campus will be occupied when a disaster occurs.

In addition to the normal disaster preparation and concerns, the Community College must also take into account the diverse population which includes nearly 800 students from 45 countries.

Critical structures are identified in Annex K.

Hazard Identification

Based on past experience, the Edmonds Community College rates its risk of natural hazards as follows:

HAZARD	RATING (out of 80 possible)
Drought	05
Earthquake	35
Flood	05
100-year	05
Tidal Surge	00
Urban	05
Landslide	05
Severe Storm	50
Tsunami & Seiche	05
Volcano	16
Wildland Urban Interface Fire	20

Drought

Rating: **05**

Drought is not considered to be a high-risk hazard for Edmonds Community College. The College's potable water is supplied the City of Lynnwood and is purchased by Lynnwood from Alderwood Water District. The water supply is relatively stable for short-term (one season) droughts.

Edmond Community College regards drought as an EXTREMELY LOW threat.

Earthquake

Rating: 35

Edmonds Community College is located in Seismic Zone 3, between several fault lines, and an earthquake is therefore considered to be a significant risk for the College.

As discussed in this document's HIVA, earthquakes occur in Washington State on an almost daily basis. While most quakes are minor, seismologists tell us that we can expect a 7.0 magnitude deep or intraplate earthquake about every 70 years and an 8.0 or greater subduction quake every 150 to 1,100 years.

Based on this information, when a major earthquake occurs in the region, the College can expect significant damage, injuries, and possibly deaths, depending on the time and day of occurrence. This is due in part to the relatively dense concentration of people in 31 buildings.

Of additional concern is the concentration of very young adults (late teens and early-20s), pre-school children (in the childcare center) and exchange students with English as a second language. Other challenges the College may face include the possibility of the surrounding neighborhood coming to the College for care and assistance, further overwhelming resources.

During the 2001 Nisqually Earthquake, Edmonds Community College did not experience any significant damage. This was due to a combination of factors including the distance away from the epicenter and the direction the shockwave traveled. The fact that most of the College's buildings are relatively new (less than 40 years old) also played a part in how well the College rode out the earthquake. A different combination of factors could lead to very different levels of damage.

The College rates the risk from earthquake as MODERATE.

Flood

Rating: 05

100-Year

None of the Community College's acreage is in a flood zone.

Tidal Surge

The College does not have any waterfront property.

Urban

The College occasionally experiences standing water in parking lots and overflowing retaining ponds when the City of Lynnwood's stormwater system is overwhelmed. This is a short-term situation and resolves itself as soon as the stormwater system is able to absorb the overage.

The College is working with the City to ensure that the College's stormwater drainage system is to current and appropriate standards ensuring proper drainage.

Overall, the risk from flood is rated EXTREMELY LOW.

Landslide

Rating: 05

Edmonds Community College is built on very stable ground, with no bluffs, steep slopes or other hazards or vulnerabilities associated with landslide or soil displacement.

The College has only minimal elevation changes that are required for adequate drainage. To improve drainage, construction and maintenance plans and activities have created elevation changes.

Additionally, the area's hardpan conditions require the design of rockeries and/or block walls with drainage tiles to improve the growing conditions for native ground covers and plants incorporated in the landscape to maintain erosion.

The College rates the landslide risk as EXTREMELY LOW.

Severe Storm

Rating: 50

Edmonds Community College and the Puget Sound area is subjected to severe storms on a regular basis. Windstorms occur nearly every winter, and rainstorms are not unusual. On rare occasions, the Puget Sound region, including the College, has also experienced heavy snows and freezing rains.

Winds and snow or ice regularly cause tree branches to break and/or trees to fall. This may cause power outages or damage buildings.

The Inaugural Day Storm in 1993 had winds of 66 mph. This storm interrupted power to the region for more than three days. Branches and trees were downed and laid across streets, roads, and yards. Roofs were damaged from a combination of branches and the wind itself.

The College rates the hazard from severe storm as HIGH.

Tsunami & Seiche

Rating: 05

The College has very little risk of damage or destruction from either tsunami or seiche. This is because Edmonds Community College is not located on Puget Sound and does not have any large lakes within or near its borders.

The risk to Edmonds Community College from tsunami or seiche is considered to be EXTREMELY LOW.

Volcano

Rating: 16

Edmonds Community College is unlikely to suffer direct damage from a volcano eruption. However, in the event of a nearby eruption, the College may experience ashfall which could interfere with the operation of motor vehicles, require expensive clean-up efforts by the College, and cause respiratory distress to students and staff. The College and surrounding area is highly unlikely to experience any lava flow, lahar activity, or any of the other risks associated with volcanoes.

A secondary effect of a volcano eruption is the influx of refugees into the area. This may be an issue to the College as a regional partner, and the region as a whole, as resources are overwhelmed by numbers of people that the infrastructure is not designed to handle. This includes everything from roads and highways, water and electric utilities, to the regional hospital and shelter facilities.

Edmonds Community College's risk from a volcanic eruption is LOW.

Wildland-Urban Interface Fire

Rating: 20

Wildland-urban interface fire is a concern to Edmonds Community College due to the parks, wetlands, greenbelts, and undeveloped land parcels scattered throughout the 51.7 acres. The threat is in reverse proportion to the amount of rainfall in the region. When rain is scarce, the fire threat increases.

The College considers this risk to be LOW.

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Mitigation

Existing and Ongoing Mitigation Activities

Edmonds Community College is taking the following actions in ongoing efforts to mitigate for natural hazards and to maintain public safety.

All Hazards

As part of the preparation and mitigation services, the college has provided education and training in the form of Community Emergency Response Team (CERT) for volunteer college faculty and staff. Each volunteer has taken classes provided by ESCA for certification along with hands on disaster training table top exercises.

All members have been supplied with a backpack for supplies and personal equipment as outlined in the CERT training.

The College has stockpiled cribbing materials, safety supplies, and personal food packets along with identifying equipment, vehicles, and buildings for administration, triage, and emergency housing.

Drought

The College will work with the Water District to conserve water as a sustainability goal, although the Puget Sound region has always supplied adequate potable water for our needs.

Existing and ongoing drought mitigation actions include:

- Conservation techniques through usage of drip irrigation, computer controllers, mulching and/or chipping planting beds, selection of drought-tolerant plants, and collection of water from roofs.
- LEED installation of low-flow toilets, urinals, and sinks during renovation and new building projects.
- College policy that water usage is reduced for lawns when drought conditions are projected.

Earthquake

- Since 2001, all remodels and new building construction projects have incorporated seismology construction upgrades to meet or exceed current Lynnwood building codes. Specific projects include:
    - Upgraded Mountlake Terrace and Brier Hall.
    - Constructed new Mukilteo Hall.

Flood

- Installed retention systems to handle flood/storm issues meeting City of Lynnwood storm water retention codes.
- Implemented Department of Ecology best storm water practices through yearly maintenance of catch basins and parking lots.

Landslide

- Installation of rockeries and block walls with drainage tiles, native ground covers and plants to maintain erosion.

Severe Storm

- Installation of electrical looping systems with PUD and generators for our buildings.
- Tree mitigation and maintenance plans for grounds staff to minimize damage and ensure quick cleanup.

Tsunami and Seiche

- None at this time.

Volcano

- Grounds maintenance has sweeping and loading equipment available for cleanup work.
- Seaview Gym and the TUB is available for housing refugees and setting up a command center if required.

Wildland-Urban Interface Fire

- Maintain swales, planting beds, and lawns/meadowland through grounds maintenance and IPM methods to minimize the potential for wildfires.
- Mowing, weed eating, chipping and sprinkling these areas to reduce the effects for fire potential.

Mitigation Action Items

The Mitigation Plan identifies short- and long-term action items developed through data collection, research, and the public participation process. Mitigation Plan activities may be considered for funding through federal and state grant programs and when other funds are made available through the budgeting process or the passage of bonds.

Action items address multi-hazard (MH) or hazard-specific issues. Upon implementation, the coordinating organizations may look to partner organizations for resources and technical assistance.

To help ensure activity implementation, each action item includes several pieces of information in the description. These include:

- *Coordinating Organization*
  The coordinating organization is that which is willing and able to organize resources, find appropriate funding, or oversee activity implementation, monitoring and evaluation. The coordinating organizations may be local or regional agencies. Organizations written in *italics* are not participating in this Plan but have an established relationship with this jurisdiction.

- *Timeline*
  Action items include both long- and short-term activities. Each action item includes an estimate of the timeline for implementation. *Short-term* action items (ST) are activities that organizations may implement with existing resources and authorities within one to two years. *Long-term* action items (LT) may require new or additional resources or authorities, and may take between two and five years to implement.

- *Ideas for Implementation*
  Each action item includes ideas for implementation. This may be individual steps for one project, or it may be several related projects that address the natural hazard.

- *Plan Goals Addressed*
  The plan goals are identified to monitor and evaluate how well the Mitigation Plan is achieving its goals once implementation begins.

- *Benefit-to-Cost Review*
  Due to limitations in staff time, and because project priorities may shift based on changes in funding options and local events, a generalized Benefit-to-Cost Review and prioritization process is

used. The steps associated with prioritizing the mitigation projects are as follows:

1. The jurisdiction rates the project cost as "high," "medium," or "low" in relation to budget and previous projects, and each rating is assigned a numerical value.
2. The project outcome is then rated as "low," "medium," or "high," and each of these ratings is assigned a numerical value.
3. The two values are added together, and the total provides the cost-benefit and the priority.

Example:

If a project has a *medium approximate cost*, and is considered to be *highly effective*, the boxes would be marked as shown below.

Approx Cost +	Effectiveness =	Priority / Benefit-to-Cost Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[**X**] 2 – Medium	[ ] 2 – Medium	[ ] 3
[ ] 3 – Low	[**X**] 3 – High	[ ] 4
		[**X**] 5
		[ ] 6 – Highest

The priority/benefit-to-cost review ratings with the highest numbers are considered to be the highest priorities. As always, however, these are subject to financial realities and may not be carried out in the exact order indicated.

MULTI-HAZARD MITIGATION ITEMS (MH)

ST-01-MH-ECC: Install Campus-wide Computer Controller for Irrigation Systems

Ideas for implementation:

- Select computer master controller that will be compatible with existing system
- Design and install fiber for connecting infield systems to master controller
- Weather station and infield soil and water sensors for communication with master controller
- Existing systems surveyed, checked, and repaired for efficiencies.

