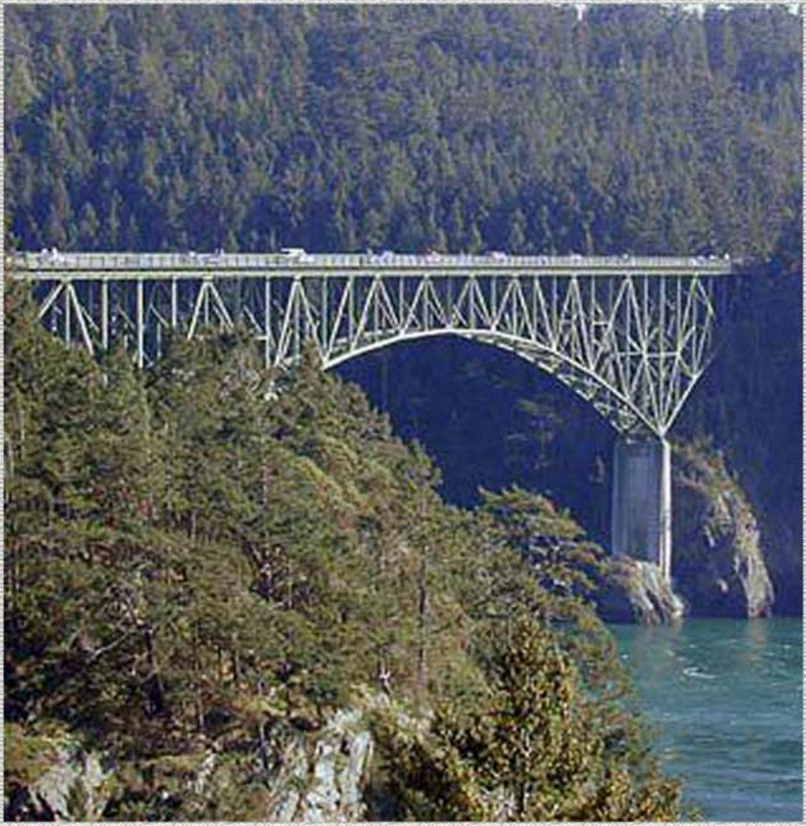
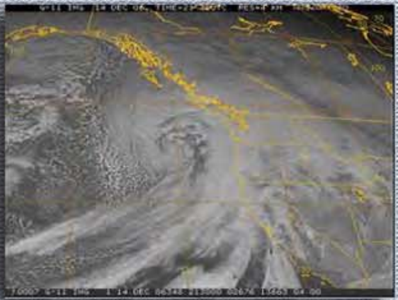
Island County Multi-Jurisdiction Hazard Mitigation Plan 2015 Update

Volume 1: Planning-Area-Wide Elements





BRIDGEVIEW CONSULTING

TETRA TECH

MULTI-JURISDICTION HAZARD MITIGATION PLAN
2015 UPDATE
VOLUME 1: PLANNING-AREA-WIDE ELEMENTS

MARCH 2015

Prepared for:
Island County Department of Emergency Management
P.O. Box 5000
Coupeville, WA 98239-5000

Prepared by:

Bridgeview Consulting LLC
915 No. Laurel Lane
Tacoma, WA 98406
(253) 301-1330

and

303 Irene Street
Helena, MT 59601
(406) 443-5210

Project #114-560439

Island County
Multi-Jurisdiction Hazard Mitigation Plan 2015 Update; Volume 1—Planning-Area-Wide Elements

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EXECUTIVE SUMMARY

The federal Disaster Mitigation Act (DMA) promotes proactive pre-disaster planning by making it a condition of receiving financial assistance under the Robert T. Stafford Act. The DMA established a Pre-Disaster Mitigation Program and new requirements for the national post-disaster Hazard Mitigation Grant Program.

The DMA encourages state and local authorities to work together on pre-disaster planning, and it promotes sustainability as a strategy for disaster resistance. Sustainable hazard mitigation addresses the sound management of natural resources and local economic and social resiliency, and it recognizes that hazards and mitigation must be understood in a broad social and economic context. The planning network called for by the DMA helps local governments articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk-reduction projects.

A planning partnership made up of Island County and local governments worked together to create this Island County Multi-Jurisdiction Hazard Mitigation Plan Update to fulfill the DMA requirements for all fully participating partners.

PLAN UPDATE

Federal regulations require hazard mitigation plans to include a plan for monitoring, evaluating, and updating the hazard mitigation plan. An update provides an opportunity to reevaluate recommendations, monitor the impacts of actions that have been accomplished, and determine if there is a need to change the focus of mitigation strategies. DMA compliance requires that plans be updated. A jurisdiction covered by a plan that has expired is not able to pursue funding under the Robert T. Stafford Act for which a current hazard mitigation plan is a prerequisite.

Initial Response to the DMA in Island County

The inevitability of natural hazards and the growing population and activities within the planning region created an urgent need to develop information, concepts, strategies and a coordination of resources to increase public awareness of the hazards of concern and the risk associated with those hazards. In an effort to reduce the impact of the hazards and assist the public in protecting life, property and the economy, the County and several planning partners determined that it was in the best interests of its citizenry to develop the 2008 Island County Hazard Mitigation Plan. That plan, once completed, served as the base for several other planning efforts throughout the planning region.

As time progressed, new technologies, information and increased awareness brought about a wealth of information to enhance the validity of the initial plan, providing the opportunity, through development of the 2015 Island County Multi-Jurisdiction Hazard Mitigation Plan, to increase the resilience of the planning region. One item which bears mentioning is the variation of dates between the written plan and its date of adoption. The base plan being updated was written in 2006, and all historical data and materials in the plan reference the pre-2006 timeframe; however, the adoption of the plan occurred in January 2008. As such, both years are used throughout this update, based on whether the reference involves the year of adoption or the last year data was captured.

The 2015 Island County Plan Update—What has changed?

The updated plan differs from the initial plan for a variety of reasons:

- Better guidance now exists on what is required to meet the intent of the DMA.
- Science and technology have improved since the development of the initial plan.
- Newly available data and tools provide for a more detailed and accurate risk assessment.

Island County is using the five-year update process to enhance the Island County Multi-Jurisdictional Mitigation Plan in scope and content. Based on availability of new data and a better understanding of the Federal Emergency Management Agency's (FEMA's) guidance to develop mitigation plans, the following changes have been incorporated in the 2015 plan which differ from the previous edition:

- The layout of the plan varies significantly for ease in use by the planning partners. The 2015 edition utilizes a two-volume approach with the base plan contained in Volume 1 and each jurisdiction's separate annex contained in Volume 2.
- The previous plan relied on a more state-specific Hazard Identification and Risk Assessment, and used Mitigation 20/20. Those components have been removed, with a risk assessment focused on the County and its planning partners.
- Hazards of concern were modified, with avalanche removed and coastal erosion, dam failure, and human-caused and technological hazards added. Severe weather was modified to be more encompassing of hazards which have the potential to impact the planning area.
- The risk assessment uses a different methodology to define risk and determine vulnerability; this edition is based on analysis using GIS and Hazus (FEMA's hazard-modeling program) and focuses on determining impacts on people, property, environment and the economy.
- The risk assessment has been prepared to better support future grant applications by providing risk and vulnerability information that will directly support the measurement of "cost-effectiveness" required under FEMA mitigation grant programs.
- A new, easier method of risk ranking was used for this update, which will allow planning partners to annually review and determine accuracy of the greatest hazards of concern.
- All charts, graphs and maps have been updated with the most current data.
- All Census and Census-related data has been updated with the most current data available.
- Goals and objectives were reviewed and updated appropriately to align with the County and its planning partners.
- Strategies from the 2008 edition were updated, and new strategies identified. A new method of prioritizing strategies was used, including benefit cost analysis (see Chapter 18).
- Three new planning partners were included: Town of Coupeville, Port of Coupeville, and Whidbey General Public Hospital District. Previous planning partners who are not part of the 2015 update include Coupeville School District #204, Holmes Harbor Sewage District and Island Transit.
- The review of the 2008 plan maintenance strategy at the onset of the process identified the 2008 concern of how to address the 2,000+ water purveyors throughout the County. Many of the purveyors are small (some with only one house per well), and specifics needed to conduct a risk assessment on those systems would be cost-prohibitive and excessive for this planning effort. The solution to help meet the needs of many purveyors was the development of the County's website, which identifies the hazards of concern in a web-based mapping application. This will allow water purveyors to seek out information on their specific hazards of concern.
- A new plan maintenance strategy was developed for use with the 2015 plan.

THE PLANNING PARTNERSHIP

The planning partnership assembled for this plan consists of Island County, three incorporated cities and towns and six special purpose districts defined as "local governments" under the Disaster Mitigation Act. Of these 10 planning partners, all completed the required phases of this plan's development. Jurisdictional annexes for those 10 partners are included in Volume 2 of the plan. Jurisdictions not covered by this process can link to this plan at a future date by following the linkage procedures identified in Volume 2 of this plan.

PLAN DEVELOPMENT METHODOLOGY

Update of the Island County hazard mitigation plan included seven phases:

- **Phase 1, Organize resources**——Under this phase, grant funding was secured to fund the effort, the planning partnership was formed and other stakeholders were assembled to oversee development of the plan. Also under this phase were coordination with local, state and federal agencies and a comprehensive review of existing programs that may support or enhance hazard mitigation.
- **Phase 2, Assess risk**—Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from natural hazards. This process focuses on the following parameters:
  - Identification of new hazards and updating hazard profiles
  - The impact of hazards on physical, social and economic assets
  - Vulnerability identification
  - Estimates of the cost of damage or costs that can be avoided through mitigation.

  Phase 2 occurred simultaneously with Phase 1, with the two efforts using information generated by one another.
- **Phase 3, Involve the public**—Under this phase, a public involvement strategy was developed that used multiple media sources to give the public multiple opportunities to provide comment on the plan. The strategy focused on three primary objectives:
  - Assess the public's perception of risk.
  - Assess the public's perception of vulnerability to those risks.
  - Identify mitigation strategies that will be supported by the public.
- **Phase 4, Identify goals, objectives and actions**—Under this phase, the goals and objectives were reviewed and updated, as well as a range of potential mitigation actions for each natural hazard identified. A "mitigation catalog" was used by each planning partner to guide the selection of recommended mitigation initiatives to reduce the effects of hazards on new development and existing inventory and infrastructure. A process was created under this phase for prioritizing, implementing, and administering action items based in part on a review of project benefits versus project costs.
- **Phase 5, Develop a plan maintenance strategy**—Under this phase, a strategy for long-term mitigation plan maintenance was created, with the following components:
  - A method for monitoring, evaluating, and updating the plan on a five-year cycle
  - A protocol for a progress report to be completed annually on the plan's accomplishments

  - A process for incorporating requirements of the mitigation plan into other planning mechanisms
  - Ongoing public participation in the mitigation plan maintenance process
  - "Linkage procedures" that address potential changes in the planning partnership.
- **Phase 6, Develop the plan**—The internal planning group for this effort assembled key information into a document to meet DMA requirements. The document was produced in two volumes: Volume 1 including all information that applies to the entire planning area; and Volume 2, including jurisdiction-specific information.
- **Phase 7, Implement and adopt the plan**—Once pre-adoption approval has been granted by the Washington Emergency Management Division and FEMA, the final adoption phase will begin. Each planning partner will be required to adopt the plan according to its own protocols.

MITIGATION GOALS AND OBJECTIVES

Goals and objectives were developed for the 2015 mitigation plan based on the work of the planning team consisting of the internal planning group, the planning partners, project stakeholders, and technical information provided and reviewed during the August 12, 2014 meeting. Based on that meeting, the planning team determined that the 2008 goals and objectives would be carried over for the current update of the mitigation plan with some revision for the 2015 plan, although the primary intent of the goals would remain consistent. It was felt by the planning team that the natural resource protection goal and a goal addressing structural projects were not as strong as they could be. The goals were modified to address those deficiencies. Goals and objectives were developed in six general categories:

- Prevention
- Property protection
- Public education and awareness
- Natural resources
- Emergency services
- Structural projects.

MITIGATION INITIATIVES

For the purposes of this document, mitigation initiatives are defined as activities designed to reduce or eliminate losses resulting from natural hazards. The mitigation initiatives are the key element of the hazard mitigation plan. It is through the implementation of these initiatives that the planning partners can strive to become disaster-resistant through sustainable hazard mitigation.

Although one of the driving influences for preparing this plan was grant funding eligibility, its purpose is more than just access to federal funding. It was important to the planning partnership to look at initiatives that will work through all phases of emergency management. Some of the initiatives outlined in this plan are not grant eligible—grant eligibility was not the focus of the selection. Rather, the focus was the initiatives' effectiveness in achieving the goals of the plan and whether they are within each jurisdiction's capabilities.

This planning process resulted in the identification of mitigation actions to be targeted for implementation by individual planning partners. These initiatives and their priorities can be found in Volume 2 of this plan.

In addition, the planning partnership identified countywide initiatives benefiting the whole partnership that will be implemented by pooling resources based on capability. These countywide initiatives are identified in Chapter 17.

CONCLUSION

Full implementation of the recommendations of this plan will take time and resources. The measure of the plan's success will be the coordination and pooling of resources within the planning partnership. Keeping this coordination and communication intact will be the key to successful implementation of the plan. Teaming together to seek financial assistance at the state and federal level will be a priority to initiate projects that are dependent on alternative funding sources. This plan was built upon the effective leadership of a multi-disciplined planning team and a process that relied heavily on public input and support. The plan will succeed for the same reasons.

CHAPTER 1.
INTRODUCTION

Hazard mitigation is defined as the use of long- and short-term strategies to reduce or alleviate the loss of life, personal injury, and property damage that can result from a disaster. It involves strategies such as planning, policy changes, programs, projects, and other activities that can mitigate the impacts of hazards. The responsibility for hazard mitigation lies with many, including private property owners; business and industry; and local, state and federal government.

1.1 AUTHORITY

The federal Disaster Mitigation Act (DMA) (Public Law 106-390) required state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. Prior to 2000, federal disaster funding focused on disaster relief and recovery, with limited funding for hazard mitigation planning. The DMA increased the emphasis on planning for disasters before they occur. DMA 2000 amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act (the Act) by repealing the previous mitigation planning section (409) and replacing it with a new mitigation planning section (322). This new section emphasizes the need for state and local entities to closely coordinate mitigation planning and implementation efforts. To implement the DMA 2000 planning requirements, the Federal Emergency Management Agency (FEMA) published an Interim Final Rule in the Federal Register on February 26, 2002. This rule (Part 201 of Title 44 of the Code of Federal Regulations (44 CFR 201)) established the mitigation planning requirements for states and local communities.

The DMA encourages state and local authorities to work together on pre-disaster planning, and it promotes sustainability for disaster resistance. Sustainable hazard mitigation includes the sound management of natural resources and the recognition that hazards and mitigation must be understood in the largest possible social and economic context. The enhanced planning network called for by the DMA helps local governments articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk reduction projects.

The Island County hazard mitigation plan update has been developed pursuant to the requirements in the Interim Final Rule for hazard mitigation planning and the guidance in the *State and Local Plan Interim Criteria* under DMA 2000. The plan meets FEMA's June 2008 guidance for multi-jurisdictional mitigation planning.

1.2 ACKNOWLEDGEMENTS

Many groups and individuals have contributed to development of the Island County hazard mitigation plan. The Island County Department of Emergency Management (DEM) provided support for all aspects of plan development, including providing data identifying critical facilities and infrastructure. The planning partners met on a regular basis to guide the project, identify the hazards most threatening to the County, develop and prioritize mitigation projects, review draft deliverables and attend public meetings.

Local communities participated in the planning process by attending public meetings and contributed to plan development by reviewing and commenting on the draft plan. Several planning partners provided assistance and guidance to support the efforts of smaller entities by providing data and information to help develop specific annex documents. Citizens' participation was exceptionally good during the plan's development, with citizens attending various public outreach sessions and providing invaluable information

with respect to concerns, strategy ideas, and hazard information. Input was incorporated as appropriate throughout the document.

1.3 PURPOSE OF PLANNING

This hazard mitigation plan identifies resources, information, and strategies for reducing risk from natural hazards. Elements and strategies in the plan were selected because they meet a program requirement and because they best meet the needs of the planning partners and their citizens. One of the benefits of multi-jurisdictional planning is the ability to pool resources and eliminate redundant activities within a planning area that has uniform risk exposure and vulnerabilities. FEMA encourages multi-jurisdictional planning under its guidance for the DMA. The plan will help guide and coordinate mitigation activities throughout Island County. It was developed to meet the following objectives:

- Meet or exceed requirements of the DMA.
- Enable all planning partners to continue using federal grant funding to reduce risk through mitigation.
- Meet the needs of each planning partner as well as state and federal requirements.
- Create a risk assessment that focuses on Island County hazards of concern.
- Create a single planning document that integrates all planning partners into a framework that supports partnerships within the county and puts all partners on the same planning cycle for future updates.
- Coordinate existing plans and programs so that high-priority initiatives and projects to mitigate possible disaster impacts are funded and implemented.

All citizens and businesses of Island County are the ultimate beneficiaries of this hazard mitigation plan. The plan reduces risk for those who live in, work in, and visit the county. It provides a viable planning framework for all foreseeable natural hazards that may impact the county. Participation in development of the plan by key stakeholders in the county helped ensure that outcomes will be mutually beneficial. The resources and background information in the plan are applicable countywide, and the plan's goals and recommendations can lay groundwork for the development and implementation of local mitigation activities and partnerships.

1.4 PLAN ADOPTION

44 CFR 201.6(c)(5) requires documentation that a hazard mitigation plan has been formally adopted by the governing body of the jurisdiction requesting federal approval of the plan. For multi-jurisdictional plans, each jurisdiction requesting approval must document that is has been formally adopted. This plan will be submitted for a pre-adoption review to the Washington State Division of Emergency Management and FEMA prior to adoption. Once pre-adoption approval has been provided, all planning partners will formally adopt the plan. All partners understand that DMA compliance and its benefits cannot be achieved until the plan is adopted. Copies of the resolutions adopting the plan as well as the FEMA approval letter can be found in Appendix C of this volume.

1.5 SCOPE AND PLAN ORGANIZATION

The process followed to update the Island County hazard mitigation plan included the following:

- Review and prioritize disaster events that are most probable and destructive.

- Update and identify new critical facilities.
- Review and update areas within the community that are most vulnerable.
- Update and identify new goals for reducing the effects of a disaster event.
- Review and identify new projects to be implemented for each goal.
- Review and identify new procedures for monitoring progress and updating the hazard mitigation plan.
- Review the draft hazard mitigation plan.
- Adopt the updated hazard mitigation plan.

This plan has been set up in two volumes so that elements that are jurisdiction-specific can easily be distinguished from those that apply to the whole planning area:

- Volume 1 includes all federally required elements of a disaster mitigation plan that apply to the entire planning area. This includes the description of the planning process, public involvement strategy, goals and objectives, countywide hazard risk assessment, countywide mitigation initiatives, and a plan maintenance strategy.
- Volume 2 includes all federally required jurisdiction-specific elements, assimilated into specific annexes for each participating jurisdiction. Volume 2 also includes a description of the participation requirements for planning partners. Volume 2 also includes “linkage” procedures for eligible jurisdictions that did not participate in development of this plan but wish to adopt it in the future, as well as contact information to obtain the annex template and instructions.

All planning partners will adopt Volume 1 and the associated appendices in their entirety, as well as each partner’s jurisdiction-specific annex contained in Volume 2.

The following appendices provided at the end of Volume 1 include information or explanations to support the main content of the plan:

- Appendix A—A glossary of acronyms and definitions
- Appendix B—Public outreach information, including the hazard mitigation questionnaire/ survey and summary and documentation of public meetings
- Appendix C—Plan adoption resolutions from planning partners
- Appendix D—A template for progress reports to be completed as this plan is implemented.

CHAPTER 2.
PLANNING PROCESS

To develop the Island County hazard mitigation plan, the County followed a process that had the following primary objectives:

- Secure grant funding
- Form an internal planning group
- Establish a planning partnership
- Coordinate with individual and agency stakeholders
- Review existing plans and studies
- Engage the public:
  - Conduct a hazard survey
  - Hold public meetings
  - Review the draft hazard mitigation plan.

These objectives are discussed in the following sections.

2.1 SECURE GRANT FUNDING

This planning effort was supplemented by a Hazard Disaster Mitigation Grant Program (HMGP) grant from FEMA. Island County was the applicant agent for the grant. The grant was applied for in 2012, and funding was appropriated in 2013. It covered 75 percent of the cost for development of this plan; the County and its planning partners covered 12.5 percent of the cost through in-kind contributions, and the state of Washington provided the balance.

2.2 INTERNAL PLANNING GROUP FORMATION

Island County hired Bridgeview Consulting, LLC and Tetra Tech, Inc. to assist with development and implementation of the plan. The Bridgeview Consulting project manager assumed the role of the lead planner, reporting directly to a County-designated project manager. An internal planning group was formed to lead the planning effort, made up of the following members:

- Eric Brooks, Island County Project Manager
- Beverly O'Dea, Bridgeview Consulting (Lead Project Planner)
- Daphne Digrindakis, Tetra Tech (Project Planner)
- Cathy Walker, Bridgeview Consulting (GIS Analyst)
- Ed Whitford, Bridgeview Consulting/Tetra Tech (GIS Analyst)

2.3 PLANNING PARTNERSHIP

A primary focus of this effort was to re-engage the original planning partnership from the 2006 plan, and to open this process to eligible local governments. Island County opened this planning effort to all eligible local governments within the county. The internal planning group made a presentation at various meetings beginning January 2014, soliciting letters of intent to participate beginning in May 2014. The initial kickoff planning meeting took place on August 12, 2014, followed by the initial workshop. These meetings introduced the mitigation planning process, solicited planning partners, and formed a planning team consisting of the internal planning group, planning partners, and key stakeholders. Key meeting objectives were as follows:

- Provide an overview of the Disaster Mitigation Act.
- Describe the reasons for a plan.
- Outline the County work plan.
- Outline planning partner expectations.

Each jurisdiction wishing to join the planning partnership was asked to provide a letter of intent to participate in the planning process. That letter designated a point of contact for the jurisdiction and confirmed the jurisdiction's commitment to the process and understanding of expectations. Linkage procedures have been established (see Volume 2 of this plan) for any jurisdiction wishing to link to the Island County plan in the future; the process was revised from the previous plan to include more of the required items for this 2015 edition. Table 2-1 summarizes the received letters of intent to participate by the planning partners.

TABLE 2-1.
LETTERS OF INTENT TO PARTICIPATE SUBMITTED BY MUNICIPALITY

Jurisdiction	Point of Contact	Title
Island County	Eric Brooks	DEM Deputy Director
City of Oak Harbor	Ray Merrill	Fire Chief
City of Langley	Fred McCarthy Mike Beech	Mayor Police Officer
Town of Coupeville	Nancy Conrad William LaRue	Mayor Public Works Director
Camano Island Fire & Rescue	Craig Helgeland Levon Yengoyan	Asst. Fire Chief Asst. Fire Chief
South Whidbey Island Fire & Rescue	Rusty Palmer	Fire Chief
Central Whidbey Island Fire & Rescue	Ed Hartin	Fire Chief
Whidbey General Public Hospital District	Linda Gipson Chris Tumblin	Chief Nursing Officer Emergency Services
Port of South Whidbey	Angi Mozer	Finance Manager
Port of Coupeville	Tim McDonald (Until 1/2015 David Day (After 1/2015) Lisa Dugger	Executive Director Executive Director Administrative Assistant

Responsibilities of the planning partners included participating in conference calls to discuss plan development, providing data for analysis in the risk assessment, attending public meetings, providing input and feedback on mitigation strategies, developing an annex document, reviewing the draft plan document, and supporting the plan throughout the adoption process.

During the August 2014 meeting, the planning partners established meeting guidelines, which identified staffing, elected a chairperson to act as spokesperson for the planning effort, identified a minimum attendance by planning team members to gain an active level of participation, established the decision-making method (quorum or attendance), identified the concept of alternative representatives for planning team members unable to attend, and identified the method in which the public would address the planning team during meetings. Specific guidelines established are available upon request to the Island County Deputy Director of the Department of Emergency Management.

During the August 12, 2014 meeting, Eric Brooks was elected chairperson of the planning team, and the team determined that decisions would be made based on the majority of members in attendance.

Conference calls were held with the planning partners while the plan was being drafted. In advance of each meeting, an agenda and materials to be discussed (i.e. example mitigation strategies, examples of projects eligible for FEMA funding, etc.) were sent to meeting participants. All members issuing letters of intent were engaged as a planning partner throughout this process.

2.4 COORDINATION WITH AGENCIES AND OTHER STAKEHOLDERS

Hazard mitigation planning enhances collaboration and support among diverse parties whose interests can be affected by hazard losses. 44 CFR requires that opportunities for involvement in the planning process be provided to neighboring communities, local and regional agencies involved in hazard mitigation, agencies with authority to regulate development, businesses, academia, and other private and nonprofit interests (Section 201(6)(b)(2)). Stakeholders were identified and invited to participate in this effort:

- County stakeholders included county commissioners, emergency managers, the floodplain coordinator, the Planning and Zoning Department, the GIS program manager, the public administrator, the fire service area manager, search and rescue, the Health Department, airport personnel, 911 dispatch, the Road and Bridge Department, and the Sheriff’s Office. Their participation included providing data, attending public meetings, and reviewing the draft hazard mitigation plan.
- Stakeholders from the communities of Coupeville, Langley, and Oak Harbor included mayors, city council members, planning offices, building departments, public works departments, fire chiefs, hazmat team leaders, chiefs of police, and community development administration. Their participation included providing data, attending public meetings, and reviewing the draft hazard mitigation plan.
- Washington State stakeholders included representatives from the Department of Natural Resources, Department of Ecology and Department of Transportation, the State Hazard Mitigation Officer, and the Hazard Mitigation Grant Program Officer. Their participation included providing data, attending meetings, and reviewing the draft hazard mitigation plan.
- Federal agency stakeholders included the National Weather Service (NWS), U.S. Army Corps of Engineers, U.S. Geologic Survey, U.S. Forest Service, and U.S. Fish and Wildlife Service. These agencies provided information on plan development, attended public meetings, and were invited to review the draft hazard mitigation plan.
- Non-government stakeholders included the American Red Cross, Puget Sound Energy, Coupeville Recreation Center, and Washington State University. Some of these entities provided information for plan development, attended the public meetings, and/or reviewed the draft hazard mitigation plan update.

Stakeholders received a variety of information during the project, including meeting notices, documents for review, and the draft mitigation strategy. Stakeholders also provided input on the plan, particularly for the risk assessment. Table 2-2 lists planning team members, stakeholders and (regular) meeting attendance.

TABLE 2-2.
PLANNING TEAM AND STAKEHOLDER MEMBERSHIP (MAY 2014- 2015)

Name	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Eric Brooks, Deputy Director Island County Dept. of Emergency Management (360) 240-5572	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Amanda Almgren, Long-Range Planner Island County Planning & Community Development a.almgren@co.island.wa.us						✓	✓	✓				
Ray Merrill Fire Chief City of Oak Harbor rmerrill@oakharbor.org	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fred McCarthy, Mayor City of Langley mayor@langleywa.org	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓
David Marks, Police Chief City of Langley		✓	✓						✓			
Nancy Conard, Mayor Town of Coupeville mayor@townofcoupeville.org	✓	✓	✓									✓
William LaRue Town of Coupeville Public Works Director utilities1@townofcoupeville.org							✓	✓	✓	✓	✓	✓
Levon Yengoyan, A/Chief Camano Island Fire & Rescue lyengoyan@camanofire.com	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
H.L. "Rusty" Palmer, Chief South Whidbey Fire/EMS chief@swfe.org	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Ed Hartin, Chief Central Whidbey Island Fire & Rescue hartin@cwfire.org		✓	✓	✓	✓			✓	✓			
Linda Gipson Whidbey General Public Hospital District gipsol@whidbeygen.org	✓											
Chris Tumblin Whidbey General Public Hospital District tumble@whidbeygen.org			✓	✓	✓	✓	✓	✓	✓	✓	✓	
Tim McDonald, Executive Director Port of Coupeville executivedirector@portofcoupeville.org		✓	✓	✓	✓							
David Day, Executive Director (After January 2015) Port of Coupeville				✓	✓			✓	✓	✓		
Lisa Dugger, Administrative Assistant Port of Coupeville								✓	✓	✓		

TABLE 2-2.
PLANNING TEAM AND STAKEHOLDER MEMBERSHIP (MAY 2014- 2015)

Name	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Angie Mozer, Finance Manager Port of South Whidbey portfinance@portofsouthwhidbey.com	✓	✓	✓	✓				✓	✓	✓		
Ron Conlin Red Cross ron.conlin@redcross.org			✓	✓								
Gary Urbas Washington State Military Department Gary.Urbas@mil.wa.gov				✓								
Sadie Whitener Washington State Department of Ecology swhi461@ECY.WA.GOV		✓	✓			✓		✓	✓	✓	✓	
Tim Walsh Washington State Department of Natural Resources, Geologist		✓				✓	✓		✓	✓		
Beverly O'Dea, Consultant/Lead Planner Bridgeview Consulting, LLC bevodea@bridgeviewconsulting.org (253) 301-1330	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Daphne Digrindakis, Consultant/Senior Planner Tetra Tech, Inc. Daphne.Digrindakis@tetratech.com	✓	✓	✓					✓				
Cathy Walker, Lead GIS Analyst Bridgeview Consulting, LLC (253) 301-1330		✓	✓	✓	✓		✓		✓	✓	✓	✓
Ed Whitford, GIS Analyst Bridgeview Consulting, LLC (253) 301-1330	✓		✓		✓	✓	✓	✓	✓			
Adam Palmer, Planner/Fiscal Bridgeview Consulting, LLC (253) 301-1330		✓	✓	✓	✓		✓		✓	✓	✓	

2.5 REVIEW OF PLANS AND STUDIES

44 CFR states that hazard mitigation planning must include review and incorporation as appropriate of existing plans, studies, reports and technical information (Section 201.6.b(3)). Laws and ordinances in effect in the planning area that can affect hazard mitigation initiatives are reviewed in Chapter 19. The list of references at the end of this volume presents sources used to capture information necessary to complete this planning effort. Plans, studies and reports used for this process include, but are not limited to:

- Island County Comprehensive Emergency Management Plan (CEMP)
- Regional Catastrophic Plan
- Oak Harbor CEMP
- Flood Insurance Study; Island County and Incorporated Areas (2007 and 2014)
- Island County Pre-Disaster Mitigation Plan, 2008

- Washington State Enhanced Hazard Mitigation Plan (2010 and 2013)
- Washington Department of Natural Resources (WDNR) Landslide Report
- Island County Transportation Plan
- Coastal erosion data (various)
- Climate change data
- Island County Feeder Bluff CGS Final Report
- Washington Department of Ecology Coastal Zone Atlas
- Washington Department of Ecology Hazardous Materials Annual Report for Island County.

Data obtained from the plan and regulation review was incorporated into various sections of the hazard mitigation plan. The risk assessments in Chapter 5 through Chapter 16 refer to plans and ordinances that affect the management of each hazard. Section 20.2 describes how mitigation can be implemented through existing programs. An assessment of all planning partners' regulatory, technical and financial capabilities to implement hazard mitigation initiatives is presented in the jurisdiction-specific annexes in Volume 2 and in Chapter 19. Many of these relevant plans, studies and regulations are cited in the capability assessment.

2.6 PUBLIC INVOLVEMENT

Broad public participation in the planning process helps ensure that diverse points of view about the planning area's needs are considered and addressed. The public must have opportunities to comment on disaster mitigation plans during the drafting stages and prior to plan approval (44 CFR Section 201.6(b), 201.6(c)(1)(i) and 201.6(c)(1)(ii)).

The County and its planning partners did extensive outreach and used different methods to increase involvement, such as pairing meetings with existing council and commission meetings, holding web-based meetings, and scheduling conference calls that allowed participation by agencies and individuals. Interviews with individuals and specialists from outside organizations identified common concerns related to natural and manmade hazards, and key long- and short-term activities to reduce risk. Interviews included public safety personnel, planning department personnel, natural resources personnel, cultural resource personnel, and representatives from other government agencies from surrounding jurisdictions. The public outreach strategy for involving the public in this plan emphasized the following elements:

- Include members of the public on the planning team.
- Use a questionnaire to determine general perceptions of risk and support for hazard mitigation and to solicit direction on alternatives. The questionnaire was available to anyone wishing to respond via the website and was distributed by hard copy for those without computer access (hard-copy results were entered by the consultant). The County published a news release in local papers and identified the survey on the hazard mitigation website.
- Attempt to reach as many citizens as possible using multiple formats. This is important because of the somewhat geographically remote areas on the islands in the county.
- Identify and involve planning area stakeholders.
- Provide newsletter articles about mitigation efforts, such as geological digs that occurred during this planning process, the update of FEMA flood maps, etc.
- Include several safety fairs from the various planning partners.
- Include a public official's workshop for all planning partners throughout the County.

2.6.1 Planning Team Input

Most members of the planning team live or work in the planning area. Planning team participation by individuals with varied backgrounds and from varied organizations added details and information that were valuable in identifying direction for the plan development process.

The County created a new website, which hosted a mitigation section, wherein all notices and survey links were posted. During meetings within the planning area or attended elsewhere by planning team members, individuals were directed to the website to gain better insight of the County's endeavors and to solicit input. The planning team identified stakeholders to target through the public involvement strategy. Members of the planning team attending conferences or meetings provided updates to those in attendance, asking for input and review of the plan. Some of the outreach sessions are identified in Table 2-3. This list is not all-inclusive, but rather demonstrative of the various efforts of the planning team.

TABLE 2-3.
PUBLIC OUTREACH EVENTS

Date	Jurisdiction	Description	Attendance
2014			
May	Countywide	Press release announcing the up-coming project	N/A
July	County	Presentation to status of project to County Commissioners during Commissioner's Meeting	
August	Countywide	Press release setting kickoff meeting dates	N/A
August	City of Oak Harbor	Chief Ray Merrill posted the notice of hazard mitigation planning process to City's website.	
August	Countywide	Presentations at various National Night Out celebrations included information on the hazard mitigation plan development effort	
August	Camano Island Fire & Rescue	A/C Yengoyan advised Board of Fire Commissioners of planning process and District's participation	25
September	Countywide	Survey deployed	
September	Oak Harbor	Survey link posted on City's website	N/A
September	Camano Island Fire & Rescue	A/C Yengoyan updated Board of Fire Commissioners of current plan status. Presented survey and requested everyone take the survey on-line.	10
September	Countywide	Deputy Emergency Management Director Eric Books discussed the County's update process during the WSEMA conference	~100
September	Countywide	Hazard mitigation plan website established; survey, frequently asked questions, agenda and minutes were posted; preliminary maps posted	N/A
October	Countywide, Oak Harbor	Safety Fair—map presentation; laptops set up for citizen input through surveys; comment sheets requesting citizen input and follow-up	+200
October	Camano Island	Halloween Safety Fair – map presentation; discussion on mitigation planning process; distribution of safety materials and survey;	+100

TABLE 2-3.
PUBLIC OUTREACH EVENTS

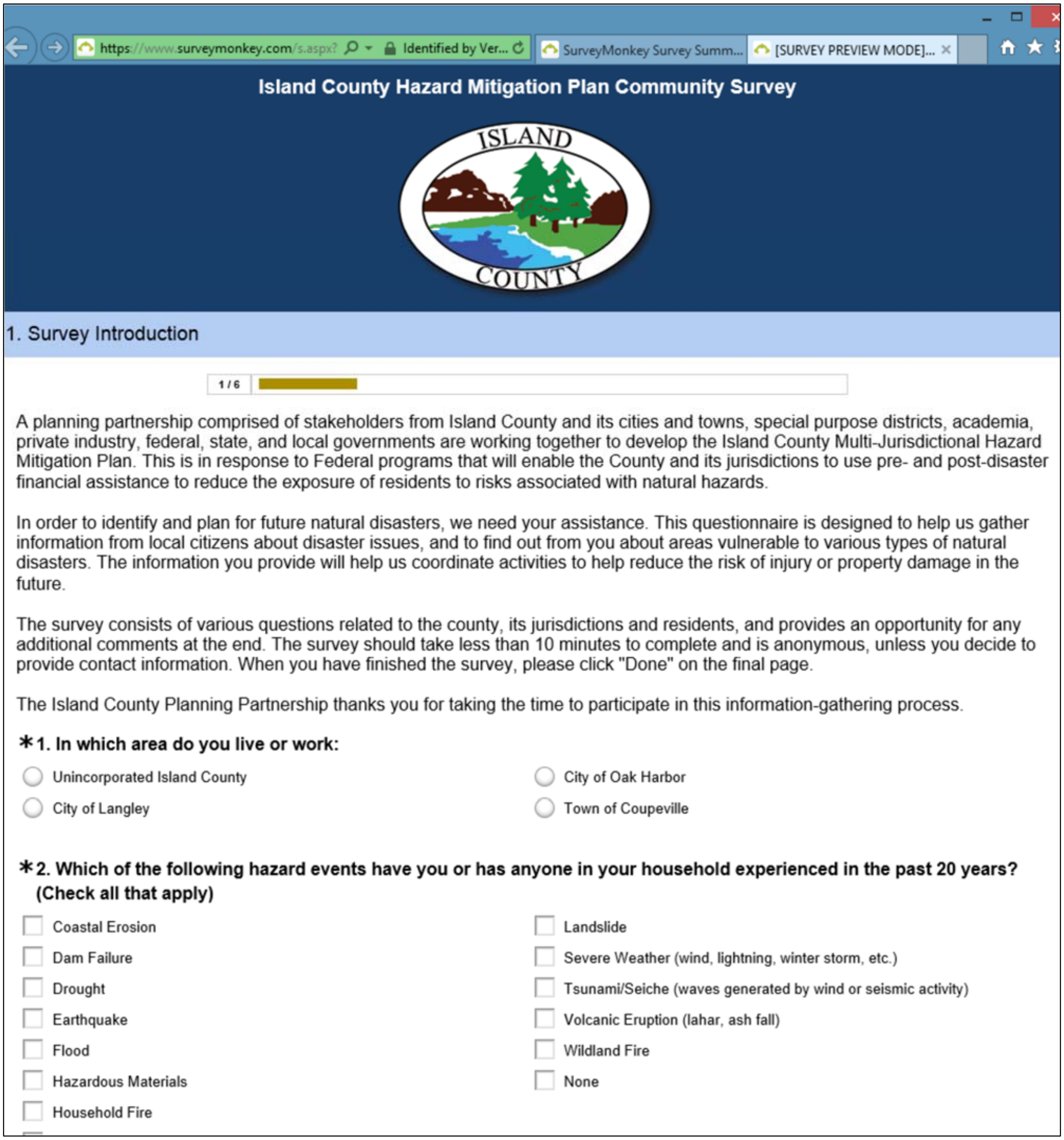
Date	Jurisdiction	Description	Attendance
November	Whidbey General Hospital	Safety Fair—hazard information presented; general emergency management items discussed, including current Ebola issues; survey was provided	+50
December	Public Official's Workshop	Countywide effort which included public officials from all of the jurisdictions and several of the special purpose districts countywide. Information was provided concerning the current hazard mitigation plan process, specific loss data provided from the risk assessment recently completed, and display of the hazard maps	+50
December	City of Coupeville Council Meeting	City of Coupeville Mayor presented an update to the planning process during the City Council Meeting; again inviting citizens to take the survey, reviewed hazard maps posted in council chambers, and directed individuals to the County's mitigation planning website for additional information; also advised attendees that the draft plan will be available for review on the County's website at the end of February	Televised
2015			
January 5	City of Langley Council Meeting	City of Langley Mayor presented an update to the planning process during the City Council Meeting; discussed 2008 plan, and changes to the current process; invited citizens to take the survey, posted hazard maps for citizen viewing; directed individuals to the County's mitigation planning website	~25
January 6	Board of Commissioners, Port of South Whidbey	Board of Commissioner's Meeting – Presentation concerning hazards of concern; strategy development; demonstration of Hazard Map Viewer on hazard mitigation plan's website	~9
January 8	Countywide First Responders, Emergency Management Personnel and Public Works Personnel	In coordination with Countywide Earthquake TTX, reviewed 2015 strategies and discussed potential additional strategies	~30
January 20	Board of Commissioners Port of South Whidbey	Board of Commissioner's Meeting – Presentation concerning hazards and strategy development (continued); hazard mitigation plan website again announced inviting citizen review of upcoming plan	~12

**TABLE 2-3.
PUBLIC OUTREACH EVENTS**

Date	Jurisdiction	Description	Attendance
February 2	Countywide – Sound Waters Presentation	In coordination with WSU and the Sound Waters Event, Island County Emergency Management made a 70-minute presentation on various hazards of concern; presented maps; solicited input on risk; provided handouts on risk and public safety; discussed identified strategies for the 2015 hazard mitigation plan update, and demonstrated the hazard mitigation planning website, including the "What's My Hazard" interactive maps. The event drew 500 to 600 people. Subject matter experts presented multiple break-out sessions during the day on hazards specific to Island County, with the final presentation being that of Island County Emergency Management on the hazard mitigation plan update. http://beachwatchers.net/soundwaters/wp/	~550
February 10	Board of Commissioners Port of South Whidbey	Board of Commissioner's Meeting – Discussion concerning mitigation plan; internal review occurring; draft plan available beginning March for citizen review and comment	~12
March	Island County Board of Commissioners	Plan review before Council; invitation extended to citizens to review existing plan; announcement of website address and that hard a copy is available for review at the office of Island County Emergency Manager – Eric Brooks;	~20
March	Island County	Press Release announcing plan availability for review on Website and hard copy available for review at the office of Island County Emergency Management	NA

2.6.2 Hazard Questionnaire

A hazard mitigation plan questionnaire developed by the planning team was used to gauge household preparedness for natural hazards and the level of knowledge of tools and techniques for reducing risk and loss from natural hazards. This questionnaire was designed to help identify areas vulnerable to one or more natural hazards. The answers to its 30 questions helped guide the planning partners in selecting goals, objectives and mitigation strategies. Over 300 hard copies were disseminated throughout the planning area, and a web-based version was made available on the hazard mitigation plan website. Over 225 questionnaires were completed. Appendix B of this volume presents the questionnaire and a summary of its findings. Figure 2-1 shows a sample from the web-based questionnaire. Figure 2-2 illustrates Oak Harbor's survey outreach. Survey responses indicate a close match between respondents' hazards of greatest concern and hazards identified through the Planning Team's risk ranking.


https://www.surveymonkey.com/s.aspx? Identified by Ver... SurveyMonkey Survey Summ... [SURVEY PREVIEW MODE]...

Island County Hazard Mitigation Plan Community Survey

ISLAND COUNTY

1. Survey Introduction

1 / 6

A planning partnership comprised of stakeholders from Island County and its cities and towns, special purpose districts, academia, private industry, federal, state, and local governments are working together to develop the Island County Multi-Jurisdictional Hazard Mitigation Plan. This is in response to Federal programs that will enable the County and its jurisdictions to use pre- and post-disaster financial assistance to reduce the exposure of residents to risks associated with natural hazards.

In order to identify and plan for future natural disasters, we need your assistance. This questionnaire is designed to help us gather information from local citizens about disaster issues, and to find out from you about areas vulnerable to various types of natural disasters. The information you provide will help us coordinate activities to help reduce the risk of injury or property damage in the future.

The survey consists of various questions related to the county, its jurisdictions and residents, and provides an opportunity for any additional comments at the end. The survey should take less than 10 minutes to complete and is anonymous, unless you decide to provide contact information. When you have finished the survey, please click "Done" on the final page.

The Island County Planning Partnership thanks you for taking the time to participate in this information-gathering process.

***1. In which area do you live or work:**

- Unincorporated Island County
- City of Langley
- City of Oak Harbor
- Town of Coupeville

***2. Which of the following hazard events have you or has anyone in your household experienced in the past 20 years? (Check all that apply)**

- Coastal Erosion
- Dam Failure
- Drought
- Earthquake
- Flood
- Hazardous Materials
- Household Fire
- Landslide
- Severe Weather (wind, lightning, winter storm, etc.)
- Tsunami/Seiche (waves generated by wind or seismic activity)
- Volcanic Eruption (lahar, ash fall)
- Wildland Fire
- None

Figure 2-1. Sample Island County Survey Web Page

Figure 2-2. Oak Harbor Disaster Survey Link

Additional points of interest from the survey results include:

- 44 percent of respondents have experienced an earthquake over the last 20 years; 73 percent had experienced a severe weather event. Severe weather events are the majority of hazards that have impacted the County in the last 20 years.
- Earthquake has the highest potential for impact and is the hazard of highest concern to Island County citizens.
- Coastal erosion and climate change are of concern to the citizens of the count.

- 46 percent of respondents have experienced one to three disaster events in their lifetime, but half of those did not occur while the respondent resided in Island County.
- Most respondents indicated that the impact of disaster incidents played a role in their decision to purchase their residence. 92 percent indicated that the impact of disasters did not restrict the use of their residence.
- 53 percent of respondents indicated some level of self-preparedness, although less than 5 percent have flood insurance through the NFIP. Approximately 20 percent of respondents have earthquake coverage.
- Over half of respondents indicated that data concerning potential hazards and risk information is readily available. 196 respondents confirmed the significance of self-education and mitigation efforts to reduce the impact of hazards.

2.6.3 News Releases

A news release was published to draw attention to the County's update process and the survey. The County published a separate news release concerning a Safety Fair. For the December Public Official's Workshop, a press release was issued inviting all public officials to participate, as well as an invitation to the general public to learn about emergency management as a whole, including presentation of risk data and hazard maps. When the draft plan was available for public review, notice was published in an effort to draw in as many comments as possible.

2.6.4 Internet

At the beginning of the plan development process, a website was created to keep the public posted on plan development milestones and to solicit input (see Figure 2-3). The plan was provided via a file-transfer site, which allowed for the plan downloading for review.

The County's website address (http://www.islandcountydem.org/home.html) was publicized in all press releases, mailings, questionnaires and public meetings. Information on the plan development process, the planning team, the questionnaire and phased drafts of the plan was made available to the public on the site throughout the process. Hazard maps were published on this site, and were available for download. Bridgeview Consulting developed a hazard viewer application, where citizens could view hazards of concern in their immediate vicinity (see Figure 2-4).

The County intends to keep a website active after the plan's completion to keep the public informed about successful mitigation projects and future plan updates. The County also developed a Facebook page, which it may use in the future for updates of events in the county (Figure 2-5).

2.6.5 Public Meetings

Several public meetings and events which were open to the public were held during this effort. All planning meetings were also open to the public, and citizens did attend those meetings, providing information and input. Highlights of the specific public outreach efforts follow, with a more detailed list in Table 2-3.

Figure 2-3 Project Website Example Page

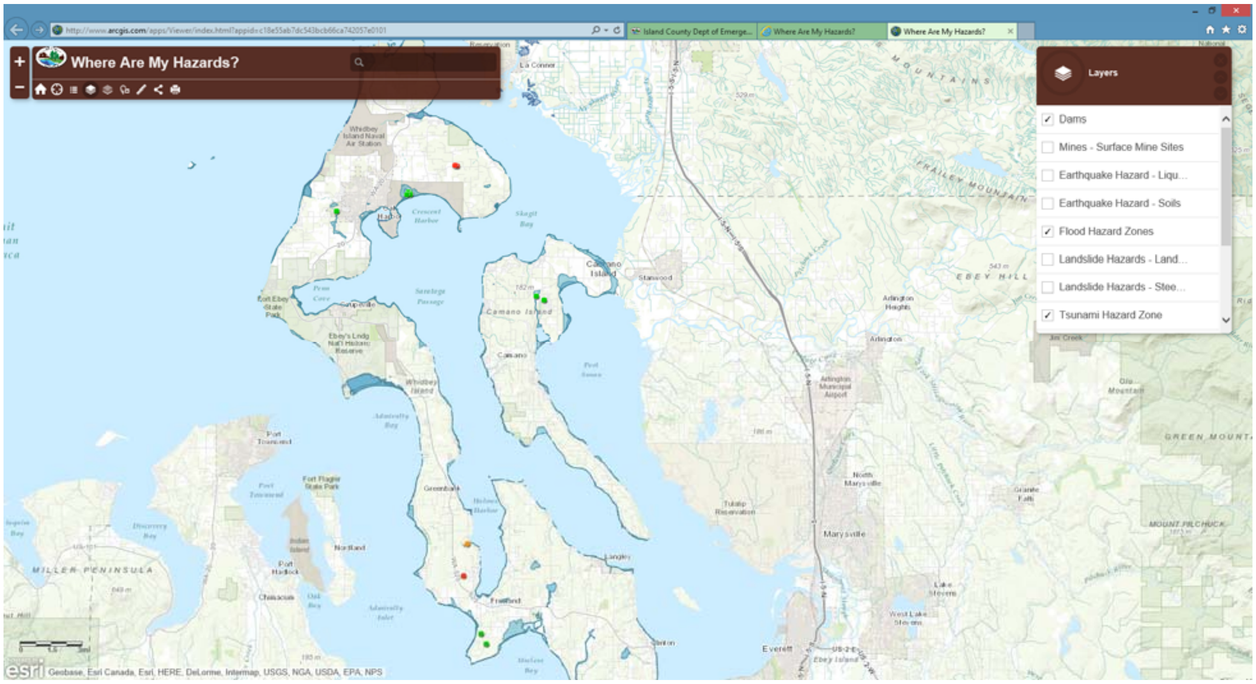


Figure 2-4 Hazard Viewer Application

Figure 2-5 Island County Facebook

A number of planning team members staffed a public information booth at the annual Home Depot Safety Fair on October 4, 2014 (see Figure 2-6). During this event, maps from the various jurisdictions were presented. It is estimated that over 200 people were in attendance. The fair ran from 9:00 a.m. to 2:00 p.m., and was held in conjunction with other safety and health-related events in hopes of capturing more interest. The meeting format allowed attendees to examine maps and handouts and have direct conversations with project staff. Reasons for planning and information generated from the risk assessment were shared with attendees. Maps were set up for each primary hazard to which the planning area is most vulnerable. This allowed citizens to see information related to their property. This was effective in illustrating risk to the public. Planning team members were present to answer questions. Each citizen attending was asked to complete a questionnaire, and each was given an opportunity to provide written comments to Planning Team members.

Figure 2-6. Public Information Booth at Home Depot Safety Fair

A December 2, 2014 Public Official's Workshop was conducted on a countywide level, with public officials from all jurisdictions and special purpose districts in attendance. Various elements of emergency management were discussed, including the 2015 update process for the County's hazard mitigation plan. Maps were available for review and comment. Citizens were invited to attend and provide input during the process, including completion of the survey.

During the March __, 2015 Commissioner's Meeting, Emergency Management Deputy Director Eric Brooks announced that the draft plan would be available for review within the next two weeks. Citizens were asked to review the draft plan, available on the County's DEM website, and to provide comments. The final public review period began March 16, 2015 lasting through April 16, 2015. The final plan will remain on the County's website over the next five years.

Planning partners held their own final public meetings, at which the plan was presented to their commission or council and the approving authority adopted the plan. Appendix C includes the adoption resolutions.

The kickoff meeting on August 12, 2014 was open to the public and was publicized in the local paper. During the kickoff meeting, the 2008 plan was reviewed in detail and hazards were identified for the 2015 update. Table 2-4 summarizes the review and analysis of the 2008 plan presented at that meeting. The meeting presentation was placed on the project website for stakeholders who could not attend the meeting, as well as for public review.

**TABLE 2-4.
REVIEW AND ANALYSIS OF 2008 HAZARD MITIGATION PLAN**

2008 PDM Sections	How Reviewed and Analyzed
Section 1—Introduction and Purpose	Reviewed existing section through discussion at public meeting. No analysis needed.
Section 2—Planning Process	Reviewed and analyzed existing section through discussion at public meeting. Planning process expanded by utilizing project website and scoring hazards using Calculated Priority Risk Index.
Section 3—Hazard Identification and Vulnerability Analysis	Reviewed and analyzed existing section through discussion during public meeting and Planning Partner conference calls. Reviewed and updated hazards, critical facilities and vulnerable populations. Updated section with recent hazard data.
Section 4—Critical Facilities and Infrastructure	CIKR data was reviewed and planning partners were asked to update the data for the 2015 edition. This information, when completed, will be incorporated into the CDMS layer for the Hazus model, and utilized during the risk assessment portion of the planning effort.
Section 5—Mitigation Initiatives	Reviewed by planning partners during conference calls, public meeting and subsequent mitigation workshop. New projects developed, existing projects re-worded and/or deleted, completed projects documented.
Section 6—Plan Maintenance	Reviewed and analyzed existing section through discussion during Planning Partner conference calls. Determined that plan maintenance procedures outlined in previous plan had not been implemented.

The Town of Coupeville discussed the mitigation planning process during its regularly scheduled meetings at the onset of the process and again in greater detail at the December council meeting, where the Mayor displayed maps and discussed the risk assessment in greater detail, inviting public input and comments.

In addition to presentations by the Mayor at Council Study Sessions and Council Meetings, the City of Langley used its Mayor's mailing list to distribute information concerning the mitigation planning effort and the survey to ~450 individuals throughout the City.

The Fire Chief for the City of Oak Harbor discussed the hazard mitigation planning effort several times by providing Council updates of events occurring and the risk associated with the hazards of concern, and by seeking input from department heads in the development of mitigation strategies during council meetings.

Once the draft plan was completed, the public was invited to provide comments on the hazard mitigation plan. The draft plan was posted on the project website and stakeholders were notified through press releases and e-mail messages of its availability. Planning partners also provided notification of the plan's availability for review during their council and commission meetings, advising citizens of the plan's availability on the website. The City of Langley used the Mayor's mailing list, advising residents of the plan's availability. Notice was distributed through the County's Facebook account and discussed at the Sound Water's presentation on February 2. The review period remained open for 30 days. Once the review period closed, final comments were addressed and the plan was submitted to FEMA for review. Once pre-adoption approval was received from FEMA, the plan was provided to the Island County Commissioners and the incorporated communities for adoption. After adoption, final copies of the plan were submitted to the Washington State Department of Emergency Management and FEMA.

Future comments on the plan should be addressed to:

Island County Office of Emergency Management
P.O. Box 5000
Coupeville, WA 98239
Office: 360-240-5572

2.7 PLAN DEVELOPMENT MILESTONES

Table 2-5 summarizes important milestones in the development of the Island County Multi-Jurisdiction Hazard Mitigation Plan.

**TABLE 2-5.
PLAN DEVELOPMENT MILESTONES**

Date	Event	Description	Attendance
2012			
2012	Submit grant application	Seek funding for plan development process	N/A
2013	Receive notice of grant award	Funding secured.	N/A
2013			
05/01	Initiate consultant procurement	Seek a planning expert to facilitate the process	N/A
05/22	Select Bridgeview Consulting and Tetra Tech to facilitate plan development	Facilitation contractor secured	N/A
08/15	Begin process of contract development		

TABLE 2-5.
PLAN DEVELOPMENT MILESTONES

Date	Event	Description	Attendance
2014			
04/15	Begin identifying planning team members	Begin formation of the planning team; Consultant begins review of various documentation	N/A
6/30	Identify planning team	Formation of the planning team and core project management team. Continue review of existing plan and existing documentation supporting effort (e.g., studies, other planning documents, etc.)	N/A
8/12	Planning meeting	Presentation on plan process, hazards, goals, objectives and public outreach strategy. Review of 2008 plan. General plan template discussed. Discussed hazards to be addressed in plan update; discussed methodology which would be used to conduct the analysis. Hazards to be addressed confirmed; it was determined that the list would be expanded to include some of the technological and human-caused hazards to allow for easier integration of THIRA process. Discussed public presentation of hazard maps at September/October Safety Fair. Goals and objectives were confirmed.	10
10/4	Public Outreach	Safety Fair—deployed survey both via web and hard copies. Surveys distributed during Safety Fair. Presentation of initial hazard information and maps presented during event.	+200
11/7	Public Outreach	Safety Fair at Whidbey General Hospital. Provided survey information, discussed hazards of concern, presented information on the development of the Hospital District's annex to the hazard mitigation plan.	50
12/2	Public Outreach	A day long emergency management workshop was held for all public officials throughout Island County. Representatives from each jurisdiction were invited to attend, as well as press releases announcing the meeting, which invited the public to attend. Presentation information included emergency management practices, the ICS/NIMS structure, discussions on public information dissemination (PIO) and the update to the hazard mitigation plan, including presentation of risk data (loss tables) and the various hazard maps	50
12/9/	Public Outreach	Town of Coupeville Council Meeting – Mayor re-introduced process and risk maps. Advised of planning process and Town's dedication to complete process. Discussed survey and provided points of contact for questions. This is a televised council meeting.	Televised
2015			
1/13	Planning Team Meeting	Risk ranking exercise completed and confirmed; strategy/action items reviewed and discussed; incorporation of risk data into other planning mechanisms discussed (e.g., land use, CEMP, evacuation plans, etc.)	18
2/15	Draft Plan Internal Review	Draft provided by planning team to Planning Team (additional strategies added during review process)	All
3/15	Public Review	Draft provided on website with press releases inviting citizens to review and comment for 30 day periods	All

CHAPTER 3.
COMMUNITY PROFILE

This section of the hazard mitigation plan presents an overview of Island County, the incorporated communities of Coupeville, Langley and Oak Harbor and unincorporated areas of the County. It provides baseline information on the characteristics of the county, the communities, economy and land use patterns, and presents the backdrop for this mitigation planning process.

The planning area for this hazard mitigation plan is defined as all incorporated and unincorporated areas of Island County. All partners to this plan have jurisdictional authority within their defined planning areas.

3.1 PHYSICAL SETTING

Island County, in northwest Washington, consists of 212 square miles on two large islands (Whidbey and Camano) and several much smaller islands (Baby, Ben Ure, Deception, Smith, Minor and Kalamut) in Puget Sound. At low tide, Minor Island appears as an extension of Smith Island and Kalamut is actually a submerged sandbar just east of Maylor Point in Crescent Harbor, Whidbey Island (Island County Hazard Identification and Vulnerability Assessment, 2006). Whidbey and Camano Islands make up the majority of the land area. Ben Ure has only 19 residential lots; the other islands are uninhabited.

Island County has three incorporated towns, all on Whidbey Island: Coupeville, Langley, and Oak Harbor. The county has numerous special districts, such as a hospital district, fire protection districts, dike and drainage districts, and others. Coupeville is the county seat.

Both Whidbey and Camano have flat to rolling terrain of mixed forest and farmland. There are several areas of significant floodplain that lie at sea level. High unstable banks and bluffs mark other coastal areas of both islands. Except in the vicinity of towns, other small residential areas, and along the few major roads, a large portion of Island County is agricultural land or second and third growth timber and brush. While there are no rivers in Island County, there are several small streams. On the south end of Whidbey Island are Glendale and Maxwelton Creeks. On Camano Island are Kristofferson, Carp, and Cavalero Creeks. The flow rates of these streams range from 1 to 2 cubic feet per second (cfs) in winter and less than 1 cfs in summer. Whidbey and Camano Islands have several small pothole lakes.

Island County is the second smallest county in Washington by landmass, just larger than neighboring San Juan County. The counties contiguous to Island County are Skagit County to the north and east and Snohomish County to the south and east. Jefferson County lies across the waters of Admiralty Inlet and Admiralty Bay on the west. Population density on Island County consists of 382.35 people per square mile, the fifth most densely populated county in Washington (U.S. Census Quick Facts, 2013).

Whidbey Island is approximately 50 highway miles long with an irregular coastline. Camano Island is approximately 17 road miles long, also with an extensive shoreline. Whidbey and Camano Islands lie adjacent to each other, separated by the Saratoga Passage of Puget Sound. The only major north-south road on Whidbey Island is State Highway 20. Highway 20 is a two-lane highway that connects Whidbey Island to Fidalgo Island and the mainland by bridge on the north at Deception Pass. The bridge is the main freight route to and from the island. Highway 20 ends on the island’s west coast at the Washington State Ferry terminal at Keystone near Fort Casey. This route connects to Port Townsend on the Olympic Peninsula. State Route 525 continues south to the Washington State Ferry terminal at Clinton. This route connects Whidbey to the mainland at Mukilteo. Camano Island has one two-lane road, State Route 532 connecting its northeast coast by bridge to the mainland in the vicinity of Stanwood. There is no other bridge or ferry access to the Camano. Oak Harbor on Whidbey Island has commuter airline access to Seattle and other Puget Sound destinations by means of a commercial floatplane service. There are five airfields on Whidbey Island including two military (Navy) and three private or commercial. Four of the airfields are on Whidbey Island and one is on northern Camano Island.

3.2 CLIMATE

Western Washington has a milder climate than any other region in the United States that is located as far north. Moist winds from the Pacific Ocean bring large amounts of precipitation to Western Washington. Island County at the east end of the Strait of Juan De Fuca is exposed to the marine air that blows through the strait, but is still in the rain shadow of the Olympic Peninsula. The surrounding waters have a moderating effect on temperatures in both summer and winter. Snow does not normally accumulate or remain on the ground long if it does. Prevailing wind direction varies with the season. Late autumn, winter, and early spring winds are generally southeasterly. The prevailing winds at Ault Field (at Naval Air Station Whidbey Island) from October through March are southeasterly at 10 to 12 knots. Frontal winds from that direction can be strong, often reaching gale force (34-47 knots). Stronger gusts do occasionally occur. Table 3-1 summarizes local climate data.

TABLE 3-1.
CLIMATE STATISTICS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Whidbey Island Naval Air Station													
Average Max. Temperature (F)	45	48	50	54	58	62	66	65	64	57	50	45	
Average Min. Temperature (F)	35	36	37	41	45	50	51	51	48	43	39	35	-
Warmest on Record (F)	65	70	72	78	82	93	86	88	88	75	69	62	-
Coldest on Record (F)	-1	6	16	28	32	37	41	39	29	22	9	3	-
Average Total Precipitation (in)	2.6	1.7	1.2	2.08	2.01	1.4	0.6	0.6	1.	2.	2.7	1.76	-
Coupeville (11/1/1895 to 2/28/2013)													
Average Max. Temperature (F)	44.4	48.1	51.9	57.3	62.7	67.2	71.7	72.0	67.0	58.3	49.9	45.5	58.0
Average Min. Temperature (F)	34.2	35.1	36.9	40.1	44.5	48.3	50.6	50.6	47.2	42.8	38.2	35.7	42.0
Average Total Precipitation (in.)	2.36	1.73	1.84	1.57	1.56	1.26	0.74	0.85	1.28	1.77	2.56	2.69	20.22
Average Total Snow Fall (in.)	2.5	1.2	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.9	6.1
Average Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	0

Sources:
http://www.homefacts.com/weather/Washington/Island-County/Whidbey-Island-Station.html, Accessed September 9, 2014
Western Regional Climate Center DRI http://www.wrcc.dri.edu/summary/Climsmwa.html, Accessed Sept. 9, 2014

3.3 MAJOR PAST HAZARD EVENTS

Major hazard events are often identified by federal disaster declarations, which are issued for hazard events that cause more damage than state and local governments can handle without assistance. FEMA categorizes disaster declarations as one of three types (FEMA, 2012a):

- **Presidential major disaster declaration**—Major disasters are hurricanes, earthquakes, floods, tornados or major fires that the President determines warrant supplemental federal aid. The event must be clearly more than state or local governments can handle alone. Funding comes from the President's Disaster Relief Fund, managed by FEMA and disaster aid programs of other participating federal agencies. A presidential major disaster declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, to help disaster victims, businesses and public entities.

- **Emergency declaration**—An emergency declaration is more limited in scope and without the long-term federal recovery programs of a presidential major disaster declaration. Generally, federal assistance and funding are provided to meet a specific emergency need or to help prevent a major disaster from occurring.
- **Fire management assistance declaration** (44 CFR 204.21)—FEMA approves declarations for fire management assistance when a fire constitutes a major disaster, based on the following criteria:
  - Threat to lives and improved property, including threats to critical facilities and critical watershed areas
  - Availability of state and local firefighting resources
  - High fire danger conditions, as indicated by nationally accepted indices such as the National Fire Danger Ratings System
  - Potential major economic impact.

Since 1956, 11 federal disaster declarations have affected Island County, as listed in Table 3-2 (FEMA, 2012b). Review of these events helps identify targets for risk reduction and ways to increase a community's capability to avoid large-scale events in the future. Still, many natural hazard events do not trigger federal disaster declaration protocol but have significant impacts on their communities. These events are also important to consider in establishing recurrence intervals for hazards of concern.

Figure 3-1 (SHELDUS, 2012) shows total hazard event economic dollar losses statewide per county for 1960 through 2009. Island County is classified among counties sustaining the second lowest losses to damages.

TABLE 3-2.
DISASTER DECLARATIONS FOR HAZARD EVENTS IN ISLAND COUNTY

Disaster Information				Municipalities				Special Purpose Districts							
Federal Disaster #	Disaster Type	Declaration Date	Incident Date	Unincorporated County	City of Langley	City of Oak Harbor	Town of Coupeville	Port of South Whidbey	Port of Coupeville	Camano Island Fire & Rescue	Central Whidbey Fire & Rescue	South Whidbey Fire & Rescue	Whidbey General Hospital	Total Number Impacted by Disaster	Losses
PRESIDENTIAL DECLARED EVENTS															
623	Volcano	5/21/1980	5/21/1980	X											
883	Flood	11/26/1990	11/9 – 12/20/1990	X											$2.9* M
896	Flood	3/8/1991	12/20 – 12/31/1990	X											$5.1 M all 10 counties
1079	Severe Storm	1/3/1996	11/7 – 12/18/1995	X											
1159	Severe Storm	1/17/1997	12/26/1996 – 2/10/1997	X			X								~$140*M
1361	Earthquake	3/1/2001	2/28 – 3/16/2001	X											
1499	Severe Storm	11/7/2003	10/15 – 10/23/2003	X			X								~$15* M
3227	Coastal Storm	9/7/2005	8/29 – 10/1/2005	X											
1641	Severe Storm	5/17/2006	1/27 – 2/4/2006	X		X	X								OH: $78,228
1682	Severe Storm	2/14/2007	12/14 – 12/15/2006	X		X	X								OH: $17,767
1825	Severe Storm	3/2/2009	12/12/2008 – 1/5/2009	X			X								PA >$5.5* M
EMERGENCY PROCLAMATIONS															
EM C-24-99	Beach Erosion/ Seawall Failure	3/10/1999		X											
Oak Harbor	Severe Storm	12/2006		X		X	X								$110,000
C01-11	Flooding (Glendale Basin)	1/4/2011		X											

TABLE 3-2.
DISASTER DECLARATIONS FOR HAZARD EVENTS IN ISLAND COUNTY

Disaster Information				Municipalities				Special Purpose Districts							
Federal Disaster #	Disaster Type	Declaration Date	Incident Date	Unincorporated County	City of Langley	City of Oak Harbor	Town of Coupeville	Port of South Whidbey	Port of Coupeville	Camano Island Fire & Rescue	Central Whidbey Fire & Rescue	South Whidbey Fire & Rescue	Whidbey General Hospital	Total Number Impacted by Disaster	Losses
C-33-11 and C-34-11 Langley Dec. (not included in County)	Landslide	3/22/2011		X	X										~$50,000 City of Langley for cleanup costs, plantings, etc.
C-62-11	Landslide (Camano Island)	5/25/2011		X											
C-24-12	Landslide/ Slope Instability (Camano Island)	3/12/2012		X											
C-28-13	Landslide (Whidbey)	3/27/2013		X											~$6.7 Million

*=Statewide Losses, no County Specific data available
Oak Harbor = Dollar Loss
Coupeville – No Dollar Losses Available

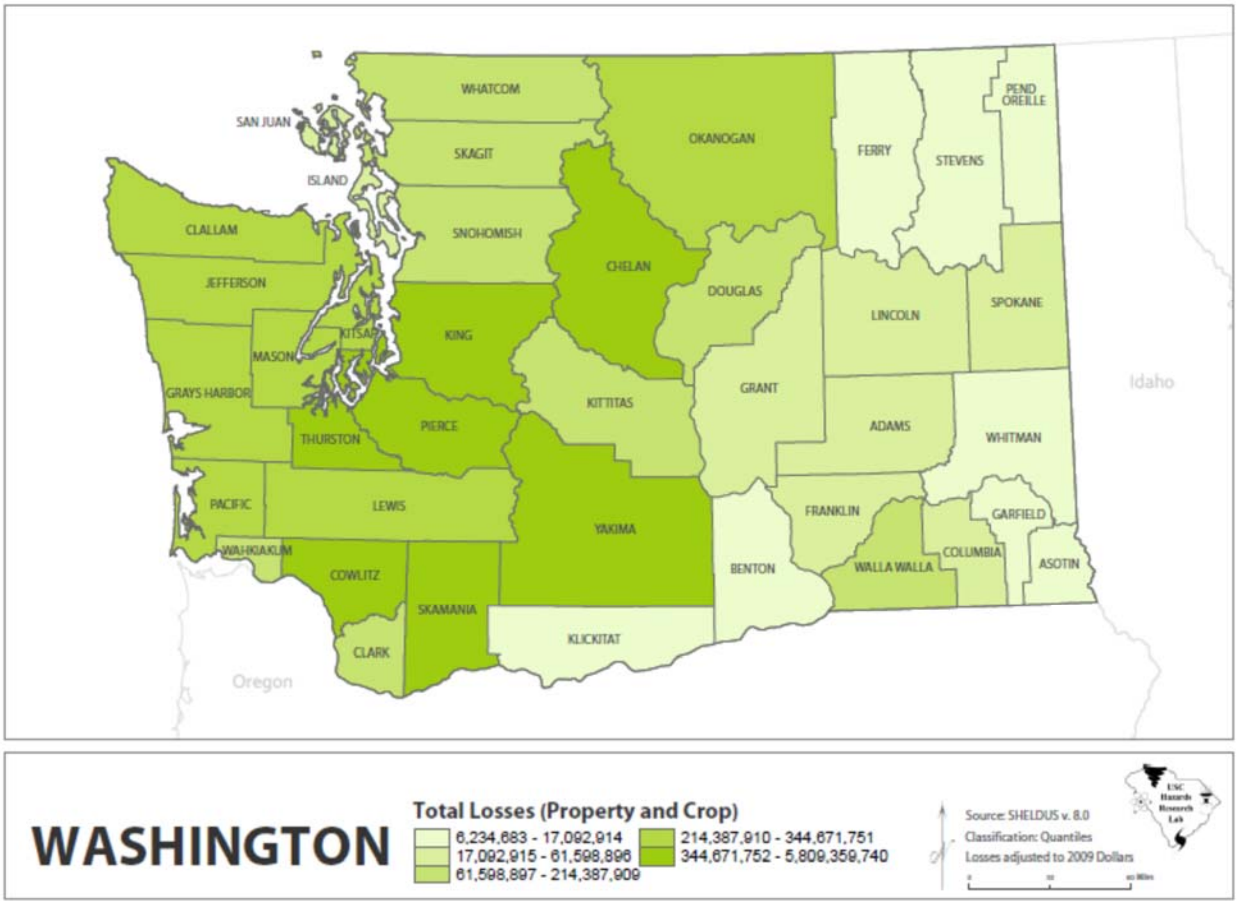


Figure 3-1. Washington Statewide Economic Losses from Hazard Events, 1960—2009

3.4 CRITICAL FACILITIES AND INFRASTRUCTURE

3.4.1 Definition

Critical facilities and infrastructure are those that are essential to the health and welfare of the population. These become especially important after a hazard event. Critical facilities typically include police and fire stations, schools and emergency operations centers. Critical infrastructure can include the roads and bridges that provide ingress and egress and allow emergency vehicles access to those in need, and the utilities that provide water, electricity and communication services to the community. Also included are "Tier II" facilities and railroads, which hold or carry significant amounts of hazardous materials with a potential to impact public health and welfare in a hazard event.

For purposes of this planning effort, the Planning Team reviewed the County's 2008 definition of critical facilities and, during the August 2014 meeting, elected to expand the definition as follows:

> A critical facility is vital to the jurisdictions' ability to provide essential services and protect life and property. Loss of a critical facility would result in a severe economic or catastrophic impact. Under the Island County hazard mitigation plan definition, critical facilities will be expanded to include the following:

- Police stations, fire stations, vehicle and equipment storage facilities, communication centers and towers, and emergency operations centers needed for disaster response before, during, and after hazard events
- Public and private utilities and infrastructure vital to maintaining or restoring normal services to areas damaged by hazard events. These include, but are not limited to:
  - Public and private water supply infrastructure, water and wastewater treatment facilities and infrastructure, potable water pumping, flow regulation, distribution and storage facilities and infrastructure. As Island County has a large number of water companies and water providers, only the 25 largest water systems are identified (this factor takes into account the 2008 hazard mitigation plan calling for refinement due to the large number of structures in place)
  - Public and private power generation (electrical and non-electrical), regulation and distribution facilities and infrastructure
  - Data and server communication facilities
  - Structures that manage or limit the impacts of natural hazards such as regional flood conveyance systems, potable water trunk main interconnect systems and redundant pipes crossing fault lines and reservoirs
  - Major road and rail systems including bridges, airports and marine terminal facilities
- Hospitals, nursing homes, and care facilities, including facilities that provide critical medical services
- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic, and/or water-reactive materials (e.g., hazmat facilities)
- Public gathering places that could be used as evacuation centers during large-scale disasters
- Governmental facilities central to governance and quality of life along with response and recovery actions taken as a result of a hazard event.

3.4.2 Comprehensive Data Management System Update

The planning partners determined that it would be prudent to use the new definition of critical facility in updating the list of critical facilities for this edition's risk assessment. This process included an update of the database contained in FEMA's Hazus software (a hazard-modeling program). Concurrent with this planning process, FEMA was updating flood maps and Hazus data for the County. FEMA data provided to the County in September 2014 was incorporated into the Comprehensive Data Management System (CDMS) update and joined with the critical facilities data gathered by the Planning Team. When both data sets were completed, the County provided the data to FEMA for use in future Hazus updates and in the flood study and flood map update currently underway. All critical infrastructure data and much of the assessor's data for the county has therefore been updated with the most current data available as of September 2014. Limitations associated with the updated CDMS data and the FEMA dataset are discussed in Section 4.1.3.

All critical facilities identified are incorporated into this planning process; however, due to the sensitivity of this information, a detailed list of facilities is not provided. The list is on file with each planning partner. Table 3-3 and Table 3-4 provide summaries of the general types of critical facilities and infrastructure, respectively, in each municipality and unincorporated county areas. All critical facilities and infrastructure were analyzed in Hazus to help rank risk and identify mitigation actions. The risk assessment for each hazard qualitatively discusses critical facilities with regard to that hazard.

TABLE 3-3.
ISLAND COUNTY CRITICAL FACILITIES

Jurisdiction	Medical and Health	Government Functions	Protective Functions	Schools	Hazmat	Other*	Total
Coupeville	7	3	5	3	8	2	28
Langley	0	1	2	2	0	0	5
Oak Harbor	1	3	4	14	28	3	53
Unincorporated	4	9	23	9	64	15	124
Total	12	16	34	28	100	20	210

*Other critical facilities are shelters, buses, and airports

TABLE 3-4.
ISLAND COUNTY CRITICAL INFRASTRUCTURE

Jurisdiction	Bridges	Water Supply	Wastewater	Power	Communications	Other*	Total
Coupeville	0	1	1	0	1	0	3
Langley	0	1	1	1	0	0	3
Oak Harbor	0	3	0	2	2	3	10
Unincorporated	6	0	6	10	10	5	37
Total	6	5	8	13	13	8	53

* Other critical infrastructure types are dams and ferries

In addition to items listed in the tables, the area is also home to five airfields and two heliports, including two Navy and three private or commercial airfields, the Whidbey General Hospital Heliport and the Barnes Lonesome Polecat Ranch Heliport (http://www.tollfreeairline.com/washington.htm). Four of the airfields are on Whidbey Island and one is on northern Camano Island. Oak Harbor Air Park on Whidbey Island has a commuter airline, with access to Puget Sound destinations.

3.5 POPULATION

Some populations are at greater risk from hazard events because of decreased resources or physical abilities. Elderly people, for example, may be more likely to require additional assistance. Research has shown that people living near or below the poverty line, the elderly (especially older single men), the disabled, women, children, ethnic minorities and renters all experience, to some degree, more severe effects from disasters than the general population. These vulnerable populations may vary from the general population in risk perception, living conditions, access to information before, during and after a hazard event, capabilities during an event, and access to resources for post-disaster recovery. Indicators of vulnerability—such as disability, age, poverty, and minority race and ethnicity—often overlap spatially and often in the geographically most vulnerable locations. Detailed spatial analysis to locate areas where there are higher concentrations of vulnerable community members would assist the County in extending focused public outreach and education to these most vulnerable citizens.

Knowledge of the composition of the population and how it has changed and may change in the future is needed for making informed planning decisions. Information about population is a critical part of planning because it directly relates to land needs such as housing, industry, stores, public facilities and services, and transportation. As of 2013, Island County is the 15th most populous county in Washington, with 79,700 residents, and the 5th most densely populated, with 382.35 residents per square mile. The average number of persons per household in Island County was 2.32 (2008-2012), according to the U.S. Census Bureau, compared to 2.52 in Washington state. Table 3-5 presents Island County 2013 populations by jurisdiction.

TABLE 3-5.
ISLAND COUNTY 2013 POPULATION BY JURISDICTION

Place	2013 Population
Coupeville	1,890
Langley	1,065
Oak Harbor	22,080
Unincorporated	54,665
Total	**79,700**

Source: U.S. Census Bureau, 2013

3.5.1 Population Trends

Population changes are useful socio-economic indicators. A growing population generally indicates a growing economy, while a decreasing population signifies economic decline. Table 3-6 lists population trends in Island County compared to the State of Washington and United States. The state has seen higher growth rates than the county over that period, but the trends of accelerating and decelerating growth have been generally the same for both. Table 3-7 presents population statistics for the incorporated communities in Island County and the Census Designated Places (CDP). The Washington State Office of Financial Management (OFM) updates county and state long-range population forecasts every five years to support Growth Management Act planning (discussed in Section 3.8.2). The most recent forecasts, which project out to 2040, were issued in May 2012 and are shown in Figure 3-2. OFM considers the medium projection the most likely (RCW 43.62.035) because it is based on assumptions that have been validated with past and current information. The high and low projections represent the range of uncertainty that should be considered when using these projections for planning. The following issues related to County population and potential growth are relevant to this plan (Island County Planning and Community Development, 2014):

- Island County's growth rate has decreased in every period since 1980.
- The median age of Island County is higher than the state median and is increasing faster. This increase will limit future population growth resulting from natural increase.
- In many Island County planning areas, population growth was previously driven by in-migration of working age people who commuted to jobs on the mainland. Increasing transportation costs, transportation capacity constraints, and changing consumer housing preferences may negatively impact future in-migration of commuters.
- The in-migration of retirees which has historically been a significant component of Island County's population growth will continue, but at an uncertain rate.
- Island County's 1998 and 2005 population projections significantly overestimated future population growth.

TABLE 3-6.
COUNTY, STATE AND NATIONAL POPULATION TRENDS

Year	Island County Population	% change from previous census	State of Washington Population	% change from previous census	United States Population	% change from previous census
2013	79,700	1.52%	6,882,400	2.35%	316,148,990	2.40%
2010	78,506	10.7%	6,724,540	14.1%	308,745,538	9%
2000	71,558	18.9%	5,894,121	21.1%	281,424,602	12%
1990	60,195	36.7%	4,866,692	17.8%	248,709,873	9%
1980	44,048	63.1%	4,132,156	21.2%	226,542,199	10%
1970	27,011	37.5%	3,409,169	19.5%	203,302,031	12%

Source: U.S. Census Bureau, 2013

TABLE 3-7.
ISLAND COUNTY POPULATION TRENDS—CITIES AND CENSUS DESIGNATED PLACES

City or CDP	1970	1980	% Change Since Last Census	1990	% Change Since Last Census	2000	% Change Since Last Census	2010	% Change Since Last Census
Ault Field CDP	—	—	—	—	—	2,064	—	—	—
Camano CDP	—	—	—	—	—	13,347	—	—	—
Clinton CDP	—	—	—	—	—	868	—	928	6.9%
Coupeville, town	678	1,006	48.4%	1,377	36.9%	1,723	25.1%	1,831	6.3%
Freeland CDP	—	—	—	—	—	1,313	—	2,045	55.7%
Langley, city	547	654	20%	845	15%	986	16%	1,035	5.0%
Oak Harbor, city	9,167	12,271	33.9%	17,176	40.0%	19,795	15.2%	22,075	11.5%

Notes:

CDP = Census Designated Place

— = data not available

Changes in Place population between years may be due to population growth or decline, due to significant boundary changes, or a combination of factors.

Source: U.S. Census Bureau, 2013

Source: OFM, 2012c

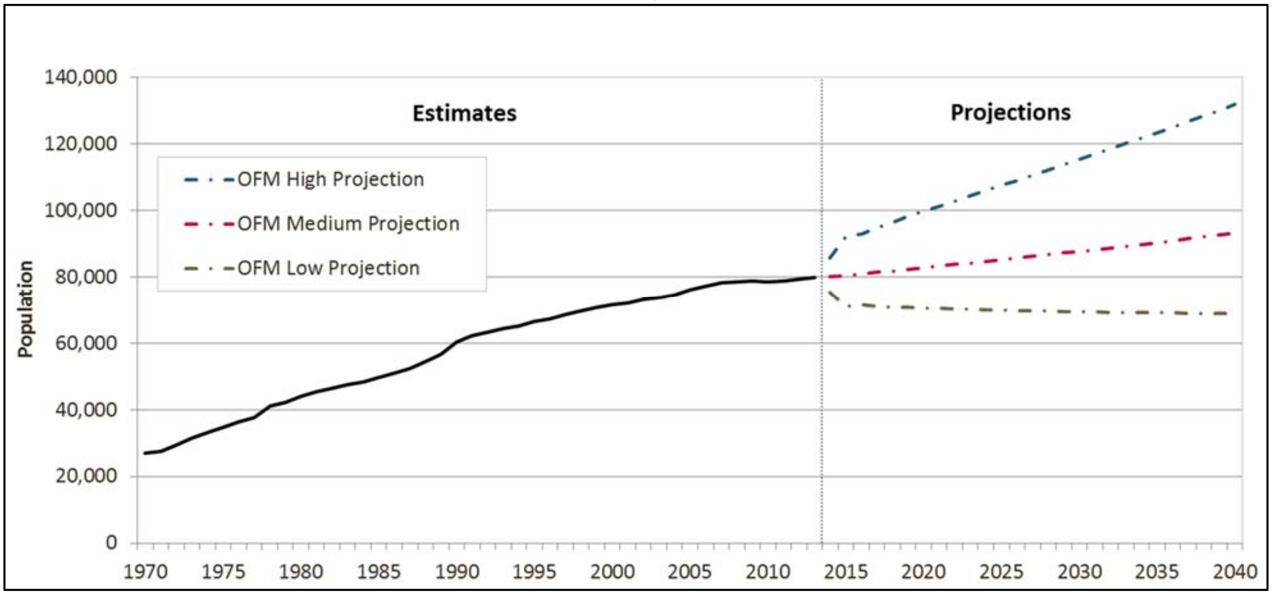


Figure 3-2. Island County Population Trends and Projections, 1970-2040

3.5.2 Age Distribution

As a group, the elderly are more apt to lack the physical and economic resources necessary for response to hazard events and are more likely to suffer health-related consequences making recovery slower. They are more likely to be vision, hearing, and/or mobility impaired, and more likely to experience mental impairment or dementia. Additionally, the elderly are more likely to live in assisted-living facilities where emergency preparedness occurs at the discretion of facility operators. These facilities are typically identified as “critical facilities” by emergency managers because they require extra notice to implement evacuation. Elderly residents living in their own homes may have more difficulty evacuating their homes and could be stranded in dangerous situations. This population group is more likely to need special medical attention, which may not be readily available during natural disasters due to isolation caused by the event. Specific planning attention for the elderly is an important consideration given the current aging of the American population.

Children under 14 are particularly vulnerable to disaster events because of their young age and dependence on others for basic necessities. Very young children may additionally be vulnerable to injury or sickness; this vulnerability can be worsened during a natural disaster because they may not understand the measures that need to be taken to protect themselves from hazards.

Based on U.S. Census estimates, 20.3 percent of Island County’s population as of 2012 is 65 or older, compared to the state average of 13.2 percent. Of the county’s over-65 population, 3.3 percent have incomes below the poverty line. It is also estimated that 5.6 percent of the county’s population is 5 or younger, compared to the state average of 6.4 percent and 19.6 percent of the county’s population is 18 or younger, compared to the state average of 23.0 percent. Children under 18 account for 13.1 percent of individuals who are below the poverty line (U.S. Census Bureau’s American Community Survey). Figure 3-3 identifies vulnerable populations under 5 years of age and those 65 years of age or older.

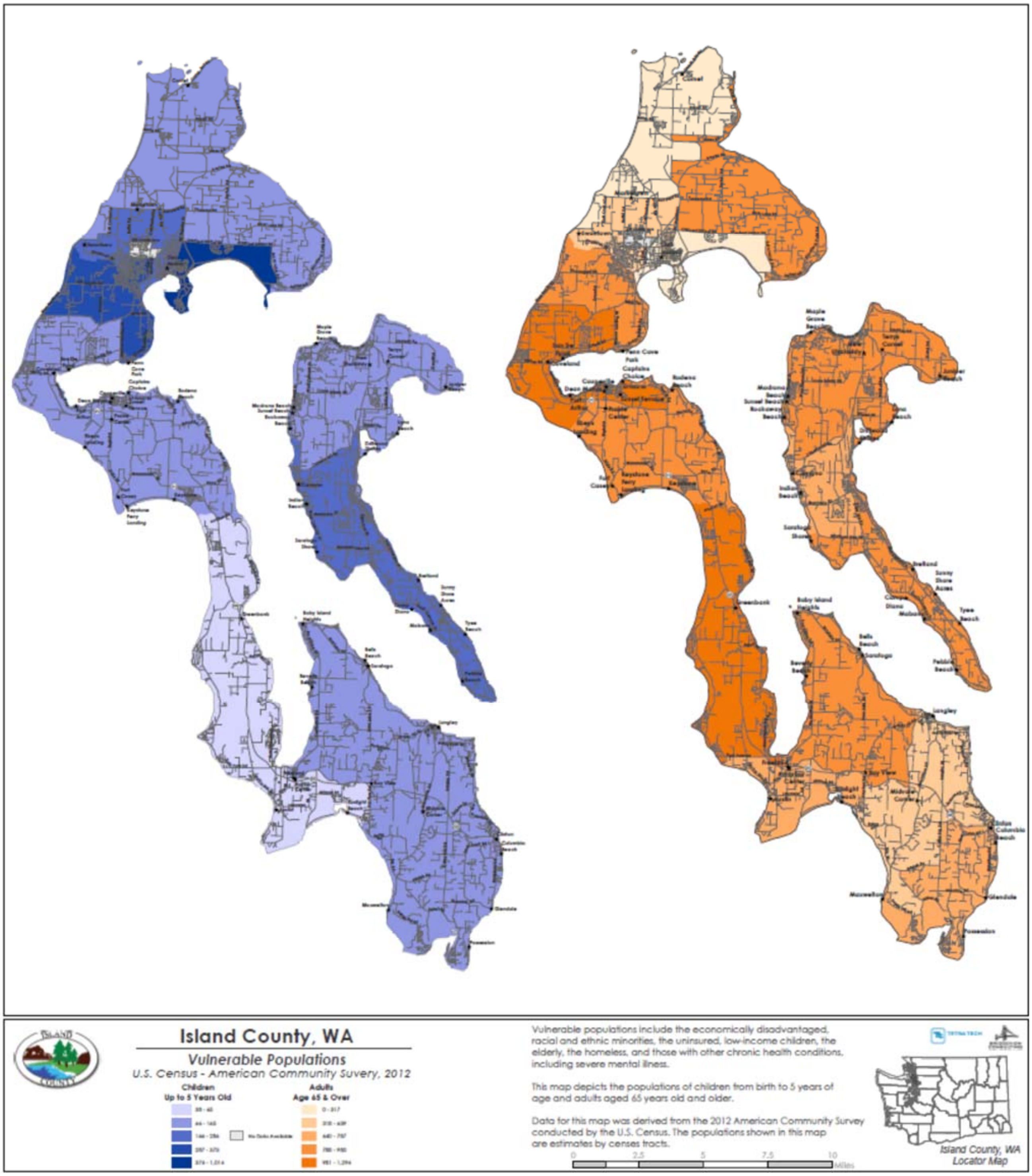


Figure 3-3. Vulnerable Populations - Under 5 and Over 65 Years

3.5.3 Race, Ethnicity and Language

Research shows that minorities are less likely to be involved in pre-disaster planning and experience higher mortality rates during a disaster event. Post-disaster recovery can be ineffective and is often characterized by cultural insensitivity. Since higher proportions of ethnic minorities live below the poverty line than the majority white population, poverty can compound vulnerability.

According to the 2012 U.S. Census Bureau's QuickFacts, the racial composition of Island County is predominantly white, at about 86.9 percent, compared to 81.6 percent at the state level. The largest minority population is Hispanic or Latino, with 6.2 percent in Island County, compared to 8.4 percent statewide. The Asian, Native Hawaiian or other Pacific Islander population is 5.2 percent of the county total versus 8.4 percent for the state.

3.5.4 Disabled Populations

People with disabilities are more likely than the general population to have difficulty responding to a hazard event. As disabled populations are increasingly integrated into society, they are more likely to require assistance during the 72 hours after a hazard event, the period generally reserved for self-help. There is no "typical" disabled person, which can complicate disaster-planning processes that attempt to incorporate them. Disability is likely to be compounded with other vulnerabilities, such as age, economic disadvantage and ethnicity, all of which mean that housing is more likely to be substandard.

According to U.S. Census Bureau 2008-2012 American Community Survey (ACS) data, 13.1 percent of the county's population has a disability. The 0 to 17 age group has a 3.9 percent disability rate, or an estimated 631 individuals. The age 65 and older group has a 28.4 percent disability rate or an estimated 4,100 individuals.

3.6 ECONOMY

3.6.1 Income

In the United States, individual households are expected to use private resources to prepare for, respond to and recover from disasters to some extent. This means that households living in poverty are automatically disadvantaged when confronting hazards. Additionally, the poor typically occupy more poorly built and inadequately maintained housing. Mobile or modular homes, for example, are more susceptible to damage in earthquakes and floods than other types of housing. In urban areas, the poor often live in older houses and apartment complexes, which are more likely to be made of un-reinforced masonry, a building type that is particularly susceptible to damage during earthquakes. Furthermore, residents below the poverty level are less likely to have insurance to compensate for losses incurred from natural disasters. This means that residents below the poverty level have a great deal to lose during an event and are the least prepared to deal with potential losses. Personal household economics also significantly impact people's decisions on evacuation. Individuals who cannot afford gas for their cars will likely decide not to evacuate.

Based on ACS estimates, per capita income in Island County was $30,601 in 2012 compared with $30,661 for Washington State. The median household income was $59,500 in Island County and $59,374 in the state. It is estimated that 8.8 percent of the population in Island County lives below the poverty level compared to 12.9 percent in Washington state.

3.6.2 Housing Stock

According to *A Social Vulnerability Index for Disaster Management* (Journal of Homeland Security and Emergency Management, 2011), housing quality is an important factor in assessing disaster vulnerability. It is closely tied to personal wealth: poor people often live in more poorly constructed homes that are especially vulnerable to strong storms or earthquakes. Mobile homes are not designed to withstand severe weather or flooding and typically do not have basements. They are frequently found outside of metropolitan areas and, therefore, may not be readily accessible by interstate highways or public transportation. Also, because mobile homes are often clustered in communities, their overall vulnerability is increased. The American Community Survey estimates that Island County has in excess of 3,600 mobile homes within its boundaries. The 2008-2012 ACS estimates that Island County had 40,084 housing units, with a median value of $301,200. A further breakdown of the housing units from the census is presented in Table 3-8.

TABLE 3-8.
ISLAND COUNTY HOUSING DATA

	Island County	Coupeville	Langley	Oak Harbor
Total Number of Housing Units	40,084	926	610	9,744
Median Value of Housing Units	$301,200	$268,500	$375,000	$230,000
Year Structure Built				
2010 or later	307	0	18	102
2000 to 2009	6,934	126	86	1,996
1990 to 1999	8,159	154	99	1,459
1980 to 1989	7,436	137	99	2,211
1970 to 1979	8,344	219	83	2,151
1960 to 1969	3,049	67	84	750
1950 to 1959	2,864	119	31	827
1940 to 1949	1,191	39	42	56
1939 or earlier	1,902	65	68	192

3.6.3 Industry and Employment

Settlement by non-indigenous people in Island County began in the 1850s. Agriculture began with wheat, oats, potatoes and sheep ranching. Logging began with oak and fir trees that were used for ship decking and ship masts, respectively.

In 1941, the U.S. Navy started construction on an airbase, which transformed Oak Harbor into a booming community due to the creation of construction jobs and influx of Navy personnel. Naval Air Station Whidbey Island remains a strong economic stabilizing force in Whidbey Island. The Naval Air Station has also brought many highly skilled workers to Whidbey Island. There is not a strong economic base to provide sufficient employment for the spouses and dependents of those workers, so commuting to nearby counties provides a relief valve for residents seeking jobs. 2012 estimates for uniformed military jobs associated with Naval Air Station Whidbey estimate 7,300 uniformed military personnel. Estimations for 2014 forward from Naval Air Station Whidbey indicate that they will add seven squadrons over the next 20-year planning period, potentially adding an additional 2,530 people to the region to account for this military expansion. Nonfarm and covered employment estimates do not include military employment figures. However, given that Island County's largest employer is the military, the success of other industries is highly dependent on the employment situation at the naval air base.

Total nonfarm employment averaged 15,260 in 2012. Nearly 30 percent of all jobs in Island County were government jobs—especially local government. For the most part, local government jobs tend to be related to K-12 education. Retail trade accounted for nearly 14 percent of Island County employment. Goods producing industries, which are predominantly construction and manufacturing, made up only 9 percent of all non-military-related jobs in Island County.

Government employment makes up the largest part of the economy, including federal, state, county, city, and public schools. Retired persons make up a growing portion of the population, as do commuters who work in Skagit, Whatcom, Snohomish, Clallam and King Counties. A commercial mussel-farming operation in Penn Cove has become a significant economic factor in the Coupeville area, as has a growing boat building business at Freeland. Estimated tourism income is slightly over $31,000 daily (ERC Contract Source Report No. C040018—Socioeconomic Costs Phase II). Current NAICS industry groups during 2002-2011 are identified in Figure 3-4.

NAICS	Industry	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
11, 21-22	Resources and Utilities	5.1%	1.0%	1.6%	1.1%	1.1%	1.0%	1.4%	1.1%	1.1%	2.0%
23	Construction	6.5%	6.7%	7.1%	7.6%	8.2%	8.6%	7.6%	5.7%	4.8%	4.2%
31-33	Manufacturing	4.1%	4.2%	4.4%	4.1%	4.4%	4.0%	3.7%	3.8%	4.2%	4.2%
42	Wholesale Trade	1.2%	1.1%	1.1%	1.2%	1.1%	1.1%	1.1%	1.0%	0.9%	1.0%
44-45	Retail Trade	15.1%	15.1%	15.0%	15.9%	15.5%	15.6%	15.1%	14.7%	14.2%	13.9%
48-49	Transportation and Warehousing	0.5%	0.8%	1.2%	1.0%	1.0%	1.0%	1.0%	1.1%	1.3%	1.3%
62	Health Care Services	8.0%	7.8%	8.0%	8.4%	8.3%	8.7%	9.2%	9.7%	10.1%	9.8%
72	Accommodation and Food Services	10.8%	11.2%	10.8%	10.5%	10.7%	10.6%	11.2%	11.2%	11.0%	11.1%
51-61, 71, 81	Other Services	18.4%	21.9%	21.1%	20.6%	20.4%	20.4%	20.0%	21.1%	21.2%	21.8%
	Government	30.4%	30.2%	29.7%	29.6%	29.1%	29.0%	29.7%	30.5%	31.3%	30.9%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Figure 3-4 Island County Employment by Industry Group - Percent of Total Employment 2002-2011

Countywide employment has remained stable since completion of the 2008 plan, with a slight downturn in the construction industry during the economic recession, and health care services gaining approximately 260 jobs during the time period 2002-2011. Based on analysis, observed stability in employment and industry sectors over time is anticipated to continue (Island County Planning and Community Development and BERK Consulting, 2014).

3.7 LAND USE AND FUTURE DEVELOPMENT

The County and its incorporated communities have adopted comprehensive plans that govern land use decision- and policy-making. Land use decisions are governed by these programs. This plan will work together with these programs to support wise land use in the future by providing vital information on the risk associated with natural hazards in Island County. All municipal planning partners will seek to incorporate by reference the Island County hazard mitigation plan in their comprehensive plans. This will assure that all future development can be established with the benefits of the information on risk and vulnerability to natural hazards identified in this plan. The County is updating its Comprehensive Land Use Plan, and this hazard mitigation plan will provide information for that effort related to areas at risk.

Each planning partner's jurisdiction-specific annex to this plan (see Volume 2) includes an assessment of regulatory, technical and financial capability to carry out proactive hazard mitigation. Refer to these annexes for a review of regulatory codes and ordinances applicable to each planning partner. In addition, Chapter 19 of this plan provides a general overview of the municipalities' regulatory authority.

3.7.1 Land Use Planning

The County's Planning & Community Development Department is responsible for updating the Comprehensive Land Use Plan and for overseeing and regulating land use and development in unincorporated Island County to protect the health, safety, and welfare of County residents. The department is also responsible for floodplain management in the County, and works with local jurisdictions as needed in this capacity. The department consists of planners, development coordinators, building inspectors, permit managers, administrative assistants, and a code enforcement officer. Collectively, they review development proposals by landowners to ensure they are consistent with federal, state, and county regulations. The department works with other government departments (including emergency management); various agencies and municipalities (including special purpose districts); the general public; land-owners; special interest groups; and businesses to oversee development in unincorporated Island County.

Planning and Community Development staff, in cooperation with staff from Island County's jurisdictions (Oak Harbor, Coupeville and Langley), have identified four planning areas for the County as shown on Figure 3-5 (Island County Planning and Community Development and BERK Consulting, 2014). Figure 3-6 shows the 2005 rural high density growth areas identified by the County and its planning partners. The Planning & Community Development Department estimated the distribution of population growth for the time period 2012-2036 as indicated in Figure 3-7 (Island County Planning & Community Development and BERK Consulting, 2014).

Figure 3-5 Island County Planning Areas

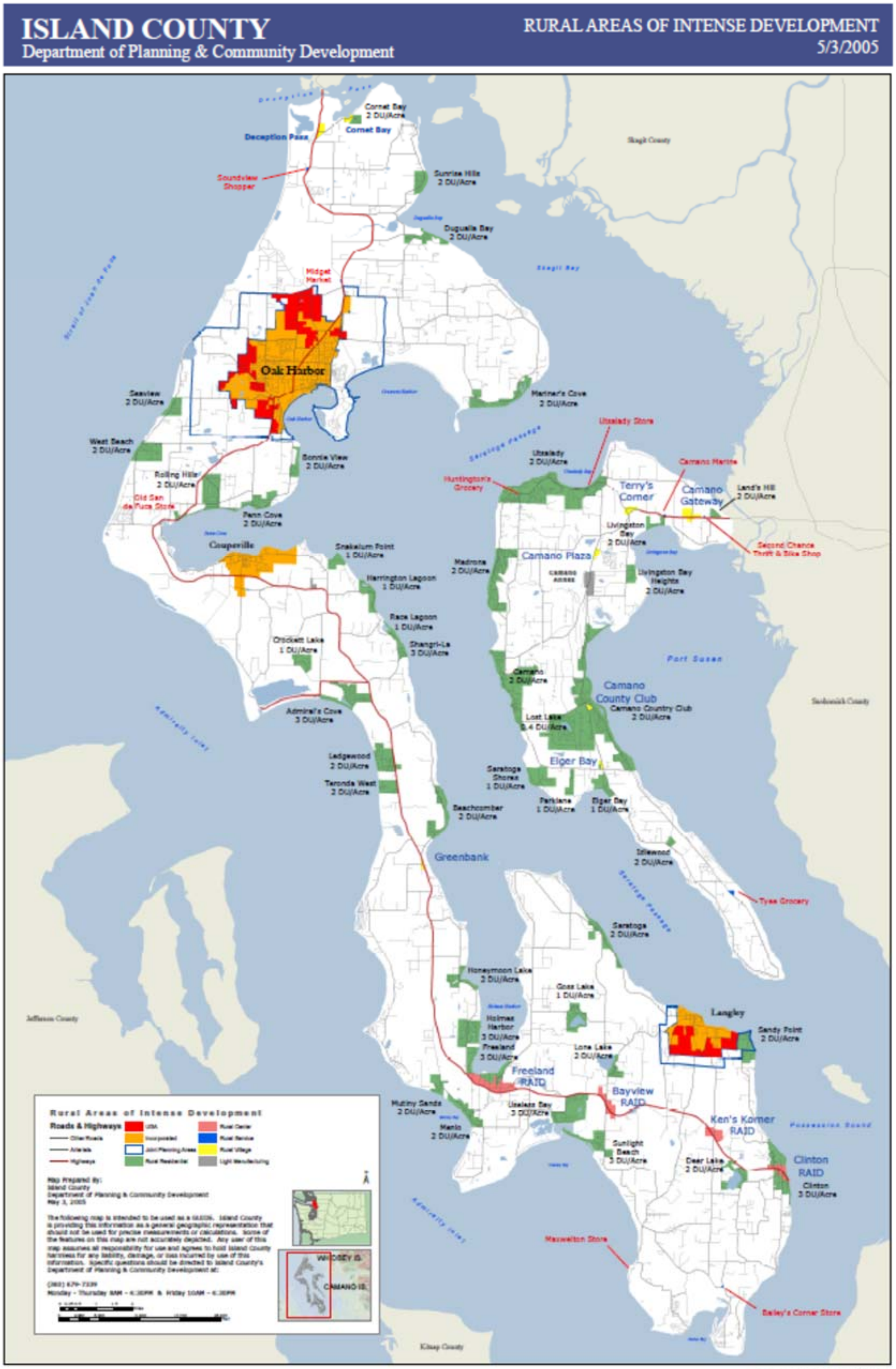


Figure 3-6 2005 Rural Areas of Intense Development

	urban/rural split		2012-2036	2012-2036 Pop Net Allocation		
	urban	rural	growth	urban	rural	total
Camano Island	0%	100%	874	0	874	874
Central Whidbey Island	15%	85%	832	125	707	832
North Whidbey Island	60%	40%	5,818	3,491	2,327	5,818
South Whidbey Island	19%	81%	1,084	206	878	1,084
Total			8,608	3,822	4,786	8,608

Figure 3-7 Island County Planning Area Projected Population Growth Allocations

Washington's Growth Management Act (GMA) requires that jurisdictions select a population projection to use for planning projections. The Office of Financial Management considers the medium projection the most likely (RCW 43.62.035) because it is based on assumptions that have been validated with past and current information. The high and low projections represent the range of uncertainty that are considered when using these projections for planning purposes. Counties must select a population projection that falls within these ranges to determine their GMA planning projection. Island County selected the medium forecast as its base (with some modifications) for GMA planning purposes. That information is used in determining other aspects of the County's growth management, including identification of critical areas.

Critical areas are environmentally sensitive natural resources that have been designated for protection and management in accordance with the requirements of the GMA. Protection and management of these areas is important to the preservation of ecological functions of our natural environment, as well as the protection of the public health, safety and welfare of our community. Information from this mitigation plan will help identify the critical areas throughout the county and its incorporated jurisdictions. That information will be used during update of the comprehensive plan.

Zoning and land use trends in the county as of January 2015 are shown in Figure 3-8. Figure 3-9 identifies currently anticipated population growth patterns. This figure is a draft and may be modified once the comprehensive plan process is finalized.

Transportation planning studies currently underway in the County have defined the following characteristics of developable parcels:

- Less than 50% coverage by critical areas
- Improvements 10 years old or older
- Areas zoned for residential development
- Improvement value less than $50,000 per acre.

Figure 3-10 identifies potential buildable lands and population growth distribution for one potential growth scenario studied by the County (Island County Planning and Community Development and BERK Consulting, 2014). This is draft information, that will change as planning continues. Additional information on buildable lands should be obtained directly from Island County Planning & Community Development. Additional land use and development trend data is contained within each hazard profile.

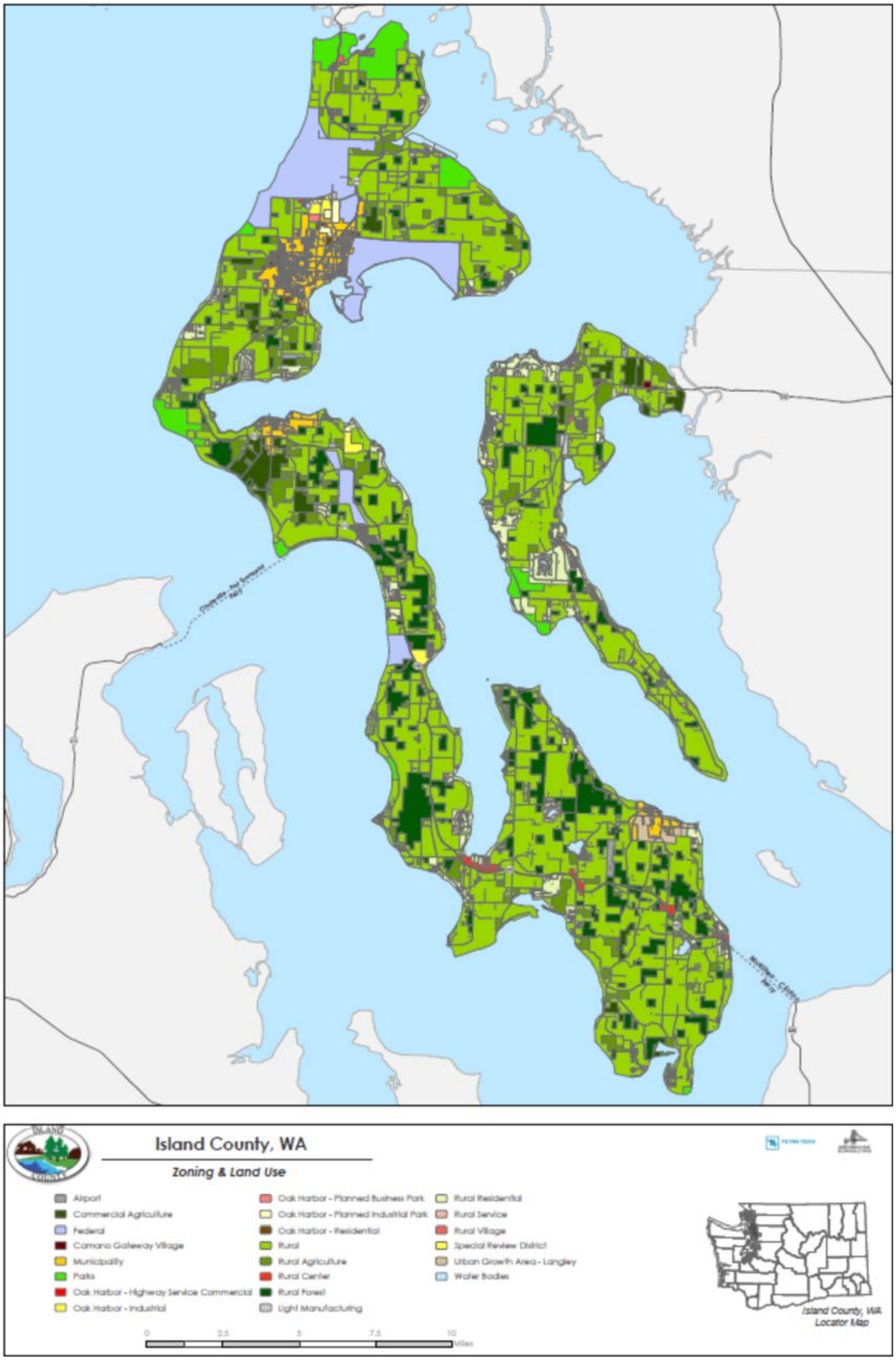


Figure 3-8. Zoning and Land Use in the Planning Area

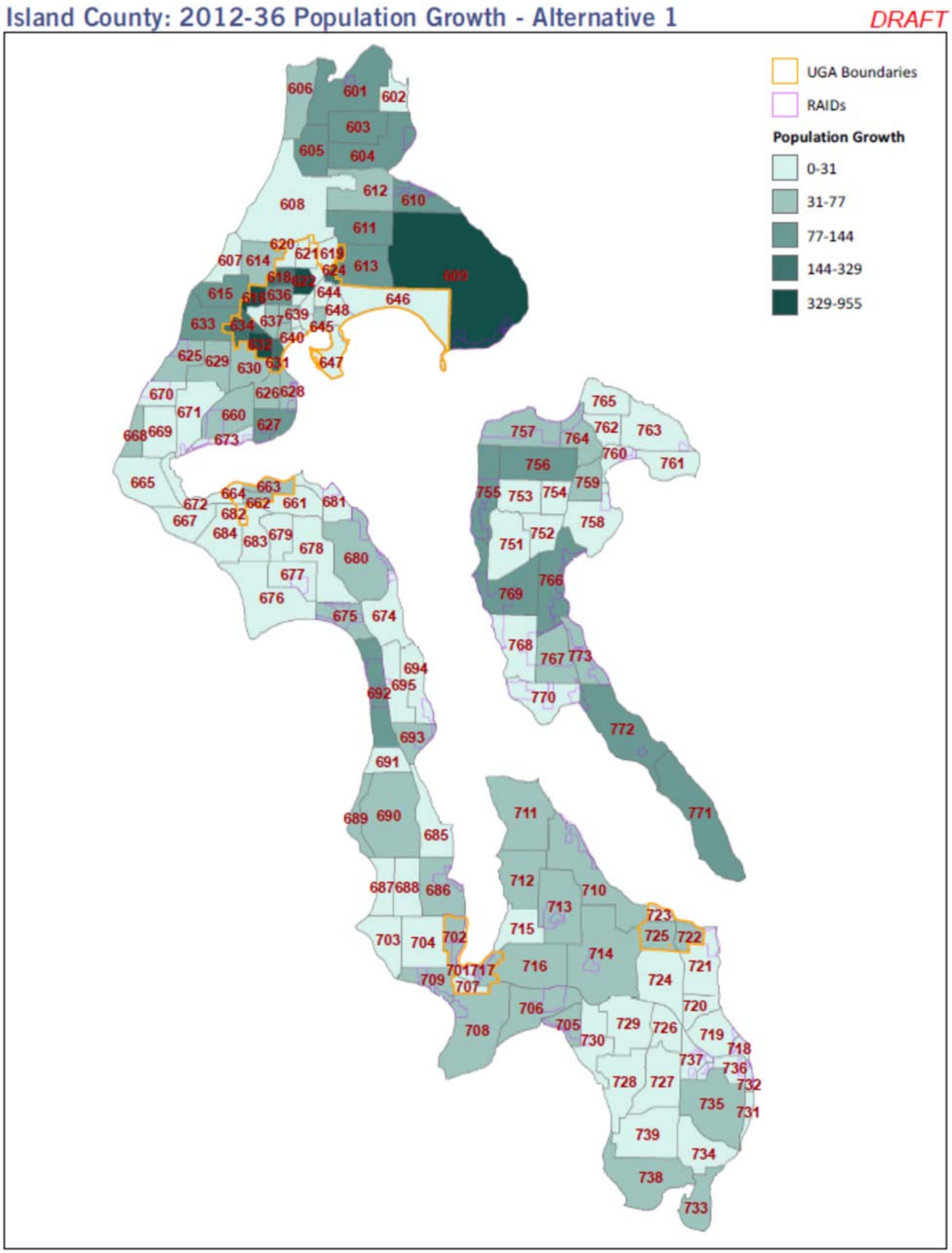


Figure 3-9. 25-Year Population Growth Potential - Draft Map

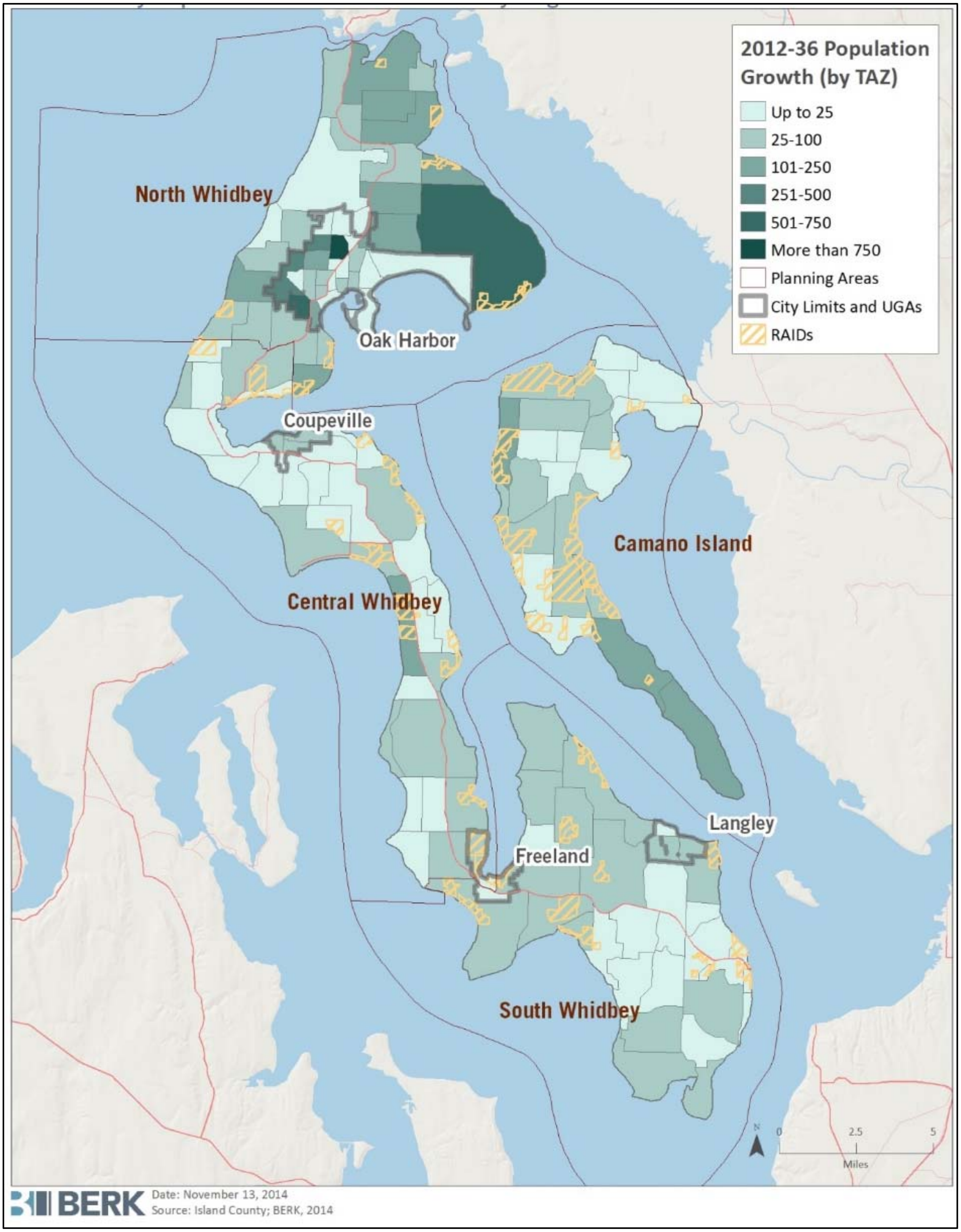


Figure 3-10 Island County Projected Buildable Lands and Potential Population Growth Draft

3.8 LAWS AND ORDINANCES

Existing laws, ordinances and plans at the federal, state and local level can support or impact hazard mitigation initiatives identified in this plan. Hazard mitigation plans are required by 44 CFR to include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process (Section 201.6.b(3)). Pertinent federal and state laws are described below. Each planning partner has individually reviewed existing local plans, studies, reports, and technical information as referenced and identified in its specific jurisdictional annexes presented in Volume 2.