Coordinating Organization:	Information Technology Staff; Grounds Staff
Estimated Price:	$5,000- $25,000
Funding Source:	College Budget; outside grants
Timeline:	2009-2011
Plan Goals Addressed:	Protect Life and Property; Protect Natural Systems
Benefit-to Cost Review:	6

Approx Cost +	Effectiveness =	Priority / Benefit-to-Cost Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[ ] 2 – Medium	[ ] 2 – Medium	[ ] 3
[**X**] 3 – Low	[**X**] 3 – High	[ ] 4
		[ ] 5
		[**X**] 6 – Highest

<u>ST-02-MH-ECC</u>: Remodel Meadowdale Hall; incorporate seismology construction upgrades to meet current seismic resistance codes.

Ideas for implementation:

- Install concrete reinforced "shear walls" on the first and second floors in both directions.
- Bracing suspended ceilings, mechanical ducts and light fixtures to resist seismic events.

Coordinating Organization:	City of Lynnwood; Edmonds Community College
Estimated Price:	$250,000-$500,000
Funding Source:	State Allocated Funds
Timeline:	2009-2010
Plan Goals Addressed:	Protect Life and Property
Benefit-to Cost Review:	5

Approx Cost +	Effectiveness =	Priority / Benefit-to-Cost Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[**X**] 2 – Medium	[ ] 2 – Medium	[ ] 3
[ ] 3 – Low	[**X**] 3 – High	[ ] 4
		[**X**] 5
		[ ] 6 – Highest

ST-03-E-ECC: Conduct non-structural retrofit activities

Ideas for implementation:

- Strap down and secure computers, shelves, and other office equipment and machinery.
- Conduct walk-through to ensure that heavy items are not stored overhead. Secure heavy items in place or move to safer locations.
- Prepare three- day emergency kits with water, food, etc. for Staff.

Coordinating Organization:	Edmonds Community College Facilities and Safety Committee.
Estimated Price:	$1,500.00
Funding Source:	College Budget
Timeline:	Ongoing
Plan Goals Addressed:	Protect Life and Property; Provide for Emergency & Critical Services; Facilitate Continuity and Recovery
Benefit-to Cost Review:	6

Approx Cost +	Effectiveness =	Priority / Benefit-to-Cost Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[ ] 2 – Medium	[ ] 2 – Medium	[ ] 3
[**X**] 3 – Low	[**X**] 3 – High	[ ] 4
		[ ] 5
		[**X**] 6 – Highest

<u>ST-04-F-ECC</u>: Monitor and maintain storm systems by being proactive during the year, during heavy rains and post snowstorms.

Ideas for implementation:

- Visually inspect and clean throughout the year as required.
- Monthly sweeping and cleaning of parking lots.
- Visually inspect drainage systems to ensure they remain free from clogs. Free blockage as necessary during and after storms.
- Educate students and staff concerning litter and debris in parking lot.

Coordinating Organization:	Lynnwood Public Works; ECC Grounds Department; ECC Facilities Staff, Faculty and Students.
Estimated Price:	$15,000-$25,000
Funding Source:	College Budget
Timeline:	Yearly and ongoing
Plan Goals Addressed:	Protect Life and Property; Protect Natural Systems
Benefit-to Cost Review:	6

Approx Cost +	Effectiveness =	Priority / Benefit-to-Cost Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[ ] 2 – Medium	[ ] 2 – Medium	[ ] 3
[**X**] 3 – Low	[**X**] 3 – High	[ ] 4
		[ ] 5
		[**X**] 6 – Highest

ST-05-SS-ECC: Installation of Phase Three of PUD Electrical Loop

Ideas for implementation:

- Design and installation of PUD electrical at intersection of 204th and 68th.
- Trench across 68th and then continue to Junction Box at Y corners; including tie into Snohomish Hall.
- Set transformers and push electrical wire for hook ups.

Coordinating Organization:	*Snohomish County PUD*; City of Lynnwood; Edmonds School District; and Edmonds Community College
Estimated Price:	$700,000-$900,000
Funding Source:	State Allocated funds
Timeline:	2009
Plan Goals Addressed:	Protect Life and Property; Provide for Emergency and Critical Services; Facilitate Continuity and Recovery
Benefit-to Cost Review:	4

Approx Cost +	Effectiveness =	Priority / Benefit-to-Cost Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[**X**] 2 – Medium	[**X**] 2 – Medium	[ ] 3
[[ ] 3 – Low	[ ] 3 – High	[**X**] 4
		[ ] 5
		[ ] 6 – Highest

ST-06-SS-ECC: Develop Tree Mitigation Plan

Ideas for implementation:

- Complete development and implementation of Tree Mitigation Plan.
- Hire arborist to evaluate trees on campus.
- Enter data regarding evaluated trees on CAD for location and identification.
- Establish and maintain a long-term plan for each tree with pruning and logging schedules.

Coordinating Organization:	Edmonds Community College Grounds Department
Estimated Price:	$10,000-$15,000
Funding Source:	College Budget
Timeline:	2009-2011
Plan Goals Addressed:	Protect Life and Property; Provide for Emergency and Critical Services
Benefit-to Cost Review:	5

Approx Cost +	Effectiveness =	Priority / Benefit-to-Cost Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[ ] 2 – Medium	[**X**] 2 – Medium	[ ] 3
[**X**] 3 – Low	[ ] 3 – High	[ ] 4
		[**X**] 5
		[ ] 6 – Highest

<u>ST-07-V-ECC</u>: Develop and Implement policy for maintaining stock of filters for key vehicles and pieces of equipment.

Ideas for implementation:

- Identify key vehicles and equipment (back-up generators, sweepers and tractors)
- Establish policy and budget to maintain spare filters.

Coordinating Organization:	Edmonds Community College Facilities departments.
Estimated Price:	$1,500
Funding Source:	College budget
Timeline:	2009-2010
Plan Goals Addressed:	Protect Life and Property; Provide for Emergency Services; Facilitate Continuity and Recovery
Benefit-to Cost Review:	4

Approx Cost +	Effectiveness =	Priority / Benefit-to-Cost Review
[ ] 1 – High	[**X**] 1 – Low	[ ] 2 – Lowest
[ ] 2 – Medium	[ ] 2 – Medium	[ ] 3
[**X**] 3 – Low	[ ] 3 – High	[**X**] 4
		[ ] 5
		[ ] 6 – Highest

ST-08-W-ECC: Develop and implement fire-resistant policies

Ideas for implementation:

- Ban fireworks on College grounds through signage and security personal monitoring parking lots.
- Minimize potential fuels by mowing grass and thinning shrubbery.
- Chip beds instead of using bark to minimize potential cigarette spark.

Coordinating Organization: Edmonds Grounds and Security Staff
Estimated Price: $5,000
Funding Source: College budget
Timeline: yearly
Plan Goals Addressed: Protect Life and Property
Benefit-to Cost Review: 5

Approx Cost +	Effectiveness =	Priority / Benefit-to-Cost Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[ ] 2 – Medium	[**X**] 2 – Medium	[ ] 3
[**X**] 3 – Low	[ ] 3 – High	[ ] 4
		[**X**] 5
		[ ] 6 – Highest

Edmonds School District

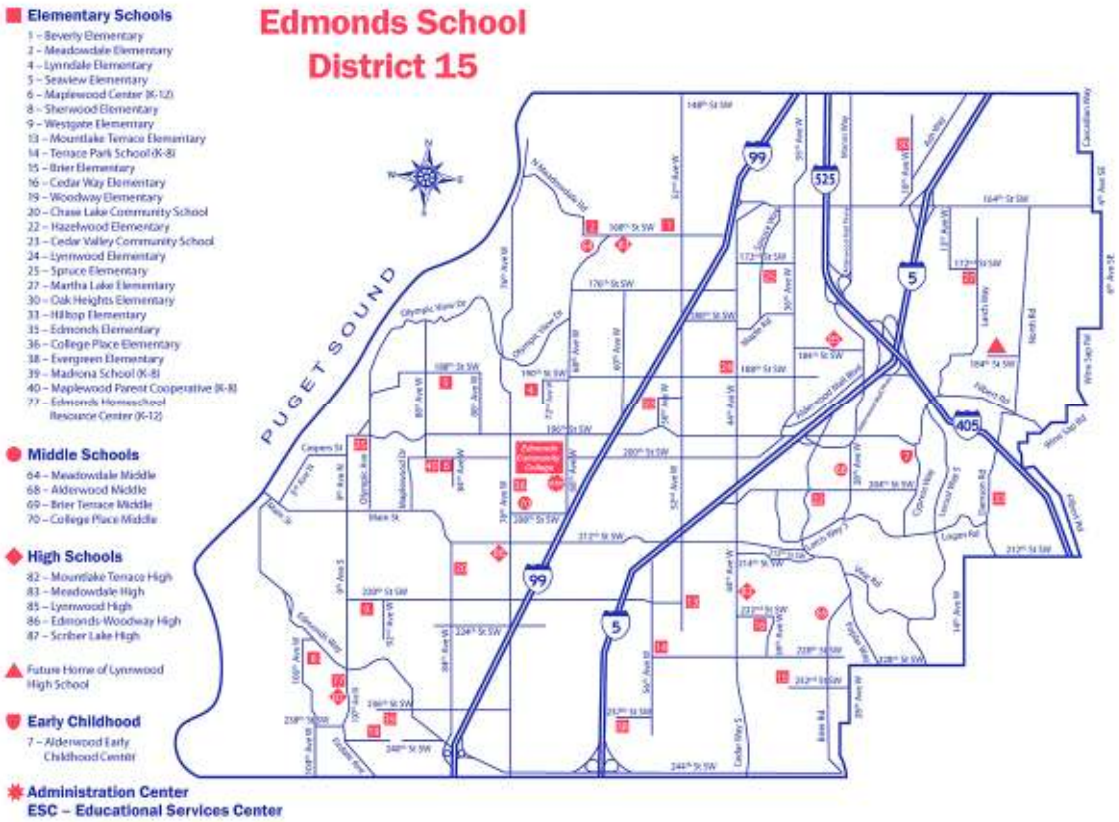
The Edmonds School District is located and operates within unincorporated south Snohomish County and the borders of the Cities of Brier, Edmonds, Lynwood, Mountlake Terrace, and Woodway. The District has 36 (elementary, K-8, middle, and high) school sites, one Home School Resource Center, one administrative support building, one maintenance support complex (multiple buildings), one transportation support complex, one warehouse, and a sports stadium.

During the 2008-2009 school year, the Edmonds School District employed over 3,100 employees while providing educational services for 20,050 students. This means that if a major disaster occurred during the school day, the Edmonds School District could be responsible for the welfare and safety of 23,150 people. In addition to caring for its employees and students, the School District would have to accommodate an influx of parents looking for their children. This influx of parents could increase the onsite headcounts by several thousand concerned adults, who themselves could become absorbed in the secondary effects of a disaster.