3.8.1 Federal

Disaster Mitigation Act

The DMA is the current federal legislation addressing hazard mitigation planning. It emphasizes planning for disasters before they occur. It specifically addresses planning at the local level, requiring plans to be in place before Hazard Mitigation Grant Program funds are available to communities. This plan is designed to meet the requirements of DMA, improving the planning partners' eligibility for future hazard mitigation funds.

Endangered Species Act

The 1973 Endangered Species Act (ESA) was enacted to conserve species facing depletion or extinction and the ecosystems that support them. The act sets forth a process for determining which species are threatened and endangered and requires the conservation of the critical habitat in which those species live. The ESA provides broad protection for species of fish, wildlife and plants that are listed as threatened or endangered. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat. The ESA outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species. It is the enabling legislation for the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Criminal and civil penalties are provided for violations of the ESA and the Convention. Federal agencies must seek to conserve endangered and threatened species. The ESA defines three fundamental terms:

- **Endangered** means that a species of fish, animal or plant is "in danger of extinction throughout all or a significant portion of its range." (For salmon and other vertebrate species, this may include subspecies and distinct population segments.)
- **Threatened** means that a species "is likely to become endangered within the foreseeable future." Regulations may be less restrictive than for endangered species.
- **Critical habitat** means "specific geographical areas that are…essential for the conservation and management of a listed species, whether occupied by the species or not."

The following are critical sections of the ESA:

- **Section 4: Listing of a Species**—The National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries) is responsible for listing marine species; the U.S. Fish and Wildlife Service is responsible for listing terrestrial and freshwater aquatic species. The agencies may initiate reviews for listings, or citizens may petition for them. A listing must be made "solely on the basis of the best scientific and commercial data available." After a listing has been proposed, agencies receive comment and conduct further scientific reviews, after which they must decide if the listing is warranted. Economic impacts cannot be considered in this decision, but it may include an evaluation of the adequacy of local and state protections.

- **Section 7: Consultation**—Federal agencies must ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed or proposed species or adversely modify its critical habitat. This includes private and public actions that require a federal permit. Once a final listing is made, non-federal actions are subject to the same review, termed a "consultation." If the listing agency finds that an action will "take" a species, it must propose mitigations or "reasonable and prudent" alternatives to the action; if the proponent rejects these, the action cannot proceed.
- **Section 9: Prohibition of Take—**It is unlawful to "take" an endangered species, including killing or injuring it or modifying its habitat in a way that interferes with essential behavioral patterns, including breeding, feeding or sheltering.
- **Section 10: Permitted Take**—Through voluntary agreements with the federal government that provide protections to an endangered species, a non-federal applicant may commit a take that would otherwise be prohibited as long as it is incidental to an otherwise lawful activity (such as developing land or building a road). These agreements often take the form of a "Habitat Conservation Plan."
- **Section 11: Citizen Lawsuits**—Civil actions initiated by any citizen can require the listing agency to enforce the ESA's prohibition of taking or to meet the requirements of the consultation process.

With the listing of salmon and trout species as threatened or endangered, the Pacific Coast states have been impacted by mandates, programs and policies based on the presumed presence of listed species. Most West Coast jurisdictions must now take into account the impact of their programs on habitat.

Coastal Zone Management Act

All states with federally approved coastal programs delineate a coastal zone consistent with the general standards act set forth in the Coastal Zone Management Act of 1972 (CZMA). According to the CZMA, the coastal zone area should encompass all important coastal resources including transitional and intertidal areas, salt marshes, beaches, coastal waters, and adjacent shorelines where activities could have the potential to impact the coastal waters. Federal land is excluded from the state coastal zone by the CZMA. Washington State has established the Washington State Coastal Zone Management Program, which was approved by the federal government in 1976, making it the first to be approved, applying to 15 coastal counties which front on salt water.

The Clean Water Act

The federal Clean Water Act (CWA) employs regulatory and non-regulatory tools to reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's surface waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water."

Evolution of CWA programs over the last decade has included a shift from a program-by-program, source-by-source, and pollutant-by-pollutant approach to more holistic watershed-based strategies. Under the watershed approach, equal emphasis is placed on protecting healthy waters and restoring impaired ones. A full array of issues are addressed, not just those subject to CWA regulatory authority. Involvement of stakeholder groups in the development and implementation of strategies for achieving and maintaining water quality and other environmental goals is a hallmark of this approach.

National Flood Insurance Program

The National Flood Insurance Program (NFIP) provides federally backed flood insurance in exchange for communities enacting floodplain regulations. Participation and good standing under NFIP are prerequisites to grant funding eligibility under the Robert T. Stafford Act. The County and its Cities and Towns participate in the NFIP and have adopted regulations that meet the NFIP requirements. At the time of the preparation of this 2015 edition, all participating jurisdictions in the partnership were in good standing with NFIP requirements. Also occurring at the time of this update was the expected delivery of updated flood maps, with an anticipated delivery of mid- to late-2015. Additional NFIP data can be found within the Flood Hazard Profile, and within each partners' annex document.

Presidential Disaster Declarations

Presidentially declared disasters are disaster events that cause more damage than state and local governments/resources can handle without federal assistance. There is not generally a specific dollar threshold that must be met. A Presidential Major Disaster Declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, and designed to help disaster victims, businesses, and public entities. A Presidential Emergency Declaration can also be declared, but assistance is limited to specific emergency needs.

3.8.2 State-Level Planning Initiatives

Washington State Enhanced Mitigation Plan

The Washington State Enhanced Hazard Mitigation Plan approved by FEMA in 2013 provides guidance for hazard mitigation throughout Washington. The plan identifies hazard mitigation goals, objectives, actions and initiatives for state government to reduce injury and damage from natural hazards. By meeting federal requirements for an enhanced state plan (44 CFR parts 201.4 and 201.5), the plan allows the state to seek significantly higher funding from the Hazard Mitigation Grant Program following presidential declared disasters (20 percent of federal disaster expenditures versus 15 percent with a standard plan).

Growth Management Act

The 1990 Washington State Growth Management Act (Revised Code of Washington (RCW) Chapter 36.70A) mandates that local jurisdictions adopt land use ordinances protect the following critical areas:

- Wetlands
- Critical aquifer recharge areas
- Fish and wildlife habitat conservation areas
- Frequently flooded areas
- Geologically hazardous areas.

The Growth Management Act (GMA) regulates development in these areas, and therefore has the potential to affect hazard vulnerability and exposure at the local level.

Coastal Zone Management Program

Washington State has established the Washington State Coastal Zone Management Program in conjunction with the federal Coastal Zone Management Act, which was approved by the federal government in 1976, making it the first to be approved, applying to 15 coastal counties which front on salt water.

Shoreline Management Act

The 1971 Shoreline Management Act (RCW 90.58) was enacted to manage and protect the shorelines of the state by regulating development in the shoreline area. A major goal of the act is to prevent the "inherent harm in an uncoordinated and piecemeal development of the state's shorelines." Its jurisdiction includes the Pacific Ocean shoreline and the shorelines of Puget Sound, the Strait of Juan de Fuca, and rivers, streams and lakes above a certain size. It also regulates wetlands associated with these shorelines.

Washington State Building Code

The Washington State Building Code Council adopted the 2012 editions of national model codes, with some amendments. The Council also adopted changes to the Washington State Energy Code (effective 2013) and Ventilation and Indoor Air Quality Code. Washington's state-developed codes are mandatory statewide for residential and commercial buildings. The residential code exceeds the 2012 International Energy Conservation Code standards for most homes, and the commercial code meets or exceeds standards of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE 90.1-2004). For residential construction covered by ASHRAE 90.1-2007 (buildings with four or more stories), the state code is more stringent. The 2012 IBC went into effect as the Washington model code on July 1, 2013.

Comprehensive Emergency Management Planning

Washington's Comprehensive Emergency Management Planning law (RCW 38.52) establishes parameters to ensure that preparations of the state will be adequate to deal with disasters, to ensure the administration of state and federal programs providing disaster relief to individuals, to ensure adequate support for search and rescue operations, to protect the public peace, health and safety, and to preserve the lives and property of the people of the state. It achieves the following:

- Provides for emergency management by the state, and authorizes the creation of local organizations for emergency management in political subdivisions of the state.
- Confers emergency powers upon the governor and upon the executive heads of political subdivisions of the state.
- Provides for the rendering of mutual aid among political subdivisions of the state and with other states and for cooperation with the federal government with respect to the carrying out of emergency management functions.
- Provides a means of compensating emergency management workers who may suffer any injury or death, who suffer economic harm including personal property damage or loss, or who incur expenses for transportation, telephone or other methods of communication, and the use of personal supplies as a result of participation in emergency management activities.
- Provides programs, with intergovernmental cooperation, to educate and train the public to be prepared for emergencies.

It is policy under this law that emergency management functions of the state and its political subdivisions be coordinated to the maximum extent with comparable functions of the federal government and agencies of other states and localities, and of private agencies of every type, to the end that the most effective preparation and use may be made of manpower, resources, and facilities for dealing with disasters.

Washington Administrative Code 118-30-060(1)

Washington Administrative Code (WAC) 118-30-060 (1) requires each political subdivision to base its comprehensive emergency management plan on a hazard analysis, and makes the following definitions related to hazards:

- Hazards are conditions that can threaten human life as the result of three main factors:
  - Natural conditions, such as weather and seismic activity
  - Human interference with natural processes, such as a levee that displaces the natural flow of floodwaters
  - Human activity and its products, such as homes on a floodplain.
- The definitions for hazard, hazard event, hazard identification, and flood hazard include related concepts:
  - A hazard may be connected to human activity.
  - Hazards are extreme events.

Hazards generally pose a risk of damage, loss, or harm to people and/or their property

Washington State Floodplain Management Law

Washington's floodplain management law (RCW 86.16, implemented through WAC 173-158) states that prevention of flood damage is a matter of statewide public concern and places regulatory control with the Department of Ecology. RCW 86.16 is cited in floodplain management literature, including FEMA's national assessment, as one of the first and strongest in the nation. A major challenge to the law in 1978, *Maple Leaf Investors v. Ecology,* is cited in legal references to floodplain management issues. The court upheld the law, declaring that denial of a permit to build residential structures in the floodway is a valid exercise of police power and did not constitute a taking. RCW Chapter 86.12 (Flood Control by Counties) authorizes county governments to levy taxes, condemn properties and undertake flood control activities directed toward a public purpose.

Flood Control Assistance Account Program

Washington's first flood control maintenance program was passed in 1951, and was called the Flood Control Maintenance Program (FCMP). In 1984, RCW 86.26 (State Participation in Flood Control Maintenance) established the Flood Control Assistance Account Program (FCAAP), which provides funding for local flood hazard management. FCAAP rules are found in WAC 173-145. Ecology distributes FCAAP matching grants to cities, counties and other special districts responsible for flood control. This is one of the few state programs in the U.S. that provides grant funding to local governments for floodplain management. The program has been funded for $4 million per Biennium since its establishment, with additional amounts provided after severe flooding events.

To be eligible for FCAAP assistance, flood hazard management activities must be approved by Ecology in consultation with the Washington Department of Fish and Wildlife (WDFW). A comprehensive flood hazard management plan must have been completed and adopted by the appropriate local authority or be in the process of being prepared in order to receive FCAAP flood damage reduction project funds. This policy evolved through years of the FCMP and early years of FCAAP in response to the observation that poor management in one part of a watershed may cause flooding problems in another part.

Local jurisdictions must participate in the NFIP and be a member in good standing to qualify for an FCAAP grant. Grants up to 75 percent of total project cost are available for comprehensive flood hazard management planning. Flood damage reduction projects can receive grants up to 50 percent of total project cost, and must be consistent with the comprehensive flood hazard management plan. Emergency grants are available to respond to unusual flood conditions. FCAAP can also be used for the purchase of flood prone properties, for limited flood mapping and for flood warning systems.

3.8.3 Local Programs

Each planning partner has prepared a jurisdiction-specific annex to this plan contained in Volume 2, which identifies its regulatory, technical and financial capability to carry out proactive mitigation efforts. Additional jurisdiction-specific information is available for review within each of those annexes. In addition, the County, City of Langley, City of Oak Harbor and Town of Coupeville developed a comprehensive listing of regulatory capabilities, contained in Chapter 19. The following sections present additional regulatory information that applies to the planning partnership.

Puget Sound Regional Catastrophic Disaster Coordination Plan

The Regional Catastrophic Planning Team was formed to guide and manage the Puget Sound Regional Catastrophic Preparedness Grant Program funded by FEMA. Supporting the coordination of regional all-hazard planning for catastrophic events that may impact the region, the effort includes the development of integrated planning communities, plans, protocols, and procedures to manage a catastrophic event. The Regional Catastrophic Planning Team consists of representatives from designated emergency management interests across an eight-county area (see Figure 3-11), including Island County and the City of Oak Harbor.

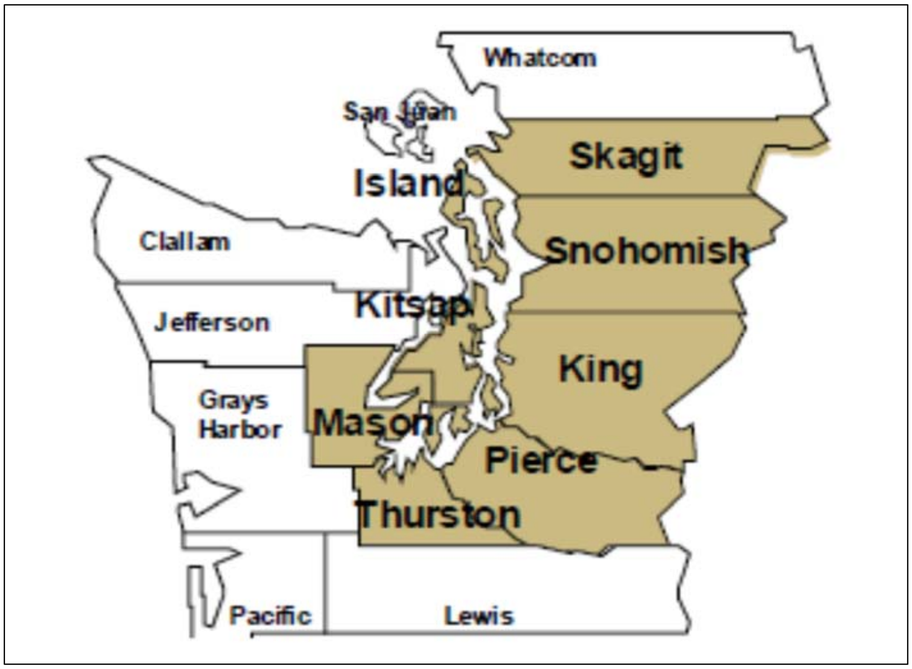


Figure 3-11 Counties in Puget Sound Regional Catastrophic Planning Region

Comprehensive Land Use Plans

Comprehensive plans are long-range in nature and serve as policy guides for how a jurisdiction plans to manage growth and development with respect to the natural environment and available resources. Washington State law (36.70A.040 RCW) requires that jurisdictions operating under the Growth Management Act develop comprehensive plans and development regulations that are consistent with the comprehensive plans and implement them (36.70A RCW).

The GMA requires that comprehensive plans consist of the following elements: land use, housing, capital facilities, utilities, rural (for counties), transportation, economic development, and park and recreation (RCW 36.70A.070). A comprehensive plan may also include additional optional elements that relate to physical development, such as conservation, historic preservation, and subarea plans (RCW 36.70A.080).

Island County adopted its original GMA Comprehensive Plan on September 28, 1998 (with an effective date of December 1, 1998; see Ordinance C-123-98). Since then, amendments to various elements of the comprehensive plan have been made on an annual basis as allowed by law (RCW 36.70A.130(2)(a)).

The GMA requires that jurisdictions periodically review their comprehensive plans and implementing development regulations in their entirety and revise them if needed. Island County is required to have this review and revision completed by June 30, 2016 and every eight years thereafter (RCW 36.70A.130(5)(b)). Opportunities for public participation in this process will be provided (see RCW 36.70A.035).

Island County Code (ICC) Chapter 16.26 describes the County's review procedure for amendments to the Island County Comprehensive Plan and development regulations. ICC Section 16.26.060 allows for any person to propose an amendment to the comprehensive plan or implementing development regulations. Comprehensive plan amendments and development regulation amendments are processed as Type IV legislative decisions by the Board of Island County Commissioners.

CHAPTER 4.
RISK ASSESSMENT METHODOLOGY

A hazard is an act or phenomenon that has the potential to produce harm or other undesirable consequences to a person or thing. Natural hazards can exist with or without the presence of people and land development. However, hazards can be exacerbated by societal behavior and practice, such as building in a floodplain, along a sea cliff, or on an earthquake fault. Natural disasters are inevitable, but the impacts of natural hazards can, at a minimum, be mitigated or, in some instances, prevented entirely.

The following chapters describe each hazard that affects the planning area, the likely location of natural hazard impact, the severity of the impact, previous occurrences, and the probability of future hazard events. These risk assessments provide risk-based information to assist the County and its planning partners in determining priorities for implementing mitigation measures. The risk assessment approach used for this plan entailed using geographic information system (GIS) and Hazus hazard-modeling software and data to develop vulnerability models for people, structures and critical facilities, and evaluating those vulnerabilities in relation to hazard profiles that model where hazards exist. This approach is dependent on the detail and accuracy of the data used. Some types of hazards are extremely difficult to model.

The DMA requires measuring potential losses to critical facilities and property resulting from natural hazards. In addition to the DMA requirements, the risk assessment approach taken in this study evaluated risks to vulnerable populations and also examines the risk presented by several human-caused hazards. The goal of the risk assessment is to determine which hazards present the greatest risk and what areas are the most vulnerable to hazards. Island County and its planning partners are exposed to many natural and human-caused hazards. The risk assessment and vulnerability analysis helps identify where mitigation measures could reduce loss of life or damage to property in the planning region.

The hazard profiles in the following chapters document the impact of past hazard events and identify the areas most at risk. To ensure a single set of terminology to describe the methodology and results of this analysis, the following is provided as the foundation for the standardized risk terminology:

- Hazard: Natural (or human caused) source or cause of harm or damage, demonstrated as actual (deterministic/historical events) or potential (probabilistic) events.
- Risk: The potential for an unwanted outcome resulting from a hazard event, as determined by its likelihood and associated consequences. For this plan, where possible, risk includes potential future losses based on probability, severity and vulnerability, expressed in dollar losses when possible. In some instances, dollar losses are based on actual demonstrated impact, such as through the use of the Hazus model. In other cases, losses are demonstrated through exposure analysis due to the inability to determine the extent to which a structure is impacted.
- Location: The area of potential or demonstrated impact within the area in which the analysis is being conducted. In some instances, the area of impact is within a geographically defined area, such as a floodplain. In other instances, such as for severe weather, there is no established geographic boundary associated with the hazard, as it can impact the entire area.
- Severity/Magnitude: The extent or magnitude upon which a hazard is ranked, demonstrated in various means, e.g., Richter Scale.
- Vulnerability: The degree of damage, e.g., building damage or the number of people injured.
- Probability of Occurrence and Return Intervals: These terms are used as a synonym for likelihood, or the estimation of the potential of an incident to occur.

4.1 PROBABILITY OF OCCURRENCE AND RETURN INTERVALS

Natural hazard events with relatively long return periods, such as a 100-year flood or a 500-year tsunami or earthquake, are often thought to be very unlikely. In reality, the probability that such events occur over the next 30 or 50 years is relatively high. Figure 4-1 defines the probabilistic return interval by given year and the associated probability of occurrence for such an event at 1-, 10-, 30- and 50-year periods.

Return period (years)	Probability of Occuring in Various Time Periods			
	1 Year	10 Years	30 Years	50 Years
5	20.00%	89.26%	99.88%	100.00%
10	10.00%	65.13%	95.76%	99.48%
25	4.00%	33.52%	70.61%	87.01%
50	2.00%	18.29%	45.45%	63.58%
100	1.00%	9.56%	26.03%	39.50%
200	0.50%	4.89%	13.96%	22.17%
250	0.40%	3.93%	11.33%	18.16%
500	0.20%	1.98%	5.83%	9.53%
1,000	0.10%	1.00%	2.96%	4.88%
2,500	0.04%	0.40%	1.19%	1.98%
5,000	0.02%	0.20%	0.60%	1.00%
10,000	0.01%	0.10%	0.30%	0.50%

Figure 4-1 Probabilistic Risk Table

Natural hazard events with very long return periods, such as 100 or 500 or 1,000 years, have significant probabilities of occurring during the lifetime of a building:

- Hazard events with return periods of 100 years have probabilities of occurring in the next 30 or 50 years of about 26 percent and about 40 percent, respectively.
- Hazard events with return periods of 500 years have about a 6 percent and about a 10 percent chance of occurring over the next 30 or 50 years, respectively.
- Hazard events with return periods of 1,000 years have about a 3 percent chance and about a 5 percent chance of occurring over the next 30 or 50 years, respectively.

For life safety considerations, even natural hazard events with return periods of more than 1,000 years are often deemed significant if the consequences of the event happening are very severe (extremely high damage and/or substantial loss of life). For example, the seismic design requirements for new construction are based on the level of ground shaking with a return period of 2,475 years (2 percent probability in 50 years). Providing life safety for this level of ground shaking is deemed necessary for seismic design of new buildings to minimize life safety risk. Of course, a hazard event with a relatively long return period may occur tomorrow, next year, or within a few years. Return periods of 100 years, 500 years or 1,000 years mean that such events have a 1 percent, a 0.2 percent or a 0.1 percent chance of occurring in any given year.

4.2 METHODOLOGY

The risk assessment for this hazard mitigation plan evaluates the risk of natural hazards prevalent in Island County and meets requirements of the DMA (44 CFR Section 201.6(c)(2)). The methodology used to complete the risk assessment is described below.

4.2.1 Hazard Identification and Profiles

For this plan, the planning partners and stakeholders considered the full range of natural hazards that could impact the planning area and then listed hazards that present the greatest concern. The process incorporated review of state and local hazard planning documents, as well as information on the frequency, magnitude and costs associated with hazards that have impacted or could impact the planning area. Anecdotal information regarding natural hazards and the perceived vulnerability of the planning area's assets to them was also used. Based on the review, the planning team, at its August 12, 2014 meeting, identified the following natural hazards that this plan addresses as the hazards of concern:

- Coastal erosion
- Dam failure
- Drought
- Earthquake
- Flood
- Landslide
- Severe weather
- Tsunami
- Volcano
- Wildfire
- Human-caused hazards
- Technological hazards.

This is a change from the previous plan editions. Two new natural hazards are included—coastal erosion and dam failure—as well as human-caused and technological hazards. The avalanche hazard assessed in the 2008 plan has been removed as it is not a hazard of concern for the planning area. Based on the full spectrum of hazards addressed, it is the intent of the County to use this risk assessment in lieu of preparing a separate hazard identification and vulnerability assessment.

The hazard profiles in Chapters 5 to 16 describe the risks associated with identified hazards of concern. Each chapter describes the hazard, the planning area's vulnerabilities, and, when possible, probable event scenarios. The following steps were used to define the risk of each hazard:

- Identify and profile the following information for each hazard:
  - Geographic areas most affected by the hazard
  - Event frequency estimates
  - Severity estimates
  - Warning time likely to be available for response.

- Determine exposure to each hazard—Exposure was determined by overlaying hazard maps with an inventory of structures, facilities, and systems to determine which of them would be exposed to each hazard.
- Assess the vulnerability of exposed facilities—Vulnerability of exposed structures and infrastructure was determined by interpreting the probability of occurrence of each event as possible, and assessing structures, facilities, and systems that are exposed to each hazard. Tools such as GIS and Hazus were used to perform this assessment for the flood and earthquake hazards. Outputs similar to those from Hazus were generated for other hazards, using maps generated by the Hazus program.

4.2.2 Risk Assessment Tools

In 1997, FEMA developed the standardized Hazards U.S., or Hazus, model to estimate losses caused by earthquakes and identify areas that face the highest risk and potential for loss. Hazus was later expanded into a multi-hazard methodology, Hazus-MH, with new models for estimating potential losses from hurricanes and floods.

Hazus-MH is a GIS-based software program used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, critical facility, transportation and utility lifeline, and multiple models to estimate potential losses from natural disasters. The program maps and displays hazard data and the results of damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that it can readily be updated as population, inventory, and other factors change and as mitigation-planning efforts evolve.
- Facilitates the review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Is administered by the local government and can be used to manage and update a hazard mitigation plan throughout its implementation.

The version used for this plan was Hazus-MH 2.1.

Hazus-MH provides default data for inventory, vulnerability and hazards; this default data can be supplemented with local data to provide a more refined analysis. The model can carry out three levels of analysis, depending on the format and level of detail of information about the planning area:

- **Level 1**—All of the information needed to produce an estimate of losses is included in the software's default data. This data is derived from national databases and describes in general terms the characteristic parameters of the planning area.
- **Level 2**—More accurate estimates of losses require more detailed information about the planning area. To produce Level 2 estimates of losses, detailed information is required about local geology, hydrology, hydraulics and building inventory, as well as data about utilities and critical facilities. This information is needed in a GIS format.

- **Level 3**—This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the planning area.

Hazus-MH was used in the vulnerability analysis for the dam failure, earthquake and flood analysis. Based on modifications of the data contained within the Hazus-MH program, the County and its planning partners conducted a modified Level 2 analysis for the 2015 update. Further details on specific methodologies are presented in the hazard profiles.

4.2.3 Limitations

Loss estimates, exposure assessments and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

- Approximations and simplifications necessary to conduct a study
- Incomplete or outdated inventory, demographic or economic parameter data
- The unique nature, geographic extent and severity of each hazard
- Mitigation measures already employed
- The amount of advance notice residents have to prepare for a specific hazard event.

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate. The results do not predict precise results and should be used only to understand relative risk. Over the long term, Island County and its planning partners will collect additional data to assist in estimating potential losses associated with other hazards.

FEMA is in the process of assimilating data sources into one primary dataset for use in its updated flood analysis. FEMA provided that dataset to the planning partnership, and it was used to the greatest extent possible to ensure consistency in determining loss, vulnerability and exposure data. The exact method that FEMA used to collect the information was not provided to a large extent.

Some assumptions were made by the planning partnership in an effort to capture as much data as necessary to supplant any significant gaps in the FEMA data. One example of this is the valuation for structures within the assessed data, most commonly as it relates to the general building stock. For structures for which data was not provided, the missing information was determined using averages of similar types of structures, determining square footage and applying a multiplier. This process, to a degree, is identified in the Hazus User's Guide.

Some hazards, such as earthquake, are pre-loaded with scientifically determined scenarios which are used during the modeling process. In some instances, this does not allow for manipulation of the data as with other hazards, such as flood. In the case of earthquake, greater reliance existed on the use of the Hazus default data, which is known to be less accurate, most often causing higher loss values. Therefore, while loss estimates are provided, they should be viewed with this flaw in mind, with data used for consideration in planning purposes for emergency management and land use development/management. A much more in-depth scientific analysis is necessary to rely on this type of data with a high degree of accuracy. Readers should view this document as a baseline or starting point, and information should be further studied and analyzed by scientists and other subject matter experts in specific hazard fields.

CHAPTER 5.
COASTAL EROSION

5.1 GENERAL BACKGROUND

5.1.1 How Coastal Erosion Happens

Coastal erosion is the loss or displacement of land along the coastline due to the action of waves, currents, tides, wind-driven water, waterborne ice, or other impacts associated with storms. It is also the loss or displacement of land due to the action of wind, runoff of surface waters, or groundwater seepage.

Coastal erosion is often attributed to major storm events and in particular to storm events where high wave energy, strong on-shore winds, and heavy rainfall coincide with a high tide. Large storm-generated waves often expedite coastal erosion processes, when wave action is high and water levels and coastal currents rapidly increase. Coastal erosion may change the shoreline over time through the long-term losses of sediment and rocks, or in other cases, may temporarily redistribute coastal sediment. Erosion in one location may result in accretion (deposition of sediments) nearby (see Figure 5-1). Deposition is the placement of sediment transported by wind, water, or ice.

The impact of waves along a coastline is dependent on storm surge, which is most severe if it coincides with high tide. Storm surge is an elevation of water levels, including tides, due to lower barometric pressure and wind stress in front of strong storms that push water toward the shoreline. Storm surge contributes substantially to coastal erosion. The three most important factors contributing to beach and dune erosion during storms are storm surge height, storm surge duration, and wave steepness (ratio of wave height to length).

Other factors that can increase erosion include fetch (the length of water over which a given wind has blown), wind direction and speed, wave length, height and period, nearshore water depth, tidal influence, increased lake or sea levels, overall strength and duration of storm events, and variability in sediment supply to the beach. Combinations of these factors can exacerbate their effects by increasing water levels, storm rise, wave run-up and wind setup, and producing damaging waves along the shore, scouring beaches and bluff areas, reducing sand from beaches, and allowing water and wave action further inland to erode dunes and bluffs (U.S. Army Corps of Engineers, 2009).

In addition, erosion can be exacerbated by man-made influences, such shoreline hardening, seawalls, groins, jetties, navigation inlets, boat wakes, dredging and other interruptions of physical coastal processes which reduce or interrupt longshore sediment transport.

DEFINITIONS

Beach Erosion—A beach is the accumulation of sand, gravel, silt or clay located at the transition zone between land and water. Beach erosion occurs through the removal of beach sediment caused by wind, wave action and longshore currents, causing offshore movement of sand from the beach.

Dune Erosion/Scarping—A dune is a hill of sand built by wind-related or man-made processes. Dune erosion is caused by wave-attack during a storm, swell or wind action. This process, known as scarping, releases sand stored in the dune to a beach or zone landward of the dune. The influx of dune sand to the active beach can be carried offshore to build temporary sand bars, helping attenuate incoming wave energy and assisting in beach recovery.

Overwash and Washover—Overwash and washover relate to the transport of sediment landward of the beach, which occurs from coastal flooding during a tsunami, high wind, or other event with extreme waves. Overwash occurs where water from the wave and storm surge go over the upper part of the beach, causing beach sediment to advance over the beach crest, dune or berm, and where the beach sediment does not directly return to the generating water body (ocean, sea, or lake) after water levels return to normal.

Tidelands – Tidelands are the lands now or formerly flowed over by the mean high tide of a natural waterway.

Source: King County Department of Natural Resources

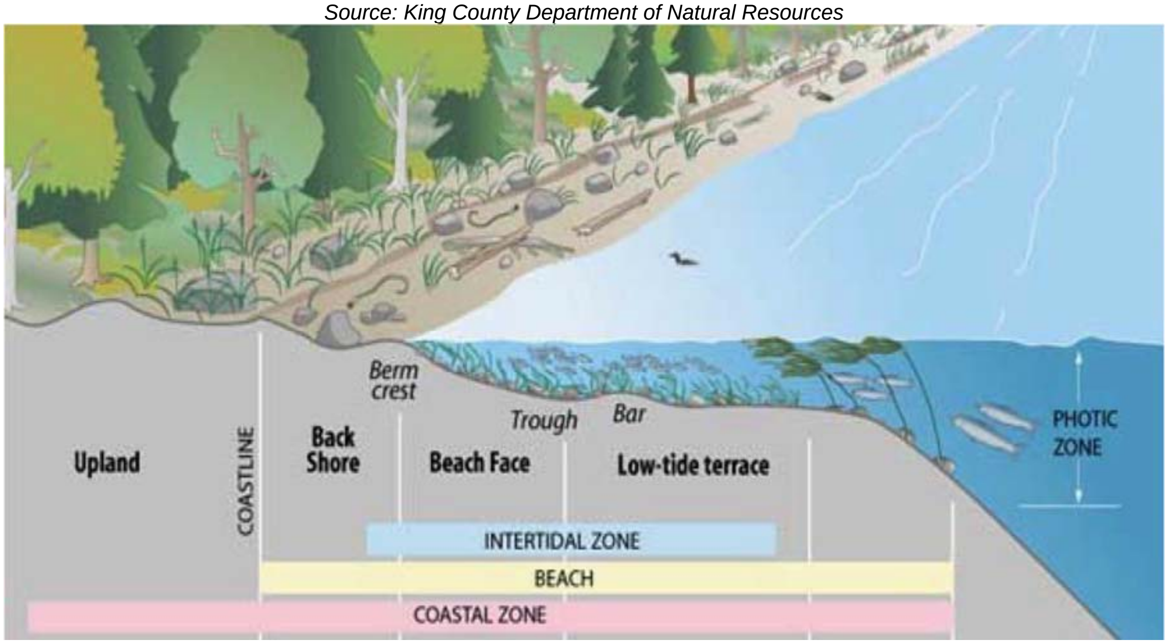


Figure 5-1. Accreting Beach Pre-Development

5.2 HAZARD PROFILE

Primary forms of coastal erosion affecting Island County are as follows:

- **Beach Erosion**—A beach is the accumulation of sand, gravel, silt or clay at the transition zone between land and water. Beach erosion occurs through the removal of beach sediment caused by wind, wave action and longshore currents, causing offshore movement of sand from the beach during storms. Beach erosion is a recurring, long-term problem, and it is a precursor of dune erosion, dune overwash, bluff erosion, failure of shoreline protection structures and destruction of shoreline development.
- **Dune Erosion/Scarping**—A dune is a hill of sand built by wind-related or man-made processes in deserts or near lakes and oceans. Dune erosion is caused by wave-attack during a storm or a large swell or by wind action. This process, generally known as scarping, releases sand that was stored in the dune to the active beach or to the zone just landward of the dune. The influx of this dune sand to the active beach is often carried offshore to build temporary sand bars, which help attenuate incoming wave energy and can assist in post-storm low profile beach recovery.
- **Overwash and Washover**—Overwash and washover are terms related to the transport of sediment landward of the active beach, which occurs from coastal flooding during a tsunami, severe wind, or other event with extreme waves. Overwash occurs where the flow of water (from wave and storm surge) over the upper part of the beach profile causes beach sediment to advance over the crest of the beach, dune or berm and where this beach sediment does not directly return to the generating water body after water level fluctuations return to normal. There are two kinds of overwash: overwash by run-up and overwash by inundation. Overwash begins when the run-up level of waves, usually coinciding with a storm surge, exceeds the local beach or dune crest height. As the water level in the ocean rises such that the beach or dune crest is inundated, a steady sheet of water and sediment runs over the barrier. Washover is the sediment deposited inland of a beach by overwash. Washover can be deposited onto the berm crest or as far as the back barrier bay, estuary, or lagoon.

- **Bluff Erosion**—A bluff is a cliff with a broad face, or a relatively long strip of land rising abruptly above surrounding land or water. Typically, it rises at least 25 feet above the water body at an average slope of 30 percent or greater. Bluff erosion is the erosion of these cliff sides or broad faces as a result of high waves, wind, groundwater or surface runoff and can lead to significant loss of land to the sea. Bluff erosion takes place from the top of the bluff down to the sea. Several processes can lead to erosion on bluffs:
  - Groundwater can leak out the face of a bluff and wash sediments down the bluff face.
  - Surface water may flow directly over the face of a bluff or down a gully on a bluff and carry soil and sediment to the sea.
  - Freeze-thaw cycles can loosen sediment in a bluff that slumps downhill in the spring.
  - At the base of the bluff, high tides, coastal flooding and wave action can scour the bluff toe to remove sediment and undercut the slope.
  - Over-steepened slopes can move downward under the pull of gravity.

  Coastal bluffs can be affected by all of these processes to some extent. The rate of bluff erosion may vary from one location to the next. Over time, erosion is often episodic with significant land loss one year and less the next. Bluff erosion leads to net land loss and the landward migration of the shoreline as well as the top of the bluff. Actively eroding bluffs are unstable and potentially unsafe for development near the bluff top. A bluff will retreat toward land as erosion occurs.
- **Feeder Bluff**—A feeder bluff is a coastal cliff or headland that provides sediment to down-current beaches as a result of wave action on the bluff. Feeder bluffs are more susceptible to erosion when they consist of unconsolidated sediments and more resistant when made of crystalline rocks such as granite. Rocks that are heavily fractured are also susceptible to erosion because water can flow between the cracks to speed up the process.

Erosion can impact beaches, dunes, bluffs, barriers, bays, cliff sides, wetlands, marshes, parks, and other natural landforms and can lead to destructive forces upon nearby manmade structures. One of the major impacts of erosion processes is the permanent breaching or creation of inlets along barrier beaches and islands. Impacts associated with new inlets could include the following:

- Increased flooding and erosion on the mainland shoreline due to increased water levels and wave action in the bays
- Changes in shoaling patterns, water circulation, temperature and salinity that could significantly alter existing bay ecosystems
- Disruption of the longshore transport of sand along the ocean shoreline that would result in increased down-drift erosion
- Stabilized inlets provide benefits for recreational and commercial navigation.

5.2.1 Extent and Location

The Washington Department of Natural Resources has mapped areas in Island County with a slope of more than 40 degrees, which are considered steep and, in some cases, unstable and susceptible to erosion (Figure 5-2). Figure 5-3 identifies slopes with degradation of nearshore reaches of coastline. Figure 5-4 identifies the shoreline designations for all of Island County. Most of the county’s coastlines are designated Residential.

Source: Island County, 2015a

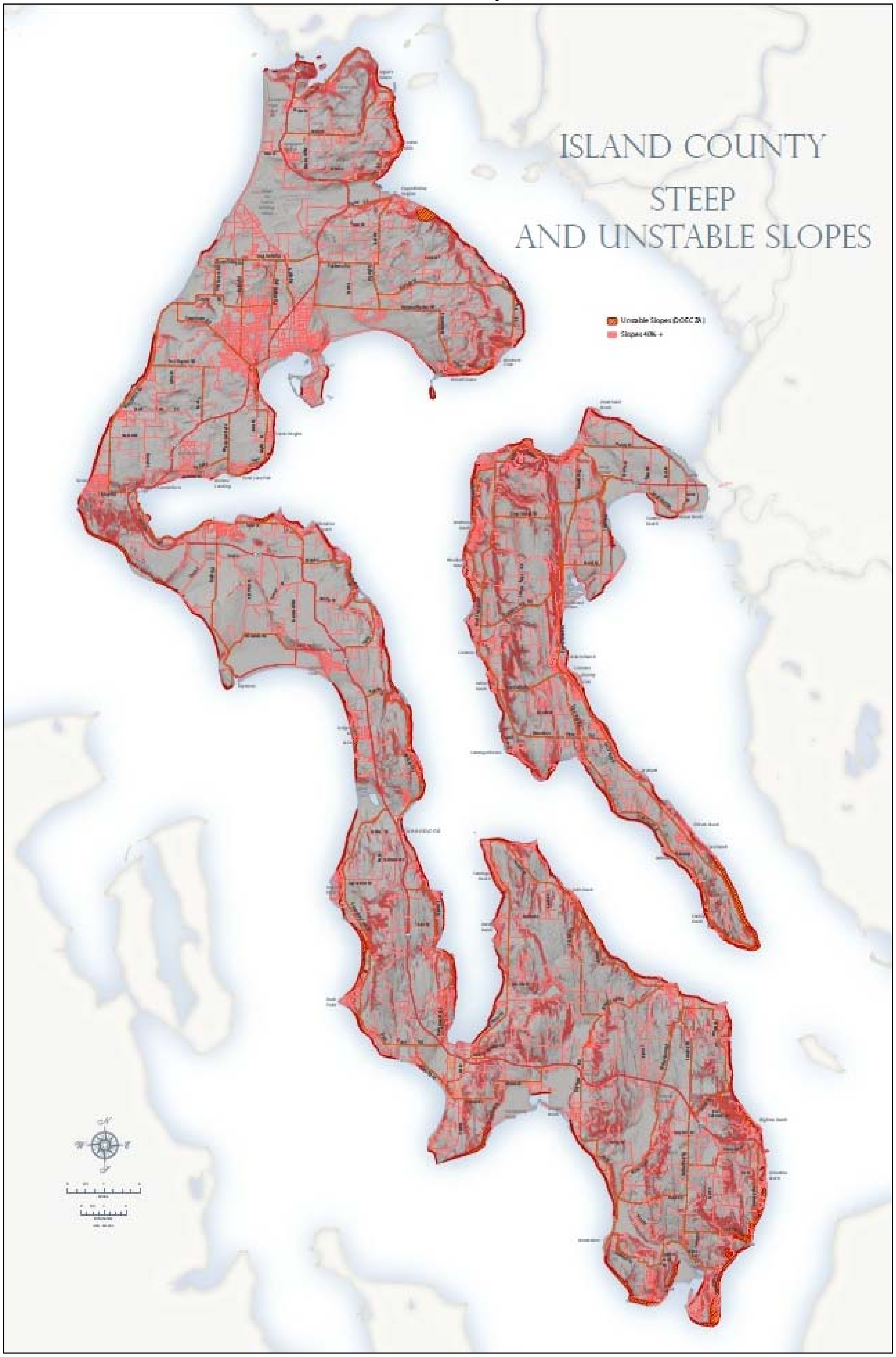


Figure 5-2. Island County Steep Slopes (40 Degrees and Higher)

Source: Schlenger, et al., 2010

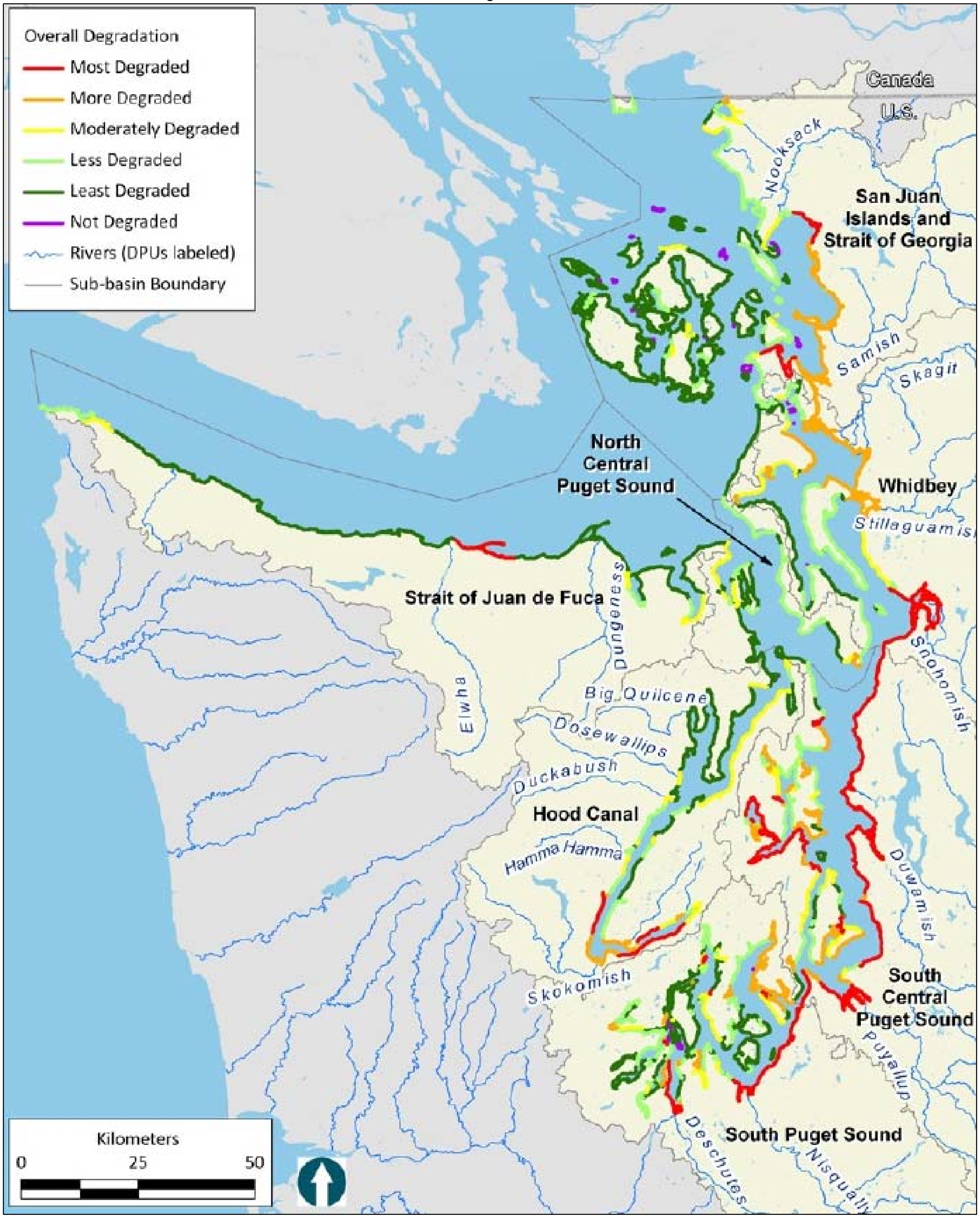


Figure 5-3. Relative Degradation of Strait of Juan de Fuca Nearshore Reach

Source: Island County, 2015b

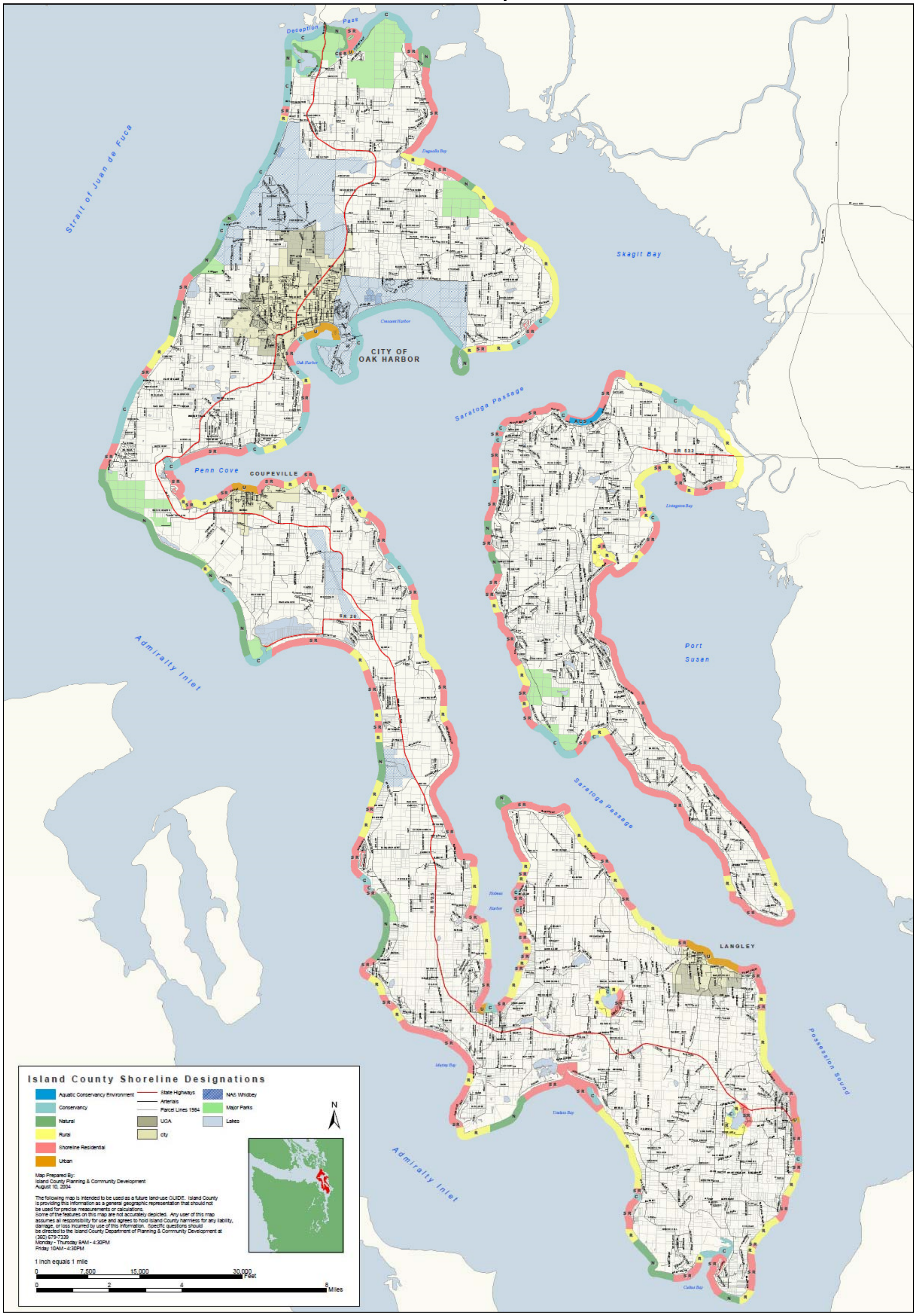


Figure 5-4. Island County Shoreline Designations

Oak Harbor and Naval Air Station Whidbey Island both have residential and commercial property on the beach that is at risk from tidal surge. The Langley Marina and the area of Sandy Hook south of Langley are exposed to tidal surge, which exacerbates coastal erosion. Wave undercutting has led to instability along many of the islands' bluffs, increasing the potential for topple mass movement when the top of the bluff rotates as a result of the actions of gravity. At bluff areas subject to wave action, the water has changed the angle of repose (the angle when material on the slope face is on the verge of sliding due to erosion).

5.2.2 Previous Occurrences

In Island County, the sea has been eroding the costal bluffs ever since the Vashon Glacier began to recede about 16,000 years ago. Retreating glaciers leave hills that point in the direction of retreat—northeast trending on Whidbey and Camano Islands. Some of these have significant slopes that continue to erode. Many of the county's coastal areas have been impacted by erosion, especially as a result of storm surge and high tides. The county is most vulnerable during winter and spring, when wind and storm surge are at their strongest.

Numerous beach-level residential areas on Whidbey and Camano Islands are at risk from tidal flooding and coastal erosion. This occurred as part of a severe storm on February 4, 2006. More recently, during the update of this plan, one house was washed away as a result of a storm surge and the cumulative impacts of previous coastal erosion. Figure 5-5 shows the coastline near residential structures where erosion has caused much of the landscape to be washed away and mitigation has been implemented in an effort to protect residences.