Although schools weren't designed to provide 24-hour student care during a major disaster, such as an earthquake or severe storm, the schools may be required to do just that, provide 24-hour care to their local communities. The District's resources may be overtaxed if it is required to provide emergency shelter for its community members.

The Edmonds School District provides its critical facilities list in *Annex L*.

Figure 1: Map of Edmonds School District



Hazard Identification

Based on past experience and regional histories, Edmonds School District rates its risk of natural hazards as follows:

HAZARD		RATING (out of a possible 80)
Drought		14
Earthquake		40
Flood		
	100-year	20
	Urban	20
Landslide		30
Severe Storm		44
Tsunami & Seiche		05
Volcano		05
Wildland Urban Interface Fire		10

Drought

Rating: 14

The School District's potable water is supplied by the local water districts and is relatively stable for short-term (one season) droughts. The School District cooperates with the cities and water districts in conservation measures as requested.

Drought is considered to be a *low-risk* hazard for the Edmonds School District.

Earthquake

Rating: 40

The School District is located in Seismic Zone 3, between several fault lines. An earthquake in Zone 3 is considered to be a significant risk.

As discussed in this document's HIVA, earthquakes occur in Washington State on an almost daily basis. While most earthquakes are minor in force, many seismologists believe that we can expect a magnitude 7.0 deep- or intra-plate earthquake about every 70 years and an 8.0 or greater subduction earthquake every 150 to 1,100 years.

Based on this information, the Edmonds School District can expect significant damage, injuries, and possible deaths, if and when a major

earthquake occurs in the region. However, due to the relative infrequency of major earthquake events, this risk is rated as *moderate*.

Flooding

The Edmonds School District does not have any major rivers running next to its buildings. It does, however, have property with wetlands, detention ponds, and several streams and tributaries either on or near the district-owned property.

100-Year Flood

Rating: 20

The risk for a 100-year flood is *MODERATELY-LOW* based on the proximity of wetlands, detention ponds, and streams or tributaries, in relation to schools and other district-owned buildings.

Urban Flooding

Rating: 20

Some schools are prone to urban flooding on a regular basis. This is due to excessive rainfall or snowmelt which overwhelms the stormwater system, wetlands, lake, and streams. Because this flooding is generally short-term in nature and does not usually include significant levels of water or rapid water movement, this is considered to be a *MODERATELY-LOW* risk.

Landslide and Soil Displacement

Rating: 30

The School District has several sites located near geologically hazardous areas comprised of steep slopes and unstable soils. These areas are made more vulnerable by the fact that the Edmonds School District is in Seismic Zone 3 and is therefore exposed to the possibility of earthquakes from several fault lines in the area. A large earthquake may destabilize and displace soil resulting in landslides.

Some areas of the School District are also made more vulnerable because of creeks. If the creeks flood, or even have an unusually high waterflow, the water may undercut or wash away sections of the creek banks. Heavy, saturating rains may also erode soil, wash away creek beds, and form sinkholes.

Landslide is considered to be a *MODERATE* risk.

Severe Storm

Rating: 44

The Edmonds School District is in an area that is seasonally and on a regular basis, subjected to severe storms. Windstorms occur nearly every winter, while rainstorms may occur throughout the winter, spring and fall seasons. Although infrequent, the lower elevations of the region have also experienced heavy snowstorms and freezing rainstorms.

Winds, snow, or ice regularly cause tree branches to break and/or trees to fall. This often results in power outages and damage to houses and business structures.

The Inaugural Day Storm in 1993 had wind speeds of up to 66 mph. This storm interrupted power to portions of the District for more than three days.

In the fall of 2004, a storm caused significant water damage to the Lynnwood High School gymnasium floor.

The storm of December 4, 2007 caused damage to 16 sites. This included damage to roofs and windows which then caused some damage to the interior of the buildings. FEMA provided reimbursement for damages sustained.

Due to the frequency of these types of events, this natural hazard has this highest risk rating. It is a *MODERATE* risk for the School District.

Tsunami and Seiche

Rating: 05

Tsunami is one of the lowest rated hazards to affect Edmonds School District. The lack of risk from tsunami is due to the fact that schools and other district properties are not located on the oceanfront, and the region is protected by the landmasses in Puget Sound.

Seiche is an even less viable hazard, primarily because of the School District's distance from any lakes. As a result, these natural hazards are considered to be an *EXTREMELY LOW* risk for the School District.

Volcano

Rating: 05

The Edmonds School District is highly unlikely to suffer direct damage from a volcano eruption. In the event of an eruption, the District may

experience ashfall, which can interfere with the operation of motor vehicles, require expensive clean-up efforts, and cause respiratory distress to the students and teachers. The School District is highly unlikely to experience any lava flow, lahar activity, or any of the other risks associated with volcanoes.

Volcanic eruption is an *EXTREMELY LOW* risk for Edmonds School District.

Wildland-Urban Interface Fire

Rating: 10

Wildland-urban interface fire is a concern to the Edmonds School District due to the parks, wetlands, greenbelts, and undeveloped land parcels that are near some of the schools. The threat is in reverse proportion to the amount of rainfall in the region. When rain is scarce, the fire threat increases.

During the summer of 2003, new records were set for the number of days without rain. As a result, the north King and south Snohomish Counties region experienced several fires that were caused by careless smokers, or sparks from machinery being operated next to dry grass. These fires were quickly contained and extinguished, but the close proximity of houses to these wildland areas, and the relative density of the housing units, makes wildland-urban interface fires a significant risk during periods of drought or excessive dryness.

During the summer of 2003, grass fires occurred on four school sites: College Place Middle, Madrona K-8, Old Woodway High, and Meadowdale High. The District sustained damage to approximately 75 feet of fencing on the Meadowdale High site.

The level of risk from wildland-urban interface fire is *VERY LOW*.

Mitigation

Existing and Ongoing Mitigation Activities

The Edmonds School District is taking the following actions in ongoing efforts to mitigate for natural hazards and to maintain public safety.

All Hazards

Codes

New buildings are built in compliance with current code. Older buildings are upgraded and brought up to code as permitted by budgetary constraints.

Critical Incident Planning and Mapping System (CIPMS)

- All Edmonds School District #15 schools have been entered into the Critical Incident Planning and Mapping System (CIPMS), a product owned by Prepared Response, Inc. This program enables the School District to meet requirements for schools to report safe school plans (commonly called "mapping" or "Rapid Responder"), as identified in RCW 28A.320.125. This is a shared program between schools and local emergency responders. Each school is required to maintain the data and input safe school plans by October 15 of each year. In addition, schools use this program to track chemical inventories as well as emergency preparedness training, drills and events.
- School District Staff was trained by Prepared Response, Inc. in September 2008.

Planning

- Fall 2008: Reviewed the Comprehensive Emergency Response and Recovery Plan (CERRP) with local Emergency Responders as well as District Representatives to ensure all hazards are addressed.

Trainings and Exercises

- August 2008: Provided Emergency Preparedness Training to all Principals. Components included ICS-100, School Messenger and Rapid Responder.
- 2008-2009 school year: Conducted three district-wide drills which activated the District Emergency Operations Center (EOC). Site-based drills included the use of CIPMS, 1 lock-down, 1 shelter-in-place and 6 fire evacuation drills.

- October 2008: Family Reunification training provided for site-based family reunification teams.
- November 2008 and February 2009: Disaster Medical training provided for site-based teams.
- December 2008 and February 2009: Light Search and rescue training for site-based teams.
- Ongoing: All new Staff receive emergency preparedness awareness training during New Employee Orientation.

Drought

- Cooperate with Cities' water conservation requests and cooperate with regional drought education programs.

Earthquake

- Planning, Preparing, and Training:
  - July 2008, conducting staff and custodial training of *ATC-20 Post-Earthquake Safety Evaluation of Buildings*.
  - Between January and April 2009, Terrace Park School (Mountlake Terrace) hosted a condensed Community Emergency Response Teams (CERT) training for interested staff and parents.
  - Madrona Elementary (Edmonds) conducted a search and rescue drill in coordination with ESCA and the CERT Leader teams in May 2004.
- A Comprehensive Seismic Deficiency Study was completed in March 2002. The results are evaluated and prioritized.
  - Projects completed to date include:
    - Lynnwood, College Place, Brier, Oak Heights, Edmonds, Sherwood, Hilltop and Woodway Elementary Schools – seismic upgrades completed in 2006.
    - College Place Middle School and Spruce Elementary School – seismic upgrades completed in 2007.
    - Cedar Way Elementary and Brier Terrace Middle Schools – seismic updated completed in 2008.
  - Schools built meeting current seismic requirements include: Edmonds Woodway High, Mountlake Terrace High, Meadowdale High, Terrace Park, Cedar Valley, Meadowdale Elementary, Maplewood, Chase Lake and Seaview Elementary Schools.
  - The remaining District Schools will be completed during new design/construction as budgetary constraints and levy passage continues.

Flood

- Build all new schools and support buildings to current code.

Landslide

- Build all new schools and support buildings to current code.

Severe Storm

- Work with Cities and utilities to minimize damage to power and telephone lines from trees.

Tsunami and Seiche

- None at this time.

Volcano

- None at this time.

Wildland-Urban Interface Fire

- School grounds maintenance to minimize dry grasses and undergrowth.
- Ban fireworks from school premises.

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Mitigation Action Items

The Mitigation Plan identifies short- and long-term action items developed through data collection, research, and the public participation process. Mitigation Plan activities may be considered for funding through federal and state grant programs and when other funds are made available through the school budgeting process or the passage of school capital bonds and/or levies.

Action items address multi-hazard (MH) and hazard-specific issues. To help ensure activity implementation, each action item includes information on the timeline and coordinating organizations. Upon implementation, the coordinating organizations may look to partner organizations for resources and technical assistance.

To help ensure activity implementation, each action item includes several pieces of information in the description. These include:

- *Coordinating Organization*
  The coordinating organization is that which is willing and able to organize resources, find appropriate funding, or oversee activity implementation, monitoring and evaluation. The coordinating organizations may be local or regional agencies. Organizations written in *italics* are not participating in this Plan but have an established relationship with this jurisdiction.

- *Timeline*
  Action items include both long- and short-term activities. Each action item includes an estimate of the timeline for implementation. *Short-term* action items (ST) are activities that organizations may implement with existing resources and authorities within one to two years. *Long-term* action items (LT) may require new or additional resources or authorities, and may take between two and five years to implement.

- *Ideas for Implementation*
  Each action item includes ideas for implementation. This may be individual steps for one project, or it may be several related projects that address the natural hazard.

- *Plan Goals Addressed*
  The plan goals are identified to monitor and evaluate how well the Mitigation Plan is achieving its goals once implementation begins.

- *Benefit-to-Cost Review*
  Due to limitations in staff time, and because project priorities may shift based on changes in funding options and local events, a generalized benefit-to-cost review is used. The steps associated with prioritizing the mitigation projects are as follows:

  1. The jurisdiction rates the project cost as "high," "medium," or "low" in relation to budget and previous projects, and each rating is assigned a numerical value.
  2. The project outcome is then rated as "low," "medium," or "high," and each of these ratings is assigned a numerical value.
  3. The two values are added together, and the total provides the cost-benefit and the priority.

  Example:

  If a project has a *medium approximate cost*, and is considered to be *highly effective*, the boxes would be marked as shown below.

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[**X**] 2 – Medium	[ ] 2 – Medium	[ ] 3
[ ] 3 – Low	[**X**] 3 – High	[ ] 4
		[**X**] 5
		[ ] 6 – Highest

  The priority and cost-to-benefit review ratings with the highest numbers are considered to be the highest priorities. As always, however, these are subject to financial realities and may not be carried out in the exact order indicated.

MULTI-HAZARD Mitigation Actions (MH)

<u>LT-01-MH-ESD</u>: Replace or upgrade obsolete or high-risk buildings to minimize threats from natural hazards. Develop and build schools and auxiliary school buildings to current building code to ensure safest environment possible.

Ideas for Implementation:

- Maintain and update building inventory to identify buildings that are inadequate for safety and usage in the Edmonds School District.
- Develop and implement ongoing strategy to maintain, upgrade, or replace buildings to ensure safety of students, staff, and public.
- Ensure that new buildings are built to current standards and are located in a way that minimizes risk from flood, landslide, tsunami/seiche, and wildland- urban interface fires.

Coordinating Organization:	Edmonds School District's Facilities Operations Department; Edmonds School Board; Bond Committee
Estimated Price:	$13,755,000
Funding Source:	School Construction Bonds
Timeline:	Approximately 4 to 10 years, and ongoing
Plan Goals Addressed:	Protect Life and Property; Provide for Emergency Services; Facilitate Continuity and Recovery
Benefit-to-Cost Review:	4

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[**X**] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[ ] 2 – Medium	[ ] 2 – Medium	[ ] 3
[ ] 3 – Low	[**X**] 3 – High	[**X**] 4
		[ ] 5
		[ ] 6 – Highest

ST-01-MH-ESD: Build and maintain emergency supply cache at each School District site.

Ideas for Implementation:

- Maintain emergency storage shed condition appropriate to house emergency supplies.
- Add additional supplies to those already provided as funds are available to suggested supply levels.
- Ensure rotation of perishable supplies.

Coordinating Organization:	Edmonds School District Administration; Edmonds Schools
Estimated Price:	To be determined (low to medium cost)
Funding Source:	To be determined
Timeline:	Ongoing
Plan Goals Addressed:	Increase Public Awareness; Encourage Partnerships
Benefit-to-Cost Review:	3

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[ ] 1 – High	[**X**] 1 – Low	[ ] 2 – Lowest
[**X**] 2 – Medium	[ ] 2 – Medium	[**X**] 3
[ ] 3 – Low	[ ] 3 – High	[ ] 4
		[ ] 5
		[ ] 6 – Highest

DROUGHT Mitigation Actions (D)

ST-02-D-ESD: Educate staff, students and their families about the effects of drought and encourage conservation efforts.

Ideas for Implementation:

- Work with Alderwood Water District to distribute information to staff, students, and families.
- Encourage the Science Department to develop and implement curriculum appropriate to Biology, Ecology, and/or other science classes.

Coordinating Organization:	Edmonds School District Administration; Edmonds School District Science Department; Olympic View Water and Sewer District; *Alderwood Water District*
Estimated Price:	To be determined (low to medium cost)
Funding Source:	To be determined
Timeline:	Ongoing
Plan Goals Addressed:	Increase Public Awareness; Encourage Partnerships
Benefit-to-Cost Review:	3

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[ ] 1 – High	[**X**] 1 – Low	[ ] 2 – Lowest
[**X**] 2 – Medium	[ ] 2 – Medium	[**X**] 3
[ ] 3 – Low	[ ] 3 – High	[ ] 4
		[ ] 5
		[ ] 6 – Highest

EARTHQUAKE Mitigation Actions (E)

ST-03-E-ESD: Conduct non-structural retrofit activities.

Ideas for Implementation:

- Purchase and install seismic shut-off valves for gas lines entering the buildings.[1]
- Conduct annual school risk management/safety survey visits.
- Strap down TV's, heaters, and shelves.
- Modify shelving to minimize falling objects.
- Store heavy items on or near the floor.
- Conduct preventative maintenance inspections on equipment (e.g., HVAC equipment, freezers, etc.).
- Ensure all fire codes are followed.

Coordinating Organization:	Edmonds School District Maintenance
Estimated Price:	$5,000 (plus periodic continuing expenses)
Funding Source:	General Fund
Timeline:	Annual and ongoing
Plan Goals Addressed:	Protect Life and Property; Facilitate Continuity and Recovery
Benefit-to-Cost Review:	6

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[ ] 2 – Medium	[ ] 2 – Medium	[ ] 3
[**X**] 3 – Low	[**X**] 3 – High	[ ] 4
		[ ] 5
		[**X**] 6 – Highest

FLOOD Mitigation Actions (F)

ST-04-F-ESD: Monitor and maintain drains during heavy rains and post-snowstorms.

Ideas for Implementation:

- Visually inspect school drainage systems to ensure they remain free from clogs. Free blockage as necessary.
- Visually inspect storm drains located adjacent to school properties to ensure they remain free from clogs. Free blockage as necessary. Notify the appropriate City or County, as necessary.

Coordinating Organization:	Edmonds School District Maintenance Department; Site Administration; Custodial Department
Estimated Price:	$5,000
Funding Source:	General Fund
Timeline:	Annual and ongoing
Plan Goals Addressed:	Protect Life and Property; Facilitate Continuity and Recovery
Benefit-to-Cost Review:	5

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[ ] 2 – Medium	[**X**] 2 – Medium	[ ] 3
[**X**] 3 – Low	[ ] 3 – High	[ ] 4
		[**X**] 5
		[ ] 6 – Highest

LANDSLIDE Mitigation Actions (L)

ST-05-L-ESD: Monitor and stabilize slopes located on school properties.

Ideas for Implementation:

- As part of annual school risk management/safety survey visits, inspect and evaluate slopes for erosion or slippage.
- Develop plan for slope stabilization as necessary.

Coordinating Organization:	Edmonds School District Grounds Crew; *Consultants*
Estimated Price:	$5,000 staff time + *Amount to be determined*
Funding Source:	General Fund
Timeline:	Annual and ongoing
Plan Goals Addressed:	Protect Life and Property; Facilitate Continuity and Recovery
Benefit-to-Cost Review:	4

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[ ] 1 – High	[**X**] 1 – Low	[ ] 2 – Lowest
[ ] 2 – Medium	[ ] 2 – Medium	[ ] 3
[**X**] 3 – Low	[ ] 3 – High	[**X**] 4
		[ ] 5
		[ ] 6 – Highest

SEVERE STORM Mitigation Actions (S)

ST-06-S-ESD: Maintain trees to minimize potential damage.

Ideas for Implementation:

- Inspect trees on school grounds and other properties for general health and viability. Remove trees that are diseased or considered a danger to life or property.
- Coordinate with utilities to trim and maintain trees as necessary to keep branches free from power lines.

Coordinating Organization:	Edmonds School District Grounds Crew; *Snohomish County PUD; Verizon*
Estimated Price:	$5,000 (plus periodic continuing expenses)
Funding Source:	General Fund
Timeline:	Annual and ongoing
Plan Goals Addressed:	Protect Life and Property; Facilitate Continuity and Recovery
Benefit-to-Cost Review:	4

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[ ] 1 – High	[**X**] 1 – Low	[ ] 2 – Lowest
[ ] 2 – Medium	[ ] 2 – Medium	[ ] 3
[**X**] 3 – Low	[ ] 3 – High	[**X**] 4
		[ ] 5
		[ ] 6 – Highest

TSUNAMI & SEICHE Mitigation Actions (T)

Edmonds School District does not have any property that is in danger from tsunami or seiche. No school or auxiliary building is located near the coast or on any large body of water.

The Edmonds Elementary School is located about one mile east of the Puget Sound waterline. The City of Edmonds has rated the City's tsunami exposure as a low risk.

VOLCANO Mitigation Actions (V)

ST-07-V-ESD: Develop and implement policy for maintaining stock of filters for key vehicles and pieces of equipment.

Ideas for implementation:

- Identify key vehicles and equipment such as: back-up generators, HVAC systems, and other large or unusual equipment requiring filters.
- Establish policy and budget to maintain spare filters.

Coordinating Organization:	Edmonds School Board; Edmonds School District's Planning Property, Risk, Safety, Emergency & Custodial Services Department
Estimated Price:	To be determined (low costs)
Funding Source:	General Fund
Timeline:	2 years
Plan Goals Addressed:	Protect Life & Property; Provide for Emergency Services; Facilitate Continuity and Recovery
Benefit-to-Cost Review:	4

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[ ] 1 – High	[**X**] 1 – Low	[ ] 2 – Lowest
[ ] 2 – Medium	[ ] 2 – Medium	[ ] 3
[**X**] 3 – Low	[ ] 3 – High	[**X**] 4
		[ ] 5
		[ ] 6 – Highest

WILDLAND-URBAN INTERFACE FIRE Mitigation Actions (W)

<u>ST-08-W-ESD</u>: Develop and implement fire-resistant policies.

Ideas for implementation:

- Work with local fire departments to develop and deliver fire-education programs to students and staff.
- Develop a list of drought-resistant plants and use these plants to the greatest extent possible in landscaping or redeveloping planting beds.
- Minimize potential fuels by mowing grass and thinning shrubbery.
- Ban the use of fireworks or cigarettes on school property.

Coordinating Organization:	Edmonds School District Facilities Operation Department
Estimated Price:	To be determined (low cost)
Funding Source:	General fund
Timeline:	5 years and ongoing
Plan Goals Addressed:	Protect Life & Property; Provide for Emergency Services; Facilitate Continuity and Recovery
Benefit-to-Cost Review:	4

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[ ] 1 – High	[**X**] 1 – Low	[ ] 2 – Lowest
[ ] 2 – Medium	[ ] 2 – Medium	[ ] 3
[**X**] 3 – Low	[ ] 3 – High	[**X**] 4
		[ ] 5
		[ ] 6 – Highest

[1] 9 schools currently have seismic shut-off valves installed.