Source: H. Shipman, WA Dept. of Ecology

Figure 5-5. South Whidbey Island Bells Beach Homes on Created Land at Toe of Bluff

5.2.3 Severity

Bluff erosion and landslides contribute sediment to beaches in large quantities (Keuler, 1988). The volume of sediment and frequency of landsliding is variable and episodic. Two bluffs can be close together but differ greatly in erosion rates due to minor changes in shore orientation, stratigraphy, exposure or land use. Some bluffs supply sediment to many miles of down-drift shoreline, others are of only local significance.

Erosion tends to increase with decreasing tidal range. This is because a small tidal range focuses wave energy at a narrow vertical band, in comparison to higher tidal ranges which dissipate energy over a larger vertical band. The Strait of Juan de Fuca has a low-moderate tidal range, meaning wave energy is focused on the upper beach and bluff toe a substantial percentage of the time.

Sea level rise will increase the severity of coastal erosion. According to the *Climate Impacts Vulnerability Assessment Report* (WSDOT, 2011) and the *Climate Impact Study* (Climate Impact Group, 2009), Island County can expect water levels to rise from 2 to 9 inches (depending on modeling methodology). Figure 5-6 and Figure 5-7 identify the anticipated areas of impact and levels of rise in the planning region.

Human Influence

Natural events play a major role in the erosion process, but human actions can exacerbate the effects of these processes through poor land use, dredging operations, vegetation removal, construction of shoreline structures (for example, homes, boardwalks, piers, recreational structures), and misguided erosion control efforts. The desire to live along coastlines is a significant factor in increased coastal growth. There has been a coastal building boom of all types of structures, which can increase the potential for coastal erosion by disturbing the natural coastline and increase the inventory exposed to coastal erosion.

Humans contribute to erosion by removing vegetation, which allows wind and precipitation to directly erode the soil, or by directing runoff from streets, parking lots, roofs and other locations to areas such as bluffs where it can cause erosion. Humans also alter the coastline by constructing hardened structures on the shore, which blocks shoreline processes and can reflect wave energy onto adjacent shoreline areas or cause deepening of the nearshore area. Many development activities damage or alter natural features that protect the upland area from erosion and storm damage:

- Building without considering the potential for damage to property
- Destroying natural protective features such as dunes or bluffs, and their vegetation
- Building structures for erosion prevention at one location that exacerbate erosion conditions on nearby properties
- Creating wakes from boats that produce erosive action on the shoreline.

Engineered structures can halt, slow, mitigate or accelerate shoreline erosion. Erosion and accretion of beaches, inlet opening and closing, alterations in bay environments, bluff slumping, dune loss, wetland loss and other changes to coastal environments have been occurring naturally on a routine basis since the glacial retreat. These events, whether occurring incrementally or in a single storm event, are part of a natural system. The placement of hard structures (e.g., groins, jetties, bulkheads, revetments, seawalls) or soft structures (e.g., beach nourishment, vegetation, beach scraping, dune building) on dynamic landforms and in floodplains adjacent to coastal waters may not always comply with the dynamic nature of the landform to produce the desired results of erosion control.

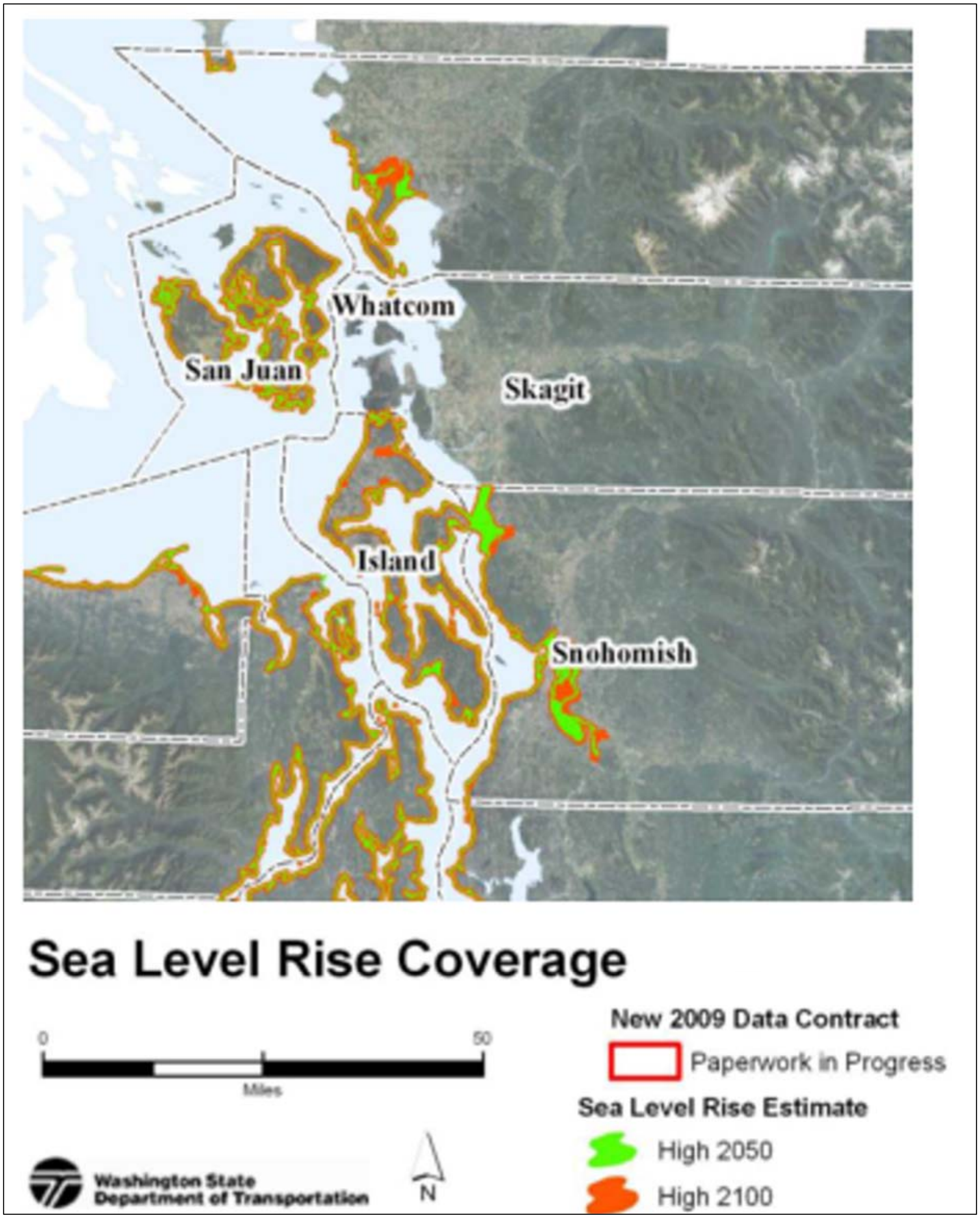


Figure 5-6. WDNR Anticipated Sea Level Rise Areas of Impact

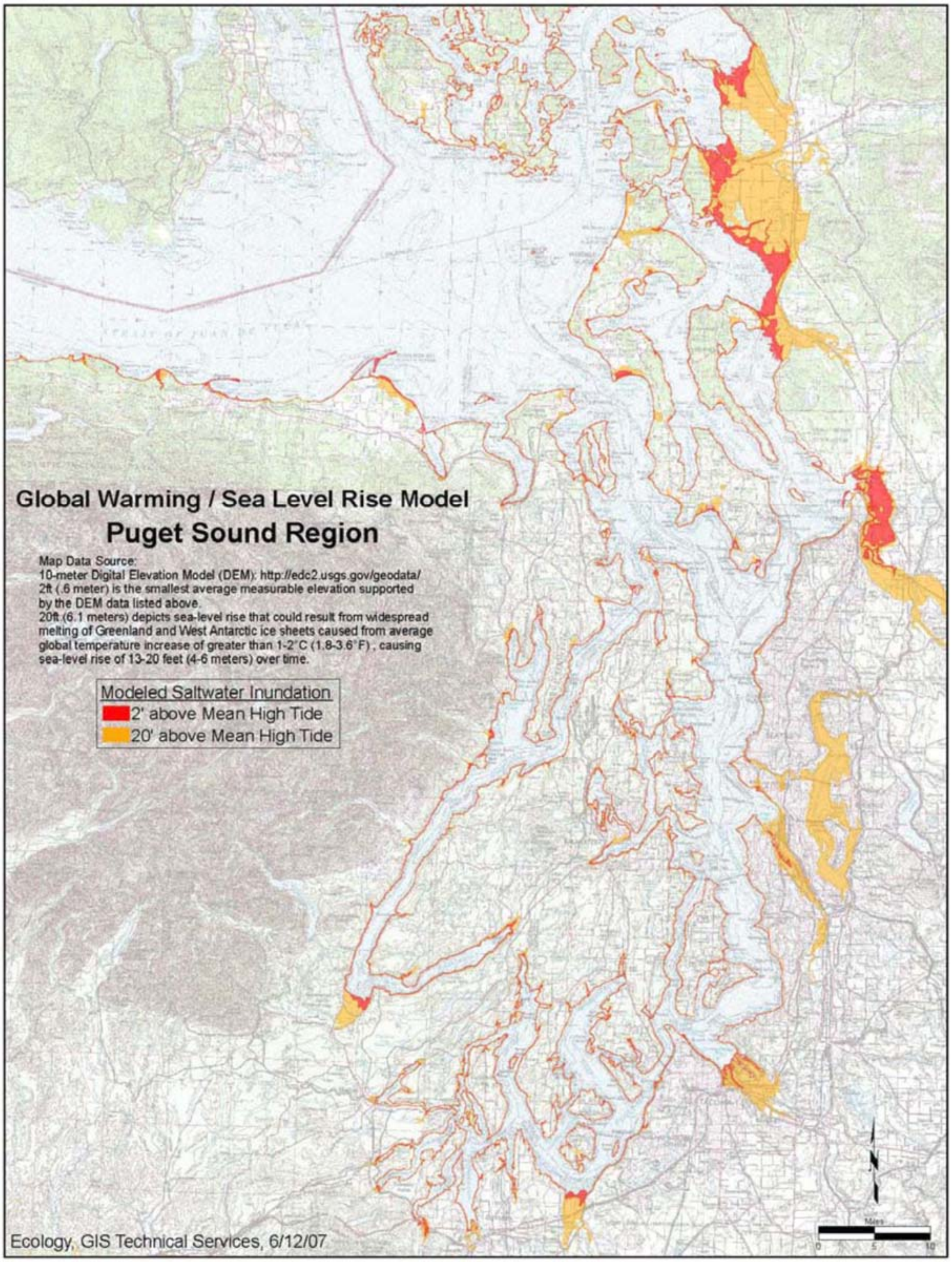


Figure 5-7. Washington State Department of Ecology Sea Level Rise Model (2007)

Frequency

In FEMA's *Multi-Hazard Identification and Risk Assessment Report*, coastal erosion is measured as the rate of change in the position or horizontal displacement of a shoreline over a specific period, measured in nits of feet or meters per year. Erosion rates vary as a function of shoreline type and are influenced primarily by episodic events. Monitoring of shoreline change based on a relatively short period of record does not always reflect actual conditions and can misrepresent long-term erosion rates. Shorelines that are accreting, stable or experiencing mild rates of erosion over a long period are generally considered as not subject to the erosion hazard. However, short-term and daily erosion can expose a segment of coast to an episodic storm event and associated erosion damage at any time.

Return periods for coastal erosion are difficult to determine due to limited information and the relatively short period of recorded data in most areas. Long-term patterns of coastal erosion are difficult to detect because of substantial coastline changes in the short-term (that is, over days or weeks from storms and natural tidal processes). It is usually severe short-term erosion events, occurring either singly or cumulatively over a few years, that cause concern and lead to attempts to influence the natural processes. Analysis of both long- and short-term shoreline changes are required to determine which is more reflective of the potential future shoreline configuration (FEMA, 1997).

Coastal erosion can occur from short-term daily, seasonal, or annual natural events such as waves, storm surge, wind, coastal storms, and flooding or from human activities including boat wakes and dredging. The most dramatic erosion often occurs during storms, because the highest energy waves are generated under storm conditions. Scores of meters of beach width can be lost in a few hours or days due to a severe storm (Keqi Zhang, Bruce Douglas, and Stephen Leatherman, 1997). Figure 5-8 shows a typical distribution of wave height and frequency.

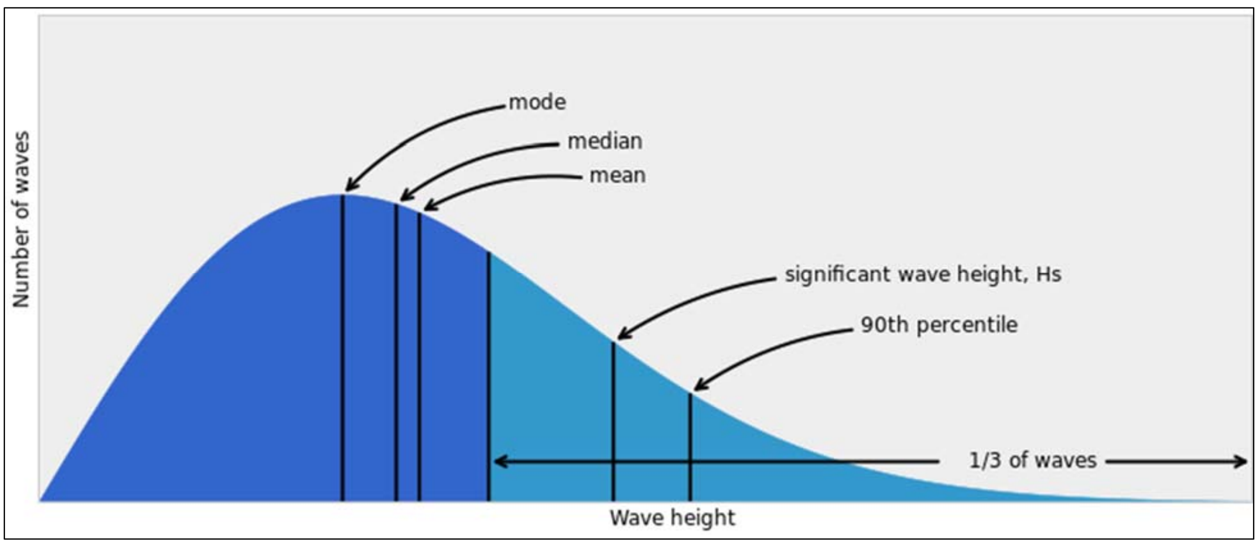


Figure 5-8. Statistical Wave Distribution

5.3 VULNERABILITY ASSESSMENT

5.3.1 Overview

Coastal erosion is exacerbated by multiple events. It is influenced by long-term climatic change effects such as sea-level rise, lack of sediment supply, subsidence, or long-term human factors such as the construction of shore protection structures and dams or aquifer depletion. As the sea level continues to rises, the shoreline will continue to be displaced inland, except where sufficient sediment accumulates to building the shoreline seaward. In coastal locations where a shortage of sediment is accompanied by sea-level rise, the problem is compounded with increased shoreline displacement.

As sea-level rise continues over the next century, it is expected to contribute significantly to physical changes along open-ocean shorelines. Anticipated sea-level rise will lead to many effects:

- Flooding of low-lying coastal areas
- Extension of flood zone areas inland
- Loss and/or displacement of coastal wetlands and other types of coastal habitats
- Accelerated erosion of beaches
- Dune line recession
- Saltwater contamination of drinking water
- Decreased longevity of low-lying roads, causeways, and bridges
- Displacement of coastal habitats
- Decreases in the ability of natural barrier, bay and wetland systems to maintain themselves, especially in light of human shoreline alterations.

Methodology

FEMA's publication on loss estimation for hazard mitigation planning (How-To 386-2) provides the following discussion about erosion losses:

> "…standard loss estimation models and tables for erosion damages are not available. As a result, you may wish to simplify your consideration of structure damage so that buildings are assumed to be either undamaged or severely damaged due to erosion. Although slight or moderate damage can occur due to erosion, the likelihood of this level of damage is considered small. Your estimated structure loss from erosion should be based on past experience, the location of the structure within the hazard area, rate of erosion, and the structure replacement value."

The level of impact in dollar loss values based on exposure could not be determined, as there are too many variables associated with potential scenarios. As such, only a qualitative assessment could be completed, providing general information. Over the course of the life cycle of this plan, the planning team will attempt to gather additional data which can be used to further enhance this hazard assessment in future updates. Based on historical evidence and events, the planning team determined that the probability for future issues associated with coastal erosion is high.

USGS Open-File Report 99-593 describes the development of a database for assessing coastal vulnerability. Six physical variables would be used to develop the coastal vulnerability index:

- Geomorphology
- Shoreline erosion and accretion rates (in meters per year)
- Coastal slope (in percent)
- Rate of relative sea-level rise (in millimeters per year)
- Mean tidal range (in meters)
- Mean wave height (in meters).

Figure 5-9 summarizes the ranking for these six variables. An atlas and a vulnerability index have been created, but only for Clallam County; no data is available for Island County coastlines. FEMA and Washington Department of Natural Resources are updating flood maps and hazard data for Island County and its planning partners. The County will work with those agencies to potentially obtain additional data such as this which will further identify vulnerable areas associated with this hazard.

	Ranking of coastal vulnerability index				
	Very low	Low	Moderate	High	Very high
VARIABLE	1	2	3	4	5
Geomorphology	Rocky, cliffed coasts Fiords Fiards	Medium cliffs Indented coasts	Low cliffs Glacial drift Alluvial plains	Cobble beaches Estuary Lagoon	Barrier beaches Sand Beaches Salt marsh Mud flats Deltas Mangrove Coral reefs
Coastal Slope (%)	> 1.9	1.3 – 1.9	0.9 – 1.3	0.6 –0.9	< .6
Relative sea-level change (mm/yr)	< -1.21	-1.21 – 0.1	0.1 – 1.24	1.24 –1.36	> 1.36
Shoreline erosion/ accretion (m/yr)	>2.0 Accretion	1.0 –2.0	-1.0 – +1.0 Stable	-1.1– -2.0	< - 2.0 Erosion
Mean tide range (m)	> 6.0	4.1 – 6.0	2.0 – 4.0	1.0 –1.9	< 1.0
Mean wave height (m)	<1.1	1.1 – 2.0	2.0 – 2.25	2.25 –2.60	>2.60

Figure 5-9. USGS Coastal Vulnerability Index

Warning Time

Coastal erosion is a gradual process, so structures threatened by it usually can be identified months to weeks before they are undermined and washed into the ocean. However, while a severe storm can be predicted days in advance, its impact on the coastline cannot. Depending on the severity of a storm, structures may be impacted more suddenly during severe weather events.

5.3.2 Impact on Life, Health and Safety

Population of the entire coastal area counts is exposed to coastal erosion. Sea level rise would increase wave height, increasing the rate and extent of erosion. Depending on the level of rise, population of some inland areas could be exposed to direct impact or secondary impact (such as loss of services or critical facilities). Figure 5-6 and Figure 5-7 identify potential seal level rise in the Puget Sound region as identified by the Washington Department of Ecology (2007).

Vulnerable populations are the elderly, low income or linguistically isolated populations, people with life-threatening illnesses, and residents of areas that are isolated from major roads. Coastal erosion can increase the risk of flooding and landslide activity, which can result in power outages which are life threatening to those dependent on electricity for life support. Isolation is a significant concern, as wave action can undercut roadways, or cause flooding, which impacts evacuation. Island County and its planning partners are making significant investments in infrastructure and facilities to better serve the needs of a growing population.

5.3.3 Impact on Property

Residential structures exist in areas which have the potential to be impacted by coastal erosion, especially in areas of high landslide risk and areas subject to storm surge. What had previously been only nuisance flooding resulting in a foot of water or less on roads, parking lots and yards and deposition of logs and debris may in the future be serious flooding with damage to residents and roadways. With each winter storm, further erosion will occur. Continued narrowing, lowering or rising of the shoreline will expose the County's shoreline to increasing erosion, thereby increasing the frequency of flooding of upland area due to storm-generated overwash during periods of elevated water.

5.3.4 Impact on Critical Facilities and Infrastructure

The County has limited critical facilities in the area subject to coastal erosion. Incapacity and loss of roads are the primary transportation failures resulting from coastal erosion. Secondary hazards resulting from erosion include flooding and landslides, which can cause significant damage, including to power lines, as well as blocking roads with debris, incapacitating transportation, isolating population, disrupting ingress and egress, and impacting the transportation system and the availability of public safety services. Of particular concern are roads providing access to isolated areas and to the elderly, reducing the ability to evacuate certain portions of the County. The flood and landslide profiles presented in later chapters of this hazard mitigation plan may be viewed for potential impacts, as the hazard assessment completed for both will provide additional information related to coastal erosion.

5.3.5 Impact on Economy

Economic impact from coastal erosion could be widespread. Cumulative economic effects larger than the sum of individual business sectors and regional effects may occur due to the interactions between industries and the economic sectors. With the increase in sea level rise further impacting coastal erosion, costly impacts on structures and infrastructure and loss of land mass will have a significant economic impact on the region. The loss of land mass alone would be significant as the county is surrounded by water. As structure losses continue, the potential for diminished tax base will increase.

Ferry terminals are generally resistant to sea level rise impacts or can accommodate rising sea levels with future terminal or loading ramp designs. Current closures due to low tides may not occur with higher sea levels. When terminals close now due to severe weather, vessels and users are rerouted to other terminals. The Eagle Harbor ferry maintenance facility is located near sea level. If this facility is inundated permanently, other options would need to be explored.

If rivers bring more debris into Puget Sound, operational expenses would need to be increased to clean out debris that could damage ferries or docks. Large waves that come over decks can move cars, and ferry elevators do not work if the vessel is rocked by large waves. With larger waves and more extreme storms, this risk may increase. With 4-foot and 6-foot sea levels, power lines to docks may be inundated.

5.3.6 Impact on Environment

Natural habitats, wildlife and aquatic life are all exposed and risk major impact. Severe weather events and high tides can increase the rate of erosion and redistribute sediment loads. Environmental vulnerability accompanying coastal erosion is also associated with the narrowing and lowering of the landmass, increasing potential flooding and landslides due to storm wave run-up and overtopping of the shoreline during periods of extreme high tides. Materials that erode can to be carried into inter-tidal areas, eventually significantly altering the ecosystem.

5.4 FUTURE DEVELOPMENT TRENDS

All future development in coast areas has the potential to be affected by coastal erosion storms. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. The County utilizes the International Building Code in an effort to keep its citizens as safe as possible from the impacts of the flooding and landslide hazard associated with coastal erosion.

The County recognizes the need to comprehensively address the serious and growing issue of coastal erosion due to Pacific Ocean storms and sea level rise. In recent decades, citizens have witnessed considerable coastal erosion damage and loss along all Washington coasts. In December 2014, a vacation home was lost in Clinton as a result of storm surge and associated coastal erosion. Such incidents will increase in number as sea level rise and costal erosion continues.

5.5 CLIMATE CHANGE IMPACTS

Coastal erosion may be a result of multi-year impacts and long-term climatic change such as sea-level rise, lack of sediment supply, subsidence, or long-term human factors such as the construction of shore protection structures and dams or aquifer depletion. As the sea level rises, the shoreline is displaced inland, except in those areas where sufficient sediment is accumulating to build the shoreline seaward. In coastal locations where a local shortage of sediment is accompanied by sea-level rise, the problem is compounded and the result is an increased rate of shoreline displacement.

Sea-level rise can lead to the flooding of low-lying coastal areas; extension of flood zone areas inland; loss and/or displacement of coastal wetlands and other types of coastal habitats; accelerated erosion of beaches; dune line recession; saltwater contamination of drinking water; decreased longevity of low-lying roads, causeways, and bridges; displacement of coastal habitats; and decreases in the ability of the natural barrier, bay, and wetland systems to maintain themselves, especially in light of present human shoreline alterations. As sea-level rise continues over the next century, it is expected to contribute significantly to physical changes along open-ocean shorelines. While it is widely believed that changes in sea level over the last century have had some role in shoreline change and land-loss along the coast, it has been difficult to quantify this relationship. The difficulty is due to the range of processes that affect coastal areas, the frequency at which coastal changes occur.

5.6 ISSUES

A worst-case event would involve prolonged high winds during a winter storm. Such an event would have both short-term and long-term effects. Some areas would experience limited ingress and egress as a result of potential flooding due to overwash. Prolonged rain would further increase flooding, overtopping culverts with increased levels of ponded water on roads. Wave action would increase landslides, especially in the high bluff areas, further increasing the severity associated with the event, especially as it relates to evacuation routes.

Coastal flooding is the secondary hazard most intensified by coastal erosion. However, erosion can also cause landslides and mudslides, as has happened frequently throughout Island County coastlines. Likewise, stream and river valleys may become vulnerable to slope failure as a result of erosion, often as a result of loss of cohesion in clay-rich soils. Building and road foundations lose load-bearing strength and may collapse as the ground beneath is washed away. Hazardous materials can be released as a result of structural integrity being compromised, causing significant damage to the environment and people.

Important issues associated with the potential impacts from coastal erosion in the planning area include the following:

- Climate change and the associated sea level rise increase the area eroded by wave action.
- Older building stock in the planning area is built to lower code standards. These structures could be highly vulnerable to the impacts of coastal erosion through increased potential for flooding.

- Roadways running along shorelines or along bluff areas are susceptible to failure if the ground beneath them is eroded.
- Redundancy of power supply must be evaluated.
- The planning area has several isolated population centers.

CHAPTER 6.
DAM FAILURE

6.1 GENERAL BACKGROUND

A dam is defined as any artificial barrier and/or any controlling works, together with appurtenant works, that can or does impound or divert water. A Dam Failure is any uncontrolled release of impounded water due to structural deficiencies in dam.

DEFINITIONS

Dam— Any artificial barrier and/or any controlling works, together with appurtenant works, that can or does impound or divert water.

Dam Failure— An uncontrolled release of impounded water due to structural deficiencies in dam.

Emergency Action Plan— A document that identifies potential emergency conditions at a dam and specifies actions to be followed to minimize property damage and loss of life. The plan specifies actions the dam owner should take to alleviate problems at a dam. It contains procedures and information to assist the dam owner in issuing early warning and notification messages to responsible downstream emergency management authorities of the emergency situation. It also contains inundation maps to show emergency management authorities the critical areas for action in case of an emergency.

High Hazard Dam—Dams where failure or operational error will probably cause loss of human life.

Significant Hazard Dam—Dams where failure or operational error will result in no probable loss of human life but can cause economic loss, environmental damage or disruption of lifeline facilities, or can impact other concerns. Significant hazard dams are often located in rural or agricultural areas but could be located in areas with population and significant infrastructure.

6.1.1 Causes of Dam Failure

Dam failures in the United States typically occur in one of four ways (see Figure 6-1):

- Overtopping of the primary dam structure, which accounts for 34 percent of all dam failures, can occur due to inadequate spillway design, settlement of the dam crest, blockage of spillways, and other factors.
- Foundation defects due to differential settlement, slides, slope instability, uplift pressures, and foundation seepage can also cause dam failure. These account for 30 percent of all dam failures.

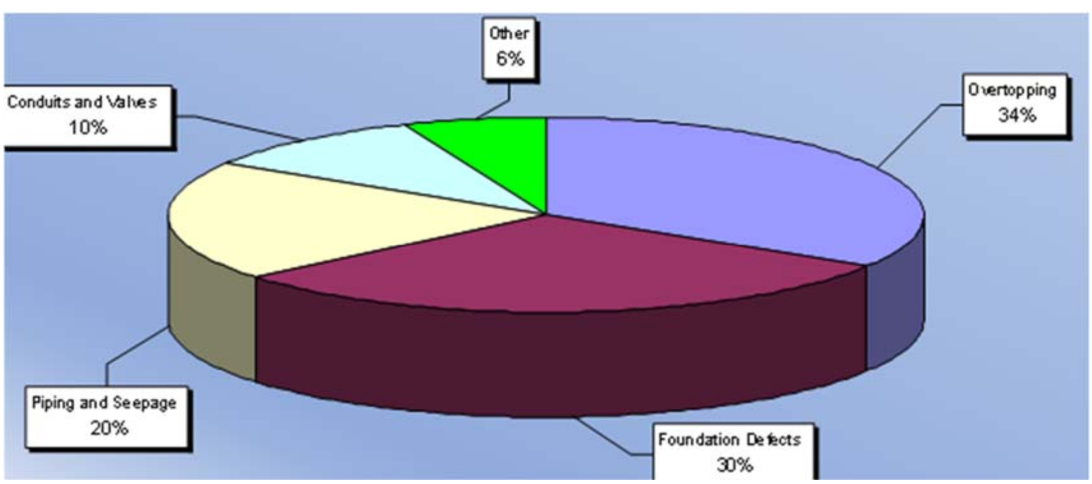


Figure 6-1. Historical Causes of Dam Failure

- Failure due to piping and seepage accounts for 20 percent of all failures. These are caused by internal erosion due to piping and seepage, erosion along hydraulic structures such as spillways, erosion due to animal burrows, and cracks in the dam structure.
- Failure due to problems with conduits and valves, typically caused by the piping of embankment material into conduits through joints or cracks, constitutes 10 percent of all failures.

The remaining 6 percent of U.S. dam failures are due to miscellaneous causes. Many dam failures in the United States have been secondary results of other disasters. The prominent causes of the dam failures are earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage. Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections. Terrorism and vandalism are serious concerns that all operators of public facilities must plan for; these threats are under continuous review by public safety agencies.

6.1.2 Regulatory Oversight

Federal Dam Safety Program

The potential for catastrophic flooding due to dam failures led to passage of the National Dam Safety Act (Public Law 92-367). The National Dam Safety Program requires a periodic engineering analysis of every major dam in the country. The goal of this effort is to identify and mitigate the risk of dam failure so as to protect the lives and property of the public.

The U.S. Army Corps of Engineers is responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act. The Corps has inventoried dams; surveyed each state and federal agency's capabilities, practices and regulations regarding design, construction, operation and maintenance of the dams; and developed guidelines for inspection and evaluation of dam safety (U.S. Army Corps of Engineers, 1997).

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) has the largest dam safety program in the United States. The FERC cooperates with a large number of federal and state agencies to ensure and promote dam safety and, more recently, homeland security. There are in excess of 3,000 dams that are part of regulated hydroelectric projects and in the FERC program. Two-thirds of these are more than 50 years old. As dams age, concern about their safety and integrity grows, so oversight and regular inspection are important. FERC staff inspects hydroelectric projects on an unscheduled basis to investigate the following:

- Potential dam safety problems
- Complaints about constructing and operating a project
- Safety concerns related to natural disasters
- Issues concerning compliance with the terms and conditions of a license.

Every five years, an independent consulting engineer, approved by the FERC, must inspect and evaluate projects with dams higher than 32.8 feet, or with a total storage capacity of more than 2,000 acre-feet.

FERC staff monitors and evaluates seismic research in geographic areas where there are concerns about seismic activity. This information is applied in investigating and performing structural analyses of hydroelectric projects in these areas. FERC staff also evaluates the effects of potential and actual large floods on the safety of dams. During and following floods, FERC staff visits dams and licensed projects, determines the extent of damage, if any, and directs any necessary studies or remedial measures the licensee must undertake. The FERC publication *Engineering Guidelines for the Evaluation of Hydropower Projects* guides the FERC engineering staff and licensees in evaluating dam safety. The publication is frequently revised to reflect current information and methodologies.

The FERC requires licensees to prepare emergency action plans and conducts training sessions on how to develop and test these plans. The plans outline an early warning system if there is an actual or potential sudden release of water from a dam due to failure. The plans include operational procedures that may be used, such as reducing reservoir levels and reducing downstream flows, as well as procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and tested to ensure that everyone knows what to do in emergency situations.

Washington Department of Ecology Dam Safety Guidelines

The first dam safety law in Washington was passed as part of the state water code in 1917 (RCW 90.03.350) This law required that engineering plans for any dam that could impound 10 or more acre-feet had to be reviewed and approved by the state before construction could begin. Over the years, the Department of Conservation and Development, then the Department of Water Resources performed this function. In 1970, responsibility transferred to the new Department of Ecology. Ecology’s Dam Safety Office currently oversees 996 of the 1,125 dams across the state. With current staffing, it is anticipated that high hazard dam inspections will occur on a 6-year cycle and significant hazard dam inspections will occur on a 12-year cycle. These periods are longer than what federal dam safety guidelines recommend.

Over 370 dams in Washington do not meet the National Inventory of Dam requirements but do fall under the state’s 10-acre-foot criterion. Through plan reviews and construction inspections, Ecology helps ensure that these facilities are properly designed and constructed. The age of dams in Washington varies from 11 dams constructed pre-1900, to more than 50 dams completed since 2000. The age of a dam is a factor in stability, as many dams are constructed for a specified number of years, and the integrity of the materials used to construct the dam may deteriorate over time.

6.2 HAZARD PROFILE

6.2.1 Extent and Location

Island County has 13 dams listed by the Washington Department of Ecology, as shown in Figure 6-2. Four of those dams are for wastewater lagoons owned by the City of Oak Harbor. The remainder are privately owned. Three have a hazard rating designation of 1C (meaning 7 to 30 lives at risk, with a *High* hazard class rating; see discussion on dam classification system below); one has a hazard rating of 2 (meaning 1 to 6 lives at risk, with a *Significant* hazard class rating); and the remainder have hazard rating of 3 (meaning no lives are at risk, with a *Low* hazard class rating). Table 6-1 lists the dams in Island County.

The oldest dam was constructed in 1958 on the Loers Reservoir at Whidbey Golf and Country. Minckler Dams A and B were built in 1975, and both have a 1C rating. New inundation studies should be performed for both dams, since a fair amount of construction has occurred in the area since the dams were built.

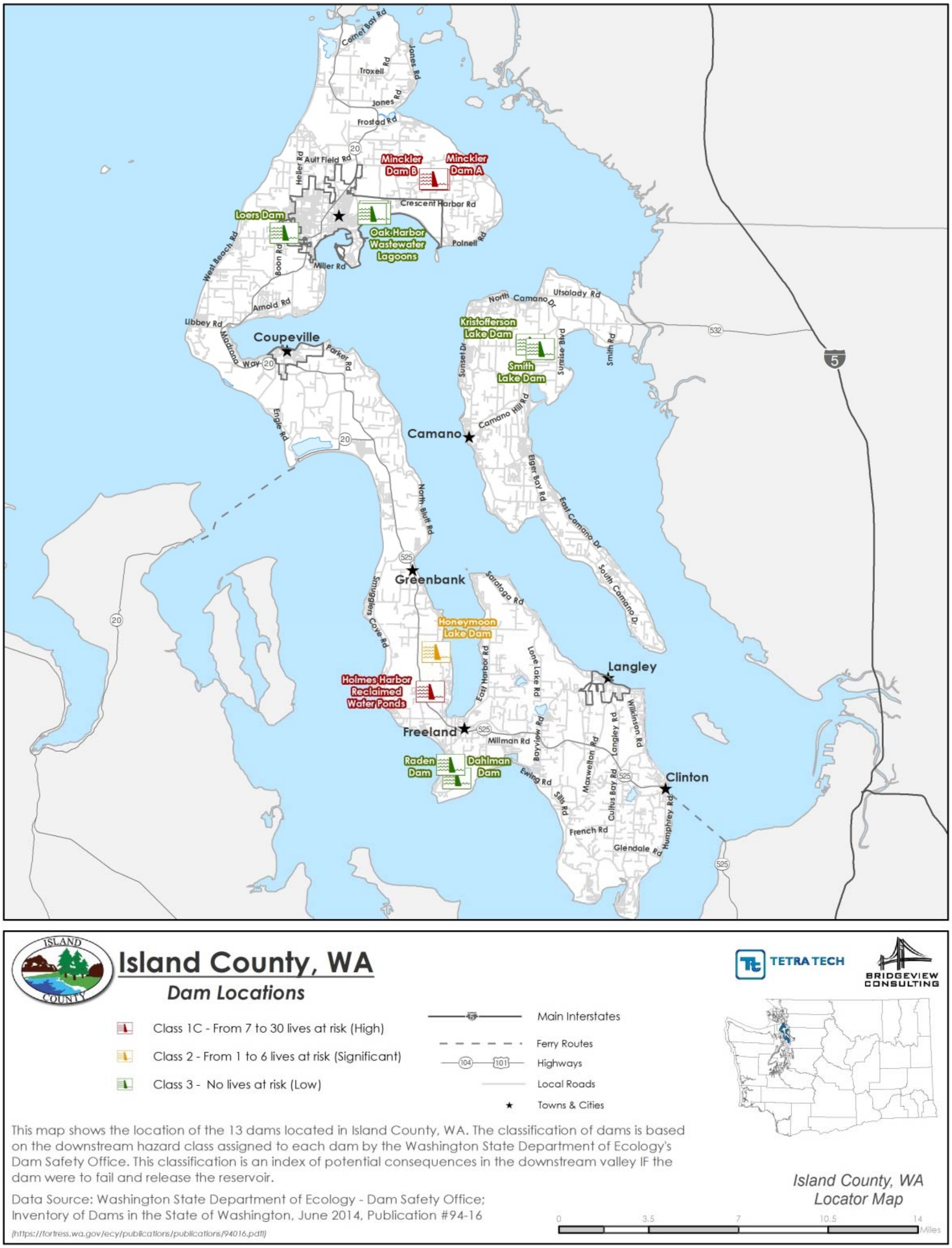


Figure 6-2. Island County Dam Locations

**TABLE 6-1.
WASHINGTON STATE DEPARTMENT OF ECOLOGY DAM CATEGORIZATION**

NAME OF DAM		NAME OF OWNER			STATE ID	NATIONAL ID	YR COMPLETED	HAZARD CLASS
RIVER OR STREAM		IMPOUNDMENT NAME			LATITUDE	LONGITUDE	SEC TWN RNGE	WRIA
DAM TYPES	RESERVOIR PURPOSES	CREST LEN	DAM HT	SURFACE AREA	STORAGE	MAX STORAGE	MAX DISCHARGE	DRAINAGE AREA
Dam Inventory for Island County								Counties: 39/39, Dams: 1141/1141
Dahlman Dam		Tinyblue Foundation			IS6-1158	WA01158	1971	3
Tr-Mutiny Bay		unnamed			47.9813340 deg	122.53135 deg	T29 NR02 ES22	6
RE	R	265 ft	12 ft	8.0 acres	8 acre-ft	12 acre-ft	0 cfs	0.02 sq mi
Holmes Harbor Reclaimed Water Ponds		Holmes Harbor Sewer District			IS6-1952	WA01952	1994	1C
Offstream		Holmes Harbor Reclaimed Water Ponds			48.0295930 deg	122.555397 deg	T00 NR00 S00	6
RE	Q	2200 ft	50 ft	3.8 acres	38 acre-ft	50 acre-ft	0 cfs	0.01 sq mi
Honeymoon Lake Dam		Honeymoon Lake Community Club			IS6-203	WA00203	1969	2
Tr-Honeymoon Bay		Honeymoon Lake			48.0520660 deg	122.55113 deg	T30 NR02 ES28	6
RE	R	380 ft	22 ft	7.0 acres	42 acre-ft	54 acre-ft	200 cfs	1.84 sq mi
Kristofferson Lake Dam		Kristofferson Farm LLC			IS6-138	WA00138	1961	3
Tr-Triangle Cove		Kristofferson Lake			48.2270080 deg	122.478479 deg	T32 NR03 ES30	6
RE	I, R	150 ft	7 ft	53.0 acres	100 acre-ft	125 acre-ft	0 cfs	1.12 sq mi
Loers Dam		Whidbey Golf & Country Club			IS6-157	WA00157	1958	3
Tr-Puget Sound		Loers Reservoir			48.2863460 deg	122.688783 deg	T32 NR01 ES04	6
RE	I, R	1500 ft	9 ft	10.0 acres	37 acre-ft	51 acre-ft	54 cfs	2.50 sq mi
Minckler Dam A		Sherwood Minckler			IS6-1884	WA01884	1975	1C
Unnamed Trib- Cresent Harbor		Minckler Pond A			48.3184750 deg	122.5621 deg	T33 NR02 ES28	6
RE	R	200 ft	9 ft	1.6 acres	11 acre-ft	14 acre-ft	5 cfs	0.04 sq mi
Minckler Dam B		Sherwood Minckler			IS6-691	WA00691	1975	1C
Unnamed Trib - Cresent Harbor		Minckler Pond B			48.3188130 deg	122.56389 deg	T33 NR02 ES28	6
RE	R	500 ft	18 ft	3.0 acres	24 acre-ft	28 acre-ft	9 cfs	0.08 sq mi
Oak Harbor Wastewater Lagoon - NE Cell		Oak Harbor City			IS6-596	WA00596	1990	3
Tr-Crescent Harbor-Offstream		Oak Harbor Wastewater Lagoon - NE Cell			48.2995170 deg	122.611355 deg	T33 NR02 ES31	6
RE	Q	1550 ft	8 ft	5.9 acres	40 acre-ft	43 acre-ft	1 cfs	0.01 sq mi
Oak Harbor Wastewater Lagoon - NW Cell		Oak Harbor City			IS6-595	WA00595	1990	3
Tr-Crescent Harbor-Offstream		Oak Harbor Wastewater Lagoon - NW Cell			48.2999030 deg	122.613495 deg	T33 NR02 ES31	6
RE	Q	2700 ft	8 ft	8.2 acres	50 acre-ft	60 acre-ft	1 cfs	0.01 sq mi
Oak Harbor Wastewater Lagoon - SE Cell		Oak Harbor City			IS6-1673	WA01673	1990	3
Tr-Crescent Harbor-Offstream		Oak Harbor Wastewater Lagoon - SE Cell			48.2985580 deg	122.611323 deg	T33 NR02 ES31	6
RE	Q	1490 ft	8 ft	3.0 acres	17 acre-ft	20 acre-ft	1 cfs	0.01 sq mi
Oak Harbor Wastewater Lagoon - SW Cell		Oak Harbor City			IS6-597	WA00597	1990	3
Tr-Crescent Harbor-Offstream		Oak Harbor Wastewater Lagoon - SW Cell			48.2982380 deg	122.615063 deg	T33 NR02 ES31	6
RE	Q	2550 ft	8 ft	8.2 acres	50 acre-ft	60 acre-ft	1 cfs	0.01 sq mi
Raden Dam		Paul Raden Trust			IS6-1138	WA01138	1968	3
Tr-Mutiny Bay		unnamed			47.9888670 deg	122.536647 deg	T29 NR02 ES22	6
RE	R	365 ft	14 ft	15.0 acres	15 acre-ft	23 acre-ft	150 cfs	0.61 sq mi
Smith Lake Dam_Island Co		Cominco American Inc			IS6-1575	WA01575	1970	3
Tr-Triangle Cove		Smith Lake			48.2245000 deg	122.470089 deg	T32 NR03 ES31	6
RE	R	180 ft	9 ft	17.0 acres	36 acre-ft	48 acre-ft	20 cfs	0.00 sq mi

6.2.2 Previous Occurrences

According to the Washington State Enhanced Hazard Mitigation Plan (2013), Washington State Department of Ecology has reported 15 dam-failure events since 1918, none of which impacted Island County. The closest dam failure to the planning area occurred in December 1967 in Everett, when a 40-foot high dam washed out by overtopping due to lack of spillway. After the initial failure in 1967, a 25-foot high dam was rebuilt in its stead, but that also failed. As a result of the dam failure, water washed out Great Northern railroad tracks, which derailed a passing train.

The deadliest Washington State dam failure occurred in 1932 near North Bend, when a slide caused water to back up and the Eastwick Railroad fill dam to fail, killing seven people. The second deadliest occurred in July 1976 near Auburn when a surge in flow caused by increased discharge from Mud Mountain Dam and removal of flashboards at Diversion Dam killed two children playing in the White River.

6.2.3 Severity

The Washington Dam Safety Program classifies dams and reservoirs in a three-tier hazard rating system based solely on the potential consequences to downstream life and property that would result from a failure of the dam and sudden release of water (Washington State Department of Ecology Dam Safety Web Site, 2013). An alphanumeric code is used as an index of potential consequences in the downstream valley if a dam were to fail and release its reservoir:

- **High Hazard**—A high-hazard means that if failure were to occur, the consequences likely would be a direct loss of human life and extensive property damage. All high-hazard dams must be properly designed and at all times responsibly maintained and operated. An up-to-date Emergency Action Plan is a requirement for all owners of high-hazard dams. The Department of Ecology assigns three alpha-numeric codes to the High Hazard category:
  - 1A = Greater than 300 lives at risk
  - 1B= From 31 to 300 lives at risk
  - 1C= From 7 to 30 lives at risk.
- **Significant Hazard**—Significant hazard dams are those whose failure would result in significant risk. The following alpha-numeric code is assigned to this hazard class:
  - 2 = From 1 to 6 lives at risk.
- **Low Hazard**—Low hazard dams typically are located in sparsely populated areas that would be largely unaffected by a breach of the dam. Although the dam and appurtenant works may be totally destroyed, damage to downstream property would be restricted to undeveloped land with minimal impacts to existing infrastructure. The following alpha-numeric code is assigned to this hazard class:
  - 3 = No lives at risk.

Flood severity from a dam failure can be measured as low, medium or high:

- Low severity—No buildings are washed off their foundations; structures are exposed to depths of less than 10 feet.
- Medium severity—Homes are destroyed but trees or mangled homes remain for people to seek refuge in or on; structures are exposed to depths of more than 10 feet.
- High severity—Locations are flooded by a near instantaneous failure of a concrete dam or an earth-fill dam that washes out in seconds rather than minutes or hours. The flooding caused by the dam failure sweeps the area clean and little or no evidence of the prior human habitation remains after the floodwater recedes (Graham, 1999).

Two factors that influence the potential severity of dam failure are the amount of water impounded and the density, type and value of development and infrastructure downstream. The U.S. Army Corps of Engineers classifies potential hazards of dam failure as summarized in Table 6-2.

6.2.4 Frequency

Dam failure events are infrequent and usually coincide with events that cause them, such as earthquakes, landslides and excessive rainfall and snowmelt. There is a “residual risk” associated with dams, which is the risk that remains after safeguards have been implemented. For dams, the residual risk is associated with events beyond those that the facility was designed to withstand. However, the probability of any type of dam failure is low in today’s regulatory environment.

**TABLE 6-2.
CORPS OF ENGINEERS HAZARD POTENTIAL CLASSIFICATION**

Hazard Category (*a)	Direct Loss of Life (*b)	Lifeline Losses (*c)	Property Losses (*d)	Environmental Losses (*e)
Low - 3	None (rural location, no permanent structures for human habitation)	No disruption of services (cosmetic or rapidly repairable damage)	Private agricultural lands, equipment, and isolated buildings	Minimal incremental damage
Significant - 2	Rural location, only transient or day-use facilities	Disruption of essential facilities and access	Major public and private facilities	Major mitigation required
High – 1 A, B, C	Certain (one or more) extensive residential, commercial, or industrial development	Disruption of essential facilities and access	Extensive public and private facilities	Extensive mitigation cost or impossible to mitigate

a. Categories are assigned to overall projects, not individual structures at a project.
b. Loss of life potential based on inundation mapping of area downstream of the project. Analyses of loss of life potential should take into account the population at risk, time of flood wave travel, and warning time.
c. Indirect threats to life caused by the interruption of lifeline services due to project failure or operational disruption; for example, loss of critical medical facilities or access to them.
d. Damage to project facilities and downstream property and indirect impact due to loss of project services, such as impact due to loss of a dam and navigation pool, or impact due to loss of water or power supply.
e. Environmental impact downstream caused by the incremental flood wave produced by the project failure, beyond what would normally be expected for the magnitude flood event under which the failure occurs.

Source: U.S. Army Corps of Engineers, 1995

6.3 VULNERABILITY ASSESSMENT

6.3.1 Overview

Historically, the owner of a dam is responsible for developing an inundation map, which is used in determining exposure to a potential dam failure or breech during development of dam response plans. Presently, no such information is available for any of the dams in Island County.

Methodology

The Hazus-MH model can estimate the number and value of structures in a mapped dam failure inundation zone. However, no inundations maps are available for any of the dams. As a result, such analysis is not possible for this plan. Future mapping, if performed, will be used to enhance this portion of the risk assessment during the next update of the plan.

Warning Time

Warning time for dam failure varies depending on the cause of the failure. In events of extreme precipitation or massive snowmelt, evacuations can be planned with sufficient time. In the event of a structural failure due to earthquake, there may be no warning time. A dam’s structural type also affects warning time. Earthen dams do not tend to fail completely or instantaneously. Once a breach is initiated, discharging water erodes the breach until either the reservoir water is depleted or the breach resists further erosion. Concrete dams also tend to have a partial breach as one or more monolith sections are forced apart by escaping water. The time of breach formation ranges from a few minutes to a few hours (U.S. Army Corps of Engineers, 1997).

6.3.2 Impact on Life, Health and Safety

All populations in a dam failure inundation zone would be exposed to the risk of a dam failure. The potential for loss of life is affected by the capacity and number of evacuation routes available to populations living in areas of potential inundation. No maps from dam owners are available for public dissemination. Therefore, it is not possible to estimate the population living within the inundation zone beyond the information designated in the dam classification analysis described in Sections 6.2.1 and 6.2.3. Of significant concern is the potential for a scenario requiring evacuation of an impacted area. For much of Island County, there are multiple route options for evacuation purposes, but there are some areas of the County where evacuation would be very difficult, such as Deception Pass from Whidbey Island.

The Holmes Harbor Reclaimed Water Pond is a Class 1C dam (high-risk classification, with the potential of 7-30 lives at risk). Should a breach or dam failure occur, it has the potential to impact Highway 525 between Freeland and Greenback. While other dams exist near major transportation routes, the Holmes Harbor dam should be taken into consideration for evacuation planning.

Vulnerable populations are all populations downstream from dam failures that are incapable of escaping the area within an allowable time frame. This population includes the elderly and young who may be unable to get themselves out of the inundation area. All three of the Class 1C dams (high risk) are in areas with a high population of elderly. Fewer young children (under 5) reside within the area of the Holmes Harbor Reclaimed Water Pond, but a significant number are within the area of both Minckler Dams.

The vulnerable population also includes those who would not have adequate warning from a television or radio emergency warning system. Over 20 percent of the population within the region consists of retirees and/or individuals over 65 years within each household, a higher percent than the rest of the state of Washington. In addition, the region has a relatively large transient population, increasing significantly the population vulnerable to hazard impact. Those unfamiliar with the area would have difficulty evacuating if such a need arose, taxing local response capabilities. This is especially true of island communities, which, if roadways were unpassable, require much longer travel times or evacuation using the ferry systems.

6.3.3 Impact on Property

Vulnerable properties are those closest to the dam inundation area. These properties would experience the largest, most destructive surge of water. Low-lying areas are also vulnerable since they are where the dam waters would collect. Transportation routes are vulnerable to dam inundation and have the potential to be wiped out, creating isolation issues. This includes all roads, railroads and bridges in the path of the dam inundation. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utilities such as overhead power lines, cable and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas.

GIS analysis can determine the amount of building stock in a mapped inundation area, but there are no inundation studies available for the dams in Island County as they are protected from public disclosure due to the potential threat associated with the dams. Without the ability to perform an inundation study, it is not possible to estimate property losses from a dam failure as a whole that could affect the planning area

While no dam failure inundation studies are available at this time, dam inundation areas may in some instances coincide with flood hazard areas. Review of the flood profile in Section 9.2 provides a general concept of structures at risk, although, based on the size of the dam, damage would vary. As development occurs downstream of dams, it is necessary to review the dams' emergency action plans and inundation maps to determine whether the dams require reclassification based on the established standards. The County will continue to work with dam owners in the area to gain information for high-hazard dams over the course of the next update.

6.3.4 Impact on Critical Facilities and Infrastructure

There are no dam inundation maps available to determine critical facilities at risk. The flood profile in Section 9.2 provides a general concept of critical facilities and infrastructure at risk, although, based on the size of the dam, damage would vary. Island County has identified working with dam owners to secure updated inundation maps as a strategy for this hazard mitigation plan. Once developed, that information will be used to conduct analysis during the next (2020) update of the plan. As the 2015 edition of the plan update does include enhanced critical facilities data within the Hazus modeling tool, once inundation studies are obtained from the dam owners, the assessment of critical facility vulnerability will be greatly enhanced.

6.3.5 Impact on the Economy

Urban growth areas and employment growth are planning elements under the Growth Management Act (GMA). The largest employer in the region is Naval Air Station Whidbey Island (NASWI) in Oak Harbor. At present, the information contained within reviewed reports when compared to the growth of the area presents a consistent ratio to allow for continued economic growth, with little impact from dam inundation. Based on these findings, Island County and its planning partners appear to be well equipped to deal with future economic growth and development, taking into consideration the critical areas ordinance as it relates to dam failure flooding.

6.3.6 Impact on the Environment

Lagoons and reservoirs held behind dams affect many ecological aspects of a river or other water body. River topography and dynamics depend on a wide range of flows, but rivers below dams often experience long periods of very stable flow conditions or saw-tooth flow patterns caused by periodic releases. Water releases from dams usually contain very little suspended sediment; this can lead to scouring of river beds and banks.

Inundation in the event of dam failure could introduce foreign elements into local waterways. This could result in destruction of downstream habitat and could have detrimental effects on many species of animals, especially endangered species such as salmon.

6.4 FUTURE DEVELOPMENT TRENDS

As inundation studies are not available to determine damage from dam failure, in some instances the dam inundation zone is similar to the flood inundation zone, and similar land use trends can be used to mitigate the impacts from dam failure.

Island County and its planning partner cities are subject to the provisions of the Washington GMA, which regulates identified critical areas. Island County critical areas regulations include frequently flooded areas, defined as the FEMA 100-year mapped floodplain. (Those floodplains are currently in the review and update process by FEMA under the RiskMAP program.) The GMA establishes review and evaluation programs that monitor commercial, residential and industrial development and the densities at which this development has occurred under each jurisdiction’s comprehensive plan and development regulations. While adjustments to initial population forecasts were made as a result of increased population on NASWI, projections have remained consistent with that assessed during the mid-point of the GMA reports. An evaluation of projected populations and land use trends is required at least every eight years to determine the sufficiency of the remaining land within urban growth areas to accommodate projected residential, commercial and industrial growth at development densities observed since the adoption of GMA plans. Island County is required to submit an updated comprehensive plan by June 30, 2016, and every eight years thereafter.

The Comprehensive Plan includes a buildable lands report which compares planned versus actual urban densities with respect to land use in order to determine whether original plan assumptions were accurate. The Comprehensive Plan excludes areas designated as "critical areas" from consideration as buildable lands, due to the scope of regulations affecting them. While some floodplains in the planning area can be developed, they are subject to regulatory provisions in the codes of Island County and its partner cities. The buildable lands analysis assumes that these regulations will discourage development from these areas. The County is in the process of updating its Comprehensive Plan under the GMA. Information contained in this analysis will be utilized during the Comprehensive Plan update and as future development occurs in the vicinity of the existing dams.