Olympic View Water and Sewer District

Olympic View Water and Sewer District provides potable water and treats waste water/effluent. It serves a population of approximately 15,000 people, or 6,680 residential customer equivalents. It covers 3.9 square miles (about 2,500 acres) and includes the Town of Woodway and part of the City of Edmonds as well as areas of unincorporated Snohomish County.[1]

To provide services, the District owns and maintains 206,000 feet (39 miles) of sewer mains and 338,000 feet (64 miles) of water mains.

Olympic View Water and Sewer District purchases most of their supply from Seattle Water. Seattle's water originates in two watersheds: the Cedar River Watershed (located between Snoqualmie Falls and the Cascade foothills) and the South Fork Tolt River Watershed (located in the Cascade foothills). Between the two sources, approximately 1.3 million people are supplied with water on a daily basis.[2] In addition, approximately 40% of Olympic View Water and Sewer District's annual demand is supplied by a treated surface source located in the Town of Woodway.

To provide water and sewer services, the District employs about people.[3]

***Annex M* identifies critical structures for Olympic View Water and Sewer District.**

Hazard Identification

Olympic View Water and Sewer District is more vulnerable to some hazards than others. At the same time, the District is part of the region's critical facilities. Not only will it cause significant problems if water and sewer services are disrupted, but loss of water service could also be a safety issue with loss of fire flow.

Due to the importance of the District's function in the community, Olympic View Water and Sewer District identified key areas of operation within the organization and rated the natural hazards according to these segments. They are: collection system; distribution system; well and springs; office and shop; lift stations; treatment plant; booster pump stations; 28th Street equipment storage; rolling stock; and storage reservoirs.

Based on past experience, regional information, and emergency response plans, the District rates its risk of natural hazards as follows:

Collection System

HAZARD	RATING (OUT OF 80 POSSIBLE)
DROUGHT	**20**
EARTHQUAKE	**56**
FLOOD (100-YEAR)	**44**
LANDSLIDE	**32**
SEVERE STORM	**20**
TSUNAMI & SEICHE	**10**
VOLCANO	**10**
WILDLAND URBAN INTERFACE FIRE	**20**

Distribution System

HAZARD	RATING (OUT OF 80 POSSIBLE)
DROUGHT	**20**
EARTHQUAKE	**56**
FLOOD (100-YEAR)	**32**
LANDSLIDE	**24**
SEVERE STORM	**20**
TSUNAMI & SEICHE	**10**
VOLCANO	**10**
WILDLAND URBAN INTERFACE FIRE	**20**

Well

HAZARD	RATING (OUT OF 80 POSSIBLE)
DROUGHT	**20**
EARTHQUAKE	**20**
FLOOD (100-YEAR)	**20**
LANDSLIDE	**20**
SEVERE STORM	**20**
TSUNAMI & SEICHE	**10**
VOLCANO	**10**
WILDLAND URBAN INTERFACE FIRE	**20**

Office and Shop

HAZARD	RATING (OUT OF 80 POSSIBLE)
DROUGHT	**20**
EARTHQUAKE	**48**
FLOOD (100-YEAR)	**20**
LANDSLIDE	**20**
SEVERE STORM	**20**
TSUNAMI & SEICHE	**10**
VOLCANO	**10**
WILDLAND URBAN INTERFACE FIRE	**20**

Lift Stations

HAZARD	RATING (OUT OF 80 POSSIBLE)
DROUGHT	**20**
EARTHQUAKE	**56**
FLOOD (100-YEAR)	**44**
LANDSLIDE	**20**
SEVERE STORM	**32**
TSUNAMI & SEICHE	**10**
VOLCANO	**10**
WILDLAND URBAN INTERFACE FIRE	**20**

Treatment Plant

HAZARD	RATING (OUT OF 80 POSSIBLE)
DROUGHT	**20**
EARTHQUAKE	**48**
FLOOD (100-YEAR)	**20**
LANDSLIDE	**44**
SEVERE STORM	**48**
TSUNAMI & SEICHE	**10**
VOLCANO	**18**
WILDLAND URBAN INTERFACE FIRE	**20**

Booster Pump Stations

HAZARD	RATING (OUT OF 80 POSSIBLE)
DROUGHT	**20**
EARTHQUAKE	**48**
FLOOD (100-YEAR)	**20**
LANDSLIDE	**20**
SEVERE STORM	**36**
TSUNAMI & SEICHE	**10**
VOLCANO	**18**
WILDLAND URBAN INTERFACE FIRE	**20**

28th Street Equipment Storage

HAZARD	RATING (OUT OF 80 POSSIBLE)
DROUGHT	**20**
EARTHQUAKE	**32**
FLOOD (100-YEAR)	**20**
LANDSLIDE	**20**
SEVERE STORM	**24**
TSUNAMI & SEICHE	**10**
VOLCANO	**12**
WILDLAND URBAN INTERFACE FIRE	**20**

Rolling Stock

HAZARD	RATING (OUT OF 80 POSSIBLE)
DROUGHT	**20**
EARTHQUAKE	**20**
FLOOD (100-YEAR)	**20**
LANDSLIDE	**20**
SEVERE STORM	**20**
TSUNAMI & SEICHE	**10**
VOLCANO	**10**
WILDLAND URBAN INTERFACE FIRE	**20**

Storage Reservoirs

HAZARD	RATING (OUT OF 80 POSSIBLE)
DROUGHT	**20**
EARTHQUAKE	**56**
FLOOD (100-YEAR)	**20**
LANDSLIDE	**20**
SEVERE STORM	**20**
TSUNAMI & SEICHE	**10**
VOLCANO	**10**
WILDLAND URBAN INTERFACE FIRE	**20**

Drought

Rating: 20

Olympic View Water and Sewer District rated drought consistently at 20 points out of a possible 80 across all segments. The District obtains its water supply from Seattle Water who, in turn, gets the water from two very stable sources: the Cedar River Watershed and the South Fork Tolt River Watershed.

Drought in this area is considered likely to occur every 25 years or less. Even with fairly regular occurrences, the droughts have historically been of short duration and last for less than one year.

Drought is considered a *MODERATELY-LOW* risk.

Earthquake

Rating: 20 - 56

Olympic View Water and Sewer District has identified earthquake as the greatest natural hazard risk.

Earthquake risk varies significantly between Olympic View Water and Sewer District's business sections. The rolling stock (equipment and supplies stored in vehicles) and the District's well are both considered very low risk, and they are rated at 20 points. The 228th Street Equipment Storage facility is at a significantly greater risk, and was scored at a 32.

Infrastructure for the Water District is considered to be very vulnerable. Distribution and collection systems are made up of miles of pipes that may be displaced, damaged, or destroyed by a prolonged or violent

earthquake. Depending on the level of damage sustained, it could take weeks to identify all the breaks, and dig up and replace the damaged pipes. For this reason, Olympic View Water and Sewer District rated these systems at 56 each.

Booster pump stations and lift stations are rated at 48 and 56 respectively. These stations are necessary to move water and effluent through the pipes when the terrain and gravity work against the flow. If these stations are damaged and disabled, some residents may not receive water until repairs are completed. Further, sewage may back up and overflow the system causing public health concerns as well as property, environmental, and economic damages.

The treatment plant hazard rating is identified at 48. If this plant was significantly damaged or put out of commission, it would mean the spring source of supply would be shut down.

The three storage reservoirs are of significant concern as they handle millions of gallons of water. Failure of these structures could cause significant damage to the surrounding area and impact fire fighting capabilities. The reservoirs hazard rating was identified at 56 points.

The risk of earthquake is *SIGNIFICANT*.

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Flood

Rating: 20 - 44

Olympic View Water and Sewer District has a range of risks identified with flooding. Those areas with low risk, rated at 20, include: Olympic View Water and Sewer District's well and spring, the office and shop, treatment plant, booster pump stations, the 28th Street equipment storage, rolling stock, and storage reservoirs. These facilities are not located in the 100-year floodplain, nor are they significantly prone to damage from urban flooding.

Collection systems and lift stations hazards are rated at 44. Distribution systems are rated at 32. If any or all of these systems or stations are overwhelmed by flooding, sewage backups will occur. The result will be moderate-to-high damage to property and environment. There is a potential for high economic damage to the collection systems.

Hazards to lift stations are also rated at 44. This has the potential to impact approximately half of the District's customers, and could cause damage to a large number of properties. The environment could experience significant damage, and the area could experience moderate amounts of economic disruption.

Risk varies from site-to-site from *MODERATELY-LOW to MODERATE.*

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Landslide

Rating: 20 - 44

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Most of the District's buildings are located in areas where they would not be prone to damage from landslides. As a result, most of the facilities are rated at a risk level of "20." The exceptions to this are the collection and distribution systems, and the treatment plant.

The collection and distribution systems are rated at 32 and 24, respectively. Water and sewer pipes go to where the people are. As a result, these pipe systems run throughout the area and may be routed near slide-prone slopes.

The treatment plant is another area of higher risk. It is rated at a score of 44 of a possible 80 risk points.

Overall, risk varies from site-to-site from *MODERATELY-LOW to MODERATE.*

Severe Storm

Rating: 20 - 48

The collection and distribution systems, office and shop, rolling stock, storage reservoirs, and well are all rated at 20 risk points.

The other sections are rated as follows:

- 28th Street equipment storage – 24
- Lift station – 32
- Booster pump stations – 36
- Treatment plant – 48

The increased vulnerability for these sections comes, in part, for the need for electricity to operate. If the power supply is interrupted to the lift station, pump stations, or treatment plant, the effluent will back up in the collection system and will not be treated.

Risk varies from *MODERATELY-LOW to MODERATE* with the treatment plan considered to be at the highest level of risk.

Tsunami & Seiche

Rating: 10

While tsunami and seiche are possible for this area, the likelihood is very low. As mentioned in Section II of this document, the north King and south Snohomish Counties area is protected by the islands that lie within Puget Sound. These islands would serve as a barrier and would help break up any tsunamis that might occur in this area.

Seiche, while it is still a possibility, is limited in scope by the size of the body of water and is a relatively rare event, as well.

Even if a tsunami or seiche were to occur in the Puget Sound area, very little of Olympic View Water and Sewer District is located in an area that would be vulnerable to this event. As a result, the risk is evaluated as *VERY LOW.*

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Volcano

Rating: 10 - 18

Volcano is considered to be a *VERY LOW* risk for Olympic View Water and Sewer District.

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As mentioned in the HIVA section of this document, the most likely impacts to this area from a volcanic eruption would be ashfall and an influx of refugees from those areas nearer the volcano. Each of these has some possibility of affecting the District: the latter from overwhelming the system's capacity, and the former blocking air intakes for equipment, vehicles, and HVAC systems. For this reason, the booster pump stations are rated at 18, the 28th Street equipment storage is at 12, and the rest of the infrastructure is rated at 10.

Wildland-Urban Interface Fire

Rating: 20

Wildland-urban interface fire is another *LOW* risk for Olympic View Water and Sewer District. Pipes are buried and are relatively well-protected from fire even in those areas where this type of fire is prone to occur. The other infrastructure for the District is not considered especially vulnerable because of location: it's not built in heavily wooded or forested areas.

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Table 1: Olympic View Water and Sewer District Hazard Rating Recap

	Drought	Earthquake	Flood	Landslide	Severe Storm	Tsunami & Seiche	Volcano	Wildland-Urban Interface Fire
228th St. Equipment Storage	20	32	20	20	24	10	12	20
Booster Pump Stations	20	48	20	20	36	10	18	20
Collection System	20	56	44	32	20	10	10	20
Distribution System	20	56	32	24	20	10	10	20
Lift Stations	20	56	44	20	32	10	10	20
Office and Shop	20	48	20	20	20	10	10	20
Rolling Stock	20	20	20	20	20	10	10	20
Storage Reservoirs	20	56	20	20	20	10	10	20
Treatment Plant	20	48	20	44	48	10	18	20
Well	20	20	20	20	20	10	10	20

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Mitigation

Existing and Ongoing Mitigation Activities

Olympic View Water and Sewer District is taking the following actions in ongoing efforts to mitigate for natural hazards and to maintain public safety.

All Hazards

- Add 1,000 gallon diesel fuel tank at Maintenance Facility.
- Codes and Plans
  - Sewer and Water Comprehensive Plans
  - Capital Improvement Plan
  - Emergency Response Plan
  - Operations and Maintenance Plan (annual)
  - Capital Budget Plan (annual)
  - District Emergency Plan

Drought

- Encourage water conservation.
- Educate the public

Earthquake

- Build to code
- Flexible pipe systems, etc., to best of ability/technology

Photograph 1: Before below-ground retrofit

(Source: Olympic View Water and Sewer District)

Photograph 2: After below-ground retrofit

(Source: Olympic View Water and Sewer District)

Photograph 3: View of above-ground flexible fitting retrofit

(Source: Olympic View Water and Sewer District)

Photograph 4: View of above-ground flexible fitting retrofit

(Source: Olympic View Water and Sewer District)

- Upgrade Forest Glen Lift Station

Flood

- Test/mitigate for leaking into/out of systems
- Maintain against blockages

Landslide

- Build to code (pipe systems and buildings)

Severe Storm

- Build to code
- Ensure trees and brush are kept clear of equipment, etc.
- Back up power supply
- Standby generator at 228th Street Booster Station

Tsunami and Seiche

- None at this time

Volcano

- Maintain stock of filters for key vehicles and engine-driven equipment

Wildland-Urban Interface Fire

- Keep brush and undergrowth trimmed and maintained.
- Water wisely.

Mitigation Action Items

The Mitigation Plan identifies short- and long-term action items developed through data collection, research, and the public participation process. Mitigation Plan activities may be considered for funding through federal and state grant programs and when other funds are made available through the school budgeting process or the passage of school bonds.

Action items address multi-hazard (MH) or hazard-specific issues. Upon implementation, the coordinating organizations may look to partner organizations for resources and technical assistance.

To help ensure activity implementation, each action item includes several pieces of information in the description. These include:

- *Coordinating Organization*
  The coordinating organization is that which is willing and able to organize resources, find appropriate funding, or oversee activity implementation, monitoring and evaluation. The coordinating organizations may be local or regional agencies.

- *Timeline*
  Action items include both long- and short-term activities. Each action item includes an estimate of the timeline for implementation. *Short-term* action items (ST) are activities that organizations may implement with existing resources and authorities within one to two years. *Long-term* action items (LT) may require new or additional resources or authorities, and may take between one and five years to implement.

- *Ideas for Implementation*
  Each action item includes ideas for implementation and potential resources.

- *Plan Goals Addressed*
  The plan goals are identified to monitor and evaluate how well the Mitigation Plan is achieving its goals once implementation begins.

- *Benefit-to-Cost Review*
  Olympic View Water and Sewer District has identified a range of mitigation projects to be completed over the next several years. Those projects that are short-term in nature are generally part of the current budget and have relatively “hard” data attached to them.

Longer-term projects do not have the same level of information available at this point in time. This information will be obtained as the projects develop.

For this reason, Olympic View Water and Sewer District is using two different methodologies in the cost-benefit analysis. The *first methodology* allows for the more concrete data to be used and is used for the short- and mid-range projects.

For these mitigation actions, the projects are well-defined and have gone through internal development processes. Estimated costs are specific and generated to current specifications.

A water outage or reduction in water pressure affects the community in a variety of ways. One of these, and one of the most crucial, is the loss or drop in fire flows. Inadequate water supply directly affects the fire departments' ability to suppress fires which, in turn, leads to the potential for loss of life and/or property. With these facts in mind, the project benefits are predicated on the following assumptions:

- A complete water outage of 24 hours or longer = $10 million value
- A reduction in water pressure of more than 24 hours = $5 million value
- A complete water outage or reduction in water pressure of less than 24 hours = $1 million value

Other potential damages not relating to fire include:

- A reduction in service that causes environmental damage = $1 million value
- A reduction in service impacting homes and businesses, but not causing permanent or long-term damage = $100,000 value

To obtain the ranking, the benefit value is then divided by the associated costs to obtain the cost-benefit ratio.

The *second methodology* uses a more general evaluation process. The steps associated with the long-term projects are as follows:

1. Olympic View Water and Sewer District rates the project cost as "high," "medium," or "low" in relation to budget and previous projects, and each rating is assigned a numerical value.

2. The Water District then rates the project outcome as “low,” “medium,” or “high,” and each of these ratings is assigned a numerical value.
3. Add the two values, and the total provides the cost-benefit and the priority.

Example:

If a project has a *medium approximate cost*, and is considered to be highly effective, the boxes would be marked as shown below.

Approx Cost +	Effectiveness =	Cost-to-Benefit Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[**X**] 2 – Medium	[ ] 2 – Medium	[ ] 3
[ ] 3 – Low	[**X**] 3 – High	[ ] 4
		[**X**] 5
		[ ] 6 – Highest

- *Priority*
  Olympic View Water and Sewer District further identifies priorities as 1, 2 or 3. While the District looks first to the Cost-to-Benefit Review to set priorities, other issues also play a part in setting final priority.

  Definitions are as follows:

  “1” – Highest priority. Considered to be a key or important project. Funding sources and timeline for implementation are identified.

  “2” – Middle priority. Either a key priority but without identified funding sources, or the project is funded but considered to be of a lower value.

  “3” – Lowest priority. Not a key project, and no funding sources are identified at this time.

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MULTI-HAZARD Mitigation Actions (MH)

None identified at this time.

DROUGHT Mitigation Actions (D)

ST-01-D-OV: Provide water conservation information to consumers.

Ideas for Implementation:

- Identify existing resources for education materials and make these materials available to consumers.
- Provide watering schedule or cycle to consumers.

Coordinating Organization:	Olympic View Executive; Olympic View Management; Olympic View Operations; *Consultants; Contractors*
Estimated Price:	$1,000
Funding Source:	General fund
Timeline:	Ongoing
Plan Goals Addressed:	Facilitate Continuity & Recovery; Protect Natural Systems
Benefit-to-Cost Review:	3
Priority:	2

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[ ] 1 – High	[**X**] 1 – Low	[ ] 2 – Lowest
[ ] 2 – Medium	[ ] 2 – Medium	[ ] 3
[**X**] 3 – Low	[ ] 3 – High	[**X**] 4
		[ ] 5
		[ ] 6 – Highest

EARTHQUAKE Mitigation Actions (E)

<u>ST-02-E-OV</u>: Build new District Office to meet current earthquake and building codes.

Ideas for Implementation:

- Obtain Land Use Authority
- Complete design and specifications.
- Obtain Building Permits
- Complete construction.

Coordinating Organization:	Olympic View Executive; Olympic View Management; Olympic View Operations *Consultants; Contractors*
Estimated Price:	$8,500,000
Funding Source:	Revenue Bond Sales
Timeline:	3 years
Plan Goals Addressed:	Protect Life & Property; Facilitate Continuity & Recovery; Provide for Emergency & Critical Services
Benefit-to-Cost Review:	2
Priority:	2

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[**X**] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[ ] 2 – Medium	[ ] 2 – Medium	[ ] 3
[ ] 3 – Low	[**X**] 3 – High	[**X**] 4
		[ ] 5
		[ ] 6 – Highest

ST-03-E-OV: Install flexible joints at all pipe-structure penetrations.

Ideas for Implementation:

- Identify all pipe-building penetrations.
- Add identified projects to CIP.
- Establish budget and obtain funding.

Coordinating Organization:	Olympic View Executive; Olympic View Management; Olympic View Operations *Consultants*
Estimated Price:	To be determined
Funding Source:	To be determined
Timeline:	3 years
Plan Goals Addressed:	Protect Life & Property; Provide for Emergency & Critical Services; Facilitate Continuity & Recovery
Benefit-to-Cost Review:	4
Priority:	2

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[**X**] 2 – Medium	[**X**] 2 – Medium	[ ] 3
[ ] 3 – Low	[ ] 3 – High	[**X**] 4
		[ ] 5
		[ ] 6 – Highest

<u>LT-01-E-OV</u>: Make seismic upgrades to reservoirs.

Ideas for Implementation:

- Install automatic earthquake valves at all reservoirs.
- Upgrade reservoirs to current earthquake codes.
- Establish budget and obtain funding.

Coordinating Organization:	Olympic View Executive; Olympic View Management; Olympic View Operations *Consultants*
Estimated Price:	To be determined
Funding Source:	Grants
Timeline:	5 years
Plan Goals Addressed:	Provide for Emergency & Critical Services; Facilitate Continuity & Recovery
Benefit-to-Cost Review:	4
Priority:	3

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[**X**] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[ ] 2 – Medium	[ ] 2 – Medium	[ ] 3
[ ] 3 – Low	[**X**] 3 – High	[**X**] 4
		[ ] 5
		[ ] 6 – Highest

LT-02-E-OV: Conduct a structural evaluation of all District structures to determine appropriate earthquake mitigation measures.