6.5 CLIMATE CHANGE IMPACTS

Dams are designed partly based on assumptions about a river's flow behavior, expressed as hydrographs. Changes in weather patterns can have significant effects on the hydrograph used for the design of a dam. If the hygrograph changes, it is conceivable that the dam can lose some or all of its designed margin of safety, also known as freeboard. If freeboard is reduced, dam operators may be forced to release increased volumes earlier in a storm cycle in order to maintain the required margins of safety. Such early releases of increased volumes can increase flood potential downstream. Throughout the west, communities downstream of dams are already seeing increases in stream flows from earlier releases from dams.

Dams are constructed with safety features known as "spillways." Spillways are put in place on dams as a safety measure in the event of the reservoir filling too quickly. Spillway overflow events, often referred to as "design failures," result in increased discharges downstream and increased flooding potential. Although climate change will not increase the probability of catastrophic dam failure, it may increase the probability of design failures.

6.6 ISSUES

An earthquake in the region could lead to liquefaction of soils around a dam. This could occur without warning during any time of the day. A human-caused failure such as a terrorist attack also could trigger a catastrophic failure of a dam that impacts the planning area. While the probability of dam failure is very low, the probability of flooding associated with changes to dam operational parameters in response to climate change is higher.

Dam designs and operations are developed based on hydrographs with historical record. If these hydrographs experience significant changes over time due to the impacts of climate change, the design and operations may no longer be valid for the changed condition. This could have significant impacts on dams that provide flood control. Specified release rates and impound thresholds may have to be changed. This would result in increased discharges downstream of these facilities, thus increasing the probability and severity of flooding.

Flooding as a result of a dam failure would significantly impact properties and populations in the inundation zone. There is often limited warning time for dam failure. These events are frequently associated with other natural hazard events such as earthquakes, tsunamis, landslides or other severe weather, which limits their predictability and compounds the hazard.

Important issues associated with dam failure hazards include the following:

- Federally regulated dams have an adequate level of oversight and sophistication in the development of emergency action plans for public notification in the unlikely event of failure. However, the protocol for notifying downstream citizens of imminent failure needs to be tied to local emergency response planning. Presently, the County has no dam safety plans in place, but it does recognize the need for such, and has included a mitigation strategy to begin addressing this issue over the life cycle of this hazard mitigation plan by working with the dam owners to develop such plans, if none currently exist.

- Mapping for non-federal-regulated dams that estimates inundation depths is needed to better assess the risk associated with dam failure from these facilities. Currently, after diligent search, no maps could be found which could be utilized for mitigation planning.
- Most dam failure mapping required at federal levels requires determination of the probable maximum flood. While the probable maximum flood represents a worst-case scenario, it is generally the event with the lowest probability of occurrence. For non-federal-regulated dams, mapping of dam failure scenarios that are less extreme than the probable maximum flood but have a higher probability of occurrence can be valuable to emergency managers and community officials downstream of these facilities. This type of mapping can illustrate areas potentially impacted by more frequent events to support emergency response and preparedness.
- The concept of residual risk associated with structural flood control projects should be considered in the design of capital projects and the application of land use regulations.
- Addressing security concerns and the need to inform the public of the risk associated with dam failure is a challenge for local officials, and some form of emergency response plan should be in place to address this issue prior to any potential occurrence.

CHAPTER 7.
DROUGHT

7.1 GENERAL BACKGROUND

Droughts originate from a deficiency of precipitation resulting from an unusual weather pattern. If the weather pattern lasts a short time (a few weeks or a couple months), the drought is considered short-term. If the weather pattern becomes entrenched and the precipitation deficits last for several months or years, the drought is considered to be long-term. It is possible for a region to experience a long-term circulation pattern that produces drought, and to have short-term changes in this long-term pattern that result in short-term wet spells. Likewise, it is possible for a long-term wet circulation pattern to be interrupted by short-term weather spells that result in short-term drought.

Drought is a prolonged period of dryness severe enough to reduce soil moisture, water and snow levels below the minimum necessary for sustaining plant, animal and economic systems. Droughts are a natural part of the climate cycle. For this plan, the County has elected to use Washington's statutory definition of drought (RCW Chapter 43.83B.400), which is based on both of the following conditions occurring:

> **DEFINITIONS**
>
> **Drought**—The cumulative impacts of several dry years on water users and agricultural producers. It can include deficiencies in surface and subsurface water supplies and cause impacts to health, well-being, and quality of life.
>
> **Hydrological Drought**—Deficiencies in surface and subsurface water supplies.
>
> **Socioeconomic Drought**—Drought impacts on health, well-being and quality of life.

- The water supply for the area is below 75 percent of normal.
- Water uses and users in the area will likely incur undue hardships because of the water shortage.

7.2 HAZARD PROFILE

7.2.1 Extent and Location

Drought can have a widespread impact on the environment and the economy, depending upon its severity, although it typically does not result in loss of life or damage to property, as do other natural disasters. The National Drought Mitigation Center uses three categories to describe likely drought impacts:

- Agricultural—Drought threatens crops that rely on natural precipitation, while also increasing the potential for infestation.
- Water supply—Drought threatens supplies of water for irrigated crops, for communities and for fish and salmon and other species of wildlife.
- Fire hazard—Drought increases the threat of wildfires from dry conditions in forest and rangelands.

In Washington, where hydroelectric power plants generate nearly three-quarters of the electricity produced, drought also threatens the supply of electricity. Unlike most disasters, droughts normally occur slowly but last a long time. Drought conditions occur every few years in Washington. The droughts of 1977 and 2001 (discussed below), the worst and second worst in state history, provide good examples of how drought can affect the state.

On average, the nationwide annual impacts of drought are greater than the impacts of any other natural hazard. They are estimated to be between $6 billion and $8 billion annually in the United States and occur primarily in the agriculture, transportation, recreation and tourism, forestry, and energy sectors. Social and environmental impacts are also significant, although it is difficult to put a precise cost on these impacts. From 1987 to 1989, losses from drought in the U.S. totaled $39 billion (OTA, 1993).

Drought affects groundwater sources, but generally not as quickly as surface water supplies, although groundwater supplies generally take longer to recover. Reduced precipitation during a drought means that groundwater supplies are not replenished at a normal rate. This can lead to a reduction in groundwater levels and problems such as reduced pumping capacity or wells going dry. Shallow wells are more susceptible than deep wells. About 16,000 drinking water systems in Washington get water from the ground; these systems serve about 5.2 million people. Reduced replenishment of groundwater affects streams. Much of the flow in streams comes from groundwater, especially during the summer when there is less precipitation and after snowmelt ends. Reduced groundwater levels mean that even less water will enter streams when steam flows are lowest.

The County's lack of rivers, streams, large lakes and reservoirs means that wells and aquifers that supply these water sources are impacted when rainfall does not replenish groundwater. The island nature of the county also means that wells are subject to saltwater intrusion.

Most areas of the County, except Oak Harbor and NASWI, depend on well water, which currently supplies over 70 percent of Island County residents with their drinking water. Oak Harbor and NASWI obtain approximately 92 percent of their water by pipeline from the Anacortes water system, which in turn accesses its water by pipeline from the Skagit River. Drought conditions within the planning area increase pressure on local aquifers, with increased pumping resulting in saltwater intrusion into freshwater aquifers. This causes restrictions on economic growth and development.

A drought directly or indirectly impacts all people in affected areas. A drought can result in farmers not being able to plant crops or the failure of planted crops. This results in loss of work for farm workers and those in related food processing jobs. Other water- or electricity-dependent industries are commonly forced to shut down all or a portion of their facilities, resulting in further layoffs. A drought can also harm recreational companies that use water (e.g., swimming pools, water parks, and river rafting companies) as well as landscape and nursery businesses because people will not invest in new plants if water is not available to sustain them. With much of Washington's energy coming from hydroelectric plants, a drought means less inexpensive electricity coming from dams and probably higher electric bills. All people would pay more for water if utilities increase their rates. This has become an issue within Island County, where a lack of snow pack has decreased Cascade hydroelectric generating capacity, and raised the electric prices, impacting county residents.

Presently, various indexes show the region around Island County to have a higher-than-average moisture content. However, because of the potential impacts from climate change, the relatively high areas of densely wooded terrain, and the difficulty accessing areas of the County in need of fire services (areas of isolation due to infrastructure failure), drought is a moderate concern to the County and its planning partners.

7.2.2 Previous Occurrences

In the past century, Washington has experienced a number of drought episodes, including several that lasted for more than a single season—1928 to 1932, 1992 to 1994, and 1996 to 1997. Table 7-1 identifies additional drought occurrences in the state. The 1977 drought was the worst on record, but the 2001 drought came close to surpassing it in some respects. Table 7-2 has data on how the two droughts affected Washington by late September of their respective years.

**TABLE 7-1.
DROUGHT OCCURRENCES**

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 0.10 inches.
March – August 1924	Lack of soil moisture retarded germination of spring wheat.
July 1925	Drought occurred in Washington
July 21-August 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.
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	Drought throughout Washington
June – August 1967	Drought throughout Washington
January – August 1973	Dry in the Cascades.
October 1976 – September 1977	Worst drought in Pacific Northwest history. Below normal precipitation in Olympia, Seattle, and Yakima. Crop yields were below normal and ski resorts closed for much of the 1976-77 season.
2001	Governor declared statewide Stage 2 drought in response to severe dry spell.
June – September 2003	Federal disaster number 1499 assigned to 15 counties including Island. The original disaster was for flooding but Island and several others were included because of previous drought conditions.

TABLE 7-2.
COMPARISON OF IMPACTS OF 1977 DROUGHT TO 2001 DROUGHT

Impact	1977 Drought	2001 Drought
Precipitation	Precipitation at most locations ranged from 50 to 75% of normal levels, and in parts of Eastern Washington as low as 42 to 45% of normal.	Precipitation was 56 to 74% of normal. U.S. Bureau of Reclamation – Yakima Project irrigators received only 37% of their normal entitlements. At the end of the irrigation season, the Bureau of Reclamation's five reservoirs stored only 50,000 acre-feet of water compared with 300,000 acre-feet typically in storage.
Wildland Fire	1,319 wildland fires burned 10,800 acres. State fire-fighting activities involved more than 7,000 man-hours and cost more than $1.5 million.	1,162 wildland fires burned 223,857 acres. Firefighting efforts cost the state $38 million and various local, regional and federal agencies another $100 million.
Fish	In August and September 1977, water levels at the Goldendale and Spokane trout hatcheries were down. Fish had difficulties passing through Kendall Creek, a tributary to the north fork of the Nooksack River in Whatcom County.	A dozen state hatcheries took a series of drought-related measures, including installing equipment at North Toutle and Puyallup hatcheries to address low water flow problems.
Emergency Water Permits	Department of Ecology issued 517 temporary groundwater permits to help farmers and communities drill more wells.	Department of Ecology issued 172 temporary emergency water-right permits and changes to existing water rights.
Economic Impacts	The state's economy lost an estimated $410 million over a two-year period. The drought hit the aluminum industry hardest. Major losses in agriculture and service industries included a $5 million loss in the ski industry. 13,000 jobs were lost because of layoffs in the aluminum industry and in agriculture.	The Bonneville Power Administration paid more than $400 million to electricity-intensive industries to shut down and remain closed for the duration of the drought. Thousands lost their jobs for months, including 2,000-3,000 workers at the Kaiser and Vanalco plants. Federal agencies provided more than $10.1 million in disaster aid to growers. More than $7.9 million in state funds paid for drought-related projects; these projects enabled the state to provide irrigation water to farmers with junior water rights and to increase water in fish-bearing streams.

The County has the following information on drought issues, including years of low precipitation and snow pack, as well as sources of power, drinking water and the fishing industry:

- Three energy curtailments resulted from drought periods prior to 1977, which caused temporary unemployment within various industry sectors.
- Certain areas of the state such as the Makah Tribe Reservation (which is across the Strait of Juan de Fuca from Island County), were declared in 1994 under Disaster Declaration 1037 for an El Niño effect on the salmon industry.
- In the summer of 2001, the governor declared a statewide Stage 2 drought in response to the worst dry spell since records began in 1929. Island County received only 66 percent of its normal precipitation, and there were sporadic problems with saltwater intrusion into wells.

- In 2003, the state and county were in another drought when the county went for over 60 days without substantial rain. The Office of the State Climatologist stated that the summer of 2003 was the driest summer (at that time) since records were officially kept. Island County was included in Presidential Disaster Declaration 1499 due to failure of several crops in the county, as well as other areas of Western Washington.
- In March 2005, Washington Department of Ecology declared a statewide drought. The state legislature approved a $12 million supplemental budget request for buying water, improving wells, implementing other emergency water-supply projects, and hiring temporary state staff to respond to the drought emergency, conduct public workshops and undertake drought-related studies. In March, the water supply forecast was 66 percent of normal, signaling an extremely poor water year and a possible reduction in electricity production. By late spring, due to record precipitation in March and April, water filled reservoirs to about 95 percent of capacity, more than enough to meet projected electricity demands. Despite projected drought impacts of up to $300 million, unexpected spring rains combined with reallocation of water and conservation measures by farmers largely mitigated the drought's impacts. Harvest of most crops was near normal levels. While statewide harvests were near normal, local farmers who did not receive the spotty rains experienced poor harvests. The number of wildfires was about 75 percent of average for the previous five years, but the acreage burned was three times greater. The largest – the School fire – burned 52,000 acres of state-protected lands, 109 homes and 106 other buildings, and cost more than $15 million to extinguish. The fire also destroyed half of the elk and bighorn sheep and a third of the deer in the Tucannon Game Management Unit.

7.2.3 Severity

Droughts impact individuals (farm owners, tenants, and farm laborers), the agricultural industry, and other agriculture-related sectors. Lack of snow pack has forced ski resorts into bankruptcy. There is increased danger of forest and wildland fires. Millions of board feet of timber have been lost. Loss of forests and trees increases erosion, causing serious damage to aquatic life, irrigation, and power development by heavy silting of streams, reservoirs and rivers.

The severity of a drought depends on the degree of moisture deficiency, the duration, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts. Droughts are not usually associated with direct impacts on people or property, but they can have significant impacts on agriculture, wildlife and fishing, which can impact people indirectly. When measuring the severity of droughts, analysts typically look at economic impacts.

The National Oceanic and Atmospheric Administration (NOAA) has developed several indices to measure drought impacts and severity to map their extent and locations:

- The ***Palmer Crop Moisture Index*** measures short-term drought on a weekly scale and is used to quantify drought's impacts on agriculture during the growing season.
- The ***Palmer Z Index*** measures short-term drought on a monthly scale. Figure 7-1 shows this index for November 2013 (most current as of the writing of this chapter for the 2014 update).
- The ***Palmer Drought Index*** measures the duration and intensity of long-term drought-inducing circulation patterns. Long-term drought is cumulative, so the intensity of drought during a given month is dependent on the current weather patterns plus the cumulative patterns of previous months. Weather patterns can change quickly from a long-term drought pattern to a long-term wet pattern, and this index can respond fairly rapidly. Figure 7-2 shows this index for November 2013.

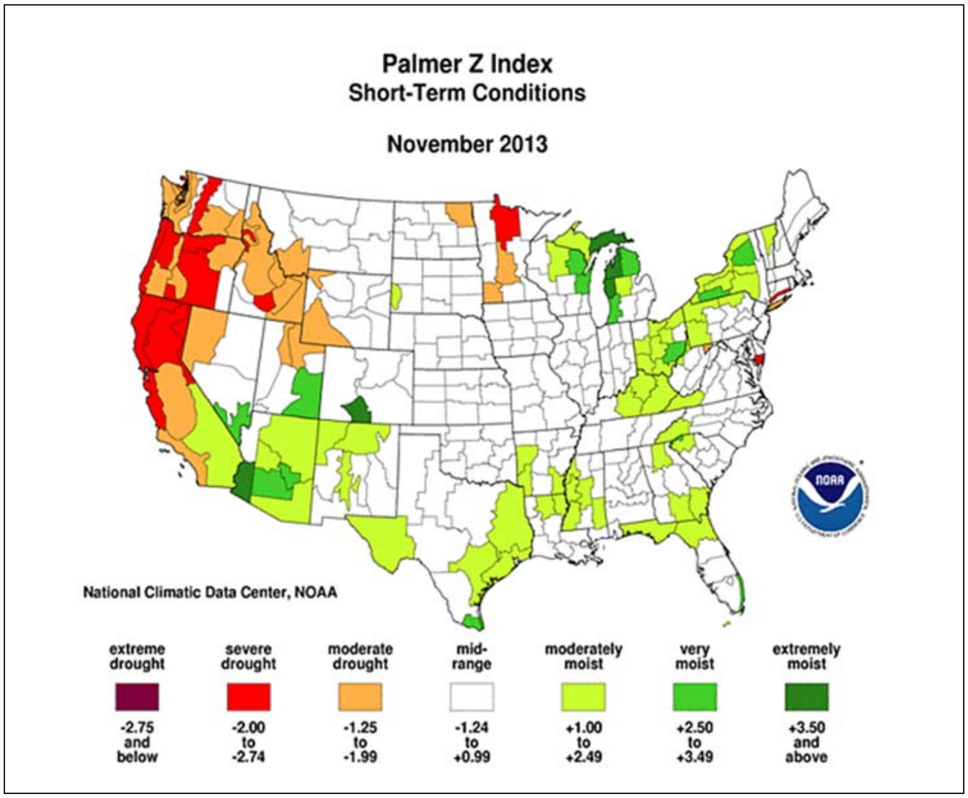


Figure 7-1. Palmer Z Index Short-Term Drought Conditions (November, 2013)

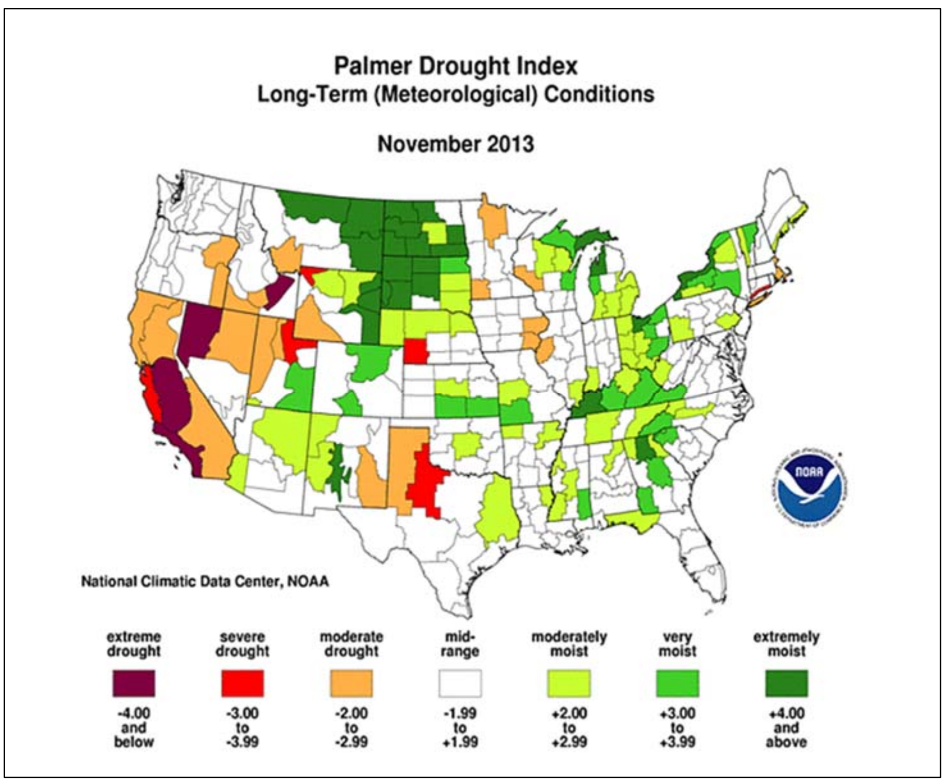


Figure 7-2. Palmer Drought Index Long-Term Drought Conditions (November, 2013)

- The hydrological impacts of drought (e.g., reservoir levels, groundwater levels, etc.) take longer to develop and it takes longer to recover from them. The ***Palmer Hydrological Drought Index***, another long-term index, was developed to quantify hydrological effects. This index responds more slowly to changing conditions than the Palmer Drought Index.
- While the Palmer indices consider precipitation, evapotranspiration and runoff, the ***Standardized Precipitation Index*** considers only precipitation. In this index, a value of zero indicates the median precipitation amount; the index is negative for drought and positive for wet conditions. The Standardized Precipitation Index is computed for time scales ranging from one month to 24 months.

Additional information and current monthly data are available from the NOAA website: http://www.ncdc.noaa.gov/oa/climate/research/prelim/drought/palmer.html

7.2.4 Frequency

Empirical studies conducted over the past century have shown that meteorological drought is never the result of a single cause. It is the result of many causes, often synergistic in nature; these include global weather patterns that produce persistent, upper-level high-pressure systems along the West Coast with warm, dry air resulting in less precipitation.

In temperate regions, including Washington, long-range forecasts of drought have limited reliability. In the tropics, empirical relationships have been demonstrated between precipitation and El Niño events, but few such relationships have been demonstrated above 30º north latitude. Meteorologists do not believe that reliable forecasts are attainable at this time a season or more in advance for temperate regions.

A great deal of research has been conducted in recent years on the role of interacting systems in explaining regional and even global patterns of climatic variability. These patterns tend to recur periodically with enough frequency and with similar characteristics over a sufficient length of time that they offer opportunities to improve the ability for long-range climate prediction. However, too many variables exist in determining the frequency with which a drought will occur.

According to the Washington State Hazard Mitigation Plan data (2012) "At this time, reliable forecasts of drought are not attainable for temperate regions of the world more than a season in advance. However, based on a 100-year history with drought, the state as a whole can expect severe or extreme drought at least 5 percent of the time in the future, with most of eastern Washington experiencing severe or extreme drought about 10 to 15 percent of the time." (EMD, 2012)

The potential for improved drought predictions in the near future differs by region, season, and climatic regime. Based on Palmer Z Short-Term predictions (Figure 7-1) for November 2013, the planning area experienced a "moderate drought" situation within the area. Figure 7-2 demonstrates mid-range meteorological conditions for the two-year period encompassed within NOAA's long-term analysis.

7.3 VULNERABILITY ASSESSMENT

7.3.1 Overview

Drought produces a complex web of impacts that spans many sectors of the economy and reaches well beyond the area experiencing physical drought. This complexity exists because water is integral to the ability to produce goods and provide services. Drought can affect a wide range of economic, environmental and social activities. The vulnerability of an activity associated with the effects of drought usually depends on its water demand, how the demand is met, and what water supplies are available to meet the demand.

All people, property and environments in the planning area could be exposed to some degree to the impacts of moderate to extreme drought. Areas densely wooded, especially areas in parks throughout the County which host campers, increase the exposure to forest fires. Additional exposure comes in the form of economic impact should a prolonged drought occur that would impact fishing, recreation, agriculture and timber harvesting—primary sources of income in the planning area. Prolonged drought would also decrease capacity within the watersheds, thereby reducing fish runs and, potentially, spawning areas.

Methodology

The Washington State Enhanced Hazard Mitigation plan defines jurisdictions as being vulnerable to drought if they meet at least five of the following criteria:

- History of severe or extreme drought conditions:
    - The jurisdiction must have been in serious or extreme drought at least 10-15 percent of the time from 1895 to 1995.
- Demand on water resources based on:
    - Acreage of irrigated cropland. The acreage of the jurisdiction's irrigated cropland must be in top 20 in the state.
    - Percentage of harvested cropland that is irrigated. The percentage of the jurisdiction's harvested cropland that is irrigated must be in top 20 in the state.
    - Value of agricultural products. The value of the jurisdiction's crops must be in the top 20 in the state.
    - Population growth greater than the state average. The population growth from 2000 to 2006 must be greater than state average of 8.17 percent.
- A County's inability to endure the economic conditions of a drought, based on:
    - The jurisdiction's median household income being less than 75 percent of the state median income of $51,749 in 2005.
    - The jurisdiction's being classified as economically distressed in 2005 because its unemployment rate was 20 percent greater than the state average from January 2002 through December 2004.

Presently, Island County is not among the nine counties referenced as vulnerable to drought in the Washington State Enhanced Hazard Mitigation Plan. The County does not meet at least five of the criteria to be considered vulnerable to drought, as shown in Table 7-3; however, given the region's dense vegetation, dependence upon the planning area watersheds, reliance on natural ecosystems and natural resources (salmon and other aquatic life for both sustenance and its economy), wildlife, fire services, and the potential impacts from climate change enhancing a drought situation, drought does raise significant concern among the planning partners.

**TABLE 7-3.
ISLAND COUNTY VULNERABILITY TO DROUGHT**

Criterion	Value	Meets Drought Vulnerability Criterion?
Percent of Time in Serious or Extreme Drought, 1895—2013	0	No
Irrigated Cropland (acres)	0	No
County's Statewide Ranking for Irrigated Cropland Area	0	No
Percent of Harvested Cropland That Is Irrigated	12.	No
Statewide Percentage of Irrigated Cropland	14.75	No
Market Value of Crops (Forest stand value)	$14 million	
Statewide Market Value of Crops (2012)	$9.89 billion	No
Population Growth, 2000—2010*	Increased 9.7%	Yes
Median Household Income (2012 Island County Figures)	$59,500	No**
Unemployment Rate 20% Greater Than State Average	No (9.1%)	No

*Based on the criterion in Washington State's 2013 Hazard Mitigation Plan "Population growth greater than the state average: The county's population growth in 2000-2006 must be greater than state average of 8.17 percent." Accordingly, if the state is maintaining that criteria, based on current population trends, Island County's growth rate exceeded that of Washington States.

** State's median income was based on 2012 figures of $59,374 (U.S. Census, 2014)

Sources: OFM, 2012a; OFM, 2012b; ESD, 2012; Washington Department of Agriculture, 2012.

Warning Time

A drought is not a sudden-onset hazard. Droughts are climatic patterns that occur over long periods, providing for some advance notice. In many instances, annual situations of low water levels are identified months in advance (e.g., snow pack at lower levels are identified during winter months), allowing for advanced planning for water conservation.

Meteorological drought is the result of many causes, including global weather patterns that produce persistent, upper-level high-pressure systems along the West Coast resulting in less precipitation. Only general warning can take place, due to the numerous variables that scientists have not pieced together well enough to make accurate and precise predictions. It is often difficult to recognize a drought before being in the middle of it. Droughts do not occur spontaneously, they evolve over time as certain conditions are met.

Scientists do not know how to predict drought more than a month in advance for most locations. Predicting drought depends on the ability to forecast precipitation and temperature. Weather anomalies may last from several months to several decades. How long they last depends on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on the global scale. In temperate regions such as Washington, long-range forecasts of drought have limited reliability. Meteorologists do not believe that reliable forecasts are attainable at this time a season or more in advance for temperate regions.

7.3.2 Impact on Life, Health and Safety

Wildfires are often associated with drought. A prolonged lack of precipitation dries out vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends. This increases the risk to the health and safety of the residents within the planning area, especially those in wildland-urban interface areas. Smoke and particles embedded within the smoke are of significant concern for the elderly and very young, especially those with breathing problems.

The County and its jurisdictions have the ability to minimize impacts on residents and water consumers within the planning area should several consecutive dry years occur.

7.3.3 Impact on Property

No structures will be directly affected by drought conditions, though some may become vulnerable to wildfires, which are more likely following years of drought. Droughts can also have significant impacts on landscapes, which could cause a financial burden to property owners. However, these impacts are not considered critical in planning for impacts from the drought hazard.

7.3.4 Impact on Critical Facilities and Infrastructure

Critical facilities will continue to be operational during a drought unless impacted by fire. Critical facility elements such as landscaping may not be maintained due to limited resources, but the risk to the planning area’s critical facilities inventory will be largely aesthetic. For example, when water conservation measures are in place, landscaped areas will not be watered and may die. These aesthetic impacts are not considered significant.

7.3.5 Impact on Economy

Economic impact from a drought is associated with different aspects, including potential loss of agricultural production; the County and its jurisdictions rely fairly heavily on the agricultural market for economic sustainability. According to the Office of Financial Management (2014), Island County’s market value of crops for 2011 (most recent data available) was approximately $14 million (OFM, 2012a).

Additional economic impact stems from the potential loss of critical infrastructure due to fire damage and impacts on industries that depend on water for their business, such as fishing industries, water-based recreational activities, and public facilities and recreational areas.

Problems of domestic and municipal water supplies have historically been corrected by building another reservoir, a larger pipeline, new well, or some other facility. While certain areas of the County receive water from a pipeline system from Anacortes, other possibilities mentioned are not resolutions for the majority of the planning area given its island nature and other factors. With drought conditions increasing pressure on aquifers and increased pumping, which can result in saltwater intrusion into fresh water aquifers, resultant reductions or restrictions on economic growth and development could occur.

Given potential political issues, a drought situation, if prolonged, could restrict building within specific areas due to lack of supporting infrastructure, thereby impacting the tax base and economy of the region by limiting growth. In addition, the lack of hydroelectric generating capacity associated with drought conditions as a result of reduced precipitation levels continues to raise electric prices throughout the region.

7.3.6 Impact on Environment

Environmental losses from drought are associated with aquatic life, plants, animals, wildlife habitat, air and water quality, forest fires, landscape quality, biodiversity, and soil erosion. Some effects are short-term and conditions quickly return to normal after the drought. Other effects linger or even become permanent. Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes and vegetation, but many species will eventually recover from this effect. Degraded landscape quality, including soil erosion, may lead to a more permanent loss of biological productivity. Public awareness and concern for environmental quality has led to greater attention to these effects. Drought conditions within the planning area could increase the demand for water supplies. Water shortages would have an adverse impact on the environment, relied upon by the planning partnership, causing social and political conflicts. If such conditions persisted for several years, the economy of Island County could experience setbacks, especially in water dependent industries.

7.4 FUTURE DEVELOPMENT TRENDS

Island County and its jurisdictions have a relatively high amount of land available. The U.S. Department of Agriculture has indicated a reduction in the amount of farm lands within Island County during the time period of 2007 to 2012, while the statewide value of agricultural products sold has increased 41.6 percent from 2007 to 2012 (USDA, 2012). The rezoning of land from agricultural to residential would have the propensity to increase water demands.

Each municipal planning partner in this effort has an established comprehensive plan that includes policies directing land use and dealing with issues of water supply and the protection of water resources. Those plans are currently in the update phase.

These plans provide the capability at the local municipal level to protect future development from the impacts of drought. All planning partners reviewed their general plans under the capability assessments performed for this effort. Deficiencies identified by these reviews can be identified as mitigation actions to increase the capability to deal with future trends in development.

The planning area continues to move forward in developing policies directing land use and dealing with zoning, density and permitting for any new development as it relates to water resources. This will provide the capability to protect future development from the impacts of drought and help ensure available water. The County identifies issues with water as a deficiency in its capabilities matrix, and has identified addressing that deficiency as a mitigation action to deal with future trends in development.

7.5 CLIMATE CHANGE IMPACTS

Research conducted by the Climate Impacts Group at the University of Washington indicates that temperatures in Washington are increasing (Climate Impacts Group, 2014). As temperatures increase, there will be less water stored as ice and snow. This may not result in a net change in annual precipitation, but it will result in lower late spring and summer river flows. Accordingly there will be increased competition between power generators, sport fishing and environmentalists, and farmers dependent on irrigation. The long-term effects of climate change on regional water resources are unknown, but global water resources are already experiencing the following stresses:

- Growing populations
- Increased competition for available water
- Poor water quality

- Environmental claims
- Uncertain reserved water rights
- Groundwater overdraft
- Aging urban water infrastructure
- Impact on salmon habitat and water quality impacting fish spawning.

With a warmer climate, droughts could become more frequent, more severe, and longer lasting. Water resource managers should start addressing current stresses on water supplies and build flexibility and robustness into any system. Flexibility helps to ensure a quick response to changing conditions, and robustness helps people prepare for and survive the worst conditions. With this approach to planning, water system managers will be better able to adapt to the impacts of climate change.

7.6 ISSUES

An extreme drought could impact the region with little warning. Combinations of low precipitation and unusually high temperatures could occur over several consecutive years, especially in response to climate change. Intensified by such conditions, extreme wildfires could break out throughout the area, increasing the need for water. Surrounding communities, also in drought conditions, could increase their demand for water, causing social and political conflicts. Low water tables could increase issues of life, safety, and health, while also impacting the economy both for loss of potential agricultural income, but also with respect to decreased ability to construct new housing due to lack of ability to provide water. If such conditions persisted for several years, the economy of the region could experience setbacks, especially in water dependent industries.

The planning team has identified the following drought-related issues:

- The need for alternative water sources should a prolonged drought occur
- Use of groundwater recharge to stabilize the groundwater supply
- The probability of increased drought frequencies and durations due to climate change
- The promotion of active water conservation even during non-drought periods
- The potential impact on businesses in the area
- The potential impact on the livelihood of those employed in industries that could be impacted by drought, such as agriculture, fishing, forestry and tourism.

CHAPTER 8.
EARTHQUAKE

An earthquake is the vibration of the earth's surface following a release of energy in the earth's crust. This energy can be generated by a sudden dislocation of the crust or by a volcanic eruption. Its epicenter is the point on the earth's surface directly above the hypocenter of an earthquake. The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth. Earthquakes many times occur along a fault, which is a fracture in the earth's crust.

8.1 GENERAL BACKGROUND

Most destructive quakes are caused by dislocations of the crust. The crust may first bend and then, when the stress exceeds the strength of the rocks, break and snap to a new position. In the process of breaking, vibrations called "seismic waves" are generated. These waves travel outward from the source of the earthquake at varying speeds.

Earthquakes tend to reoccur along faults, which are zones of weakness in the crust. Even if a fault zone has recently experienced an earthquake, there is no guarantee that all the stress has been relieved. Another earthquake could still occur.

Geologists classify faults by their relative hazards. Active faults, which represent the highest hazard, are those that have ruptured to the ground surface during the Holocene period (about the last 11,000 years). Potentially active faults are those that displaced layers of rock from the Quaternary period (the last 1,800,000 years). Determining if a fault is "active" or "potentially active" depends on geologic evidence, which may not be available for every fault.

Faults are more likely to have earthquakes on them if they have more rapid rates of movement, have had recent earthquakes along them, experience greater total displacements, and are aligned so that movement can relieve accumulating tectonic stresses. A direct relationship exists between a fault's length and location and its ability to generate damaging ground motion at a given site. In some areas, smaller, local faults produce lower magnitude quakes, but ground shaking can be strong, and damage can be significant as a result of the fault's proximity to the area. In contrast, large regional faults can generate great magnitudes but, because of their distance and depth, may result in only moderate shaking in the area.

It is generally agreed that three source zones exist for Pacific Northwest quakes: a shallow (crustal) zone; the Cascadia Subduction Zone; and a deep, intraplate "Benioff" zone. These are shown in Figure 8-1. More than 90 percent of Pacific Northwest earthquakes occur along the boundary between the Juan de Fuca plate and the North American plate.

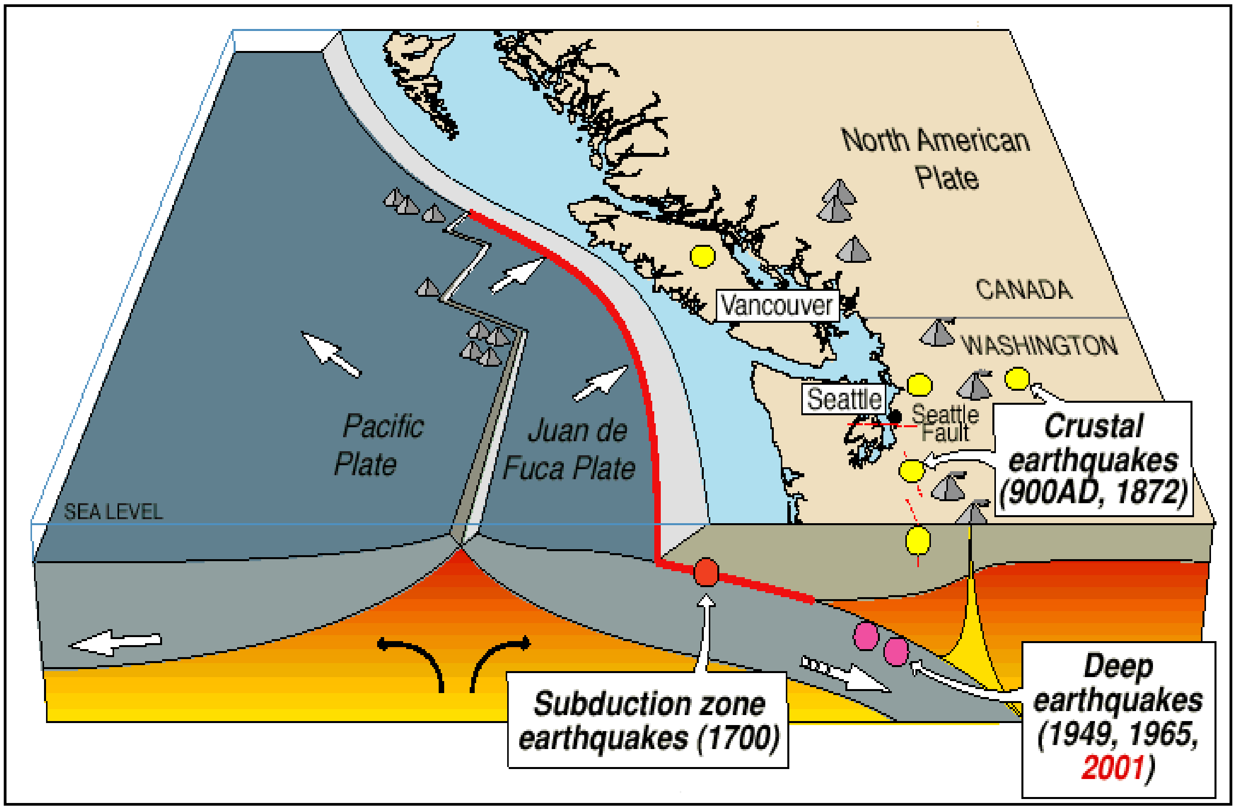


Figure 8-1. Earthquake Types in the Pacific Northwest

An earthquake will generally produce the strongest ground motions near the epicenter (the point on the ground above where the earthquake initiated) with the intensity of ground motions diminishing with increasing distance from the epicenter. The intensity of ground shaking at a given site depends on four main factors:

- Earthquake magnitude
- Earthquake epicenter
- Earthquake depth
- Soil or rock conditions at the site, which may amplify or de-amplify earthquake ground motions.

For any given earthquake, there will be contours of varying intensity of ground shaking with distance from the epicenter. The intensity will generally decrease with distance from the epicenter, and often in an irregular pattern, not simply in concentric circles. The irregularity is caused by soil conditions, the complexity of earthquake fault rupture patterns, and directionality in the dispersion of earthquake energy.

8.1.1 Earthquake Classifications

Earthquakes are typically classified in one of two ways: By the amount of energy released, measured as **magnitude**; or by the impact on people and structures, measured as **intensity**. Magnitude is related to the amount of seismic energy released at the hypocenter of an earthquake. It is determined by the amplitude of the earthquake waves recorded on instruments. Magnitude is represented by a single, instrumentally determined value for each earthquake event. Intensity indicates how the earthquake is felt at various distances from the earthquake epicenter.

Magnitude

Currently the most commonly used magnitude scale is the moment magnitude (M_W) scale, with the follow classifications of magnitude:

- Great—$M_W \geq 8$
- Major—$M_W = 7.0$—7.9
- Strong—$M_W = 6.0$—6.9
- Moderate—$M_W = 5.0$—5.9
- Light—$M_W = 4.0$—4.9
- Minor—$M_W = 3.0$—3.9
- Micro—$M_W < 3$

Estimates of moment magnitude roughly match the local magnitude scale (ML) commonly called the Richter scale. One advantage of the moment magnitude scale is that, unlike other magnitude scales, it does not saturate at the upper end. That is, there is no value beyond which all large earthquakes have about the same magnitude. For this reason, moment magnitude is now the most often used estimate of large earthquake magnitudes.

Intensity

There are many measures of the severity or intensity of earthquake ground motions. The Modified Mercalli Intensity scale (MMI) was widely used beginning in the early 1900s. MMI is a descriptive, qualitative scale that relates severity of ground motions to the types of damage experienced. MMI values range from I to XII (USGS, 1989):

- I. Not felt except by a very few under especially favorable conditions
- II. Felt only by a few persons at rest, especially on upper floors of buildings.
- III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it is an earthquake. Standing cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
- IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like a heavy truck striking building. Standing cars rocked noticeably.
- V. Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
- VI. Felt by all; many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
- VII. Damage negligible in buildings of good design and construction; slight in well-built ordinary structures; considerable in poorly built or badly designed structures. Some chimneys broken.
- VIII. Damage slight in specially designed structures; considerable damage in ordinary buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.

- IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
- X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
- XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
- XII. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

More accurate, quantitative measures of the intensity of ground shaking have largely replaced the MMI and are used in this mitigation plan. These scales use terms that can be physically measured with seismometers, such as the acceleration, velocity, or displacement (movement) of the ground. The intensity may also be measured as a function of the frequency of earthquake waves propagating through the earth. In the same way that sound waves contain a mix of low-, moderate- and high-frequency sound waves, earthquake waves contain ground motions of various frequencies. The behavior of buildings and other structures depends substantially on the vibration frequencies of the building or structure versus the frequency of earthquake waves. Earthquake ground motions also include both horizontal and vertical components.

Ground Motion

Earthquake hazard assessment is also based on expected ground motion. This involves determining the probability that certain ground motion accelerations will be exceeded over a time period of interest. A common physical measure of the intensity of earthquake ground shaking, and the one used in this mitigation plan, is peak ground acceleration (PGA). PGA is a measure of the intensity of shaking relative to the acceleration of gravity (g). For example, an acceleration of 1.0 g PGA is an extremely strong ground motion, which does occur near the epicenter of large earthquakes. With a vertical acceleration of 1.0 g, objects are thrown into the air. With a horizontal acceleration of 1.0 g, objects accelerate sideways at the same rate as if they had been dropped from the ceiling. A PGA equal to 10% g means that the ground acceleration is 10 percent that of gravity, and so on.

Damage levels experienced in an earthquake vary with the intensity of ground shaking and with the seismic capacity of structures. The following generalized observations provide qualitative statements about the likely extent of damage for earthquakes with various levels of ground shaking (PGA) at a given site:

- Ground motions of only 1% g or 2% g are widely felt by people; hanging plants and lamps swing strongly, but damage levels, if any, are usually very low.
- Ground motions below about 10% g usually cause only slight damage.
- Ground motions between about 10% g and 30% g may cause minor to moderate damage in well-designed buildings, with higher levels of damage in more vulnerable buildings. At this level of ground shaking, some poorly built buildings may be subject to collapse.
- Ground motions above about 30% g may cause significant damage in well-designed buildings and very high levels of damage (including collapse) in poorly designed buildings.
- Ground motions above about 50% g may cause significant damage in most buildings, even those designed to resist seismic forces.

PGA is the basis of seismic zone maps that are included in building codes such as the International Building Code. Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. PGA values are directly related to these lateral forces that could damage “short period structures” (e.g. single-family dwellings). Longer period response components determine the lateral forces that damage larger structures with longer natural periods (apartment buildings, factories, high-rises, bridges). The amount of earthquake damage and the size of the geographic area affected generally increase with earthquake magnitude:

- Earthquakes below M5 are not likely to cause significant damage, even near the epicenter.
- Earthquakes between about M5 and M6 are likely to cause moderate damage near the epicenter.
- Earthquakes of about M6.5 or greater (e.g., the 2001 Nisqually earthquake in Washington) can cause major damage, with damage usually concentrated fairly near the epicenter.
- Larger earthquakes of M7+ cause damage over increasingly wider geographic areas with the potential for very high levels of damage near the epicenter.
- Great earthquakes with M8+ can cause major damage over wide geographic areas.
- An M9 mega-quake on the Cascadia Subduction Zone could affect the entire Pacific Northwest from British Columbia, through Washington and Oregon, and as far south as Northern California, with the highest levels of damage nearest the coast.

Table 8-1 lists damage potential and perceived shaking by PGA factors, compared to the Mercalli scale.

**TABLE 8-1.
COMPARISON OF MERCALLI SCALE AND PEAK GROUND ACCELERATION**

Modified Mercalli Scale	Perceived Shaking	Potential Structure Damage: Resistant Buildings	Potential Structure Damage: Vulnerable Buildings	Estimated PGA[a] (%g)
I	Not Felt	None	None	<0.17%
II-III	Weak	None	None	0.17%—1.4%
IV	Light	None	None	1.4%—3.9%
V	Moderate	Very Light	Light	3.9%—9.2%
VI	Strong	Light	Moderate	9.2%—18%
VII	Very Strong	Moderate	Moderate/Heavy	18%—34%
VIII	Severe	Moderate/Heavy	Heavy	34%—65%
IX	Violent	Heavy	Very Heavy	65%—124%
X—XII	Extreme	Very Heavy	Very Heavy	>124%

a. PGA measured in percent of g, where g is the acceleration of gravity

Sources: USGS, 2008; USGS, 2010

8.1.2 Effect of Soil Types

Liquefaction is a secondary effect of an earthquake in which soils lose their shear strength and flow or behave as liquid, thereby damaging structures that derive their support from the soil. Liquefaction generally occurs in soft, unconsolidated sedimentary soils. The National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics to help identify locations subject to liquefaction. Table 8-2 summarizes NEHRP soil classifications. NEHRP Soils B and C typically can sustain ground shaking without much effect, dependent on the earthquake magnitude. Areas that are commonly most affected by ground shaking and susceptible to liquefaction have NEHRP Soils D, E and F.

TABLE 8-2.
NEHRP SOIL CLASSIFICATION SYSTEM

NEHRP Soil Type	Description	Mean Shear Velocity to 30 Meters (m/s)
A	Hard Rock	1,500
B	Firm to Hard Rock	760-1,500
C	Dense Soil/Soft Rock	360-760
D	Stiff Soil	180-360
E	Soft Clays	< 180
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 m thick)	

8.1.3 Fault Classification

The U.S. Geologic Survey defines four fault classes based on evidence of tectonic movement associated with large-magnitude earthquakes during the Quaternary period, which is the period from about 1.6 million years ago to the present:

- Class A—Geologic evidence demonstrates the existence of a Quaternary fault of tectonic origin, whether the fault is exposed by mapping or inferred from liquefaction or other deformational features.
- Class B—Geologic evidence demonstrates the existence of Quaternary deformation, but either (1) the fault might not extend deep enough to be a potential source of significant earthquakes, or (2) the currently available geologic evidence is too strong to confidently assign the feature to Class C but not strong enough to assign it to Class A.
- Class C—Geologic evidence is insufficient to demonstrate (1) the existence of tectonic faulting, or (2) Quaternary slip or deformation associated with the feature.
- Class D—Geologic evidence demonstrates that the feature is not a tectonic fault or feature; this category includes features such as joints, landslides, erosional or fluvial scarps, or other landforms resembling fault scarps but of demonstrable non-tectonic origin.

8.2 HAZARD PROFILE

Seismic-related hazards in Island County include ground motion from shallow (less than 20 miles deep) or deep faults; liquefaction and differential settling of soil in areas with saturated sand, silt or gravel; and tsunamis that result from seismic activities. Earthquakes also can cause damage by triggering landslides or bluff failure. High-magnitude (8 to 9+) earthquakes are possible in Island County when the Juan de Fuca slips beneath the North American plates. Deep zone or Benioff zone quakes have occurred within the San De Fuca plate (1949, 1965, and 2001) and can be expected in the future.

8.2.1 Extent and Location

Washington State as a whole is one of the most seismically active states in United States. Figure 8-2 depicts the faults and seismogenic folds known or suspected to be active according to the 2013 Washington State Hazard Mitigation Plan.

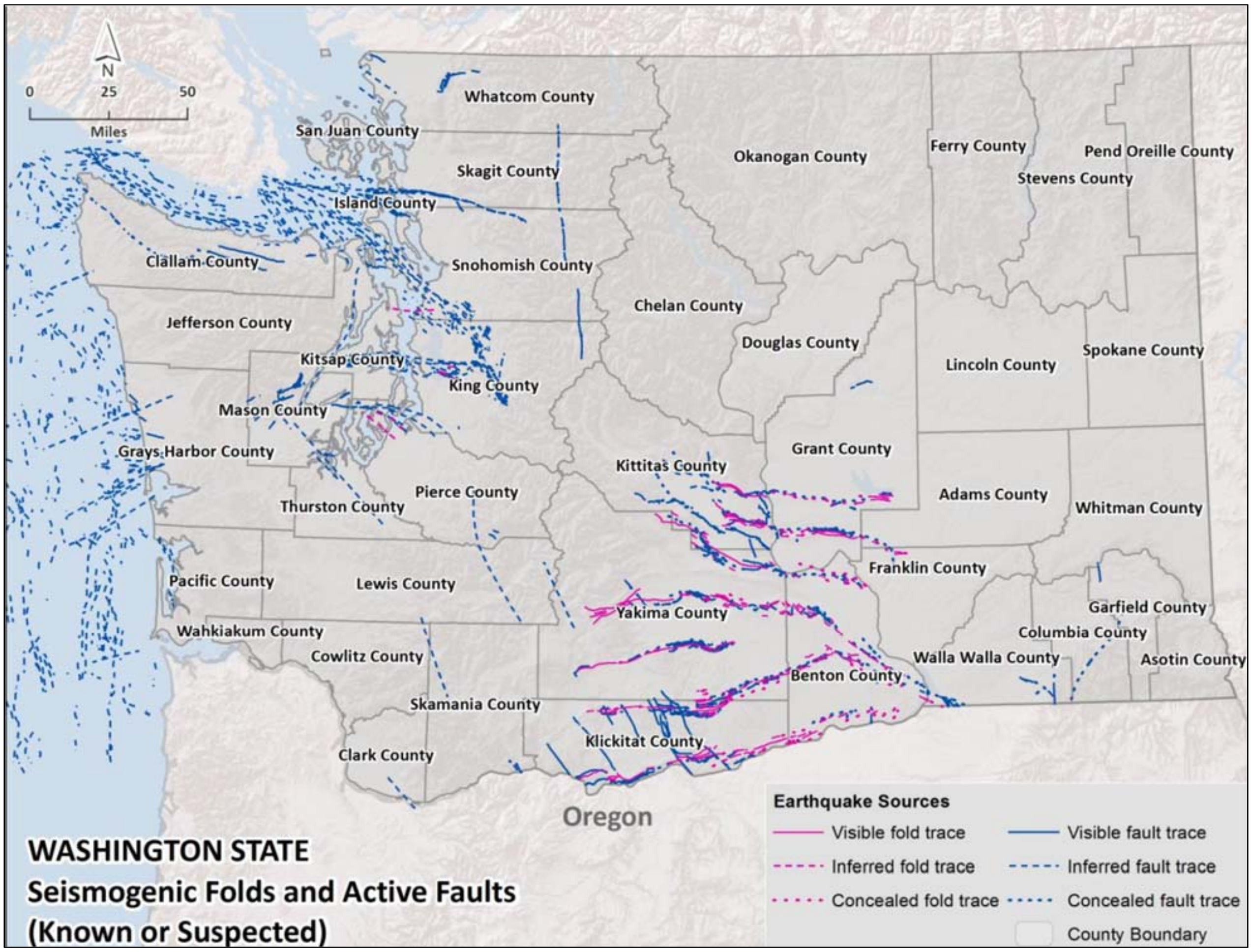


Figure 8-2. Washington State Seismogenic Folds and Active Faults

Local Faults

There are a number of faults running near or through Island County (see Figure 8-3 and Figure 8-4):

- USGS Number 571—Strawberry Point Fault (Whidbey Island)
- USGS Number 572—Southern Whidbey Island Fault Zone
- USGS Number 573—Utsalady Point Fault (Whidbey Island)
- USGS Number 574—Devils Mountain Fault

These faults are considered as part of the North American (continental) plate). The majority of them have been inactive for extended periods of time. Evidence suggests that the Devil's Mountain fault and the Southern Whidbey Island Fault are capable of generating a quake of magnitude 7 or greater. The Utsalady Point and Strawberry Point faults are capable of a quake of magnitude 6.7 or greater.

Several other suspected faults may cross south Whidbey Island from south to north. Various sources indicate that parts of the North Whidbey fault run through a portion of Oak Harbor. One fault scarp is visible on NAS Ault Field at the Rocky Point area. Langley also sits very close to the plotted location of the South Whidbey Fault. Several neighborhoods on south Whidbey Island—Clinton, Useless Bay, and Freeland—are on or close to the South Whidbey Fault. Geologists have not determined likely earthquake occurrence intervals for these faults.

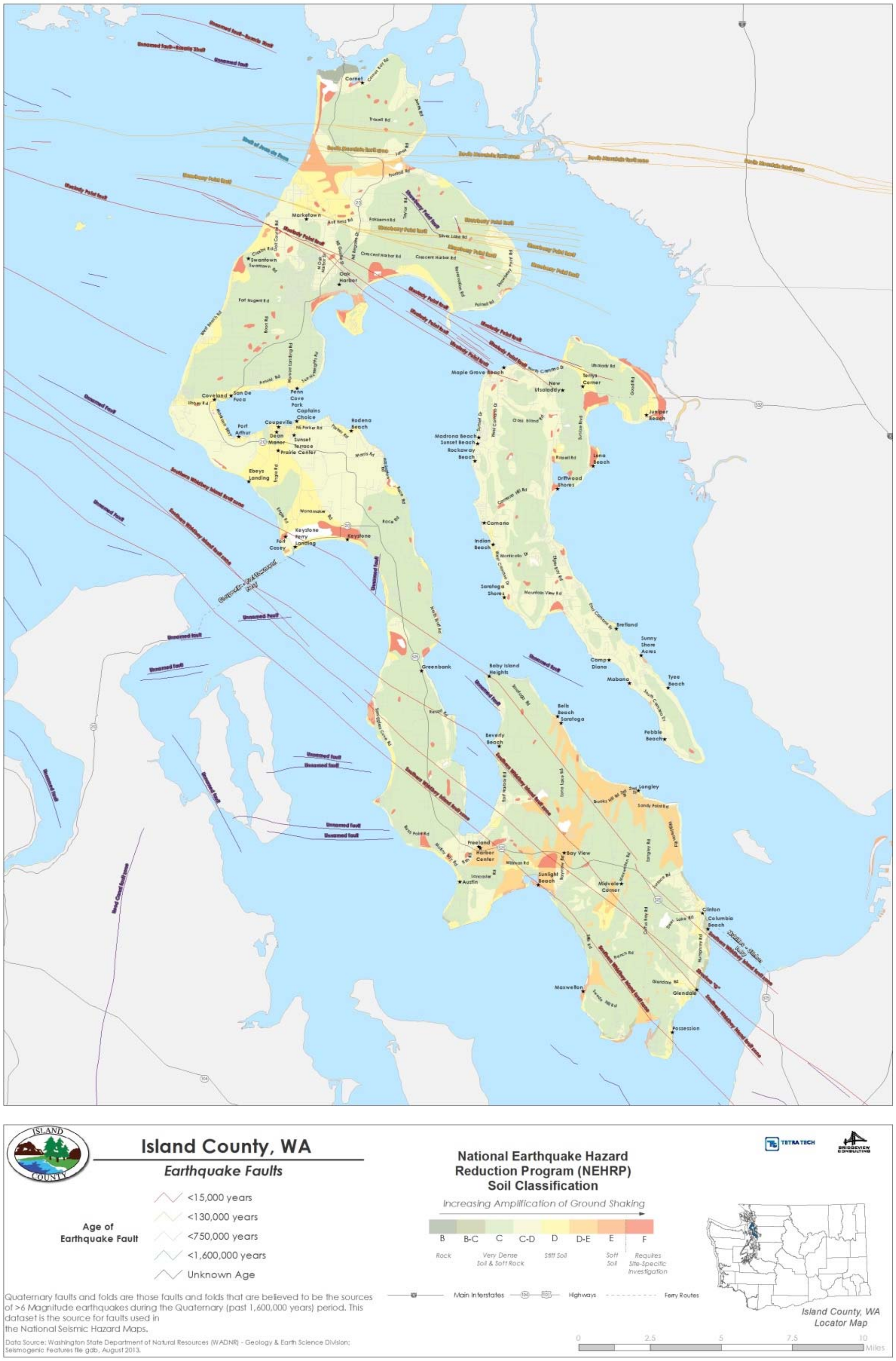


Figure 8-3. Regional Faults with NEHRP Soils Classifications

Source: USGS, 2015a

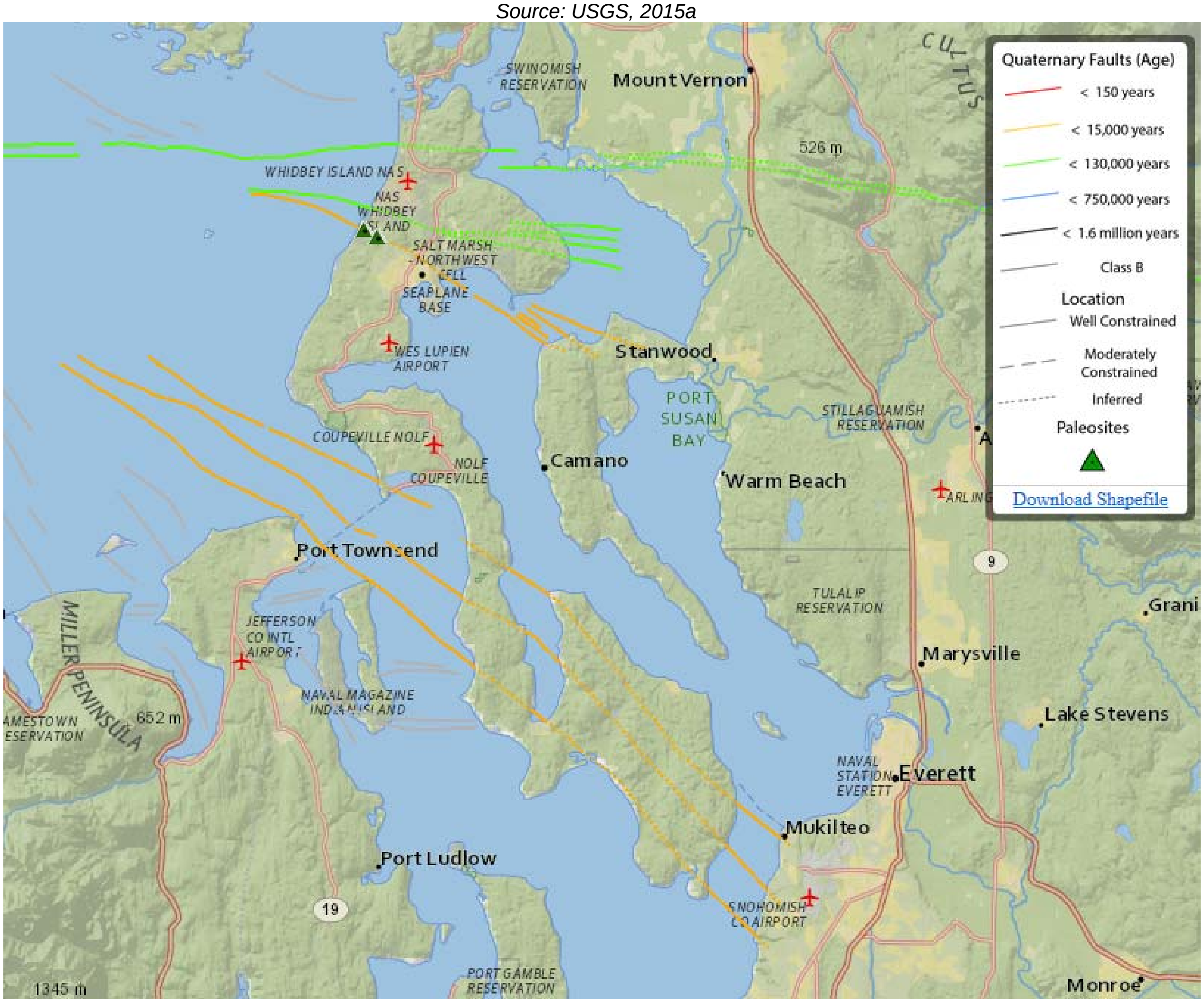


Figure 8-4. USGS Known Faults in Vicinity of Island County

The sections below provide descriptions of the planning area's main faults, taken directly from the County's previous (2008) hazard mitigation plan.

Utsalady Point Fault

The northwest-trending, Utsalady Point fault cuts across northern Whidbey Island and has a minimum length of 28 km. It forms the southern margin of a pre-Tertiary basement block on the west coast of Whidbey Island, where it has north-side-up offset. Offshore seismic-reflection data from east of Whidbey Island indicate that it bifurcates eastward into a broad (1.5-km-wide) zone of several splays. Onshore outcrops and subsurface logs from Camano Island indicate a probable reversal of offset (to south side up) along the zone and display both faulting and folding (dips as steep as ~24) in upper Pleistocene strata. The vertical fault traces, reversal of offset, and evidence of associated contractional deformation suggest the Utsalady Point fault is an oblique-slip, transpressional fault. The fault occurs 3 to 10 km south of the Devils Mountain fault, near the northern boundary of the northward-migrating portion of the fore-arc region of the Cascadia convergent margin. The fault cuts across the northern part of the Quaternary-Tertiary Everett basin. Tomography studies indicate that the fault lies along the boundary between lower seismic velocities associated with a northwest trending projection of the Everett basin and higher velocity "basement" rocks to the north of the basin.

South Whidbey Island Fault

The South Whidbey Island Fault is a northwest-trending fault zone which extends more than 65 km across Possession Sound, southern Whidbey Island, and Admiralty Inlet into the eastern Strait of Juan de Fuca. The fault zone is as wide as 5 to 7 km, correlates with gravity and magnetic anomalies, and has been interpreted as a complex zone of transpressional deformation. Seismic tomography studies reveal that only the northwestern end of the fault zone in the southeastern Strait of Juan de Fuca is associated with a strong velocity contrast. The southeastern and central parts of the southern Whidbey Island fault zone form the southwest margin of the Everett basin and northeast boundary of the Seattle basin. The northwestern part of the fault zone forms the northeastern limit of the Port Townsend basin.

The offshore location of the southern Whidbey Island fault zone is relatively well-constrained based on interpretation of a dense network of industry and high-resolution seismic-reflection profiles. Onshore, strands of the southern Whidbey Island fault zone are generally concealed beneath a cover of dense vegetation and thick Pleistocene glacial and interglacial deposits.

Strawberry Point Fault

The west-northwest-trending Strawberry Point fault cuts across northern Whidbey Island and has a minimum length of about 22 km. On the west coast of Whidbey Island and in the Strait of Juan de Fuca, the fault has south-side-up offset and forms the northern boundary of an uplift of pre-Tertiary basement rock. Exposures and subsurface logs of upper Pleistocene strata indicate that the fault bifurcates into a 2-kilometer-wide zone as it crosses Whidbey Island. Each of four fault splays in this zone has apparent north-side-up offset, and upper Pleistocene strata between the faults exhibit considerable shortening (dips as steep as ~45). The vertical fault trace, reversal of offset along strike, and evidence of contractional deformation suggest that the Strawberry Point fault is an oblique-slip, transpressional fault (USGS, 2015b).

Devils Mountain Fault

The north-dipping fault zone of the Devils Mountain fault extends for more than 125 km from the Cascade Range foothills to offshore Vancouver Island. At its east end, the Devils Mountain fault intersects or merges with the Darrington fault zone. At its west end, the Devils Mountain fault may merge with the Leech River and (or) San Juan faults on Vancouver Island. The Devils Mountain fault is bounded by northwest-trending echelon folds and faults, a map pattern strongly suggesting that it is a left-lateral, oblique-slip, transpressional structure. The western part of the Devils Mountain fault in the eastern Strait of Juan de Fuca has been proposed to form the southern limb of a structural pop-up cored by the San Juan Islands. On land to the east, the fault forms the northern boundary of the Tertiary-to-Quaternary Everett basin.

Cascadia Subduction Zone

The Cascadia Subduction Zone runs along the west coast from northern Vancouver Island to northern California, where it meets the San Andreas Fault. It is one of the world’s most treacherous faults, capable of unleashing mega quakes and tsunamis on a par with the 2004 Sumatra disaster. Future Cascadia Subduction Zone-related earthquakes have been predicted to be Magnitude 8 or greater and could subject communities on the Washington ocean and Strait of Juan de Fuca coasts to intense ground shaking, subsidence, landslides, and liquefaction. Tsunami waves of 8 meters or higher are predicted to inundate the outer Washington coast 30 to 60 minutes after initial ground shaking in a Magnitude 8 or larger earthquake.

Research from USGS, University of Washington and Pacific Northwest Seismic Network gathered from 60 seismometers over the Olympic Peninsula indicate that the Juan de Fuca plate extends much further under the Olympic Peninsula than previously thought. The research suggests that rupture of the fault will occur 50 miles further inland than previously believed, right under Washington’s most populous area, where vital infrastructure is concentrated. Such an earthquake would have devastating consequences.

Hazard Mapping

Identifying the extent and location of an earthquake is not as simple as it is for other hazards such as flood, landslide or wildfire. The impact of an earthquake is largely a function of the following factors:

- Ground shaking (ground motion accelerations)
- Liquefaction (soil instability)
- Distance from the source (both horizontally and vertically).

Mapping that shows the impacts of these components was used to assess the risk of earthquakes within the planning area. While the impacts from each of these components can build upon each other during an earthquake event, the mapping looks at each component individually. The mapping used in this assessment is described below.

Shake Maps

A shake map is a representation of ground shaking produced by an earthquake (Peak Ground Acceleration). The information it presents is different from the earthquake magnitude and epicenter that are released after an earthquake because shake maps focus on the ground shaking resulting from the earthquake, rather than the parameters describing the earthquake source. An earthquake has only one magnitude and one epicenter, but it produces a range of ground shaking at sites throughout the region, depending on the distance from the earthquake, the rock and soil conditions at sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth's crust. A shake map shows the extent and variation of ground shaking in a region immediately following significant earthquakes.

Ground motion and intensity maps are derived from peak ground motion recorded on seismic sensors, with interpolation where data are lacking and site-specific corrections. Color-coded intensity maps are derived from empirical relations between peak ground motions and Modified Mercalli intensity. Two types of shake map are typically generated from the data:

- A probabilistic seismic hazard map shows the hazard from earthquakes that geologists and seismologists agree could occur. The maps are expressed in terms of probability of exceeding a certain ground motion, such as the 10 percent probability of exceedance in 50 years. This level of ground shaking has been used for designing buildings in high seismic areas. Hazard maps for the 100-year and 500-year probabilistic earthquakes are shown on Figure 8-5 and Figure 8-6.
- Earthquake scenario maps describe the expected ground motions and effects of hypothetical large earthquakes for a region. Maps of these scenarios can be used to support all phases of emergency management. Two scenarios were chosen for this plan:
  - South Whidbey Fault Scenario—This scenario created by USGS in April 2009 is based on a Magnitude 7.4 earthquake on the South Whidbey Fault, with an epicenter northwest of Langley (see Figure 8-7)
  - Utsalady Fault Scenario—This scenario was based on a USGS publication (2004) that estimates previous Magnitude-6.7 occurrences from 100 to 500 years ago and 1,100 to 2,200 years ago and an offshore rupture that may have produced tsunami events (USGS, 2015c) (see Figure 8-8).

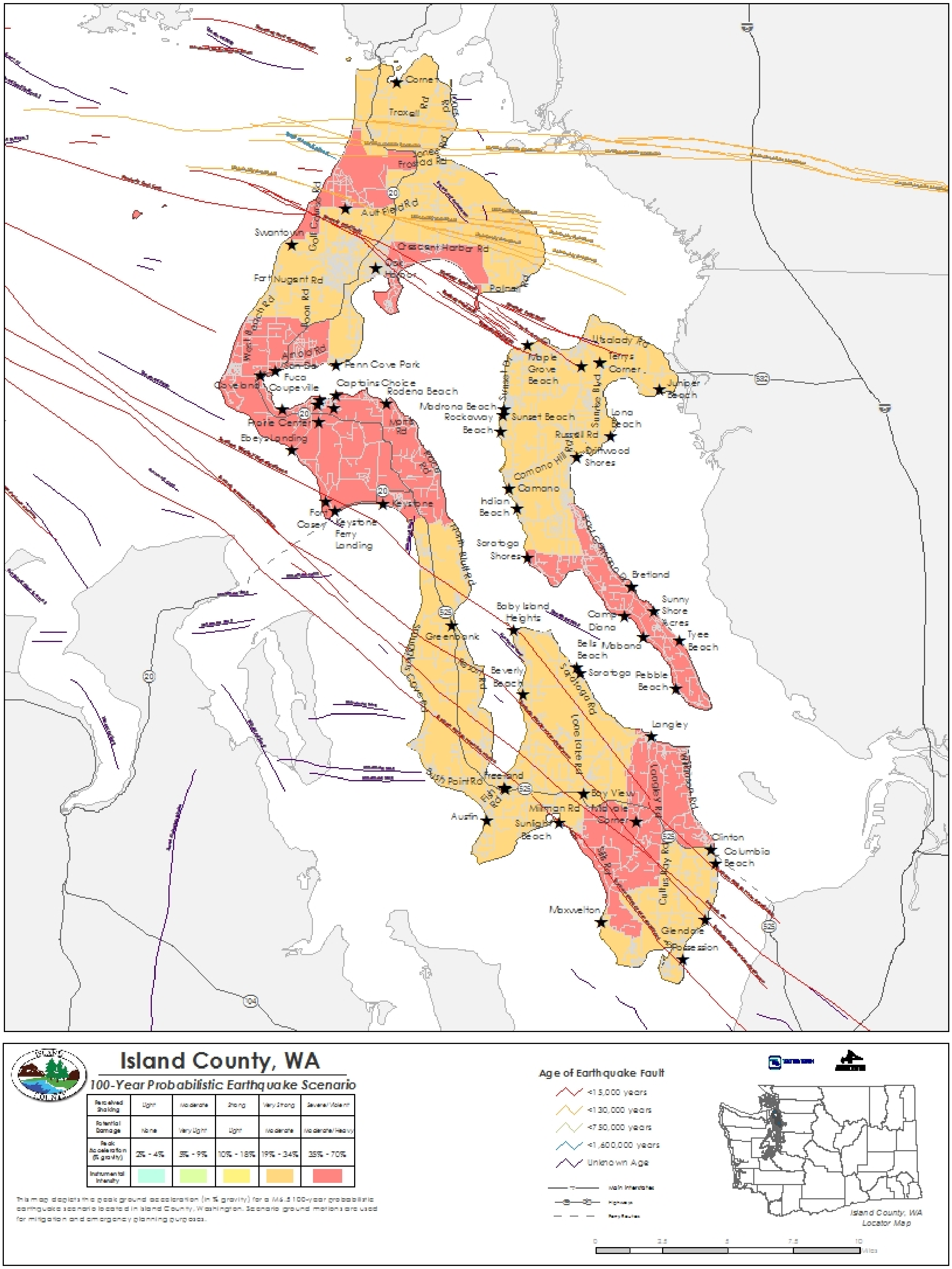


Figure 8-5. 100-Year Probabilistic

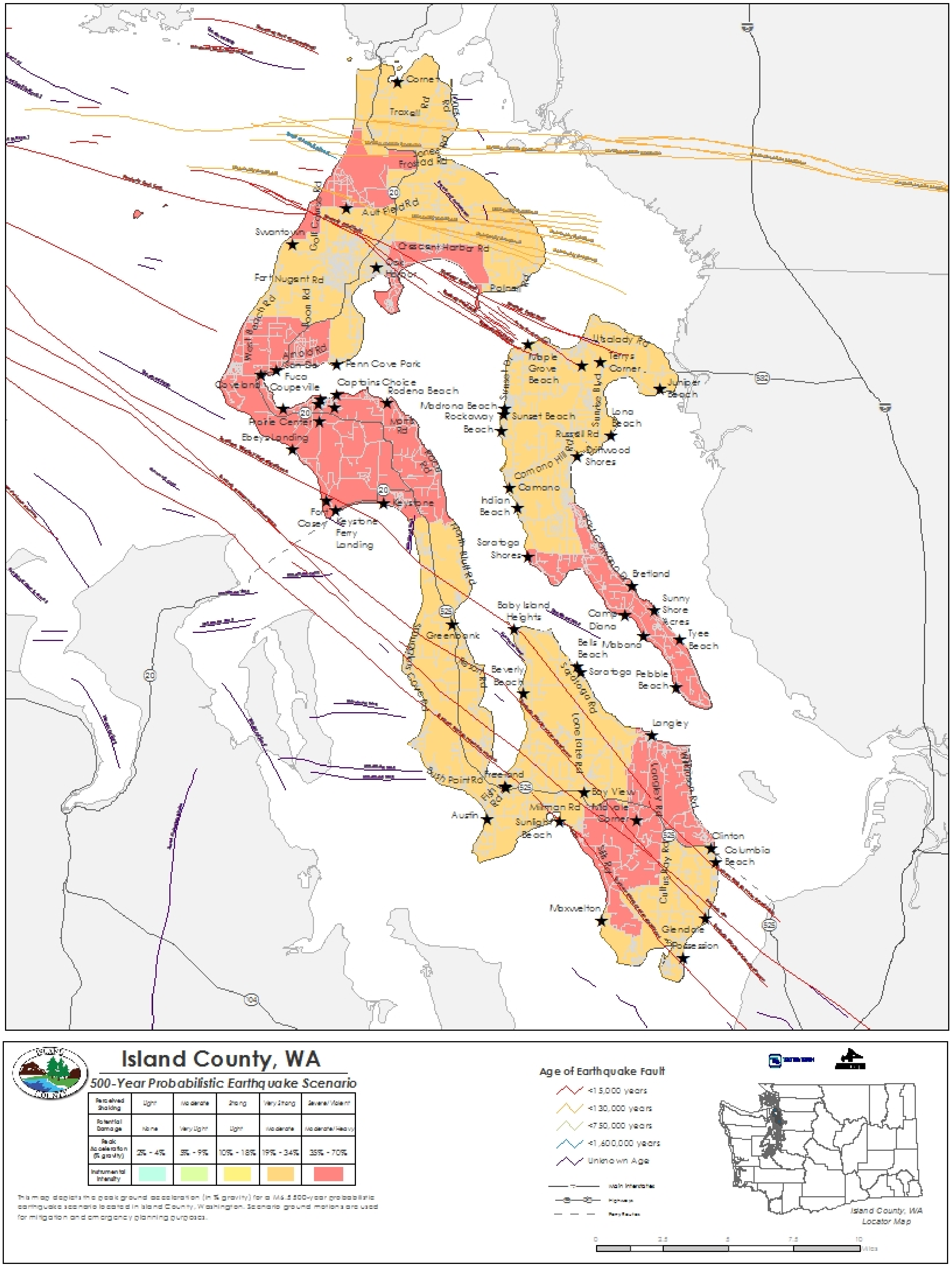


Figure 8-6. 500-Year Probabilistic

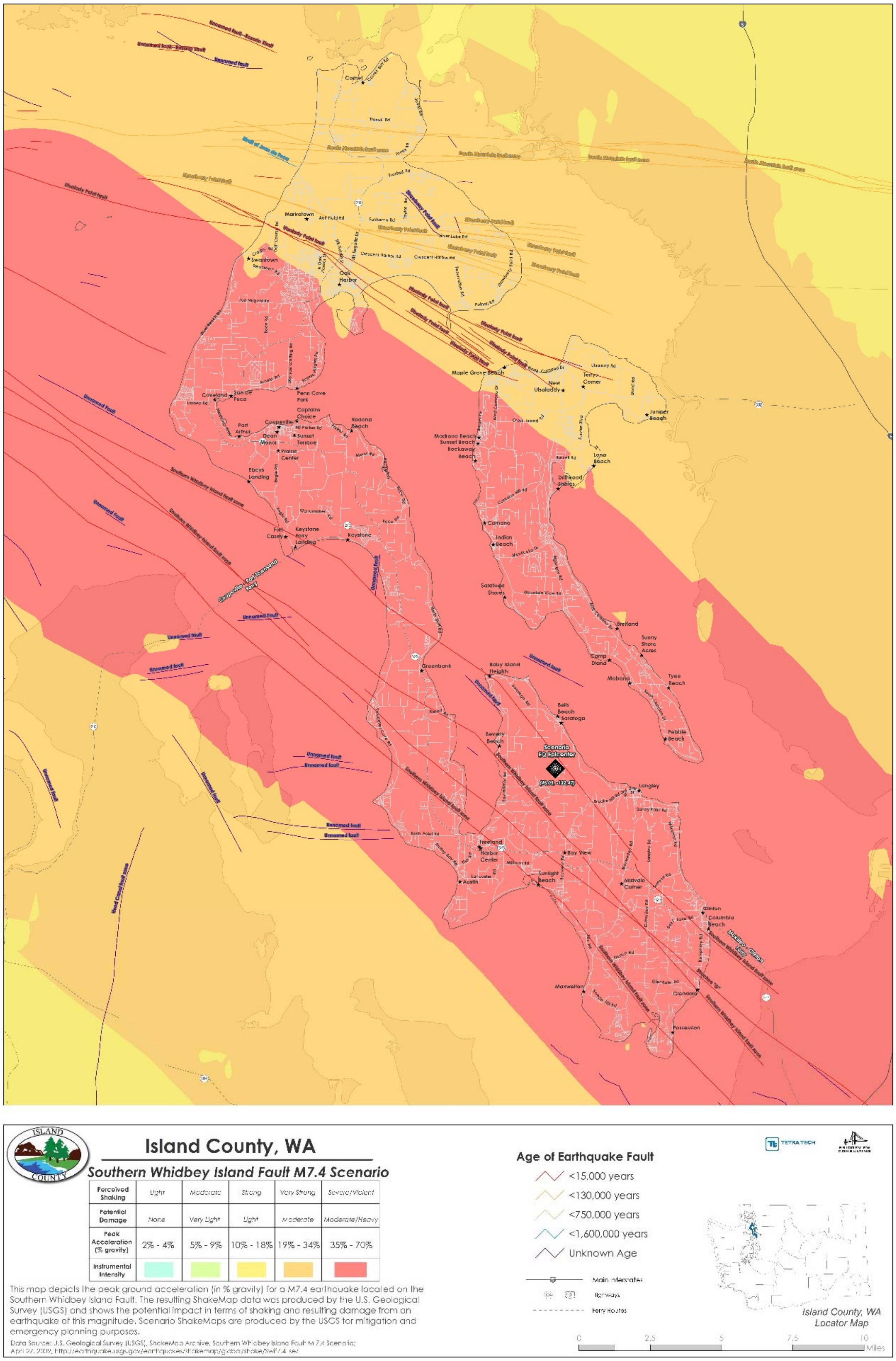
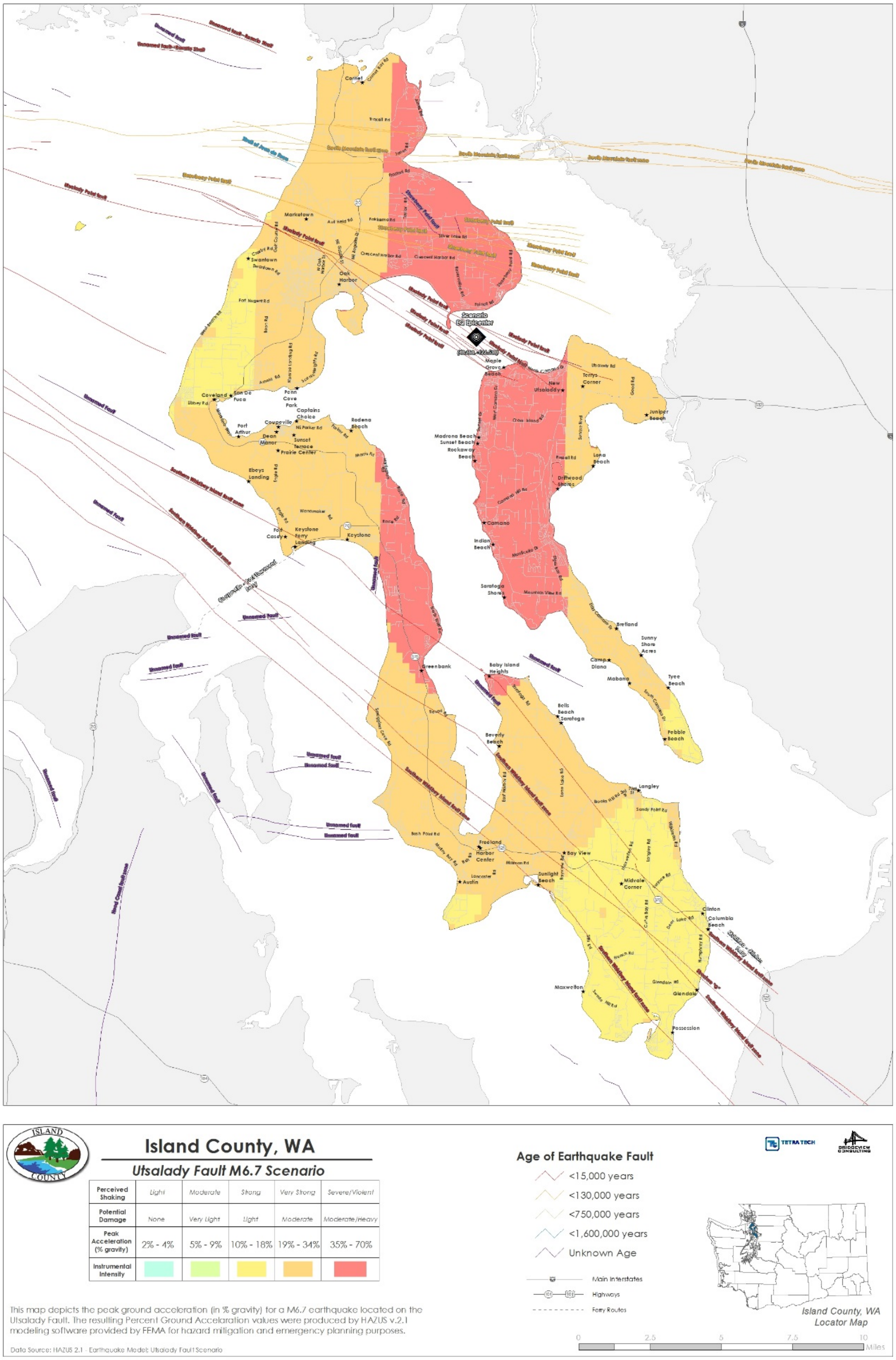


Figure 8-7. South Whidbey Fault Scenario



Perceived Shaking	Light	Moderate	Strong	Very Strong	Severe/Violent
Potential Damage	None	Very Light	Light	Moderate	Moderate/Heavy
Peak Acceleration (% gravity)	2% - 4%	5% - 9%	10% - 18%	19% - 34%	35% - 70%
Instrumental Intensity					

Figure 8-8. Utsalady Fault Scenario

NEHRP Soil Maps

NEHRP soil types define the locations that will be significantly impacted by an earthquake. NEHRP Soils B and C typically can sustain low-magnitude ground shaking without much effect. The areas that are most commonly affected by ground shaking have NEHRP Soils D, E and F. Figure 8-3 shows NEHRP soil classifications in Island County.

Liquefaction Maps

Soil liquefaction maps are useful tools to assess potential damage from earthquakes. When the ground liquefies, sandy or silty materials saturated with water behave like a liquid, causing pipes to leak, roads and airport runways to buckle, and building foundations to be damaged. In general, areas with NEHRP Soils D, E and F are susceptible to liquefaction. If there is a dry soil crust, excess water will sometimes come to the surface through cracks in the confining layer, bringing liquefied sand with it and creating sand boils.

Areas of Whidbey and Camano Islands susceptible to liquefaction are primarily low-lying marine or formerly tidal areas and filled areas. There are also extensive peat deposits on Whidbey and Camano Islands. Peat does not "liquefy" like fill soil or mud, but earthquake shaking and vibration can cause it to fail and slump away from piling, supports, and foundations. Examples of these types of land on Whidbey Island are Dugualla Bay, Maple Valley, the Oak Harbor and Crescent Harbor shorelines and lowlands and the area roughly from Langley south across the island to Useless Bay. On Camano Island, these types of soils occur in the areas of West Pass and Livingston Bay, the west coast in the vicinity of Camano Cove, and the area south of the line of Wagner-Elger Bay Road. This is not a complete list, but shows the widespread potential for liquefaction and soil failure. Figure 8-9 shows liquefaction susceptibility throughout the County.

8.2.2 Previous Occurrences

Based on geologic evidence along the Washington coast, the Cascadia Subduction Zone has ruptured and created tsunamis at least seven times in the past 3,500 years and has a considerable range in recurrence intervals, from as little as 140 years between events to more than 1,000 years. The last Cascadia Subduction Zone-related earthquake is believed to have occurred on January 26, 1700, and researchers predict a 10 to 14 percent chance that another could occur in the next 50 years. Table 8-3 lists past seismic events that have affected the areas in and around Island County.

8.2.3 Severity

Earthquakes can last from a few seconds to over five minutes; they may also occur as a series of tremors over several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties generally result from falling objects and debris, because the shocks shake, damage or demolish buildings and other structures. Disruption of communications, electrical power supplies and gas, sewer and water lines should be expected. Earthquakes may trigger fires, dam failures, landslides or releases of hazardous material, compounding their disastrous effects.

Small, local faults produce lower magnitude quakes, but ground shaking can be strong and damage can be significant in areas close to the fault. In contrast, large regional faults can generate earthquakes of great magnitudes but, because of their distance and depth, they may result in only moderate shaking in an area.

USGS ground motion maps based on current information about fault zones show the PGA that has a certain probability (2 or 10 percent) of being exceeded in a 50-year period. The PGA is measured in %g. Figure 8-10 shows the PGA with a 2 percent exceedance chance in 50 years in Washington.

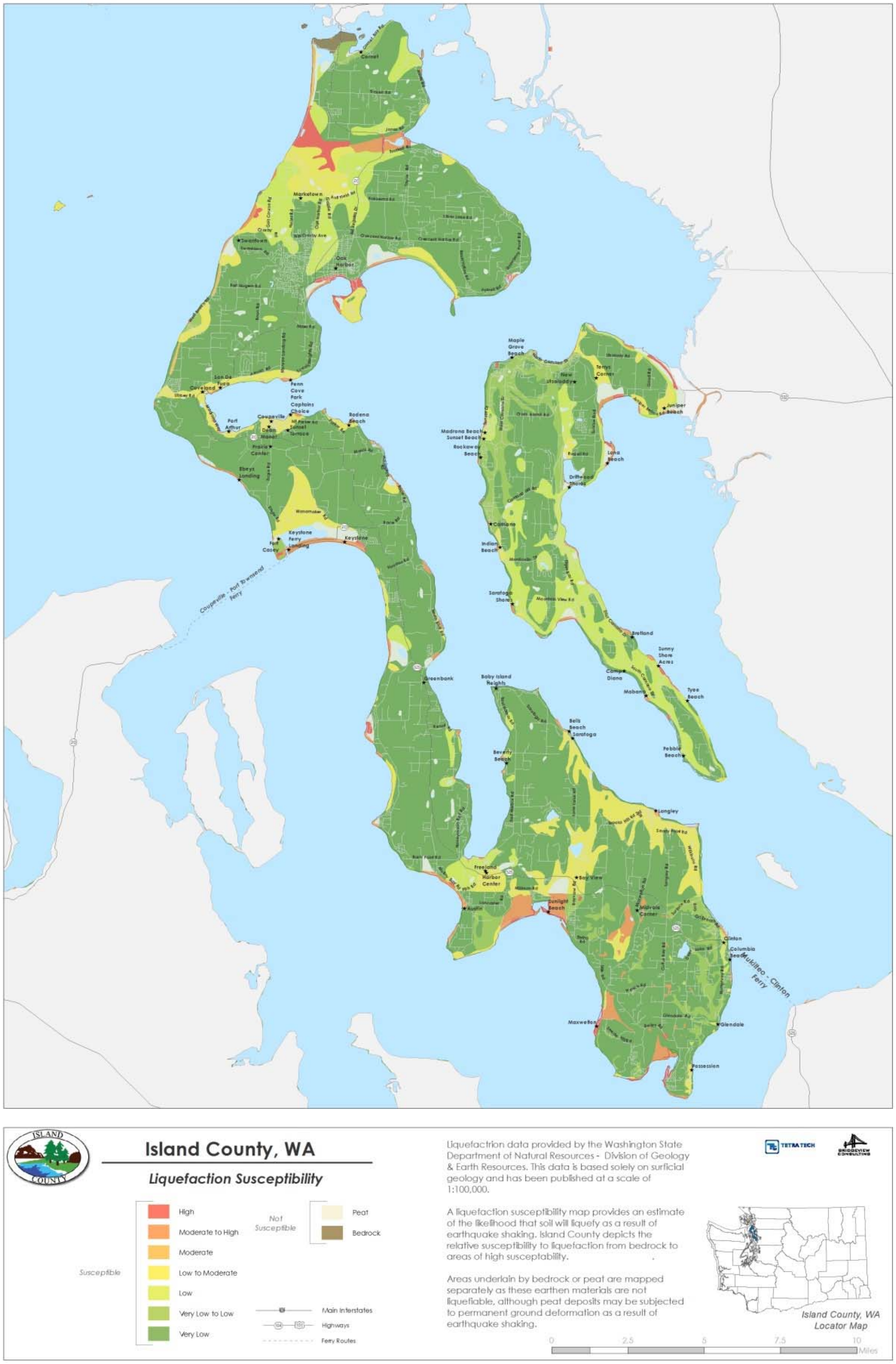


Figure 8-9. Liquefaction Susceptibility

**TABLE 8-3.
HISTORICAL EARTHQUAKES IMPACTING THE PLANNING AREA**

Year	Magnitude	Epicenter	Type
2/28/2001	6.8	Olympia (Nisqually)	Benioff
6/10/2001	5.0	Matlock	Benioff
7/3/1999	5.8	8.0 km N of Satsop	Benioff
6/23/1997	4.7	Bremerton	Shallow Crustal
5/3/1996	5.5	Duvall	Shallow Crustal
1/29/1995	5.1	Seattle-Tacoma	Shallow Crustal
2/14/1981	5.5	Mt. St. Helens (Ash)	Crustal
4/29/1965	6.6	18.3 KM N of Tacoma (Sea Tac)	Benioff
1/13/1949	7.0	12.3 KM ENE of Olympia	Benioff
6/23/1946	7.3	Strait of Georgia	Benioff
4/1945	5.7	Northbend (8 miles south/southeast)	Unknown
1939	5.8	Puget Sound – Near Vashon Island	Unknown
1932	5.3	Central Cascades	Unknown
1/23/1920	5.5	Puget Sound	Unknown
12/6/1918	7.0	Vancouver Island	Unknown
8/18/1915	5.6	North Cascades	Unknown
1/11/1909	6.0	Puget Sound	Unknown
4/30/1882	5.8	Olympia area	Unknown
12/15/1872	6.8	Pacific Coast	Unknown

Source: PNSN, 2015

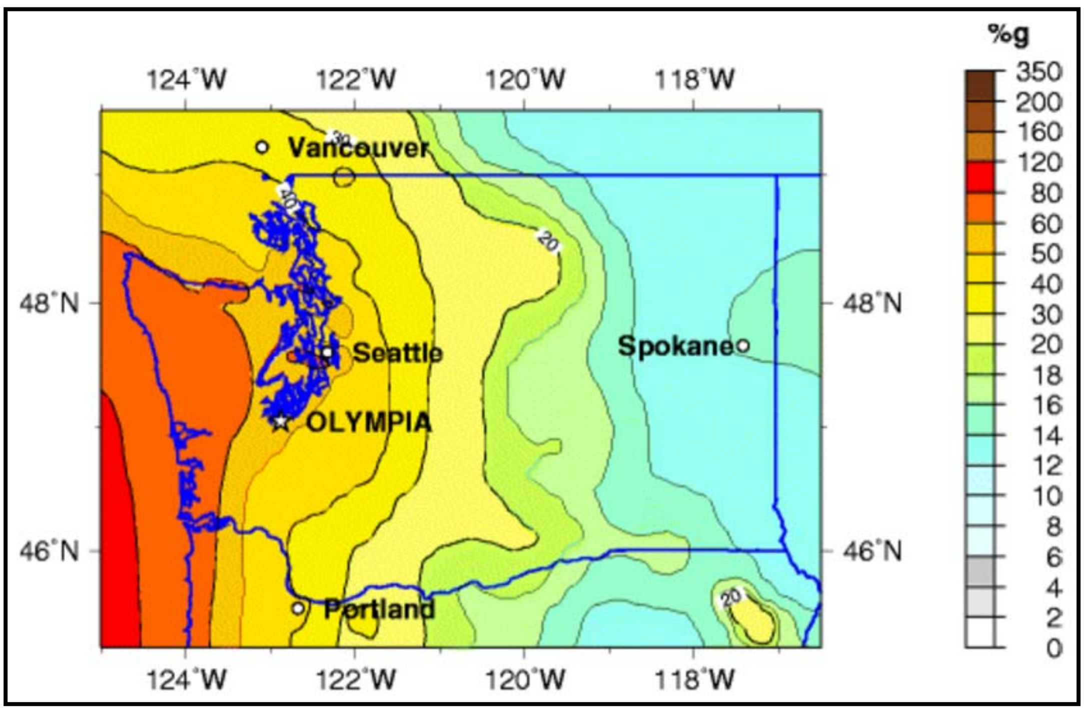


Figure 8-10. PGA with 2-Percent Probability of Exceedance in 50 Years, Northwest Region

8.2.4 Frequency

Scientists are currently developing methods to more accurately determine when an earthquake will occur. Recent advancements in determining the probability of an earthquake in a given period use a log-normal, Brownian Passage Time, or other probability distribution in which the probability of an event depends on the time since the last event. Such time-dependent models produce results broadly consistent with the elastic rebound theory of earthquakes. The USGS and others are beginning to develop such products as new geologic and seismic information regarding the dates of previous events along faults becomes available (USGS, 2015a). At present, however, estimations are based on the assumption that the probability of the occurrence of an earthquake in a given period of time follows a Poisson distribution. Probabilities calculated in this way require only knowledge of the mean recurrence time. Results of these calculations are independent of the time since the last event and are a reasonable basis for earthquake-resistance provisions in building codes and long-term mitigation strategies. Currently, the Poisson distribution remains the best available science for this region, and is the approach used for this update.

Scientists currently estimate that a Magnitude-9 earthquake in the Cascadia Subduction Zone occurs about once every 500 years. The last one was in 1700. Paleoseismic investigations have identified 41 Cascadia Subduction Zone interface earthquakes over the past 10,000 years, which corresponds to one earthquake about every 250 years. About half were M9.0 or greater earthquakes that represented full rupture of the fault zone from Northern California to British Columbia. The other half were M8+ earthquakes that ruptured only the southern portion of the subduction zone.

The 300+ years since the last major Cascadia Subduction Zone earthquake is longer than the average of about 250 years for M8 or greater and shorter than some of the intervals between M9.0 earthquakes.

Scientists currently estimate the frequency of deep earthquakes similar to the 1965 Magnitude-6.5 Seattle-Tacoma event and the 2001 Magnitude-6.8 Nisqually event as about once every 35 years. The USGS estimates an 84-percent chance of a Magnitude-6.5 or greater deep earthquake over the next 50 years.

Scientists estimate the approximate recurrence rate of a Magnitude-6.5 or greater earthquake anywhere on a shallow fault in the Puget Sound basin to be once in about 350 years. There have been four earthquakes of less than Magnitude 5 in the past 20 years.

Earthquakes on the South Whidbey Island and Seattle Faults have a 2-percent probability of occurrence in 50 years. A Benioff zone earthquake has an 85 percent probability of occurrence in 50 years, making it the most likely of the three types.

8.3 VULNERABILITY ASSESSMENT

8.3.1 Overview

Several faults within the planning region have the potential to cause direct impact. The area also is vulnerable to impact from an event outside the County, although the intensity of ground motions diminishes with increasing distance from the epicenter. As a result, the entire population of the planning area is exposed to both direct and indirect impacts from earthquakes. The degree of direct impact (and exposure) is dependent on factors including the soil type on which homes are constructed, the proximity to fault location, the type of materials used to construct residences and facilities, etc. Indirect impacts are associated with elements such as the inability to evacuate the area as a result of earthquakes occurring in other regions of the state as well as impact on commodity flow for goods and services into the area, many of which are serviced only by one roadway in or out (Highway 20; State Route 532) or the Clinton or Port Townsend

Ferries, each servicing only one island. Impact from other parts of the state could require shipment of supplies via a barge. Evacuation points of potential concern include:

- The bridge at Deception Pass, which, if closed, requires a much longer evacuation via ferry
- Landslides associated with an earthquake occurring along Highway 20, which connects Whidbey Island to Fidalgo Island
- Impact on State Route 532, which connects Camano Island by bridge on the northeast coast to the mainland near Stanwood.

Methodology

Earthquake vulnerability data was generated using a Level 2 Hazus analysis. Once the location and size of an earthquake are identified, Hazus estimates the intensity of the ground shaking, the number of buildings damaged, the number of casualties, the damage to transportation systems and utilities, the number of people displaced from their homes, and the estimated cost of repair and clean up.

Warning Time

There is currently no reliable way to predict the day or month that an earthquake will occur at any given location. Research is being done with warning systems that use the low energy waves that precede major earthquakes. These potential warning systems give approximately 40 seconds notice that a major earthquake is about to occur. The warning time is very short but it could allow for someone to get under a desk, step away from a hazardous material they are working with, or shut down a computer system.

8.3.2 Impact on Life, Health and Safety

The entire population of the planning area is potentially exposed to direct and indirect impacts from earthquakes. Two of the most vulnerable populations to a disaster incident such as this are the young and the elderly. Island County has a fairly high population of retirees. The need for increased rescue efforts and/or to provide assistance to such a large population base could tax the first-responder resources in the area during an event. Although many injuries may not be life-threatening, people will require medical attention and, in many cases, hospitalization. Potential life-threatening injuries and fatalities are expected; these are likely to be at an increased level if an earthquake happens during the afternoon or early evening.

The degree of exposure is dependent on many factors, including the soil type their homes are constructed on, quality of construction, their proximity to fault location, etc. Whether impacted directly or indirectly, the entire population will have to deal with the consequences of earthquakes to some degree. Business interruption could keep people from working, road closures could isolate populations, and loss of functions of utilities could impact populations that suffered no direct damage from an event itself.

Given the high dependence on the Deception Pass Bridge and the State Route 532 Bridge on the northeast coast of Camano Island, significant impact resulting from an earthquake would hinder and slow evacuation of the planning area, causing isolation. Impact or closure of the bridge could also diminish response capabilities of first responders if assistance from areas outside of Camano or Whidbey Islands were needed, as well as other parts of the planning area.

The number of people without power or water will be high, especially given the number of wells on which the County relies to supply water to individuals who most likely do not have generators to run pumps on the wells. This need will increase the number of individuals seeking shelter assistance.

Table 8-4 identifies the number of individuals and households impacted by the various earthquake events.

TABLE 8-4.
ESTIMATED EARTHQUAKE IMPACT ON PERSON AND HOUSEHOLDS

	Displaced Households	Persons Requiring Short-Term Shelter
100-Year Probabilistic Earthquake		
Unincorporated Island County	36	17
Coupeville	9	5
Oak Harbor	184	111
Langley	8	4
Total	**237**	**137**
500-Year Probabilistic Earthquake		
Unincorporated Island County	36	17
Coupeville	9	5
Oak Harbor	184	111
Langley	8	4
Total	**237**	**137**
South Whidbey Fault Earthquake		
Unincorporated Island County	7	3
Coupeville	1	1
Oak Harbor	90	49
Langley	3	1
Total	**101**	**54**
Utsalady Fault Earthquake		
Unincorporated Island County	53	26
Coupeville	4	2
Oak Harbor	107	72
Langley	3	1
Total	**167**	**101**

8.3.3 Impact on Property

There are 38,267 buildings in the planning area, with an estimated total replacement and content value of $7.155 billion. Most of the buildings are residential, and most of the building stock is of considerable age and not supported by building codes which increase resilience to seismic events. Portions of these buildings are constructed out of unreinforced masonry; many have chimneys that may be in need of repair, and many, because of the age of the building stock, may contain some level of asbestos in building components such as the boiler room, ceiling tiles, carpeting, or glue. Since all structures in the planning area are susceptible to earthquake impacts to varying degrees (including liquefaction and landslides), these figures represent total numbers region-wide for property exposure to seismic events.

Property losses were estimated through the Level 2 Hazus-MH analysis for the 100-year and 500-year earthquakes and the two scenario events (utilizing the USGS/Washington State Department of Natural Resources 2013 scenario catalog data and FEMA 2014 GIS datasets). A summary of the total building-related loss, which includes structure and content loss, is as follows:

- For a 100-year probabilistic earthquake, the estimated damage potential is $40.86 million or 0.57 percent of the total value for the planning area.

- For a 500-year earthquake, the estimated damage potential is $217.2 million, or 3.04 percent of the total value for the planning area.
- For the South Whidbey Island earthquake, the estimated potential is $264.8 million, or 3.7 percent of the total value for the planning area.
- For the Utsalady earthquake, the estimated potential is $153.4 million, or 2.14 percent of the total value for the planning area.

During the July 2014 Crescent Harbor tsunami research project which included a geologic dig, researchers discovered evidence of additional significant earthquake activity along the Utsalady Fault. As of the update of this 2015 plan, radiocarbon dating of samples was still underway to confirm connectivity of the events with known faults in the area. However, researchers have indicated that if such an event as they anticipated to have occurred historically were to occur present day within Oak Harbor, much of the area would be significantly impacted, including Ault field, with its runways sustaining significant levels of damage (South Whidbey Record, 2014).

Building Age

Structures that are in compliance with the Uniform Building Code (UBC) of 1970 or later are generally less vulnerable to seismic damage because 1970 was when the UBC started including seismic construction standards based on regional location. This stipulated that all structures be constructed to at least seismic risk Zone 2 standards.

The State of Washington adopted the UBC as its state building code in 1972, so it is assumed that buildings in the planning area built after 1972 were built in conformance with UBC seismic standards and have less vulnerability. Issues such as code enforcement and code compliance could impact this assumption. Construction material is also important when determining the potential risk to a structure. However, for planning purposes, establishing this line of demarcation can be an effective tool for estimating vulnerability. In 1994, seismic risk Zone 3 standards of the UBC went into effect in Washington, requiring all new construction to be capable of withstanding the effects of 0.3 g. More recent housing stock is in compliance with Zone 3 standards. In July 2004, the state again upgraded the building code to follow International Building Code Standards.

Based on Census data, the median date of construction for the planning area is approximately 1979. It is estimated that 20 percent of the building stock in the planning area was constructed between 1970 and 1979, and 22 percent was constructed pre-1969 (U.S. Census, 2014). The planning team used Hazus to identify the number of structures within the County by date of construction. Table 8-5 and Figure 8-11 show the results of this analysis.

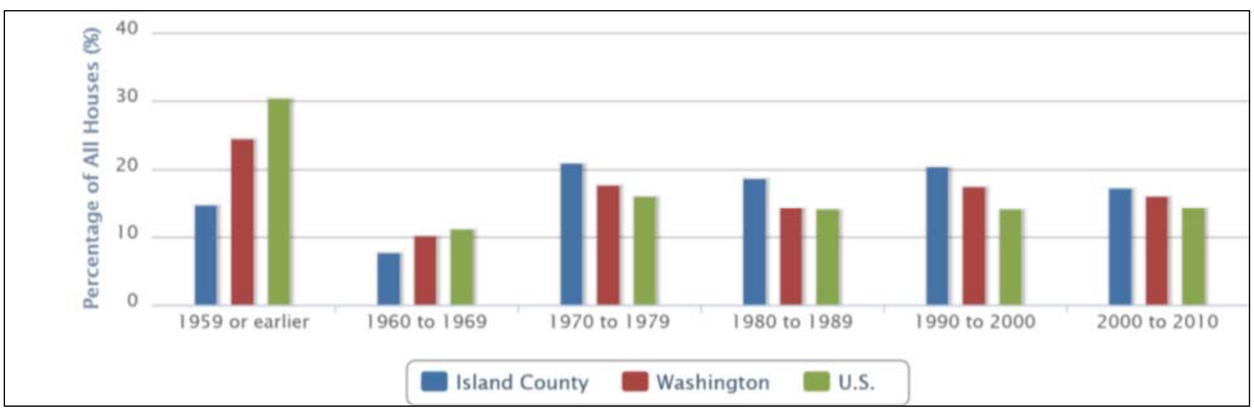


Figure 8-11. Distribution of Planning Area Structures by Year Constructed

TABLE 8-5.
AGE OF STRUCTURES WITHIN PLANNING AREA

Time Period	Number of Current Structures Building within Identified Period	Code Significance for Identified Time Period
Pre-1972	11,207	No standardized earthquake requirements in building codes. Washington State law did not require the issuance of any building permits, or require actual building officials.
1972-1993	14,047	UBC seismic construction standards were adopted in Washington.
1994-2003	9,173	Seismic Risk Zone 3 was established within the Uniform Building Code in 1994, requiring higher standards
2004-Present	3,849	Washington State upgraded its building codes to follow the International Building Code Standard. As upgrades occur, the state continues to adopt said standards. Most recent adoptions include the 2006 editions of the National Model Codes (with some amendments).
Total	**38,276**	

8.3.4 Impact on Critical Facilities and Infrastructure

All critical facilities in Island County are exposed to the earthquake hazard. Additionally, hazardous materials releases can occur during an earthquake from fixed facilities or transportation-related incidents. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment. Facilities holding hazardous materials are of particular concern because of possible isolation of residences surrounding them. During an earthquake, structures storing these materials could rupture and leak into the surrounding area or an adjacent waterway, having a disastrous effect on the environment. As a coastal community, this is of particular concern as spills into water bodies, including the coastline, could have devastating impact. Additionally, the potential for landslide-induced roadway closure is of significant concern. Closure of major arterials could require increased evacuation periods in some instances by several hours, including the need to evacuate by ferry in certain locations.

Level of Damage

Hazus-MH classifies the vulnerability of critical facilities to earthquake damage in five categories: no damage, slight damage, moderate damage, extensive damage, or complete damage. The model was used to assign a vulnerability category to each critical facility in the planning area except hazmat facilities and “other infrastructure” facilities, for which there are no established damage functions. The analysis was performed for four events: the 100- and 500-year events, the Utsalady scenario, and the South Whidbey Island Fault scenario. These events, respectively, have the highest probability of occurrence and the largest potential impact on the planning area The results are summarized in Table 8-6 through Table 8-9.

Time to Return to Functionality

Hazus-MH estimates the time to restore critical facilities to fully functional use. Results are presented as probability of being functional at specified time increments: 1, 3, 7, 14, 30 and 90 days after the event. For example, Hazus-MH may estimate that a facility has 5 percent chance of being fully functional at Day 3, and a 95 percent chance of being fully functional at Day 90. The analysis of critical facilities in the planning area was performed for the 100-year, 500-year, Utsalady Fault, and South Whidbey Island Fault scenario earthquake events. The results are summarized in Table 8-10 through Table 8-13.

**TABLE 8-6.
ESTIMATED DAMAGE TO CRITICAL FACILITIES FROM 100-YEAR PROBABILISTIC EARTHQUAKE EVENT**

Category	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical & Health	1	11	0	0	0
Government Functions	14	0	0	0	0
Protective Functions	34	0	0	0	0
Schools	0	0	0	0	28
Other Critical Facilities	11	12	0	0	2
Bridges	6	0	0	0	0
Water Supply	0	0	3	0	0
Wastewater	0	0	6	0	0
Power	0	0	13	0	0
Communications	0	0	13	0	0
Total	**66**	**23**	**35**	**0**	**30**

**TABLE 8-7.
ESTIMATED DAMAGE TO CRITICAL FACILITIES FROM 500-YEAR PROBABILISTIC EARTHQUAKE EVENT**

Category	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical & Health	1	11	0	0	0
Government Functions	14	0	0	0	0
Protective Functions	34	0	0	0	0
Schools	28	0	0	0	0
Other Critical Facilities	11	12	0	0	2
Bridges	6	0	0	0	0
Water Supply	0	0	3	0	0
Wastewater	0	0	6	0	0
Power	0	0	13	0	0
Communications	0	0	13	0	0
Total	**94**	**23**	**35**	**0**	**2**

**TABLE 8-8.
ESTIMATED DAMAGE TO CRITICAL FACILITIES FROM UTSALADY EARTHQUAKE EVENT**

Category	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical & Health	12	0	0	0	0
Government Functions	14	0	0	0	0
Protective Functions	27	4	3	0	0
Schools	28	0	0	0	0
Other Critical Facilities	9	16	0	0	0
Bridges	6	0	0	0	0
Water Supply	0	1	2	0	0
Wastewater	0	5	1	0	0
Power	0	9	4	0	0
Communications	0	11	2	0	0
Total	**96**	**46**	**12**	**0**	**0**

**TABLE 8-9.
ESTIMATED DAMAGE TO CRITICAL FACILITIES FROM SOUTH WHIDBEY EARTHQUAKE SCENARIO**

Category	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical & Health	1	1	7	3	0
Government Functions	11	1	2	0	0
Protective Functions	9	5	20	0	0
Schools	8	12	6	2	0
Other Critical Facilities	15	1	7	2	0
Bridges	1	2	3	0	0
Water Supply	1	1	1	0	0
Wastewater	2	1	2	1	0
Power	5	3	4	1	0
Communications	1	8	1	3	0
Total	**54**	**35**	**53**	**12**	**0**

**TABLE 8-10.
FUNCTIONALITY OF CRITICAL FACILITIES FOR 100-YEAR PROBABILISTIC EVENT**

	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical & Health	12	36	37	73	74	97	98
Government Functions	14	47	48	83	84	99	99
Protective Functions	34	41	42	77	78	97	98
Schools	28	47	47	83	84	99	99
Other Critical Facilities	25	55	62	79	80	87	92
Bridges	6	85	90	92	93	93	95
Water Supply	3	41	78	86	87	90	98
Wastewater	6	25	56	79	83	85	97
Power	13	29	63	90	98	99	100
Communications	13	64	86	90	96	98	100
Total	**154**	**47**	**55**	**82**	**84**	**95**	**97**

**TABLE 8-11.
FUNCTIONALITY OF CRITICAL FACILITIES FOR 500-YEAR PROBABILISTIC EVENT**

	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical & Health	12	36	37	73	74	97	98
Government Functions	14	47	48	83	84	99	99
Protective Functions	34	41	42	77	78	97	98
Schools	28	47	47	83	84	99	99
Other Critical Facilities	25	55	62	79	80	87	92
Bridges	6	85	90	92	93	93	95
Water Supply	3	41	78	86	87	90	98
Wastewater	6	25	56	79	83	85	97
Power	13	29	63	90	98	99	100
Communications	13	64	86	90	96	98	100
Total	**154**	**47**	**55**	**82**	**84**	**95**	**97**

TABLE 8-12.
FUNCTIONALITY OF CRITICAL FACILITIES FOR UTSALADY EARTHQUAKE EVENT

	# of Critical	Probability of Being Fully Functional (%)					
	Facilities	at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical & Health	12	64	65	90	90	99	100
Government Functions	14	55	56	87	88	99	99
Protective Functions	34	53	53	82	83	97	98
Schools	28	61	62	90	91	99	100
Other Critical Facilities	25	67	73	89	89	96	98
Bridges	6	90	93	94	95	95	96
Water Supply	3	45	81	88	89	92	98
Wastewater	6	33	65	84	88	89	97
Power	13	40	74	94	99	99	100
Communications	13	77	93	95	98	99	100
Total	**154**	**59**	**67**	**88**	**90**	**97**	**99**

TABLE 8-13.
FUNCTIONALITY OF CRITICAL FACILITIES FOR SOUTH WHIDBEY ISLAND FAULT SCENARIO

	# of Critical	Probability of Being Fully Functional (%)					
	Facilities	at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical & Health	12	10	11	44	45	94	97
Government Functions	14	100	100	100	100	100	100
Protective Functions	34	20	21	58	59	95	97
Schools	28	33	34	77	79	99	100
Other Critical Facilities	25	74	81	84	85	86	92
Bridges	6	79	84	86	87	88	92
Water Supply	3	44	80	88	89	92	99
Wastewater	6	18	40	60	63	67	89
Power	13	24	53	81	93	96	100
Communications	13	48	69	77	87	94	99
Total	**154**	**43**	**51**	**74**	**76**	**93**	**97**

Debris

The Hazus-MH analysis also estimated the amount of earthquake-caused debris in the planning area for the 100-year and 500-year earthquakes and the three scenario events, as summarized in Table 8-14.