Ideas for Implementation:

- Establish study criteria, budgeting, and funding source.
- Select consultant.
- Conduct study.
- Evaluate results and incorporate into budget and CIP as appropriate.

Coordinating Organization:	Olympic View Executive; Olympic View Management; Olympic View Operations *Consultant*
Estimated Price:	To be determined (medium cost)
Funding Source:	To be determined
Timeline:	5 years
Plan Goals Addressed:	Protect Live & Property; Provide for Emergency & Critical Services; Facilitate Continuity & Recovery
Benefit-to-Cost Review:	4
Priority:	3

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[**X**] 2 – Medium	[**X**] 2 – Medium	[ ] 3
[ ] 3 – Low	[ ] 3 – High	[**X**] 4
		[ ] 5
		[ ] 6 – Highest

FLOOD MITIGATION ACTIONS (F)

None at this time.

LANDSLIDE Mitigation Actions (L)

<u>LT-03-L-OV</u>: Conduct a Landslide Vulnerability Study of the District to determine the location of slide areas and the probability of slides.

Ideas for Implementation:

- Establish study criteria, budgeting, and funding source.
- Select consultant.
- Conduct study.
- Evaluate results and incorporate into planning documents as appropriate.

Coordinating Organization:	Olympic View Executive; Olympic View Management; Olympic View Operations *Consultant*
Estimated Price:	Grants
Funding Source:	To be determined
Timeline:	5 years
Plan Goals Addressed:	Protect Live & Property; Provide for Emergency & Critical Services; Facilitate Continuity & Recovery
Benefit-to-Cost Review:	4
Priority:	3

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[**X**] 2 – Medium	[**X**] 2 – Medium	[ ] 3
[ ] 3 – Low	[ ] 3 – High	[**X**] 4
		[ ] 5
		[ ] 6 – Highest

LT-04-L-OV: Replace pipelines in landslide-prone areas with restrained joint pipelines.

Ideas for Implementation:

- Identify landside-prone areas. *(See LT-01-L-OV, above.)*
- Establish priority list, budget and funding source.
- Select consultant.
- Design and construct pipelines.

Coordinating Organization:	Olympic View Executive; Olympic View Management; Olympic View Operations *Consultant*
Estimated Price:	To be determined
Funding Source:	To be determined
Timeline:	5 years
Plan Goals Addressed:	Protect Live & Property; Provide for Emergency & Critical Services; Facilitate Continuity & Recovery
Benefit-to-Cost Review:	4
Priority:	3

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[**X**] 2 – Medium	[**X**] 2 – Medium	[ ] 3
[ ] 3 – Low	[ ] 3 – High	[**X**] 4
		[ ] 5
		[ ] 6 – Highest

<u>LT-05-S-OV</u>: Develop and implement a policy that all future manhole construction will include a lid seal.

Ideas for implementation:

- Establish the policy.

Coordinating Organization:	Olympic View Executive; Olympic View Management
Estimated Price:	To be determined (low cost)
Funding Source:	To be determined
Timeline:	5 years
Plan Goals Addressed:	Protect Life & Property; Facilitate Continuity & Recovery
Benefit-to-Cost Review:	5
Priority:	3

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[ ] 2 – Medium	[**X**] 2 – Medium	[ ] 3
[**X**] 3 – Low	[ ] 3 – High	[ ] 4
		[**X**] 5
		[ ] 6 – Highest

LT-06-S-OV: Conduct an infiltration study to determine areas of excessive infiltration.

Ideas for implementation:

- Establish the study criteria.
- Establish a budget.

Coordinating Organization:	Olympic View Executive; Olympic View Management; Olympic View Operations
Estimated Price:	To be determined (medium cost)
Funding Source:	To be determined
Timeline:	5 years
Plan Goals Addressed:	Protect Life & Property; Facilitate Continuity & Recovery
Benefit-to-Cost Review:	4
Priority:	3

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[**X**] 2 – Medium	[**X**] 2 – Medium	[ ] 3
[ ] 3 – Low	[ ] 3 – High	[**X**] 4
		[ ] 5
		[ ] 6 – Highest

TSUNAMI AND SEICHE MITIGATION ACTION ITEMS (T)

No actions identified at this time.

VOLCANO MITIGATION ACTIONS (V)

LT-07-V-OV: Add air intake filters at all unfiltered facility HVAC forced air intakes.

Ideas for implementation:

- Evaluate facilities and identify unfiltered HVAC intakes.
- Include upgrades in District Capital Improvement Plan (CIP).
- Budget for capital facilities equipment upgrades.

Coordinating Organization:	Olympic View Management; Olympic View Operations
Estimated Price:	To be determined (low cost)
Funding Source:	Capital Fund
Timeline:	5 years
Plan Goals Addressed:	Facilitate Continuity & Recovery
Benefit-to-Cost Review:	5
Priority:	3

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[ ] 2 – Medium	[**X**] 2 – Medium	[ ] 3
[**X**] 3 – Low	[ ] 3 – High	[ ] 4
		[**X**] 5
		[ ] 6 – Highest

WILDLAND-URBAN INTERFACE FIRE Mitigation Actions (W)

LT-08-W-OV: Install an automatic fire protection system at Woodway Booster Station.

Ideas for Implementation:

- Establish a budget and obtain funding source.
- Develop project design and specifications.
- Install and test system.

Coordinating Organization:	Olympic View Executive; Olympic View Management; Olympic View Operations *Consultant*
Estimated Price:	To be determined (medium cost)
Funding Source:	To be determined
Timeline:	5 years
Plan Goals Addressed:	Protect Live & Property; Provide for Emergency & Critical Services; Facilitate Continuity & Recovery
Benefit-to-Cost Review:	4
Priority:	3

Approx Cost +	Effectiveness =	Priority / Cost-to Benefit Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[**X**] 2 – Medium	[**X**] 2 – Medium	[ ] 3
[ ] 3 – Low	[ ] 3 – High	[**X**] 4
		[ ] 5
		[ ] 6 – Highest

[1] Penhallegon Associates Consulting Engineers, Inc. *Olympic View Water and Sewer District Comprehensive Water System Plan* (2003).
[2] Seattle Public Utilities. *Drinking Water Quality Annual Report* (May 2003).
[3] Employment figures as of 2008.

Port of Edmonds

The Port of Edmonds encompasses just over 62[1] acres and is located a few blocks west of the downtown core of Edmonds. It is an integral spoke in the wheel of various transportation systems bordering it. This includes the UNOCAL site, a portion of which may develop into a multi-modal site for a possible ferry terminal location, and the Burlington Northern tracks, an integral part of the region's proposed commuter rail transportation system and an existing piece of the region's heavy rail system. The Port itself, with its marina capabilities, provides boating traffic transportation links. At present, the boating traffic is personal, pleasure boating with a few commercial charters.[2]

The Port provides the following facilities and services:

- Twenty-five acres of wet moorage accommodating 670 vessels
- Dry stack storage for 276 boats
- Two hydraulic boat launchers for boats up to 15,000 pounds or 32-feet LOA, 10-feet wide
- Fifty ton travel-lift
- Pressure washing area with wastewater treatment containment
- Environmentally-friendly workyard accessible to the public
- Marine fuel dock, Guest Moorage and Bait Shop
- Public Fishing Pier (500 feet long), managed by the City of Edmonds
- Public parking for shoreline facilities
- Sixty commercial, light-industrial and marine-oriented businesses
- A variety of shops and restaurants
- A yacht sales establishment
- A variety of office facilities
- Private yacht club facilities

The Port of Edmonds' critical structures are identified in *Annex N*.

Hazard Identification

Based on past experience, the Port of Edmonds rates its risk of natural hazards as follows:

HAZARD	RATING (out of 80 possible)
DROUGHT	07
EARTHQUAKE	40
FLOOD	20
LANDSLIDE	18
SEVERE STORM	30
TSUNAMI & SEICHE	11
VOLCANO	05
WILDLAND URBAN INTERFACE FIRE	05

Drought

Rating: 7

Even in the case of a wide-spread and long-term drought, the Port of Edmonds is not considered to be particularly vulnerable to drought. The Port is located on Puget Sound, so while it experiences variations in water depths due to tides, it does not experience the chronic water shortages that those mooring on a river may experience in connection with drought. Drought is an ***EXTREMELY-LOW*** risk for the Port of Edmonds.

Earthquake

Rating: 40

Earthquake is the greatest hazard that the Port may experience. If a major quake was to occur in the region, it would affect the entire Port area. Property will be damaged or destroyed during a major event. It is probable that people will be injured, and possibly killed, from falling debris or boats and watercraft stored in dry-dock.

The economy will be disrupted if the facilities receive significant damage. This disruption will continue for the duration of rebuilding and beyond as some boat owners who find temporary moorage or storage sites may not return once the facilities are restored. Foot traffic will also be discouraged due to inconveniences caused by traffic revisions and rebuilding activities.

Environmental damage may occur from the waters of Puget Sound being stirred up both during the event as well as during the rebuilding process.

Secondary effects from an earthquake could include the possibility of Hazardous Material spills or fire should fuel lines or tanks be ruptured.

Earthquake is rated as a ***MODERATE*** risk.

Flood

Rating: 20

100-Year and Urban

The Port is, by definition, located on the water. This limits the impact of flooding as Puget Sound can easily absorb waterflows coming most rainstorms or stormwater overflows. There is some risk of 100-year or urban flooding especially at its Harbor Square Business Complex.

Shoreline

Shoreline flooding is a possibility for the Port of Edmonds. Storm events are often accompanied by significant wave action, and this, combined with heavy rains and run-off from overwhelmed stormwater systems, may cause some flooding in the Port. This will be of short duration and will, with the Port's topography, dissipate as soon as the waves and rainfall abate.

Shoreline flooding represents a ***MODERATE*** risk.

Landslide and Soil Displacement

Rating: 18

The Port is located at the base of the bluff that contains the former Unocal plant. The upper site is developed with residential condominiums. The slopes are steep enough that it is possible for soil to be displaced during heavy rains or tidal action or during an earthquake. Should this occur, it could destabilize infrastructure such as roadways, parking lots, and ramps.

If the soil surrounding and supporting fuel tanks and lines is displaced, the tank or line could rupture. In such a case, it is possible that the Port of Edmonds would experience a Hazardous Material spill and/or a fire.

Depending on the amount of damage, and how much time, effort, and money it takes to restore the facilities, the Port could experience significant economic damage as a result.