8.3.5 Impact on Economy

Economic losses due to earthquake damage include damage to buildings, including the cost of structural and non-structural damage, damage to contents, and loss of inventory, loss of wages and loss of income (Table 8-15). Loss of tax base both from revenue and lack of improved land values will increase the economic loss to the County and its planning partners. In addition, loss of goods and services may hamper recovery efforts, and even preclude residents from rebuilding within the area.

**TABLE 8-14.
ESTIMATED EARTHQUAKE CAUSED DEBRIS**

Event	Amount of Debris to be Removed
100-Year Earthquake (M 6.5)	0.05 million tons
500- Year Probabilistic Earthquake (M 6.5)	0.33 million tons
M 6.7 Utsalady Fault Scenario	0.22 million tons
M 7.4 South Whidbey Island Fault Scenario	0.40 million tons

Note: Values in this table are accurate only for purposes of comparison among results presented in this plan. Data limitations exist as defined.

**TABLE 8-15.
EARTHQUAKE ECONOMIC LOSS POTENTIAL**

Scenario/Jurisdiction	Structural	Non-Structural	Total
100-Year Probabilistic Earthquake			
Coupeville	$2,595,590	$9,997,600	$22,331,330
Langley	$2,689,970	$10,817,810	$23,897,190
Oak Harbor	$5,158,020	$23,026,640	$47,261,380
Unincorporated Island County	$5,378,100	$25,653,520	$49,028,020
Total	**$15,821,680**	**$69,495,570**	**$142,517,920**
500-Year Probabilistic Earthquake			
Coupeville	$8,850,950	$29,747,900	$68,502,040
Langley	$8,473,450	$29,908,970	$68,531,500
Oak Harbor	$35,117,020	$133,830,570	$295,557,980
Unincorporated Island County	$35,821,470	$161,831,360	$330,466,130
Total	**$88,262,890**	**$355,318,800**	**$763,057,650**
Utsalady M 6.7 Scenario			
Coupeville	$4,264,390	$15,622,070	$35,363,300
Langley	$3,496,990	$13,637,870	$30,332,680
Oak Harbor	$21,484,180	$89,560,370	$187,590,250
Unincorporated Island County	$32,373,040	$145,430,020	$288,517,890
Total	**$61,618,600**	**$264,250,330**	**$541,804,120**
South Whidbey Island Fault M 7.4 Scenario			
Coupeville	$11,136,690	$39,635,320	$93,366,200
Langley	$13,597,970	$50,964,700	$117,026,950
Oak Harbor	$20,434,480	$70,458,260	$171,565,310
Unincorporated Island County	$56,038,180	$255,377,820	$538,937,210
Total	**$101,207,320**	**$416,436,100**	**$920,895,670**

a. Total includes Building and Content Damages, Inventory Losses, Relocation Costs, Income Losses, Rental Income Losses and Wage Losses.

Additional economic losses identified in the Hazus global summary report should be considered (e.g., life-line losses, sheltering costs, debris removal costs). A summary of the total economic loss including these types of losses is as follows:

- For a 100-year probabilistic earthquake, the estimated damage potential is $163.2 million, or 1.43 percent of the total assessed value for the planning area.
- For a 500-year probabilistic earthquake, the estimated damage potential is $809.12 million or 7.1 percent of the total assessed value for the planning area.
- For a 6.7-magnitude Utsalady Fault event, the estimated damage potential is $578.93 million, or 5.08 percent of the total assessed value for the planning area.
- For a 7.4-magnitude South Whidbey Fault event, the estimated damage potential is $1.001 billion, or 8.78 percent of the total assessed value for the planning area.

These values were based on the user-defined table provided by FEMA and WDNR, which utilized $11,391,475,821 as the total assessed value for the planning area. That data set does not provide values for all government structures.

8.3.6 Impact on Environment

Earthquake-induced landslides can significantly impact habitat. It is also possible for streams to be rerouted after an earthquake. This can change water quality, possibly damaging habitat and feeding areas. There is a possibility of streams fed by groundwater drying up because of changes in underlying geology.

8.4 FUTURE DEVELOPMENT TRENDS

Island County continues to utilize the International Building Code, which requires structures to be built at a level which supports soil types and earthquake hazards (ground shaking). As existing buildings are renovated, provisions are in place which require reconstruction at higher standards.

8.5 CLIMATE CHANGE IMPACTS

The impacts of global climate change on earthquake probability are unknown. Some scientists say that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the earth’s crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity according to research into prehistoric earthquakes and volcanic activity. NASA and USGS scientists found that retreating glaciers in southern Alaska may be opening the way for future earthquakes (NASA, 2004).

Secondary impacts of earthquakes could be magnified by climate change. Soils saturated by repetitive storms could experience liquefaction during seismic activity due to the increased saturation. Dams storing increased volumes of water due to changes in the hydrograph could fail during seismic events. There are currently no models available to estimate these impacts.

8.6 ISSUES

While the area has a high probability of an earthquake event occurring within its boundaries, an earthquake does not necessarily have to occur in the planning area to have a significant impact as such an event would disrupt transportation to and from the region as a whole and impact commodity flow. As such, any seismic activity of 6.0 or greater on faults in or near the planning area would have significant impact, including areas across the Salish Sea which support ferry transportation to and from Whidbey or Camano Islands. Potential warning systems could give approximately 40 seconds notice that a major earthquake is about to occur. This would not provide adequate time for preparation. Earthquakes of this magnitude or higher would lead to massive structural failure of property on NEHRP C, D, E, and F soils. Levees and revetments built on these poor soils would likely fail, representing a loss of critical infrastructure. These events could cause secondary hazards, including landslides and mudslides that would further damage structures. River valley hydraulic-fill sediment areas are also vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction would occur in water-saturated sands, silts or gravelly soils.

Earthquakes can cause large and sometimes disastrous landslides and mudslides. River valleys are vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction occurs when water-saturated sands, silts or gravelly soils are shaken so violently that the individual grains lose contact with one another and float freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people. Earthen dams and levees are highly susceptible to seismic events and the impacts of their eventual failures can be considered secondary risks for earthquakes. Earthquakes at sea can generate destructive tsunamis. Important issues associated with an earthquake include, but are not limited to the following:

- More information is needed on the exposure and performance of construction within the planning area. Much information on the age, type of construction, or updated work on facilities is not readily available in a useable format for a risk assessment of this type.
- It is presently unknown to what standards portions of the planning area's building stock were constructed or renovated.
- Based on the modeling of critical facility performance for this plan, a high number of facilities in the planning area are expected to have complete or extensive damage from scenario events. These facilities are prime targets for structural retrofits.
- The County and its planning partners are encouraged to create or enhance continuity of operations plans using the information on risk and vulnerability contained in this plan.
- Geotechnical standards should be established that take into account the probable impacts from earthquakes in the design and construction of new or enhanced facilities.
- Dam failure warning, evacuation plans and procedures should be updated (and maintained) to reflect dam risk potential associated with earthquake activity in the region, with said information being distributed to the County and its planning partners to allow for appropriate planning to occur.
- Earthquakes could trigger other natural hazard events such as a tsunami, which would have far-reaching impacts.

CHAPTER 9.
FLOOD

Floods are one of the most common natural hazards in the U.S. They can develop slowly over a period of days or develop quickly, with disastrous effects that can be local (impacting a neighborhood or community) or regional (affecting entire river basins, coastlines and multiple counties or states) (FEMA, 2010). Most communities in the U.S. have experienced some kind of flooding, after spring rains, heavy thunderstorms, coastal storms, or winter snow thaws. Floods are one of the most frequent and costly natural hazards in terms of human hardship and economic loss, particularly to communities that lie within flood-prone areas or floodplains of a major water source.

DEFINITIONS

Flood—The inundation of normally dry land resulting from the rising and overflowing of a body of water.

Floodplain—The land area along the sides of a river that becomes inundated with water during a flood.

100-Year Floodplain—The area flooded by a flood that has a 1-percent chance of being equaled or exceeded each year. This is a statistical average only; a 100-year flood can occur more than once in a short period of time. The 1-percent annual chance flood is the standard used by most federal and state agencies.

Floodway—The channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height.

9.1 GENERAL BACKGROUND

Flooding is a general and temporary condition of partial or complete inundation on normally dry land from the following:

- Riverine flooding, including overflow from a river channel, flash floods, alluvial fan floods, dam-break floods and ice jam floods
- Local drainage or high groundwater levels
- Fluctuating lake levels
- Coastal flooding
- Coastal erosion
- Unusual and rapid accumulation or runoff of surface waters from any source
- Mudflows (or mudslides)
- Collapse or subsidence of land along the shore of a lake or similar body of water that result in a flood, caused by erosion, waves or currents of water exceeding anticipated levels (Floodsmart.gov, 2012)
- Sea level rise
- Climate Change (USEPA, 2012).

9.1.1 Flooding Types

Many floods fall into one of three categories: riverine, coastal or shallow (FEMA, 2005). Other types of floods include alluvial fan floods, dam failure floods, and floods associated with local drainage or high groundwater. For this hazard mitigation plan and as deemed appropriate by the County, riverine, flash, dam failure (addressed in a separate profile) and coastal/storm surge flooding are the main flood types of concern for the planning area. These types of flood are further discussed below.

Riverine

Riverine floods are the most common flood type. They occur along a channel, and include overbank and flash flooding. Channels are defined ground features that carry water through and out of a watershed. They may be called rivers, creeks, streams or ditches. When a channel receives too much water, the excess water flows over its banks and inundates low-lying areas (FEMA, 2005).

Flash Floods

A flash flood is a rapid, extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within six hours of the causative event (e.g., intense rainfall, dam failure, ice jam). The time may vary in different areas. Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising floodwaters (NWS, 2009).

Dam Failure Floods

See Chapter 6 for additional information on dam failure floods.

Coastal Flooding

Coastal flooding is the flooding of normally dry, low-lying coastal land, primarily caused by severe weather events along the coast, estuaries, and adjoining rivers. These flood events are some of the more frequent, costly, and deadly hazards that can impact coastal communities. Factors causing coastal flooding include:

- Storm surges, which are rises in water level above the regular astronomical tide caused by a severe storm's wind, waves, and low atmospheric pressure. Storm surges are extremely dangerous, because they are capable of flooding large coastal areas.
- Large waves, whether driven by local winds or swell from distant storms, raise average coastal water levels and individual waves roll up over land.
- High tide levels are caused by normal variations in the astronomical tide cycle.
- Other larger scale regional and ocean scale variations are caused by seasonal heating and cooling and ocean dynamics.

Coastal floods are extremely dangerous, and the combination of tides, storm surge, and waves can cause severe damage. Coastal flooding is different from river flooding, which is generally caused by severe precipitation. Depending on the storm event, in the upper reaches of some tidal rivers, flooding from storm surge may be followed by river flooding from rain in the upland watershed. This increases the flood severity.

9.1.2 Measuring Floods and Floodplains

A floodplain is the area adjacent to a river, creek or lake that becomes inundated during a flood. Floodplains may be broad, as when a river crosses an extensive flat landscape, or narrow, as when a river is confined in a canyon. Connections between a river and its floodplain are most apparent during and after major flood events. These areas form a complex physical and biological system that not only supports a variety of natural resources but also provides natural flood and erosion control. When a river is separated from its floodplain with levees and other flood control facilities, natural, built-in benefits can be lost, altered, or significantly reduced.

In the case of riverine or flash flooding, once a river reaches flood stage, the flood extent or severity categories used by the NWS include minor flooding, moderate flooding, and major flooding. Each category has a definition based on property damage and public threat (NWS, 2011):

- Minor Flooding—Minimal or no property damage, but possibly some public threat or inconvenience.
- Moderate Flooding—Some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations are necessary.
- Major Flooding—Extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations.

9.1.3 Flood Insurance Rate Maps

According to FEMA, flood hazard areas are defined as areas that are shown to be inundated by a flood of a given magnitude on a map (see Figure 9-1). These areas are determined using statistical analyses of records of river flow, storm tides, and rainfall; information obtained through consultation with the community; floodplain topographic surveys; and hydrologic and hydraulic analyses.

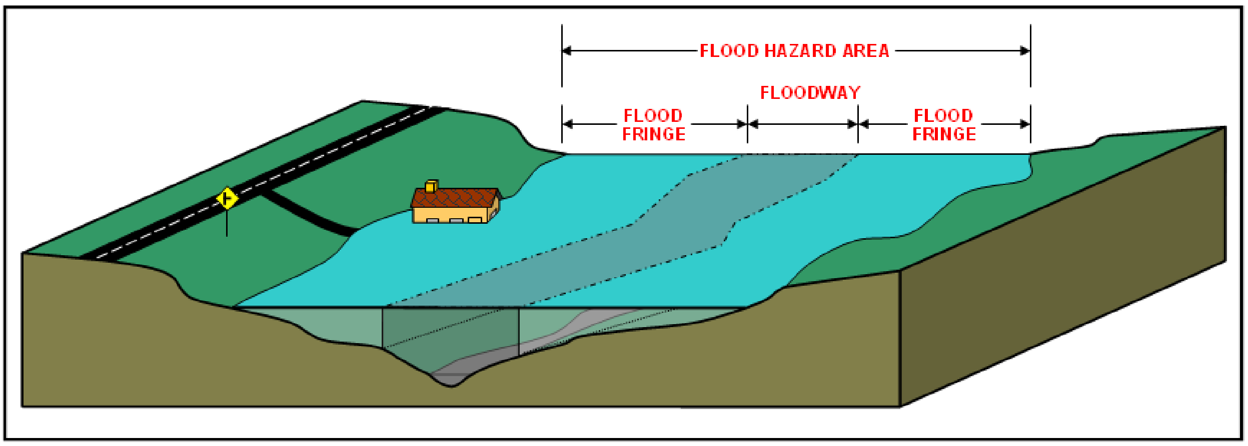


Figure 9-1. Flood Hazard Area Referred to as Floodplain

Flood hazard areas are delineated on FEMA's Flood Insurance Rate Maps (FIRM), which are official maps of a community on which the Federal Insurance and Mitigation Administration has indicated both the special flood hazard areas and the risk premium zones applicable to the community. These maps identify the special flood hazard areas; the location of a specific property in relation to the special flood hazard area; the base (100-year) flood elevation at a specific site; the magnitude of a flood hazard in a specific area; and undeveloped coastal barriers where flood insurance is not available. The maps also locate regulatory floodways and floodplain boundaries—the 100-year and 500-year floodplain boundaries (FEMA, 2003; FEMA, 2005; FEMA, 2008). As of development of this update, FEMA is in the Discovery Phase of developing updated flood maps for Island County. It is anticipated that these maps will be completed and published for initial review in late 2015, after which time, if the County is in agreement with the analysis completed by FEMA, they will adopt the new flood maps.

The frequency and severity of flooding are measured using a discharge probability, which is a statistical tool used to define the probability that a certain river discharge (flow) level will be equaled or exceeded within a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels.

The extent of flooding associated with a 1-percent annual probability of occurrence (the base flood or 100-year flood) is used as the regulatory boundary by many agencies. Also referred to as the special flood hazard area, this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities have maps that show the extent and likely depth of flooding for the base flood.

Corresponding water-surface elevations describe the elevation of water that will result from a given discharge level, which is one of the most important factors used in estimating flood damage.

A structure located within a 1 percent (100-year) floodplain has a 26 percent chance of suffering flood damage during the term of a 30-year mortgage. The 100-year flood is a regulatory standard used by federal agencies and most states to administer floodplain management programs. The 1 percent (100-year) annual chance flood is used by the NFIP as the basis for insurance requirements nationwide. FIRMs also depict 500-year flood designations, which is a boundary of the flood that has a 0.2-percent chance of being equaled or exceeded in any given year (FEMA, 2003; FEMA, 2005). It is important to recognize, however, that flood events and flood risk are not limited to the NFIP delineated flood hazard areas.

Figure 9-2 shows the existing 100-year and 500-year floodplains within Island County, based on FEMA's existing digital flood insurance rate maps (DFIRMs).

9.1.4 National Flood Insurance Program (NFIP)

The NFIP is a federal program enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for state and community floodplain management regulations that reduce future flood damage. The U.S. Congress established the NFIP with the passage of the National Flood Insurance Act of 1968 (FEMA's 2002 *National Flood Insurance Program (NFIP): Program Description*). There are three components to the NFIP: flood insurance, floodplain management and flood hazard mapping. Nearly 20,000 communities across the U.S. and its territories participate in the NFIP by adopting and enforcing floodplain management ordinances to reduce future flood damage. In exchange, the NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in these communities. Community participation in the NFIP is voluntary.

For most participating communities, FEMA has prepared a detailed Flood Insurance Study. The study presents water surface elevations for floods of various magnitudes, including the 1-percent annual chance flood and the 0.2-percent annual chance flood (the 500-year flood). Base flood elevations and the boundaries of the 100- and 500-year floodplains are shown on Flood Insurance Rate Maps (FIRMs), which are the principle tool for identifying the extent and location of the flood hazard. FIRMs are the most detailed and consistent data source available, and for many communities they represent the minimum area of oversight under their floodplain management program.

FEMA, under the Risk Map Program, is updating the FIRMs for Island County and its jurisdictions. Those maps have not yet been released for use in this analysis; this risk assessment relies on previous FIRMs created in 2007 until such time as the new maps are released, reviewed and adopted by the County. It is anticipated that those maps will be released for use during late 2015.

NFIP Participants must regulate development in floodplain areas in accordance with NFIP criteria. Before issuing a permit to build in a floodplain, participating jurisdictions must ensure that three criteria are met:

- New buildings and those undergoing substantial improvements must, at a minimum, be elevated to protect against damage by the 100-year flood.
- New floodplain development must not aggravate existing flood problems or increase damage to other properties.
- New floodplain development must exercise a reasonable and prudent effort to reduce its adverse impacts on threatened salmonid species.

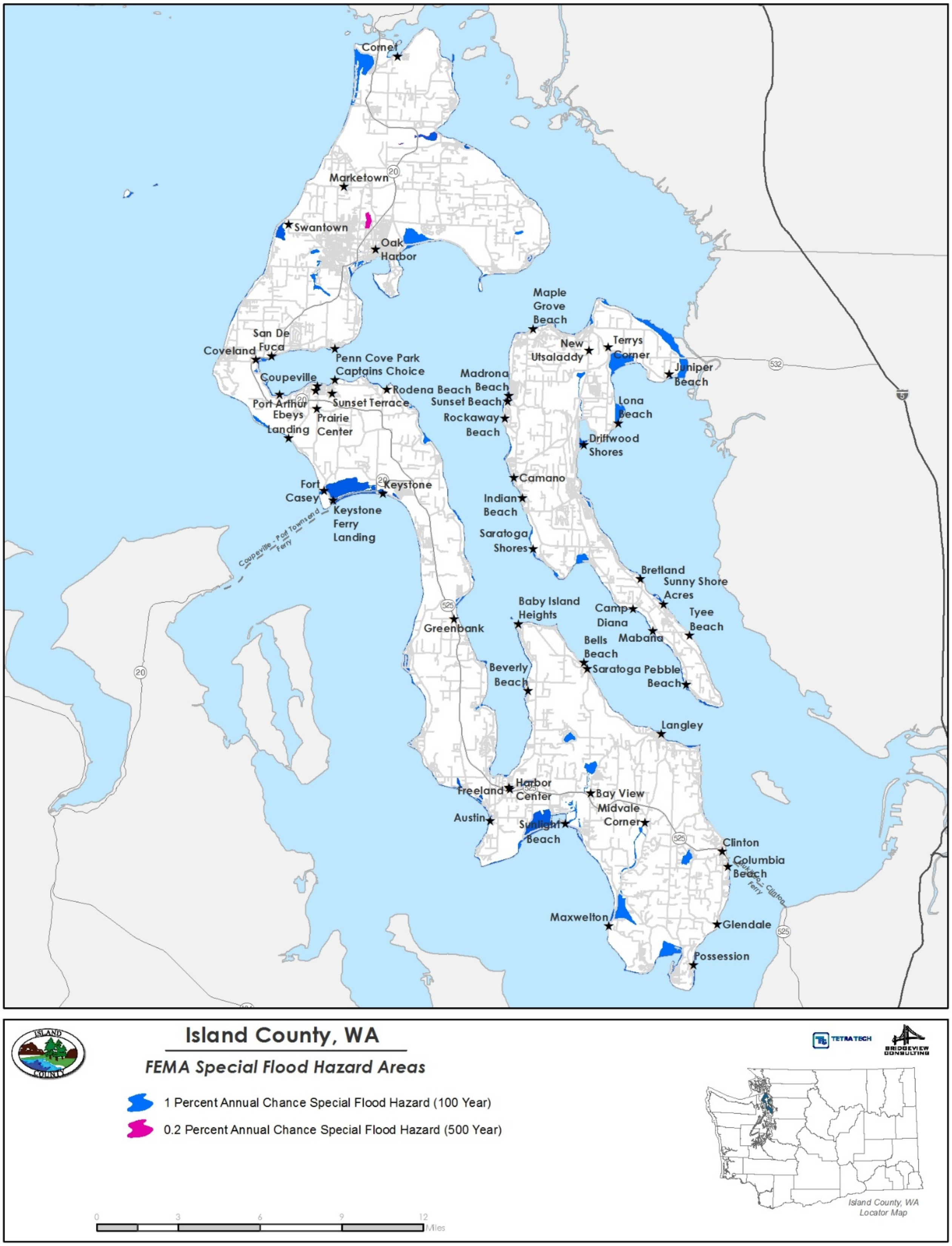


Figure 9-2. Island County Flood Hazard Areas

NFIP Status and Severe Loss/Repetitive Loss Properties

Island County is a member in good standing in the NFIP, and does incorporate regulatory authority within its land use planning. Table 9-1 presents the NFIP policy status as of August 2014.

TABLE 9-1.
NFIP POLICY STATISTICS

Community Name	Policies In-Force	Insurance In-Force	Premiums In-Force
Island County	982	246,646,600	1,181,455
Coupeville	4	1,286,200	3,778
Langley	6	1,790,000	4,383
Oak Harbor	36	9,004,300	18,865

Source: http://bsa.nfipstat.fema.gov/reports/1011.htm#WAT

Repetitive Flood Claims

Residential or non-residential (commercial) properties that have received one or more NFIP insurance payments are identified as repetitive flood properties under the NFIP. Such properties are eligible for funding to help mitigate the impacts of flooding through various FEMA programs, subject to meeting certain criteria and based on the State's Hazard Mitigation Plan maintaining a Repetitive Loss Strategy. Washington State's 2013 Hazard Mitigation Plan does contain such a strategy. Specifically, the Repetitive Loss Strategy must identify the specific actions the State has taken to reduce the number of repetitive loss properties, which must include severe repetitive loss properties, and specify how the State intends to reduce the number of such repetitive loss properties. In addition, the hazard mitigation plan must describe the State's strategy to ensure that local jurisdictions with severe repetitive loss properties take actions to reduce the number of these properties, including the development of local hazard mitigation plans.

Repetitive flood claims provides funding to reduce or eliminate the long-term risk of flood damage to structures insured under the NFIP that have had one or more claim payments for flood damages.

Severe Repetitive Loss Program

The severe repetitive loss program is authorized by Section 1361A of the National Flood Insurance Act (42 U.S.C. 4102a), with the goal of reducing flood damages to residential properties that have experienced *severe* repetitive losses under flood insurance coverage and that will result in the greatest savings to the NFIP in the shortest period of time. A severe repetitive loss property is a residential property that is covered under an NFIP flood insurance policy and:

- a) That has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or
- b) For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

For both (a) and (b) above, at least two of the referenced claims must have occurred within any 10-year period, and must be greater than 10 days apart.

As of August 2014, neither the County nor any of its planning partners have severe repetitive loss or Repetitive Flood Claim properties.

The Community Rating System

The Community Rating System (CRS) is a voluntary program within the NFIP that encourages floodplain management activities that exceed the minimum NFIP requirements. Flood insurance premiums are discounted to reflect the reduced flood risk resulting from community actions.

As of November 2014, Island County and its planning partners are not CRS Communities. At present, the planning partnership does not feel the level of effort to become a CRS community is warranted, nor within the capacity of the present staffing levels to facility such an endeavor.

9.2 HAZARD PROFILE

9.2.1 Extent and Location

Island County is within the rain shadow of the Olympic Mountains (see Severe Weather Chapter for identification of rain shadow area within Washington). Historically, the Olympic Mountains receive more rain than any other place in the contiguous United States; however, Island County receives only approximately 25 inches annually, compared to approximately 39 inches statewide average. While snow is not rare to Island County, it normally does not accumulate or remain on the ground for extended periods of time. As a result, flooding within the County is limited in both extent and location, with flooding occurring primarily along the coastal areas, which are vulnerable to tidal flooding when conditions are right. The risk of a flood occurring in any one year is high while the magnitude of the flood will be restricted by the geography of the islands.

Principal Flooding Sources

Principal flooding sources in Island County are typically caused by storms and rapid accumulation of runoff surface water, or through storm surges coming off of the coast during high tides, which increases the impact of flood events. In almost all historical cases of flooding within Island County, the cause has been associated with a storm surge driven by high winds. Flooding from rainfall and runoff ponding has occurred in limited areas in the past during exceptional rainstorms.

Numerous beach level residential areas on Whidbey and Camano Islands are risk from tidal flooding. This occurred as part of the severe storm that struck Island County on February 4, 2006. Oak Harbor and the NASWI both have residential and commercial properties on the beach that are at risk from flooding related to tidal surge. The Langley Marina and the area of Sandy Hook south of Langley are exposed to flooding resulting from tidal surge risk.

9.2.2 Previous Occurrences

Major floods in the planning area have resulted from intense rainstorms customarily between October and April. Table 9-2 highlights typical historical flood events.

9.2.3 Severity

The severity of a flood depends not only on the amount of water that accumulates in a period of time, but also on the land's ability to manage this water. One element is the size of rivers and streams in an area; but an equally important factor is the land's absorbency. When it rains, soil acts as a sponge. When the land is saturated or frozen, infiltration into the ground slows and any more water that accumulates must flow as runoff (Harris, 2001). Flood severity from a dam failure is discussed in Chapter 6.

**TABLE 9-2.
FLOOD EVENTS IMPACTING PLANNING AREA SINCE 1956**

Date	Type	Deaths or Injuries	Property Damage
November 1990 (Disaster 883)	Flooding and Severe Storms	2 people died statewide	Interstate 90 Lake Washington floating bridge sank; impact occurred throughout the state. Combined, $2.9* million dollars in losses occurred.
Description: Thanksgiving weekend flood set record stages on several Washington rivers. Strong winds, snowfall and flooding affected 10 counties in Washington, including Island County.			
December 1990 (Disaster #896*)	Flooding, severe winter storm, snow and high winds	Unknown	$5.1 million combined from all 10 affected counties*
Description: Strong winds, snowfall and flooding affected 10 counties in Washington, including Island County.			
November 1995 (Disaster 1079)	Flooding, severe storm, thunderstorm	Unknown	Unknown
Description: Heavy rains land wind lead to flooding throughout the region			
Dec. 1996—Jan. 1997 (Disaster #1159)	Severe winter storm, snow, freezing rain; high winds; landslides.	24 deaths statewide	Statewide: Stafford Act assistance $83 million; SBA $31.7 million; total losses $140 million statewide
Description: Saturated ground combined with snow, freezing rain, rain, rapid warming and high winds within a five-day period produced flooding and landslides. 37 counties were impacted, with large power outages throughout the impacted counties.			
October 2003 (Disaster 1499)	Flooding and Severe Storm	Unknown	Statewide losses* PA >$9 million IA >$5.5 million
Description: Heavy rains, severe storms.			
January 2006 (Disaster 1641)	Flooding, severe winter storm, landslide, mudslide, tidal surge	Unknown	Unknown
Description: Heavy rains			
December 2006 Disaster 1682	Severe winter storm, landslides and mudslides	Unknown	Unknown
Description: Severe winter storm caused landslides and mudslides throughout region.			
January 2009 (Disaster 1825)	Severe winter storm, record and near record snow, heavy rains, landslides, winds, tidal surge	Unknown	Public Assistance to all declared counties was over $5.5* million
Description: Severe winter storm, including record and near record snowfall and heavy rains and winds.			

Source: Spatial Hazard Events and Losses Database for the United States (SHELDUS) and FEMA website.

*= Statewide Amount

N/A = Information is not available

The principal factors affecting flood damage are flood depth and velocity. The deeper and faster flood flows become, the more damage they can cause. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity. This is especially true when a channel migrates over a broad floodplain, redirecting high velocity flows and transporting debris and sediment. Flood severity is often evaluated by examining peak discharges, some of which are indicated above.

9.2.4 Frequency

Island County experiences flooding on a fairly regular basis. Large floods that can cause property damage typically occur every two to three years. Frequency for this calculation was based on the period covering 1990 to 2013, and the number of events averaged based on years and number of floods. It should be noted that this does not reflect the recurrence interval, as that calculation is specific on varying factors, such as the incident type, discharge rate, etc., and that type of analysis was not included in this process.

9.3 VULNERABILITY ASSESSMENT

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For the flood hazard, areas identified as hazard areas include the 1 percent and 0.2 percent (100- and 500-year) floodplains. The following text evaluates and estimates the potential impact of flooding in Island County.

9.3.1 Overview

All types of flooding can cause widespread damage throughout rural and urban areas, including but not limited to: water-related damage to the interior and exterior of buildings; destruction of electrical and other expensive and difficult-to-replace equipment; injury and loss of life; proliferation of disease vectors; disruption of utilities, including water, sewer, electricity, communications networks and facilities; loss of agricultural crops and livestock; placement of stress on emergency response and healthcare facilities and personnel; loss of productivity; and displacement of persons from homes and places of employment.

Methodology

The 1 percent and 0.2 percent (100- and 500-year) annual chance flood events were examined to evaluate Island County's risk and vulnerability to the flood hazard. These flood events are generally those considered by planners and evaluated under federal programs such as the NFIP.

As indicated, the County's FIRMs are currently being updated, but as of the development of this profile – November 2014, the new maps have not been adopted by the County. Therefore, for purposes of this update, the existing, adopted Digital FIRMs (DFIRMs) were considered the best available data, and were used to identify exposure for this plan. A modified Level 1/Level 2 (for updated critical facilities and user defined facilities) Hazus protocol was used to assess exposure to flooding in the planning area. This type of analysis has a level of accuracy acceptable for planning purposes. Where possible, the Hazus default data was enhanced using critical infrastructure and building data provided by the County, as well as data from the state and federal sources. Figure 9-2 shows the flood boundaries used for this exposure assessment.

Warning Time

Due to the sequential pattern of meteorological conditions needed to cause serious flooding, it is unusual for a flood to occur without some warning. Warning times for floods can be between 24 and 48 hours. Flash flooding can be less predictable, but potential hazard areas can be warned in advanced of potential flash flooding danger.

9.3.2 Impact on Life, Health and Safety

The impact of flooding on life, health and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time is provided to residents. Exposure represents the population living in or near floodplain areas that could be impacted should a flood event occur. Additionally, exposure should not be limited to only those who reside in a defined hazard zone, but everyone who may be affected by the effects of a hazard event (e.g., people are at risk while traveling in flooded areas, or their access to emergency services is compromised during an event). The degree of that impact will vary and is not measurable.

Of significant concern within the planning area is the number of tourists who can be impacted during periods of flooding. Tourism is a fairly large economy within the planning area, with many tourists traveling through the area to view the scenic area. In addition, tourism is increased as a result of recreational activities, especially during summer months.

To estimate the population exposed to the 1 percent and 0.2 percent annual chance (100- and 500-year) flood events, the preliminary FEMA DFIRM floodplain boundaries were intersected with residential parcels (based off of Island County Assessor data) whose centers intersect the floodplain. Total population was estimated by multiplying the number of residential structures by the average Island County household size of 2 persons per household. Table 9-3 lists the estimated population located within these flood zones by municipality. There are currently no structures exposed to the adopted FEMA 0.2 percent annual chance flood hazard.

TABLE 9-3.
VULNERABLE POPULATIONS WITHIN FLOOD HAZARD AREAS

Jurisdiction	Population in the 1% annual chance event (100- Year) Flood Boundary	Population in the 0.2% annual chance (500-Year) Flood Boundary
Unincorporated Island County	4,110	0
Coupeville	2	0
Langley	16	0
Oak Harbor	40	0
Total	**4,168**	**0**

Of the population exposed, the most vulnerable include the economically disadvantaged and the population over the age of 65. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on the net economic impact on their family. The population over the age of 65 is also more vulnerable because they are more likely to seek or need medical attention which may not be available due to isolation during a flood event and they may have more difficulty evacuating.

The number of injuries and casualties resulting from flooding is generally limited based on advance weather forecasting, blockades and warnings. Therefore, injuries and deaths generally are not anticipated if proper warning and precautions are in place. Ongoing mitigation efforts should help to avoid the most likely cause of injury, which results from persons trying to cross flooded roadways or channels during a flood.

9.3.3 Impact on Property

Table 9-4 summarizes the total area and number of structures in the 100- flood boundaries. Table 9-5 summarizes the estimated value of exposed buildings in the 100- year flood boundaries. No structures were impacted by a 500-year flood event (this is an anomaly which will be reviewed once new NFIP maps are released).

TABLE 9-4.
AREA AND STRUCTURES IN THE 100-YEAR FLOODPLAIN

	Area in Floodplain (Acres)	Number of Structures in Floodplain							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	**Total**
Unincorporated	5,739	2,054	134	0	0	0	0	0	**2,188**
Coupeville	15	1	7	0	0	0	0	0	**8**
Langley	19	8	15	0	0	0	0	0	**23**
Oak Harbor	463	20	6	1	0	0	1	0	**28**
Total	**6,236**	**2,083**	**162**	**1**	**0**	**0**	**1**	**0**	**2,247**

TABLE 9-5.
VALUE OF STRUCTURES IN 100-YEAR FLOODPLAIN

	Value Exposed			% of Total Assessed Value
	Structure	Contents	Total	
Unincorporated	$372,196,920	$200,397,349	$572,594,269	7.62%
Coupeville	$786,278	$732,176	$1,518,454	0.62%
Langley	$3,756,043	$2,935,926	$6,691,969	3.77%
Oak Harbor	$4,912,531	$3,590,940	$8,503,471	0.25%
Total	**$381,651,772**	**$207,656,390**	**$589,308,162**	**5.17%**

Notes: Structure assessed value (AV) was calculated by subtracting the land AV from the total AV.

After considering the population exposed to the flood hazard, the Hazus-MH default value of general building stock exposed to, and damaged by, the 100- and 500-year annual chance flood events were evaluated. Exposure in the flood zone includes buildings in the flood zone. The Hazus-MH model does not accurately estimate general building stock exposure to the flood hazard. To provide a general estimate of number of properties and structural/content replacement value, the current FEMA DFIRM flood boundaries and an Island County parcel GIS shape file (developed by FEMA for the 2014 map update process) containing assessed values (provided to FEMA by Island County) were used. For structures for which no assessor's valuation was provided, assumptions were made based on average square footage for similar structure type/occupancy code. The FEMA current DFIRM 100- and 500-year flood zones were intersected with the County parcel layer and the real property layers for each municipality. Parcel centroids that intersected the 1 and 0.2 percent flood zones were totaled to approximate the number of properties and assessed values (total, building and land) located in the flood zone. For this update, only exposure numbers were generated to eliminate potential conflict with the new FEMA flood maps currently under review.

The County has identified an enhancement project for the Assessor's data as a potential mitigation strategy over the next five-year life cycle of this plan.

9.3.4 Impact on Critical Facilities and Infrastructure

In addition to considering general building stock at risk, the risk of flood to critical facilities and utilities was evaluated. Hazus-MH was used to estimate critical facilities exposed to the flood risk. Table 9-6 and Table 9-7 list critical facilities and infrastructure located in the FEMA 100-year flood hazard area. There are currently no facilities exposed to the FEMA 500-year flood hazard area.

TABLE 9-6
CRITICAL FACILITIES IN THE 100-YEAR FLOODPLAIN

Jurisdiction	Medical and Health Services	Government Function	Protective	Hazardous Materials	Schools	Other	**Total**
Unincorporated	0	0	0	0	0	1	**1**
Coupeville	0	0	0	0	0	0	**0**
Langley	0	0	0	0	0	0	**0**
Oak Harbor	0	0	0	0	0	2	**2**
Total	**0**	**0**	**0**	**0**	**0**	**3**	**3**

TABLE 9-7.
CRITICAL INFRASTRUCTURE IN THE 100-YEAR FLOODPLAIN

Jurisdiction	Transportation	Water Supply	Wastewater	Power	Communications	Other	**Total**
Unincorporated	8	0	0	0	0	1	**9**
Coupeville	0	0	0	0	0	0	**0**
Langley	0	0	0	0	0	0	**0**
Oak Harbor	0	0	0	0	0	2	**2**
Total	**8**	**0**	**0**	**0**	**0**	**3**	**11**

In cases where short-term functionality is impacted by a hazard, other facilities of neighboring municipalities may need to increase support response functions during a disaster event. Mitigation planning should consider means to reduce impact on critical facilities and ensure sufficient emergency and school services remain when a significant event occurs.

9.3.5 Impact on Economy

Impact on the economy related to a flood event in Island County would include loss of property and associated tax revenue, as well as potential loss of businesses. Depending on the duration between onset of the event and recovery, businesses within the area may not be able to sustain the economic loss of their business being disrupted for an extended period of time. Historical data has demonstrated that those businesses impacted by a disaster are less likely to reopen after an event.

9.3.6 Impact on Environment

Flooding is a natural event, and floodplains provide many natural and beneficial functions. Nonetheless, with human development factored in, flooding can impact the environment in negative ways.

Because they border water bodies, floodplains have historically been popular sites to establish settlements. Human activities tend to concentrate in floodplains for a number of reasons: water is readily available; land is fertile and suitable for farming; transportation by water is easily accessible; and land is flatter and easier to develop. But human activity in floodplains frequently interferes with the natural function of floodplains. It can affect the distribution and timing of drainage, thereby increasing flood problems. Human development can create local flooding problems by altering or confining drainage channels. This increases flood potential in two ways: it reduces the stream's capacity to contain flows, and it increases flow rates or velocities downstream during all stages of a flood event. Migrating fish can wash into roads or over dikes into flooded fields, with no possibility of escape. Pollution from roads, such as oil, and hazardous materials can wash into rivers and streams. During floods, these can settle onto normally dry soils, polluting them for agricultural uses. Human development such as bridge abutments and levees, and logjams from timber harvesting can increase stream bank erosion, causing rivers and streams to migrate into non-natural courses.

Floodplains can support ecosystems that are rich in quantity and diversity of plant and animal species. A floodplain can contain 100 or even 1000 times as many species as a river. Wetting of the floodplain soil releases an immediate surge of nutrients: those left over from the last flood, and those that result from the rapid decomposition of organic matter that has accumulated since then. Microscopic organisms thrive and larger species enter a rapid breeding cycle. Opportunistic feeders (particularly birds) move in to take advantage. The production of nutrients peaks and falls away quickly; however the surge of new growth endures for some time. This makes floodplains particularly valuable for agriculture. Species growing in floodplains are markedly different from those that grow outside floodplains. For instance, riparian trees (trees that grow in floodplains) tend to be very tolerant of root disturbance and very quick-growing compared to non-riparian trees.

In addition to those critical facilities referenced in Table 9-6 and Table 9-7, there are 13 transportation facilities exposed to the 100-year flood hazard.

9.4 FUTURE DEVELOPMENT TRENDS

Island County and its planning partner cities are subject to the provisions of the Washington State Growth Management Act (GMA), which regulates identified critical areas. Island County critical areas regulations include frequently flooded areas, defined as the FEMA 100-year mapped floodplain. The GMA establishes review and evaluation programs that monitor commercial, residential and industrial development and the densities at which this development has occurred under each jurisdiction's GMA comprehensive plan and development regulations. An evaluation is required at least every five years of the sufficiency of remaining land within urban growth areas to accommodate projected residential, commercial and industrial growth at development densities observed since the adoption of GMA plans. This buildable lands report compares planned versus actual urban densities in order to determine whether original plan assumptions were accurate.

Island County's most recent buildable lands report was completed in 2009, which included land use map changes. It excludes areas designated as "critical areas" from consideration as buildable lands due to the scope of regulations affecting them. Some floodplains in the planning area can be developed, but are subject to regulatory provisions in the codes of Island County and its partner cities. The buildable lands analysis assumes that these regulations will discourage development from these areas. At present, the county and its planning partners are in the process of updating its Buildable Lands Analysis in preparation of its update to the Comprehensive Land Use Plan. As the County and its planning partners embark on this effort, coordination with this mitigation plan will occur to help define areas of potential risk and determining where development should occur, and where regulatory authority may need to be reviewed and updated.

The floodplain portions of the planning area are regulated under the GMA and the NFIP. Development will occur in the floodplain; however, it will be regulated such that the degree of risk will be reduced through building standards and performance measures. It should again be noted that as of development of this risk assessment, Island County is in the Discovery Process for NFIP map updates. Those updates, once available, will be utilized to further expand, modify and enhance this portion of the plan.

Based on analysis performed utilizing the 2007 adopted flood maps (not the 2015 maps currently under development), 605.768 acres encompassing 35 parcels are completely within or intersect the floodplain. The floodplain in Island County totals 6,153.496 acres. There are 10,588.329 acres of parcels which are designated as agricultural. Of the 567 parcels designated as agricultural, 93 of these are either completely within or intersect the floodplain and have a size of 2,060.16 acres.

9.5 CLIMATE CHANGE IMPACTS

Use of historical hydrologic data has long been the standard of practice for designing and operating water supply and flood protection projects. For example historical data are used for flood forecasting models and to forecast snowmelt runoff for water supply. This method of forecasting assumes that the climate of the future will be similar to that of the period of historical record. However, the hydrologic record cannot be used to predict changes in frequency and severity of extreme climate events such as floods. Going forward, model calibration or statistical relation development must happen more frequently, new forecast-based tools must be developed, and a standard of practice that explicitly considers climate change must be adopted.

In an effort to prepare for such efforts, in 2009, the Washington State Legislature directed certain state agencies to prepare an integrated climate response strategy to "better enable state and local agencies, public and private businesses, nongovernmental organizations, and individuals to prepare for, address, and adapt to the impacts of climate change." (Washington Department of Commerce, 2015). This adaption plan is an interdisciplinary approach to increasing resiliency and preparedness.

Climate change is already impacting water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied upon to forecast the water future.
- Precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management and ecosystem functions.
- Extreme climatic events will become more frequent, necessitating improvement in flood protection, drought preparedness and emergency response.

The amount of snow is critical for water supply and environmental needs, but so is the timing of snowmelt runoff into rivers and streams. Rising snowlines caused by climate change will allow more mountain area to contribute to peak storm runoff. High frequency flood event s (e.g. 10 -year floods) in particular will likely increase with a changing climate. Along with reductions in the amount of the snowpack and accelerated snowmelt, scientists project greater storm intensity, resulting in more direct runoff and flooding. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As stream flows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. With potential increases in the frequency and intensity of wildfires due to climate change, there is potential for more floods following fire, which increase sediment loads and water quality impacts.

As hydrology changes, what is currently considered a 100-year flood may strike more often, leaving many communities at greater risk. Planners will need to factor a new level of safety into the design, operation, and regulation of flood protection facilities such as dams, floodways, bypass channels and levees, as well as the design of local sewers and storm drains.

9.6 ISSUES

As a coastal community in the Puget Sound, a large portion of the planning area has the potential to flood at irregular intervals, generally in response to a succession of intense winter rainstorms and storm surges. Storm patterns of warm, moist air are normal events, usually occurring between October and April can cause severe flooding in the planning area.

A worst-case scenario for a flood event within the County would be a series of storms that result in high accumulations of runoff surface water within a relatively short time period, along with a high tide event. This could overwhelm response capabilities within Island County. Major roads could be blocked, preventing critical access for residents and critical functions in portions of the planning region. High in-channel flows leading into Puget Sound could cause watercourses to scour, possibly washing out roads or impacting bridges, creating more isolation problems, and further exacerbating erosion along the coastline. In the case of multi-basin flooding, repairs could not be made quickly enough to restore critical facilities and infrastructure. While human activities influence the impact of flooding events, human activities can also interface effectively with a floodplain as long as steps are taken to mitigate the activities' adverse impacts on floodplain functions.

The following flood-related issues are relevant to the planning area:

- The lack of current flood hazard mapping is a difficult obstacle to overcome when attempting to develop a strategy for hazard prone areas in land use planning and for development of this mitigation plan. This issue will be addressed when new flood maps, currently under development, are released and adopted by the planning area.
- The risk associated with the flood hazard overlaps the risk associated with other hazards such as coastal erosion, severe storm events, earthquake, dam failure, tsunami and landslide. This provides an opportunity to seek mitigation goals with multiple objectives to reduce the risk of multiple hazards.
- Potential climate change may impact flood conditions throughout the County.
- More information is needed on flood risk with respect to structure type, year built, elevation, etc., to support the concept of risk-based analysis of capital projects.
- There needs to be a sustained effort to gather historical damage data, such as high water marks on structures and damage reports, to measure the cost-effectiveness of future mitigation projects.
- Ongoing flood hazard mitigation will require funding from multiple sources.
- There needs to be a coordinated hazard mitigation effort between the County, its cities, towns and the Washington Department of Transportation as it relates to flooding and flood induced issues and the potential for areas to experience isolation as a result of limited ingress and egress to certain areas of the County (e.g., Whidbey and Camano Islands).
- Floodplain residents need to continue to be educated about flood preparedness and the resources available during and after floods.

- The promotion of flood insurance as a means of protecting property from the economic impacts of frequent flood events should continue.
- Existing floodplain-compatible uses such as agricultural and open space need to be maintained.

CHAPTER 10.
LANDSLIDE

A landslide is defined as the sliding movement of masses of loosened rock and soil down a hillside or slope. Such failures occur when the strength of the soils forming the slope is exceeded by the pressure acting upon them, such as weight or saturation. Earthquakes provide many times more energy than needed to initiate soil liquefaction, enhancing not only the probability of a landslide, but also its magnitude. Washington State climate, topography, and geology create a perfect setting for landslides, which occur in the state every year.

In Western Washington, most landslides are triggered during fall and winter after storms dump large amounts of rain or snow. (Washington Department of Natural Resources, 2015). Landslides can be shallow or deep. Shallow landslides typically occur in winter in Western Washington and summer in Eastern Washington, but are possible at any time. They often form as slumps along roadways or fast-moving debris flows down valleys or concave topography. They are commonly called "mudslides" by the news media. Deep-seated landslides are often slow moving, but can cover large areas and devastate infrastructure and housing developments.

A mudslide or debris flow is a fast moving fluid mass of rock fragments, soil, water, and organic material with more than half of the particles being larger than sand size. Generally, these types of movement occur on steep slopes or in gullies and can travel long distances. Typically, debris flows result from unusually high rainfall, or rain-on-snow events.

A rock fall is the fall of newly detached segments of bedrock of any size from a cliff or steep slope. The rock descends by free fall, bouncing, or rolling. Movements are very rapid to extremely rapid, and may not be preceded by minor movements.

10.1 GENERAL BACKGROUND

A landslide, or a mass of rock, earth or debris moving down a slope, may be minor or very large, and can move at slow to very high speeds. They can be initiated by storms, earthquakes, fires, volcanic eruptions or human modification of the land.

Mudslides (or mudflows or debris flows) are rivers of rock, earth, organic matter and other soil materials saturated with water. They develop in the soil overlying bedrock on sloping surfaces when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt. Water pressure in the pore spaces of the material increases to the point that the internal strength of the soil is drastically weakened. The soil's reduced resistance can then easily be overcome by gravity, changing the earth into a flowing river of mud or "slurry." A debris flow or mudflow can move rapidly down slopes or through channels, and can strike with little or no warning at avalanche speeds. The slurry can travel miles from its source, growing as it descends, picking up trees, boulders, cars and anything else in its path. Although these slides behave as fluids, they pack many times the hydraulic force of water, due to the mass of material included in them. Locally, they can be some of the most destructive events in nature.

All mass movements are caused by a combination of geological and climate conditions, as well as the encroaching influence of urbanization. Vulnerable natural conditions are affected by human residential, agricultural, commercial and industrial development and the infrastructure that supports it.

The occurrence of a landslide is dependent on a combination of site-specific conditions and influencing factors. Most commonly, the factors that contribute to landslides fall into four broad categories:

- Climatic or hydrologic (rainfall or precipitation)
- Geomorphic (slope form and conditions, e.g., slope, shape, height, steepness, vegetation and underlying geology)
- Geologic/geotechnical/hydrogeological (groundwater)
- Human activity.

Change in slope of the terrain, increased load on the land, shocks and vibrations, change in water content, groundwater movement, frost action, weathering of rocks, and removing or changing the type of vegetation covering slopes are all contributing factors. In general, landslide hazard areas are where the land has characteristics that contribute to the risk of the downhill movement of material, such as the following:

- A slope greater than 40 percent
- A history of landslide activity or movement during the last 10,000 years
- Stream or wave activity, which has caused erosion, undercut a bank or cut into a bank to cause the surrounding land to be unstable
- The presence of an alluvial fan, indicating vulnerability to the flow of debris or sediments
- The presence of impermeable soils, such as silt or clay, which are mixed with granular soils such as sand and gravel.

Flows and slides are commonly categorized by the form of initial ground failure. Common types of slides are shown on Figure 10-1 through Figure 10-4. The most common is the shallow colluvial slide, occurring particularly in response to intense, short-duration storms, where antecedent conditions are prevalent (Baum, et. al, 2000). The largest and most destructive are deep-seated slides, although they are less common.

Slides and earth flows can pose serious hazard to property in hillside terrain. They tend to move slowly and thus rarely threaten life directly. When they move—in response to such changes as increased water content, earthquake shaking, addition of load, or removal of downslope support—they deform and tilt the ground surface. The result can be destruction of foundations, offset of roads, breaking of underground pipes, or overriding of downslope property and structures.

Erosion is the process by which material is removed from a region of the earth's surface. It can occur by weathering and transport of solids (sediment, soil, rock, and other particles) in the natural environment. This also leads to the deposition of these materials elsewhere, which can increase the impacts from flood events. Erosion usually occurs as a result of transport of solids by wind, water or ice and by down-slope creep of soil and other material under the force of gravity, similar to landslides. It can also be caused by animals burrowing, reducing soil stability.

Although erosion is a natural process, as with landslides, human land use policies have an effect on erosion, especially industrial agriculture, deforestation, and urban sprawl. Land that is used for industrial agriculture generally experiences a significantly greater rate of erosion than land with natural vegetation or land used for sustainable agricultural. This is particularly true if tillage is used in farm practices, which reduces vegetation cover on the surface of the soil and disturbs both soil structure and plant roots that would otherwise hold the soil in place.

Improved land use practices can limit erosion, using techniques such as terracing or terrace-building, no or limited tilling, limited logging or replanting after logging, and the planting of vegetation to limit erosion through ground cover.

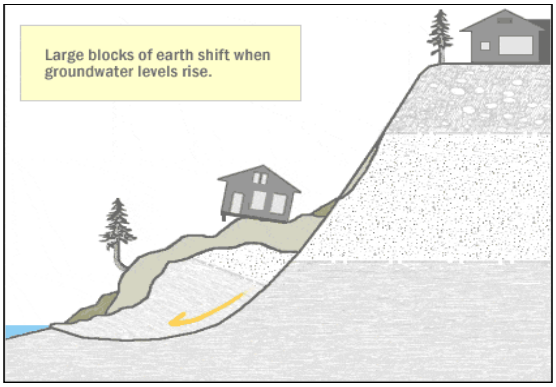


Figure 10-1. Deep Seated Slide

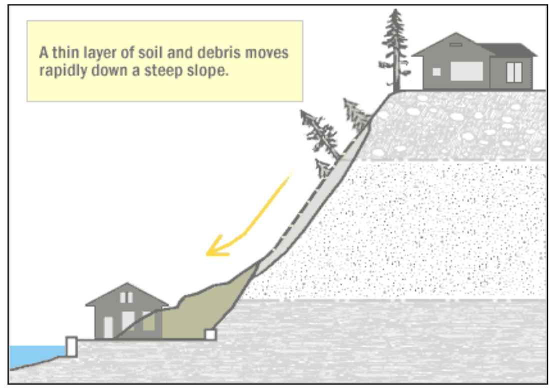


Figure 10-2. Shallow Colluvial Slide

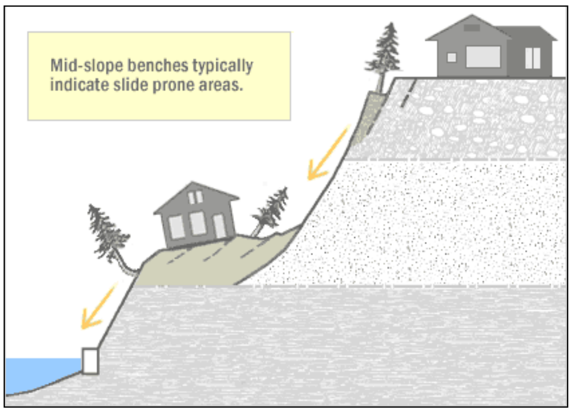


Figure 10-3. Bench Slide

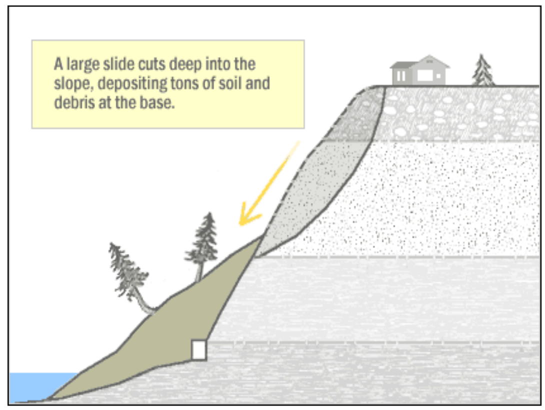


Figure 10-4. Large Slide

While a certain amount of erosion is natural and healthy for an ecosystem—such as gravel continuously moving downstream in watercourses—excessive erosion causes serious problems, such as receiving water sedimentation, ecosystem damage and loss of soil and slop stability. Erosion can cause a loss of forests and trees, which causes serious damage to aquatic life, irrigation, and power development by heavy silting of streams, reservoirs, and rivers. Concentrated surface water runoff in drainages and swales can lead to channel-confined slope failures, involving the rapid transport of fluidized debris, known as debris flows.