Overall, landslide is a ***MODERATELY-LOW*** risk.

Severe Storm

Rating: 30

Although severe storm is identified as a ***MODERATE*** hazard, it is one of the higher risks for the Port of Edmonds. This is due to the frequency of the events, the variety of factors that could affect the event, and the Port's purpose.

Both docks and boats may be damaged when high winds and/or heavy wave actions repeatedly slamming the boats into the docks. Other debris in the water may also become water-borne missiles and cause damage during severe weather.

Photograph 1: Heavy wave action due to winds. Source: Port of Edmonds.

Landslide and soil displacement may occur as a part of the severe storms experienced by the Port. Heavy wave activity may erode and destabilize the waterfront, threatening Port infrastructure. In addition, a section of the Port is located at the base of a steep bluff, and this area may be prone to landslide during periods of saturating rains or freeze-thaw cycles.

Snow and freezing rains may damage or destroy storage structures. This occurred in 1996 when heavy snows collapsed dock roofs. Many of the boats moored under these structures were damaged, and several of them were sunk under the weight of the downed roof.

Photograph 2: Dock collapse from winter storms, December 1996.
Source: Port of Edmonds

Tsunami & Seiche

Rating: 11

Tsunami and seiche are ***LOW*** risks for the Port of Edmonds. Again, this is due to the fact that the facilities are located on Puget Sound, and would be vulnerable should such an event occur.

While not extremely likely to occur, if a tsunami event takes place, it is possible that the entire Port facility could be seriously damaged or destroyed. In such a case, it is very likely that there would be injuries and/or deaths.

As with other natural disasters, there is the potential for environmental damage as the bed of Puget Sound is agitated by the wave action. In addition, beach-front properties have the possibility of being eroded or washed away, and this would change the ecological base for the beach area.

Assuming that there is significant damage to the facilities, the Port would also experience a significant drop-off in the number of people using the moorage facilities as well as a decrease in people using the shopping and business areas. The result would be economic damage that may be very difficult to recover from.

Volcano

Rating: 5

Volcano is considered to be an ***EXTREMELY-LOW*** risk for the Port of Edmonds. As was discussed in the HIVA (Section II), the primary concern during a volcanic eruption would be ashfall. Due to the limited purpose associated with the Port Authority, this would have limited impact.

Other concerns associated with a volcanic eruption would be the occurrence of an earthquake and/or tsunami as part of the volcanic activity. These hazards are addressed in the previous sections.

Wildland-Urban Interface Fire

Rating: 5

The Port of Edmonds has very little undeveloped land around it. As a result, the threat level from wildland-urban interface fire is ***EXTREMELY-LOW***. Furthermore, the Port's infrastructure is located some distance away from potential fuels for wildfire.

Mitigation

Existing and Ongoing Mitigation Activities

The Port of Edmonds is taking the following actions in ongoing efforts to mitigate for natural hazards and to maintain public safety.

All Hazards

- All new structures built to current codes.
- Codes and Plans
  - Port of Edmonds Master Plan
- Placed flexible fuel lines inside new cement docks to allow for water level fluctuation and movement without breakage.
- Purchased (and maintaining) emergency supplies, including items for first aid, water and food.
- Conducted all-hazards facility survey.

Photograph 3: New dock and embedded fuel lines.
Source: Port of Edmonds.

Drought

- Work with the City of Edmonds and the local water utilities to comply with water conservation measures.

Earthquake

- Replaced fuel tanks and lines and brought up to current code. (Note: The new fuel tanks are double-walled to increase integrity.)
- Conducted initial non-structural mitigation activities in office facilities.

Photograph 4: Double-walled fuel tanks.
Source: Port of Edmonds

Photograph 5: New fuel lines installed.
Source: Port of Edmonds

Landslide and Soil Displacement

- Use bulkheads as appropriate and in accordance with SEPA.

Severe Storm

- Replaced dock roofs with more steeply sloped structures to slough ice and snow and prevent future collapses from accumulated ice or snow.
- Replaced wooden docks with cement dock.

Photograph 6: New docks and covers.
Source: Port of Edmonds

Tsunami and Seiche

- Participated in regional planning meetings with Washington State Department of Natural Resources as they developed a regional model for tsunami and seiche in Puget Sound.

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Mitigation Action Items

The Mitigation Plan identifies short- and long-term action items developed through data collection, research, and the public participation process. Mitigation Plan activities may be considered for funding through federal and state grant programs and when other funds are made available through the budgeting process or the passage of bonds.

Action items address multi-hazard (MH) or hazard-specific issues. Upon implementation, the coordinating organizations may look to partner organizations for resources and technical assistance.

To help ensure activity implementation, each action item includes several pieces of information in the description. These include:

- *Coordinating Organization*
  The coordinating organization is that which is willing and able to organize resources, find appropriate funding, or oversee activity implementation, monitoring and evaluation. The coordinating organizations may be local or regional agencies. Organizations written in *italics* are not participating in this Plan but have an established relationship with this jurisdiction.

- *Timeline*
  Action items include both long- and short-term activities. Each action item includes an estimate of the timeline for implementation. *Short-term* action items (ST) are activities that organizations may implement with existing resources and authorities within one to two years. *Long-term* action items (LT) may require new or additional resources or authorities, and may take between two and five years to implement.

- *Ideas for Implementation*
  Each action item includes ideas for implementation. This may be individual steps for one project, or it may be several related projects that address the natural hazard.

- *Plan Goals Addressed*
  The plan goals are identified to monitor and evaluate how well the Mitigation Plan is achieving its goals once implementation begins.

- *Benefit-to-Cost Review*
  Due to limitations in staff time, and because project priorities may shift based on changes in funding options and local events, a

generalized benefit-to-cost review is used. The steps associated with prioritizing the mitigation projects are as follows:

1. The jurisdiction rates the project cost as "high," "medium," or "low" in relation to budget and previous projects, and each rating is assigned a numerical value.
2. The project outcome is then rated as "low," "medium," or "high," and each of these ratings is assigned a numerical value.
3. The two values are added together, and the total provides the cost-benefit and the priority.

Example:

If a project has a *medium approximate cost*, and is considered to be *highly effective*, the boxes would be marked as shown below.

Approx Cost +	Effectiveness =	Benefit-to-Cost Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[**X**] 2 – Medium	[ ] 2 – Medium	[ ] 3
[ ] 3 – Low	[**X**] 3 – High	[ ] 4
		[**X**] 5
		[ ] 6 – Highest

The priority ratings with the highest numbers are considered to be the highest priorities. As always, however, these are subject to financial realities and may not be carried out in the exact order indicated.

MULTI-HAZARD Mitigation Actions (MH)

LT-01-MH-PE: Upgrade safety and security features.

Ideas for implementation:
- Purchase and install new back-up generator.
- Install emergency lighting on docks.
- Install public announcement (sound) system.

Coordinating Organization:	Port of Edmonds Administration
Estimated Price:	To be determined
Funding Source:	General Fund
Timeline:	5 years
Plan Goals Addressed:	Protect Life & Property
Benefit-to-Cost Review:	4

Approx Cost +	Effectiveness =	Benefit-to-Cost Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[**X**] 2 – Medium	[**X**] 2 – Medium	[ ] 3
[ ] 3 – Low	[ ] 3 – High	[**X**] 4
		[ ] 5
		[ ] 6 – Highest

DROUGHT Mitigation Actions (D)
None identified at this time.

EARTHQUAKE Mitigation Actions (E)

ST-01-E-PE: Conduct non-structural retrofit activities.

Ideas for implementation:

- Strap down and secure computers and other office equipment and machinery.
- Secure shelves, lockers, and furniture to walls.
- Conduct walk-throughs to ensure that heavy items are not stored overhead. Secure in place or move to safer locations
- Mount computer servers on seismic isolation platforms, or use other appropriate technology to secure servers.
- Ensure facility water heaters are strapped securely to wall studs in accordance with current requirements.
- Secure ceiling tiles and light fixtures with wires.
- Secure back-up generator and HVAC equipment.
- Secure ducts and piping.
- Use plastic sleeves on fluorescent lighting tubes.
- Replace untempered glass with tempered glass, or install polyester shatter-resistant film over existing glass.
- Install child-proof latches on drawers and cabinets in appropriate locations.

Coordinating Organization:	Port of Edmonds Administration
Estimated Price:	$2,000
Funding Source:	General Fund/Grants
Timeline:	5 years, ongoing
Plan Goals Addressed:	Protect Life & Property; Provide for Emergency & Critical Services; Facilitate Continuity & Recovery
Benefit-to Cost Review:	5

Approx Cost +	Effectiveness =	Benefit-to-Cost Review
[ ] 1 – High	[ ] 1 – Low	[ ] 2 – Lowest
[ ] 2 – Medium	[**X**] 2 – Medium	[ ] 3
[**X**] 3 – Low	[ ] 3 – High	[ ] 4
		[**X**] 5
		[ ] 6 – Highest

FLOOD Mitigation Actions (F)

None identified at this time.

LANDSLIDE Mitigation Actions (L)
None identified at this time.

SEVERE STORM Mitigation Actions (S)
Addressed under Multi-Hazard (MH) Mitigation Projects

TSUNAMI AND SEICHE Mitigation Actions (T)
None identified at this time.

VOLCANO Mitigation Actions (V)

LT-03-V-PE: Develop and implement policy for maintaining stock of filters for key vehicles and pieces of equipment.

Ideas for implementation:
- Identify key vehicles and equipment such as: back-up generators, HVAC and/or other large or unusual equipment requiring filters.
- Establish policy and budget to maintain spare filters.

Coordinating Organization:	Port of Edmonds Administration; Port of Edmonds Maintenance Department
Estimated Price:	To be determined
Funding Source:	General fund
Timeline:	5 years
Plan Goals Addressed:	Protect Life & Property; Provide for Emergency Services; Facility Continuity and Recovery
Benefit-to-Cost Review:	To be determined
Priority:	3

Approx Cost +	Effectiveness =	Benefit-to-Cost Review
[ ] 1 – High	[**X**] 1 – Low	[ ] 2 – Lowest
[ ] 2 – Medium	[ ] 2 – Medium	[ ] 3
[**X**] 3 – Low	[ ] 3 – High	[**X**] 4
		[ ] 5
		[ ] 6 – Highest

WILDLAND-URBAN INTERFACE FIRE Mitigation Actions (W)
Not applicable.

[1] City of Edmonds Comprehensive Plan (2002).
[2] David Evans and Associates, Inc., et al. Master Plan for the Port of Edmonds (May 21, 2001).