10.2 HAZARD PROFILE

10.2.1 Extent and Location

The best predictor of where slides and earth flows might occur is the location of past movements. Past landslides can be recognized by their distinctive topographic shapes, which can remain in place for thousands of years. Most landslides recognizable in this fashion range from a few acres to several square miles. Most show no evidence of recent movement and are not currently active. A small portion of them may become active in any given year. The recognition of ancient dormant mass movement sites is important in the identification of areas susceptible to flows and slides because they can be reactivated by earthquakes or by exceptionally wet weather. Also, because they consist of broken materials and frequently involve disruption of groundwater flow, these dormant sites are vulnerable to construction-triggered sliding.

A study conducted by the Department of Earth and Space Sciences at the University of Washington found that most of the bluff slopes in the Puget Sound region (including those on Whidbey Island) are composed of unconsolidated sediment, deposited during glacial and/or interglacial periods (ESS, 2013). The report indicates that only the extreme northern portion of Whidbey Island and the San Juan Islands are composed of bedrock. Previous studies (Shipman, 2004) indicate that of the 221 miles of Island County shoreline, 112 miles, or 57 percent, are unstable.

Landslide hazard areas are mapped throughout Island County where steep slopes are present, such as Blowers Bluff and Double Bluff Beach (see Figure 10-5 and Figure 10-6). Erosion hazards in the County have been mapped as well (WSDOT, 2006). The County's low-lying areas along the coast have been threatened by storms and tsunamis for thousands of years. Hillsides have been washed out numerous times due to rainfall and storm surges undercutting hillsides. The Washington Department of Ecology has identified various areas in Water Resource Inventory Area (WRIA) 6 considered to have unstable slopes. Figure 10-7 identifies those areas.

Source: Jim Nieland
http://www.panoramio.com/photo_explorer#view=photo&position=3227&with_photo_id=25035280&order=date_desc&user=587955

Figure 10-5. Blowers Bluff, Penn Cove

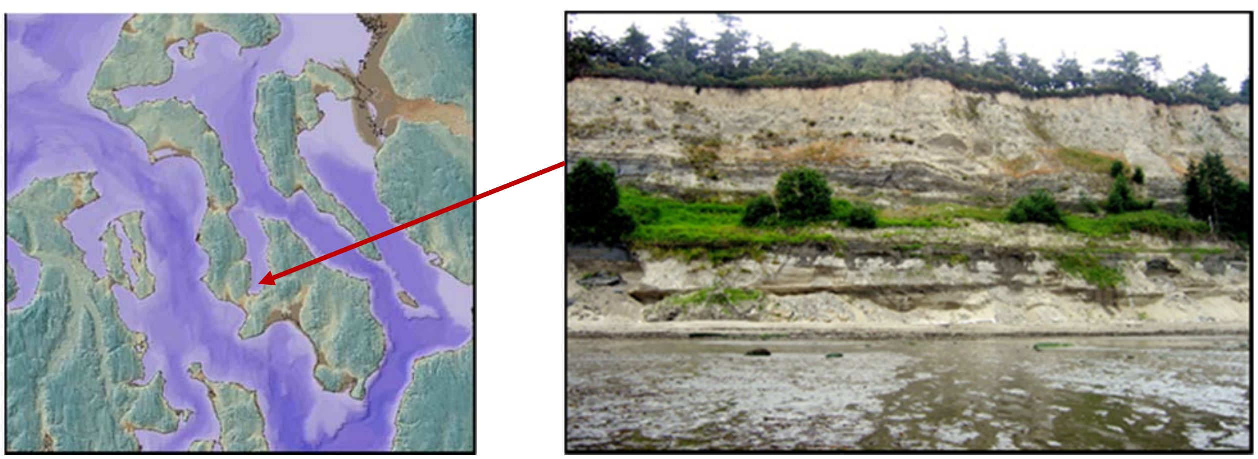


Figure 10-6. Double Bluff Beach

Source: WSDOT, 2010

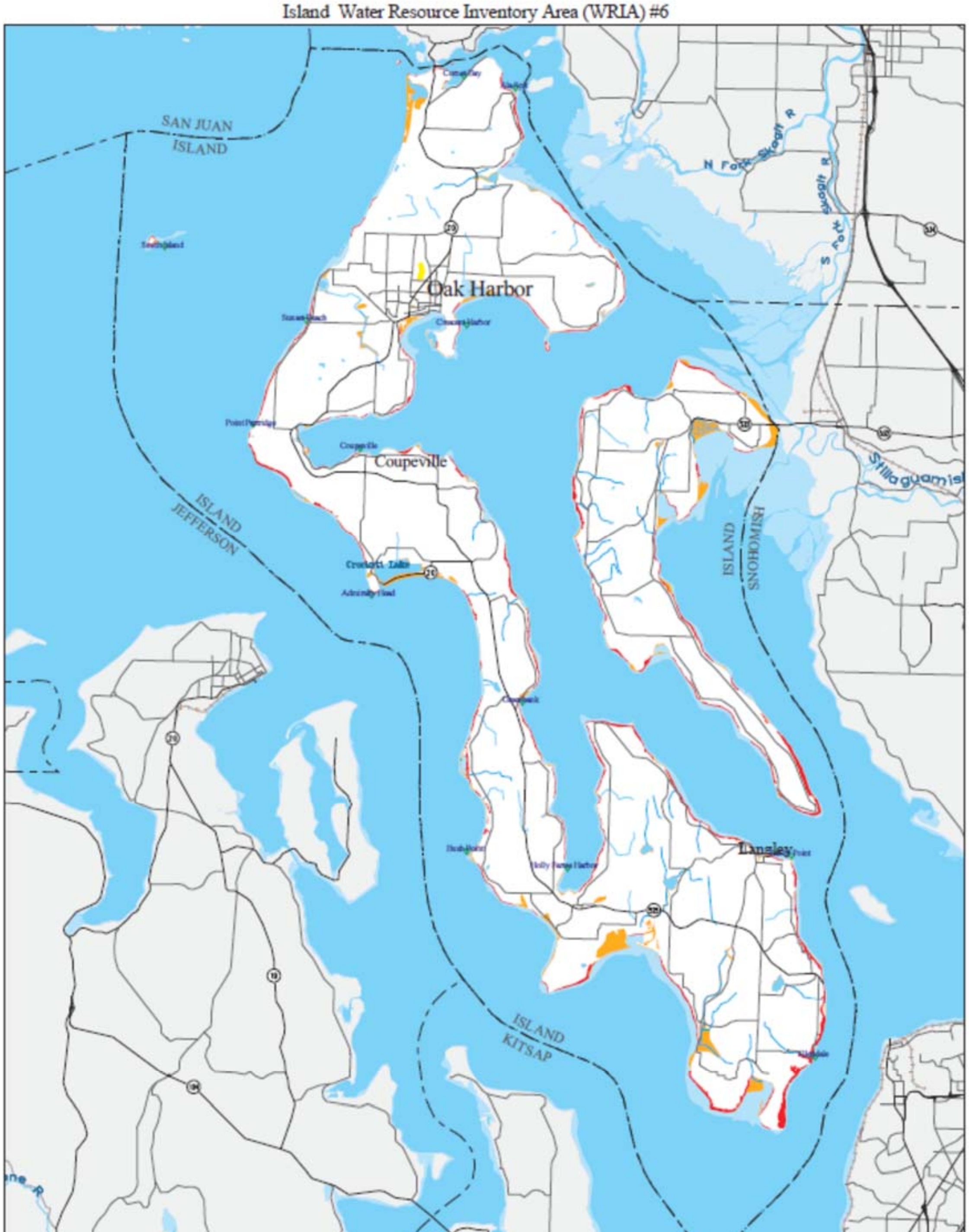


Figure 10-7. WRIA 6 Unstable Slopes

10.2.2 Previous Occurrences

Landslides within the planning area are fairly common, as identified by FEMA and the Spatial Hazard Events and Losses Database for the United States (SHELDUS). Landslides have been associated with disaster declarations for severe storms and flooding events in Island County, as listed in Table 10-1. There are no records of fatalities or physical injuries due to landslide in the County.

TABLE 10-1.
ISLAND COUNTY FEMA-DECLARED LANDSLIDE EVENTS SINCE 1965

Disaster Number	Date	Event Description
DR-1682	12/2006	Landslide, Mudslide, Wind, Severe Winter Storm,
DR-1641	1-2/2006	Landslide, Flood, Severe Winter Storm, Tidal Surge
DR-1499	11/2003	Flood and Resulting Landslide
DR-1159	2/ 1997	Landslide, Ice, Wind, Snow, and Flood

Source: SHELDUS and FEMA Websites

The Ledgewood-Bonair Landslide on Whidbey Island occurred around 3:45 a.m. on March 27, 2013, although WDNR geologists believe the slide started moving as early as 2002, with the entire area having a history of instability "stretching back for thousands of years" (Island County, 2015a). Photos of the slide are shown on Figure 10-8 through Figure 10-10. The landslide's location is shown on Figure 10-11.

Figure 10-8. Ledgewood-Bonair Landslide March 2013

Photo by: WDNR/Stephen Slaughter March 27, 2013

Figure 10-9. Ledgewood-Bonair Landslide

Source: Isabelle Sarikhan/WDNR.

Figure 10-10. Newly Exposed Hillside at Site of Ledgewood-Bonair Landslide

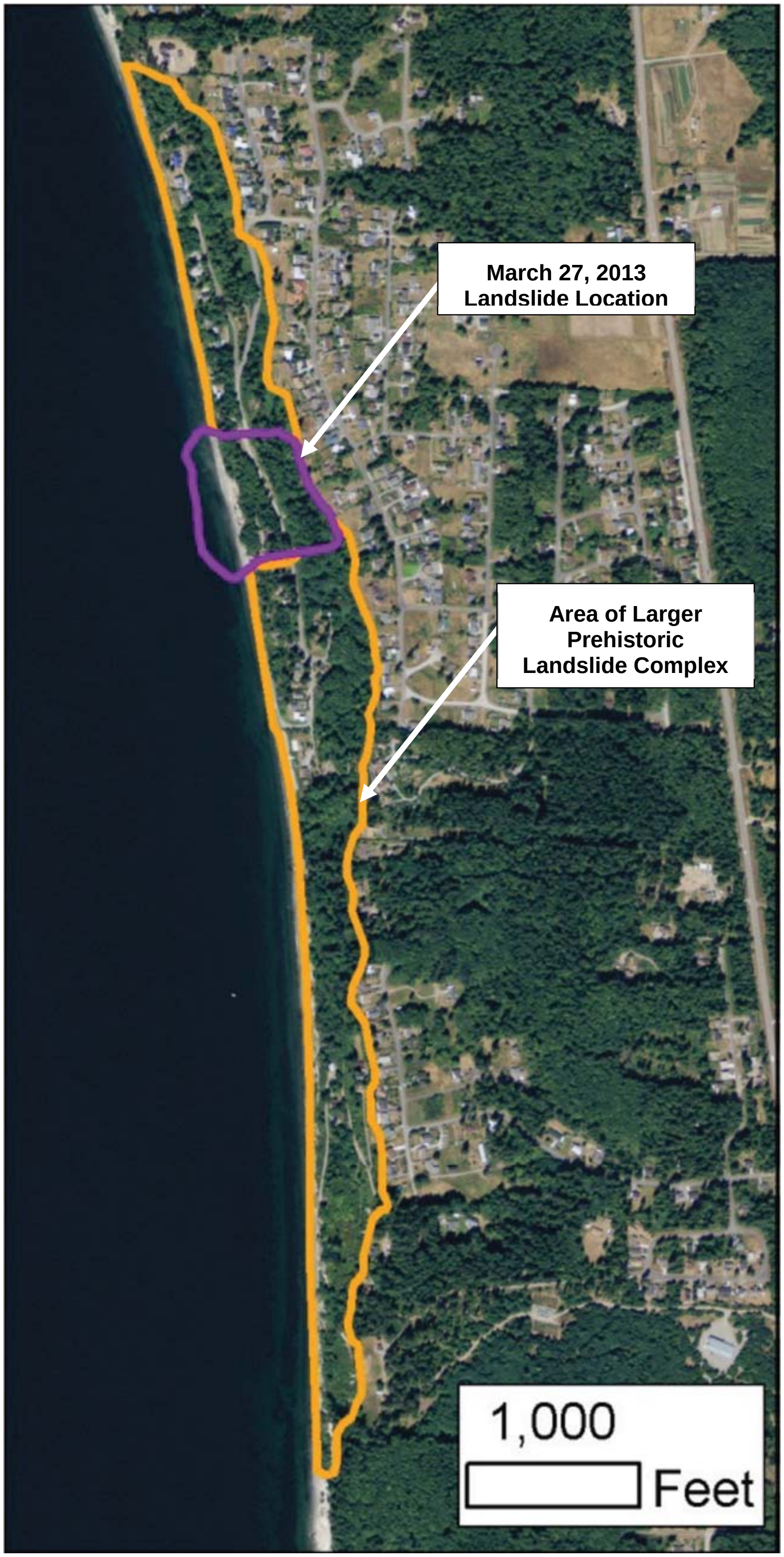


Figure 10-11. WDNR Reconnaissance Map of Ledgewood-Bonair Landslide

The Washington Department of Natural Resources conducted a study on the Ledgewood-Bonair Landslide and concluded that it was a deep-seated landslide. The study identified the following characteristics:

- It was a small portion of a much larger landslide complex, approximately 1.5 miles long, that was prehistoric and may date back as far as 11,000 years. The area of the larger complex is shown on Figure 10-11.
- The top of the landslide scarp averages 200 feet above sea level.
- The landslide pushed (uplifted) the beach as high as 30 feet above the shore.
- The toe (front of landslide at the beach) was slightly over 1,100 feet long and extended approximately 300 feet into Puget Sound.
- Uplift of the beach was presumed to have been relatively slow (i.e., over a few minutes).
- Wave and tidal action actively eroded the toe with small sections (1 to 10 cubic feet) observed calving with the rising tide.
- The volume of material moved was approximately 200,000 cubic yards.
- Where observed, the access road has been shifted approximately 80 feet down vertically and to the west.

Other significant events occurred from November 1996 through March 1997, when a series of wet winter storms delivered snow, freezing rain, and warm rain to Western Washington, producing floods and landslides. Prior to the storms, late autumn had above normal precipitation, building soil moisture and heavy snow packs. The combination of pre-existing soil moisture and heavy rain brought soils to saturation. The lateral movement of groundwater toward the free faces of bluffs and banks caused water pressures that triggered landslides. Mudslides were reported in several locations on Camano Island, including Cavalero County Park, Tyee Beach, Wilkes Gray Heights, Pebble Beach, Summerland Beach and Woodland Beach. On Whidbey Island, slides were reported on Madrona Way, Harrington Road, Driftwood Beach and Marshall Road.

Recent reviews of steep slope areas show continued slope movement on Whidbey Island at Suzanna Drive, Possession Point, Driftwood Lane, Hidden Beach Drive and Whidbey Shores at East Point. Other steep slope areas, while covered with vegetation, show the bowing of tree trunks from what may be continued slope subsidence. Discussions with residents in several of these areas indicated that tree fall from these slopes are a continual problem after periods of heavy wind and rain. This presents a risk to persons, property and access to these mostly single-road areas. The Town of Coupeville and City of Langley share business area locations on high banks. Oak Harbor has an area adjacent to the city where high bank subsidence previously claimed a portion of Scenic Heights Road, since rerouted.

10.2.3 Severity

Landslides destroy property and infrastructure, and can have a long-lasting effect on the environment and can take the lives of people. Nationally, landslides account for more than $2 billion in losses annually and result in an estimated 25 to 50 deaths a year (Spiker and Gori, 2003; Schuster and Highland, 2001; Schuster, 1996). As of the writing of this update, Snohomish County was still in the recovery phase following a mile-wide catastrophic landslide which killed over 40 people. Island County has experienced several landslides historically, with approximately 57 percent of its shorelines designated as areas of potential slide.

10.2.4 Frequency

Landslides are often triggered by other natural hazards such as earthquakes, heavy rain, floods or wildfires, so landslide frequency is often related to the frequency of these other hazards. Landslides typically occur during and after major storms, so the potential for landslides largely coincides with the potential for sequential severe storms and flood events that saturate steep, vulnerable soils. Four declared landslides have occurred in conjunction with severe storm events; however, some type of landslide event occurs annually within the planning region. A specific recurrence interval has not been established by geologists, but historical data indicates several successive years of slide activities, followed by dormant periods.

Landslides are most likely to occur during periods of higher than average rainfall. The ground in many instances is already saturated prior to the onset of a major storm, which increases the likelihood of significant landslides to occur. Most local landslides occur between October and April after water tables have risen. Water is involved in nearly all cases and human influence has been identified in more than 80 percent of reported slides. Until better data is generated specifically for landslide hazards, the severe storm frequency is appropriate for the purpose of ranking risk associated with the landslide hazard.

10.3 VULNERABILITY ASSESSMENT

10.3.1 Overview

Landslides have the potential to cause widespread damage throughout both rural and urban areas. While some landslides are more of a nuisance-type event, even the smallest of slides has the potential to injure or kill individuals and damage infrastructure. Given Island County's relatively steep slopes in certain areas, its soil type, and its historical patterns of previous slide occurrences, the landslide hazard is a major concern for the planning partners.

Methodology

Historical occurrences, combined with analysis of the slope and the type of soil, are the most effective indicator of areas at risk to landslide. While limited data is available concerning landslide history throughout Washington State, including Island County, the Washington Department of Natural Resources is in the process of collecting data to use in determining historical events and landslide danger. Once completed, that data will be incorporated into the risk assessment to determine areas of impact.

Because no damage figures have been developed for the landslide hazard, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures.

Warning Time

Unlike flood hazards which often are predictable, mass movements or landslides are generally unpredictable, with little or no advanced warning. The speed of onset and velocity associated with a slide event can have devastating impacts. While some methods used to monitor mass movements can provide an idea of the type of movement and provide some indicators (potentially) with respect to the amount of time prior to failure, exact science is not available.

Mass movements can occur suddenly or slowly. The velocity of movement may range from a slow creep of inches per year to many feet per second, depending on slope angle, material and water content. Generally accepted warning signs for landslide activity include:

- Springs, seeps, or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavements or sidewalks

- Soil moving away from foundations
- Ancillary structures such as decks and patios tilting and/or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls or fences
- Offset fence lines
- Sunken or down-dropped road beds
- Rapid increase in creek water levels, possibly accompanied by increased turbidity (soil content)
- Sudden decrease in creek water levels though rain is still falling or just recently stopped
- Sticking doors and windows, and visible open spaces indicating jambs and frames out of plumb
- A faint rumbling sound that increases in volume as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together.

It is possible, based on historical occurrences, to determine what areas are at a higher risk. Assessing the geology, vegetation and amount of predicted precipitation for an area can help in these predictions; such an analysis is beyond the scope of this planning effort. However, there is no practical warning system for individual landslides. Historical events remain the best indicators of potential landslide activity, but it is generally impossible to determine with precision the size of a slide event or when an event will occur. Increased precipitation in the form of snow or rain increases the potential for landslide activity. Steep slopes also increase the potential for slides, especially when combined with specific types of soil.

10.3.2 Impact on Life, Health and Safety

A geographic analysis of demographics was performed using GIS data. Population figures (in census blocks) were cross-referenced with maps showing landslide hazard areas. As identified in Table 10-2, this approach estimated that there are 13,816 residential structures (single and multi-family) on parcels in the mapped landslide areas. Using a value of 2 persons per household, it is estimated that there are 27,632 persons living in households exposed to the landslide hazard. This represents 35.2 percent of the total population for the planning area.

TABLE 10-2.
POPULATION AND RESIDENTIAL IMPACT IN LANDSLIDE RISK AREA

Jurisdiction	Residential Building Count	Population Exposed[b]	% of Total Population in Planning Area[b]	% of Impacted Population in Planning Area
Unincorporated County	12,761	25,522	32.5%	92.4%
Coupeville	307	614	0.8%	2.2%
Langley	249	498	0.6%	1.8%
Oak Harbor	499	998	1.3%	3.6%
Total	**13,816**	**27,632**	**35.2%**	**100%**

a. Based on factor of 2 per person/household
b. Total population of 78,506 as of April 2014 (OFM data)

Also to be taken into account when determining affected population are the area-wide impact on transportation systems and the isolation of residents who may not be directly impacted but whose ability to ingress and egress is restricted, such as at Deception Pass and Camano Island. Likewise, impacts on primary roadways and the ferry system would affect commodity flow into the area. Finally, Island County's population of retirees may increase the level of first-responder requirements for residents whose structures were not directly impacted but who were affected by power outages, lack of logistical support, etc. Landslides can also damage water treatment facilities, potentially harming water quality.

10.3.3 Impact on Property

Landslides affect private property and public infrastructure and facilities. The predominant land use in the planning area is single-family residential, much of it supporting multiple families. In addition, there are many small businesses in the area as well as large commercial industries and government facilities. The area and the type and value of structures exposed to the landslide hazard in the planning area are summarized in Table 10-3 through Table 10-5.

TABLE 10-3.
PERCENT OF LAND AREA IN LANDSLIDE RISK AREAS

Jurisdiction	Area in Landslide Risk Area (acres)	% of Total Planning Area
Unincorporated Island County	6,990.5	5.52%
Coupeville	77.01	9.43%
Langley	50.83	7.61%
Oak Harbor	50.44	0.82%
Total	**7,168.78**	**23.38%**

TABLE 10-4.
STRUCTURES BY BUILDING TYPE EXPOSED TO LANDSLIDE HAZARDS

Jurisdiction	Government	Industrial	Commercial	Agricultural
Unincorporated Island County	7	0	625	0
Coupeville	0	0	46	0
Langley	0	0	81	0
Oak Harbor	1	8	36	0

TABLE 10-5.
POTENTIAL BUILDING LOSSES IN LANDSLIDE RISK AREA

Jurisdiction	Building Count	Estimated Value	Content Value	10% Damage	30% Damage	50% Damage
Unincorporated County	13,413	$2,425 billion	$1,272 billion	$369.7 M	$1.109 B	$1.849 B
Coupeville	353	$60,285,634	$35,086,529	$9.54 M	$28.6 M	$47.7 M
Langley	332	$62,455,674	$41,102,964	$10.4 M	$31.1 M	$51.8 M
Oak Harbor	548	$144,896,741	$94,265,097	$23.9 M	$71.7 M	$119.6 M

Because no damage figures have been developed for the landslide hazard, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction. Table 10-5 shows these estimates.

10.3.4 Impact on Critical Facilities and Infrastructure

Table 10-6 summarizes the critical facilities exposed to the landslide hazard. No loss estimation of these facilities was performed due to the lack of established damage functions for the landslide hazard.

TABLE 10-6.
CRITICAL FACILITIES EXPOSED TO LANDSLIDE HAZARDS

Jurisdiction	Total Number Identified	Number Impacted	Percent of Total
Unincorporated Island County	95	29	30.5%
Coupeville	21	1	4.8%
Langley	6	5	83.3%
Oak Harbor	32	3	9.4%

Several types of infrastructure are exposed to mass movements, including transportation facilities, airports, bridges, and water, sewer and power infrastructure. Highly susceptible areas include mountain and coastal roads and transportation infrastructure. All infrastructure and transportation corridors identified as exposed to the landslide hazard are considered vulnerable until more information becomes available. Figure 10-12 shows the location of critical facilities relative to the landslide hazard. Significant infrastructure in the planning region exposed to mass movements includes the following:

- **Roads**—Access to major roads is crucial to life-safety after a disaster event and to response and recovery operations. Landslides can block egress and ingress on roads, causing isolation for neighborhoods, traffic problems and delays for public and private transportation. This can result in economic losses for businesses.
- **Bridges and Ferry Docks**—Landslides can significantly impact road bridges and ferry docks. Mass movements can knock out bridge and dock abutments, causing significant misalignment and restricting access and usages, as well as significantly weaken the soil supporting the structures, making them hazardous for use.
- **Power Lines**—Power lines are generally elevated above steep slopes, but the towers supporting them can be subject to landslides. A landslide could trigger failure of the soil beneath a tower, causing it to collapse and ripping down the lines. Power and communication failures due to landslides can create problems for vulnerable populations and businesses.

10.3.5 Impact on Economy

A landslide can have catastrophic impact on both the private sector and governmental agencies. Economic losses include damage costs as well as lost revenue and taxes. Damaged bridges, roadways and ferry landings can have a significant impact on the economy. Damage to the ferry docks and loss of ferry connectivity would have a significant economic impact on not only Island County but also other areas of the state, such as the peninsula region of Clallam County.

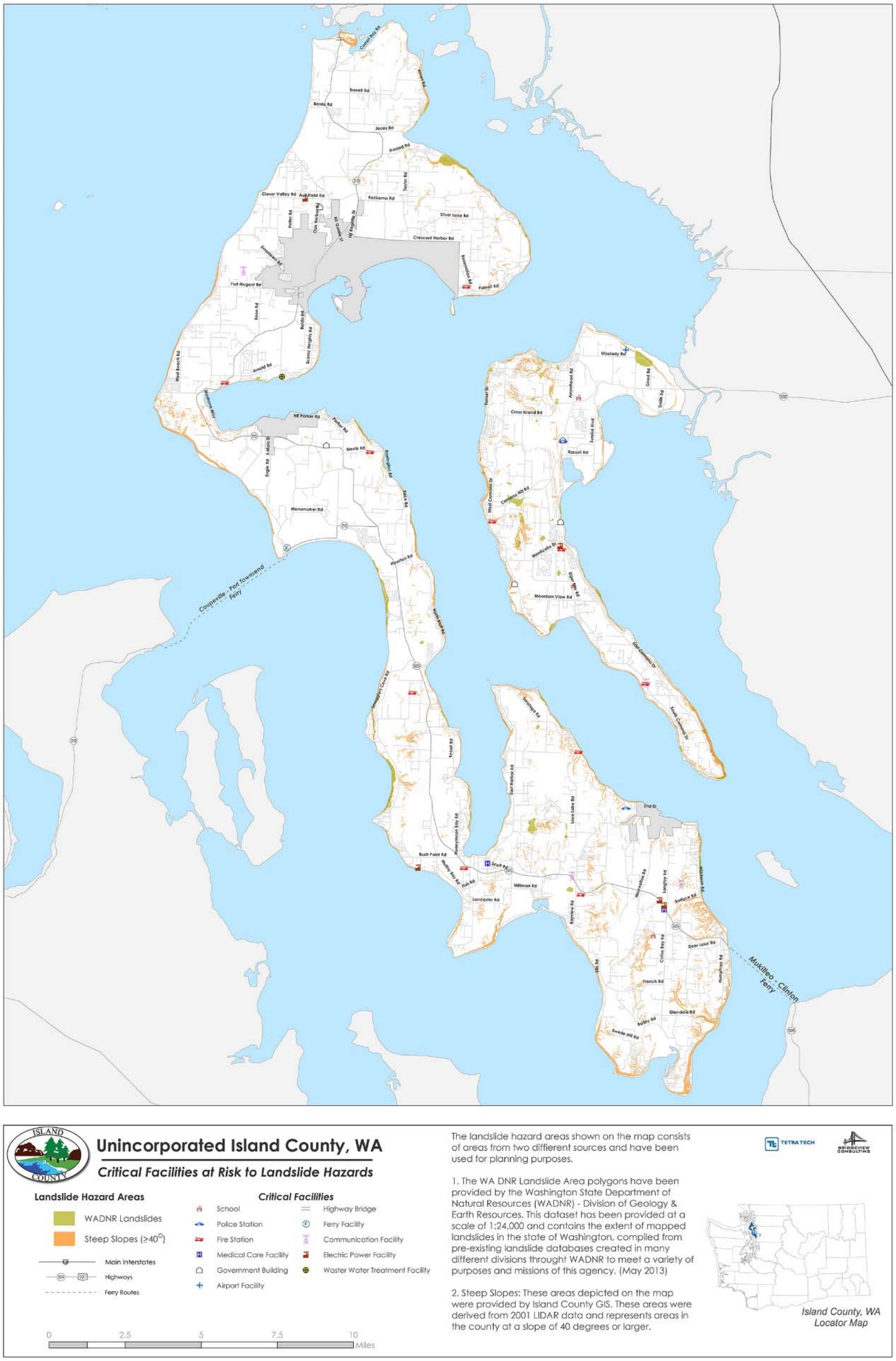


Figure 10-12. Landslide Risk to Critical Facilities

The impact on commodity flow from a significant landslide shutting down major access routes would not only limit the resources available for citizens' use, but also would cause economic impact on businesses. Debris could impact cargo staging areas and lands needed for business operations. Ferry transportation reduces travel time between the inland Puget Sound area and the peninsula region, compared to requiring vehicles to travel much greater distances around the sound on land. Impacts on ridership would also significantly impact the tourism industry within the County.

10.3.6 Impact on Environment

Environmental problems as a result of mass movements can be numerous. Landslides that fall into water bodies, wetlands or streams may significantly impact fish and wildlife habitat, as well as affecting water quality. Hillsides that provide wildlife habitat can be lost for prolonged periods of time due to landslides.

10.4 FUTURE DEVELOPMENT TRENDS

Under the Growth Management Act, the County is required to address geologic hazards within its Critical Areas Ordinance. Continued application of land use and zoning regulations, as well as implementation of the International Building Codes, will assist in reducing the risk of impact from landslide hazards.

Island County and its jurisdictions have experienced a relatively steady growth over the past 10 years. The region is attempting to expand its business base, which will increase economic vitality by providing businesses that stimulate retail sales and services and increased tourism. As a relatively high retirement and tourist destination for Washington, continued land use supported by regulatory authority which supports economic growth but practices smart planning will be vital. All planning partners are committed to assessing the landslide risk and developing mitigation efforts to reduce impact or enhance resiliency. There are four basic strategies to mitigate landslide risk:

- Stabilization
- Protection
- Avoidance
- Maintenance and monitoring.

Stabilization seeks to counter one or more key failure mechanisms necessary to prevent slope failure. The other three strategies seek to avoid, protect against or limit associated impacts. Development of this mitigation plan creates an opportunity to enhance and develop wise land use decision-making policies. It allows for the expansion of capital improvement plans to sustain future growth through the use of these four basic strategies.

10.5 CLIMATE CHANGE IMPACTS

Climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration which can saturate soils beyond capacity. Increase in global temperature could further exacerbate this by affecting the snowpack and its ability to hold and store water, further raising sea levels, and increasing beach erosion along the County's coastline. Warming temperatures also could increase the occurrence and duration of droughts, which would increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. As parts of the County maintain fairly dense forested areas, such an incident would be significant. All of these factors would increase the probability of landslides.

10.6 ISSUES

Landslides throughout the County occur as a result of soil conditions that have been affected by severe storms, groundwater or human development. The worst-case scenario for landslide hazards in the planning area would generally correspond to a severe storm that had heavy rain and caused flooding. Landslides are most likely during late fall or early spring —months when the water tables are high. After heavy rains from October to April, soils become saturated with water. As water seeps downward through upper soils that may consist of permeable sands and gravels and accumulates on impermeable silt, it will cause weakness and destabilization in the slope. A short intense storm could cause saturated soil to move, resulting in landslides. As rains continue, the groundwater table rises, adding to the weakening of the slope. Gravity, a small tremor or earthquake, poor drainage, steep bank cutting, a rising groundwater table, and poor soil exacerbate hazardous conditions.

Mass movements are becoming more of a concern as development moves outside of urban centers and into areas less developed in terms of infrastructure. While most mass movements would be isolated events affecting specific areas, the areas impacted can be very large. It is probable that private and public property, including infrastructure, will be affected. Mass movements could affect bridges that pass over landslide prone ravines and knock out ferry services. Road obstructions caused by mass movements would create isolation problems for residents and businesses in sparsely developed areas, and impact commodity flows. Property owners exposed to steep slopes may suffer damage to property or structures. Landslides carrying vegetation such as shrubs and trees may cause a break in utility lines, cutting off power and communication access to residents; they may block ingress and egress to areas of the County, especially for areas with limited roadways.

Important issues associated with landslides throughout Island County include the following:

- There are existing homes in landslide risk areas throughout the County. The degree of vulnerability of these structures depends on the codes and standards the structures were constructed to. Information to this level of detail is not currently available.
- Future development could lead to more homes in landslide risk areas.
- Portions of the County are surrounded by very steep banks and cliffs. Coastal erosion causes landslides as the ground washes away.
- Mapping and assessment of landslide hazards are constantly evolving. As new data and science become available, assessments of landslide risk should be re-evaluated. LiDAR data would greatly enhance the ability to determine landslide hazards, as well as other hazards.
- While the impact of climate change on landslides in general is uncertain, the impact of sea level rise caused by increased temperatures has already enhanced coastal erosion within the planning area. As climate change continues to impact atmospheric conditions, the exposure to landslide risks is likely to increase.
- Landslides cause many negative environmental consequences, including water quality degradation, degradation of fish spawning areas, and destruction of vegetation along waterways, ultimately impacting the flow of water bodies.
- The risk associated with the landslide hazard overlaps the risk associated with other hazards such as earthquake, flood and wildfire. This provides an opportunity to seek mitigation goals with multiple objectives that can reduce risk for multiple hazards.

CHAPTER 11.
SEVERE WEATHER

Severe weather refers to any dangerous meteorological phenomena with the potential to cause damage, serious social disruption, or loss of human life. It includes thunderstorms, downbursts, wind, tornadoes, waterspouts, and snowstorms. Severe weather differs from extreme weather, which refers to unusual weather events at the extremes of the historical distribution.

General severe weather covers wide geographic areas; localized severe weather affects more limited geographic areas. The severe weather event that most typically impacts the planning area is a damaging windstorm, which causes storm surges exacerbating coastal erosion. Flooding associated with severe weather is discussed in Chapter 9. Coastal erosion, described in Chapter 5 is also related to severe weather.

DEFINITIONS

Freezing Rain—The result of rain occurring when the temperature is below the freezing point. The rain freezes on impact, resulting in a layer of glaze ice up to an inch thick. In a severe ice storm, an evergreen tree 60 feet high and 30 feet wide can be burdened with up to six tons of ice, creating a threat to power and telephone lines and transportation routes.

Hail Storm—Any thunderstorm which produces hail that reaches the ground is known as a hailstorm. Hail has a diameter of 0.20 inches or more. Hail is composed of transparent ice or alternating layers of transparent and translucent ice at least 0.04 inches thick. Although the diameter of hail is varied, in the United States, the average observation of damaging hail is between 1 inch and golf ball-sized 1.75 inches. Stones larger than 0.75 inches are usually large enough to cause damage.

Severe Local Storm—"Microscale" atmospheric systems, including tornadoes, thunderstorms, windstorms, ice storms and snowstorms. These storms may cause a great deal of destruction and even death, but their impact is generally confined to a small area. Typical impacts are on transportation infrastructure and utilities.

Thunderstorm—A storm featuring heavy rains, strong winds, thunder and lightning, typically about 15 miles in diameter and lasting about 30 minutes. Hail and tornadoes are also dangers associated with thunderstorms. Lightning is a serious threat to human life. Heavy rains over a small area in a short time can lead to flash flooding.

Tornado—. Most tornadoes have wind speeds less than 110 miles per hour are about 250 feet across, and travel a few miles before dissipating. The most extreme tornadoes can attain wind speeds of more than 300 miles per hour, stretch more than two miles across, and stay on the ground for dozens of miles They are measured using the Enhanced Fujita Scale, ranging from EF0 to EF5.

Windstorm—A storm featuring violent winds. Southwesterly winds are associated with strong storms moving onto the coast from the Pacific Ocean. Southern winds parallel to the coastal mountains are the strongest and most destructive winds. Windstorms tend to damage ridgelines that face into the winds.

Winter Storm—A storm having significant snowfall, ice, and/or freezing rain; the quantity of precipitation varies by elevation.

11.1 GENERAL BACKGROUND

11.1.1 Rain Shadow

Island County has a predominantly marine climate, influenced by the Olympic Mountain Range and the rain shadow effect (Figure 11-1 and Figure 11-2). The first major release of rain in weather systems coming off the Pacific Ocean occurs along the west slopes of the Olympics. The second major release occurs along the west slopes of the Cascade Range. The rain shadow area includes lower elevations along the northeastern slope of the Olympic Mountains extending eastward along the Strait of Juan de Fuca from near Port Angeles, east to Whidbey Island and then northward to the Strait of Juan de Fuca. The Olympic Mountains and the extension of the Coastal Range on Vancouver Island to the north shield this area from winter storms moving inland from over the ocean. This belt in the "rain shadow" of the Olympic Mountains is the driest area in western Washington.

Source: Olympic Rain Shadow, 2015

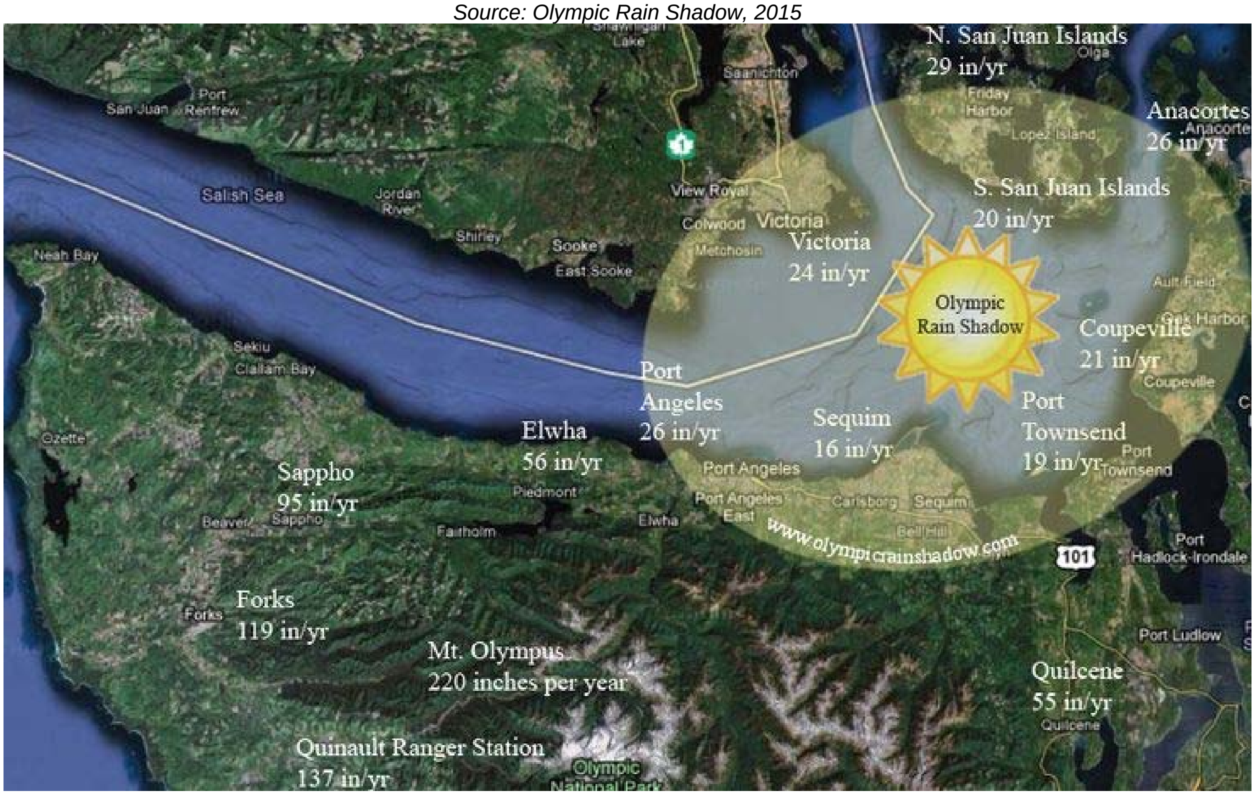


Figure 11-1. Washington's Rain Shadow

Source: Wikimedia.org, 2015

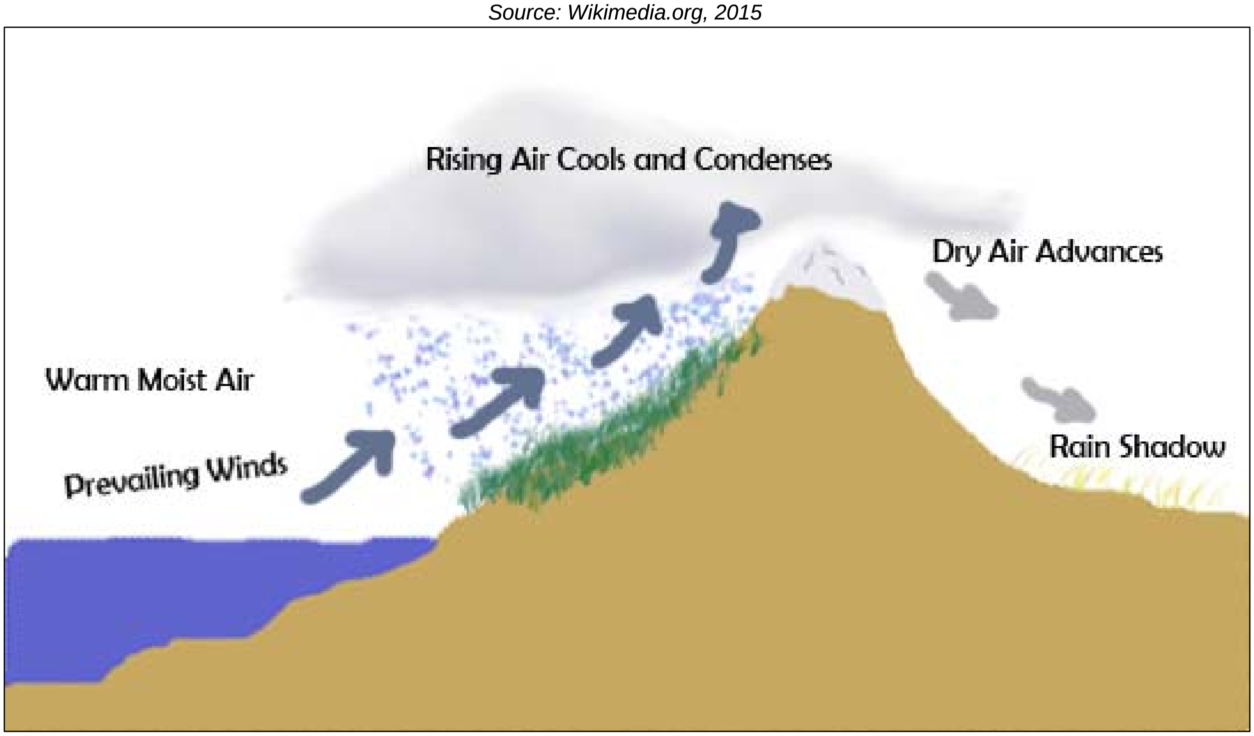


Figure 11-2. Rain Shadow Effect

11.1.2 Semi-Permanent High- and Low-Pressure Areas Over the North Pacific Ocean

During summer and fall, the circulation of air around a high-pressure area over the north Pacific brings a prevailing westerly and northwesterly flow of comparatively dry, cool and stable air into the Pacific Northwest. As the air moves inland, it becomes warmer and drier, resulting in a dry season. In the winter and spring, the high pressure is further south and low pressure prevails in the northeast Pacific. Circulation of air around both pressure centers brings a prevailing southwesterly and westerly flow of mild, moist air into the Pacific Northwest. Condensation occurs as the air moves inland over the cooler land and rises along the windward slopes of the mountains. This results in a wet season beginning in late October or November, reaching a peak in winter, and gradually decreasing by late spring.

West of the Cascade Mountains, summers are cool and relatively dry while winters are mild, wet and generally cloudy. Measurable rainfall occurs on 150 days each year in interior valleys and on 190 days in the mountains and along the coast.

Thunderstorms occur up to 10 days each year over the lower elevations and up to 15 days over the mountains. Damaging hailstorms are rare in western Washington. During July and August, the driest months, two to four weeks can pass with only a few showers; however, in December and January, the wettest months, precipitation is frequently recorded on 25 days or more each month. Snowfall is light in the lower elevations and heavier in the mountains. During the wet season, rainfall is usually of light to moderate intensity and continuous over a long period rather than occurring in heavy downpours for brief periods; heavier intensities occur along the windward slopes of the mountains.

11.1.3 Thunderstorms

A thunderstorm is a rain event that includes thunder and lightning. A thunderstorm is classified as “severe” when it contains one or more of the following: hail with a diameter of three-quarter inch or greater, winds gusting in excess of 50 knots (57.5 mph), or tornado. Thunderstorms have three stages (see Figure 11-3):

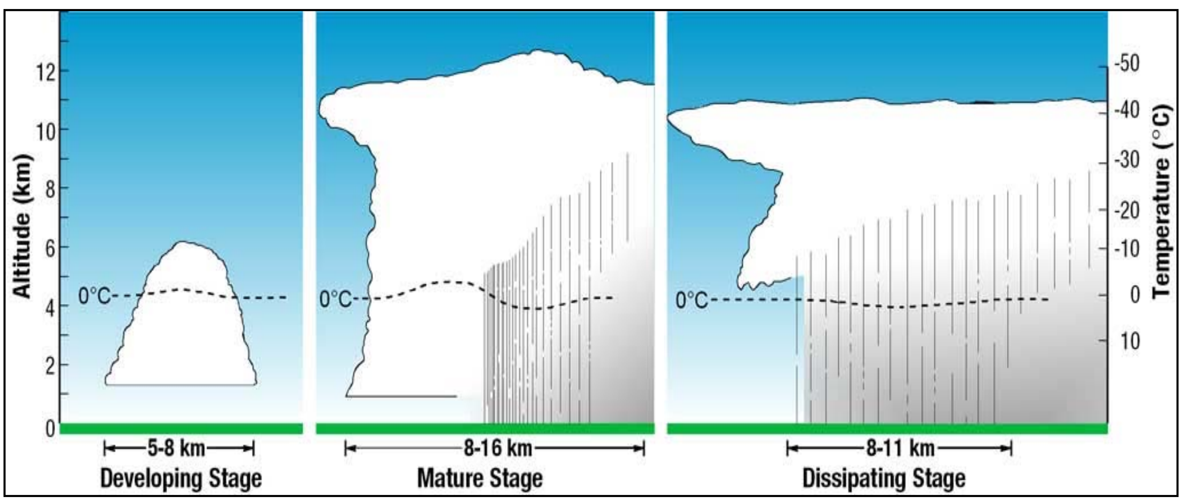


Figure 11-3. The Thunderstorm Life Cycle

Three factors cause thunderstorms: moisture, rising unstable air (air that keeps rising once disturbed), and a lifting mechanism to provide the disturbance. The sun heats the surface of the earth, which warms the air above it. If this warm surface air is forced to rise (hills or mountains can cause rising motion, as can the interaction of warm air and cold air or wet air and dry air) it will continue to rise as long as it weighs less and stays warmer than the air around it. As the air rises, it transfers heat from the earth surface to the upper atmosphere (the process of convection). The water vapor it contains begins to cool and it condenses into a cloud. The cloud eventually grows upward into areas where the temperature is below freezing. Some of the water vapor turns to ice and some of it turns into water droplets. Both have electrical charges. Ice particles usually have positive charges, and rain droplets usually have negative charges. When the charges build up enough, they are discharged in a bolt of lightning, which causes the sound heard as thunder. There are four types of thunderstorms:

- **Single-Cell Thunderstorms—**Single-cell thunderstorms usually last 20 to 30 minutes. A true single-cell storm is rare, because the gust front of one cell often triggers the growth of another. Most single-cell storms are not usually severe, but a single-cell storm can produce a brief severe weather event. When this happens, it is called a pulse severe storm.
- **Multi-Cell Cluster Storm—**A multi-cell cluster is the most common type of thunderstorm. The multi-cell cluster consists of a group of cells, moving as one unit, with each cell in a different phase of the thunderstorm life cycle. Mature cells are usually found at the center of the cluster and dissipating cells at the downwind edge. Multi-cell cluster storms can produce moderate-size hail, flash floods and weak tornadoes. Each cell in a multi-cell cluster lasts only about 20 minutes; the multi-cell cluster itself may persist for several hours. This type of storm is usually more intense than a single cell storm.
- **Multi-Cell Squall Line—**A multi-cell line storm, or squall line, consists of a long line of storms with a continuous well-developed gust front at the leading edge. The line of storms can be solid, or there can be gaps and breaks in the line. Squall lines can produce hail up to golf-ball size, heavy rainfall, and weak tornadoes, but they are best known as the producers of strong downdrafts. Occasionally, a strong downburst will accelerate a portion of the squall line ahead of the rest of the line. This produces what is called a bow echo. Bow echoes can develop with isolated cells as well as squall lines. Bow echoes are easily detected on radar but are difficult to observe visually.
- **Super-Cell Storm—**A super-cell is a highly organized thunderstorm that poses a high threat to life and property. It is similar to a single-cell storm in that it has one main updraft, but the updraft is extremely strong, reaching speeds of 150 to 175 miles per hour. Super-cells are rare. The main characteristic that sets them apart from other thunderstorms is the presence of rotation. The rotating updraft of a super-cell (called a mesocyclone when visible on radar) helps the super-cell to produce extreme weather events, such as giant hail (more than 2 inches in diameter), strong downbursts of 80 miles an hour or more, and strong to violent tornadoes.

According to NOAA, Washington ranks 50th nationwide in deaths associated with lightning strikes, having five deaths during the time period 1959-2013 (see Figure 11-4). Annually, 30 percent of all power outages nationwide are lightning related, with total costs approaching $1 billion dollars (CoreLogic, 2015). Lightning starts approximately 4,400 house fires each year, with estimated losses exceeding $280 million

11.1.4 Damaging Winds

Damaging winds are classified as those exceeding 60 mph. Damage from such winds accounts for half of all severe weather reports in the lower 48 states and is more common than damage from tornadoes. Wind speeds can reach up to 100 mph and can produce a damage path extending for hundreds of miles. There are seven types of damaging winds:

- **Straight-line winds —**Any thunderstorm wind that is not associated with rotation; this term is used mainly to differentiate from tornado winds. Most thunderstorms produce some straight-line winds as a result of outflow generated by the thunderstorm downdraft.

Source: Vaisala, 2015

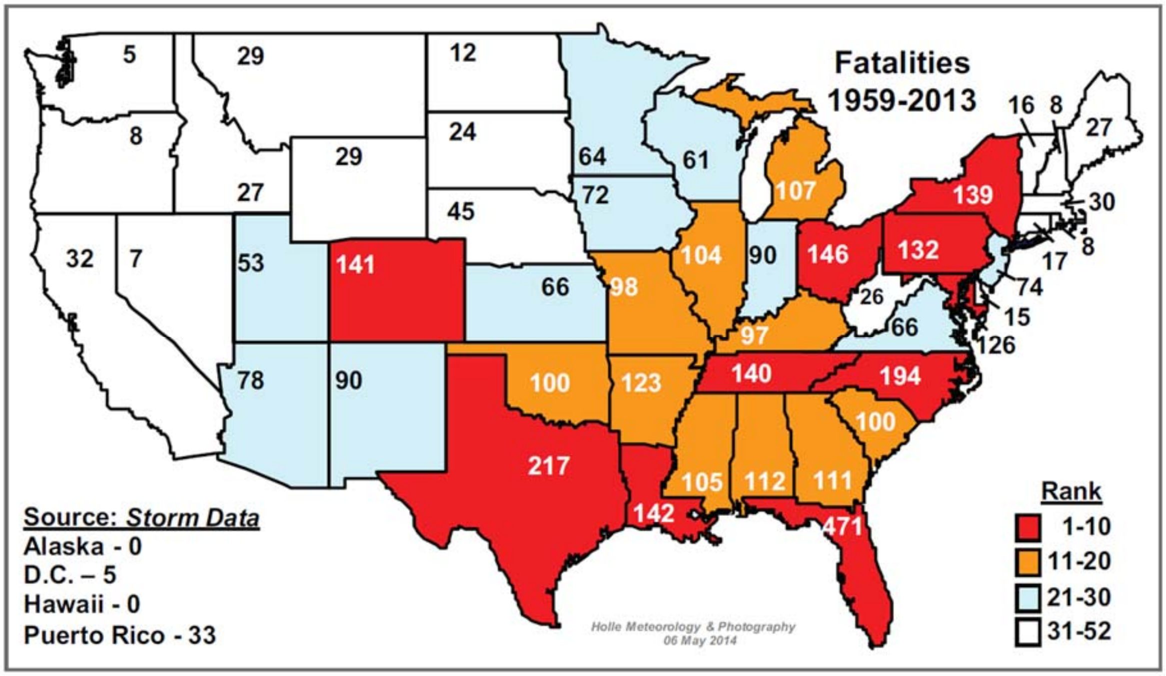


Figure 11-4. Lightening Fatalities by State, 1959-2013

- **Downdrafts** —A small-scale column of air that rapidly sinks toward the ground.
- **Downbursts—**A strong downdraft with horizontal dimensions larger than 2.5 miles resulting in an outward burst or damaging winds on or near the ground. Downburst winds may begin as a microburst and spread out over a wider area, sometimes producing damage similar to a strong tornado. Although usually associated with thunderstorms, downbursts can occur with showers too weak to produce thunder.
- **Microbursts—**A small concentrated downburst that produces an outward burst of damaging winds at the surface. Microbursts are generally less than 2.5 miles across and short-lived, lasting only 5 to 10 minutes, with maximum wind speeds up to 168 mph. There are two kinds of microbursts: wet and dry. A wet microburst is accompanied by heavy precipitation at the surface. Dry microbursts, common in places like the high plains and the intermountain west, occur with little or no precipitation reaching the ground.
- **Gust front—**A gust front is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Sometimes the winds push up air above them, forming a shelf cloud or detached roll cloud.
- **Derecho—**A derecho is a widespread thunderstorm wind caused when new thunderstorms form along the leading edge of an outflow boundary (the boundary formed by horizontal spreading of thunderstorm-cooled air). The word "derecho" is of Spanish origin and means "straight ahead." Thunderstorms feed on the boundary and continue to reproduce. Derechos typically occur in summer when complexes of thunderstorms form over plains, producing heavy rain and severe wind. The damaging winds can last a long time and cover a large area.
- **Bow Echo—**A bow echo is a linear wind front bent outward in a bow shape. Damaging straight-line winds often occur near the center of a bow echo. Bow echoes can be 200 miles long, last for several hours, and produce extensive wind damage at the ground.

There are four main types of windstorm tracks that impact the Pacific Northwest and Island County as identified in Figure 11-5. These four tracks are distinguished by two basic windstorm patterns have emerged in the Puget Sound Region: the South Wind Event and the East Wind Event. South wind events are generally large- scale events that affect large portions of not only Island County, but also most of Western Washington and possibly Western Oregon. On occasional cases, they have reached as far south as Northern California.

Source: Oregon Climate Service, 2015

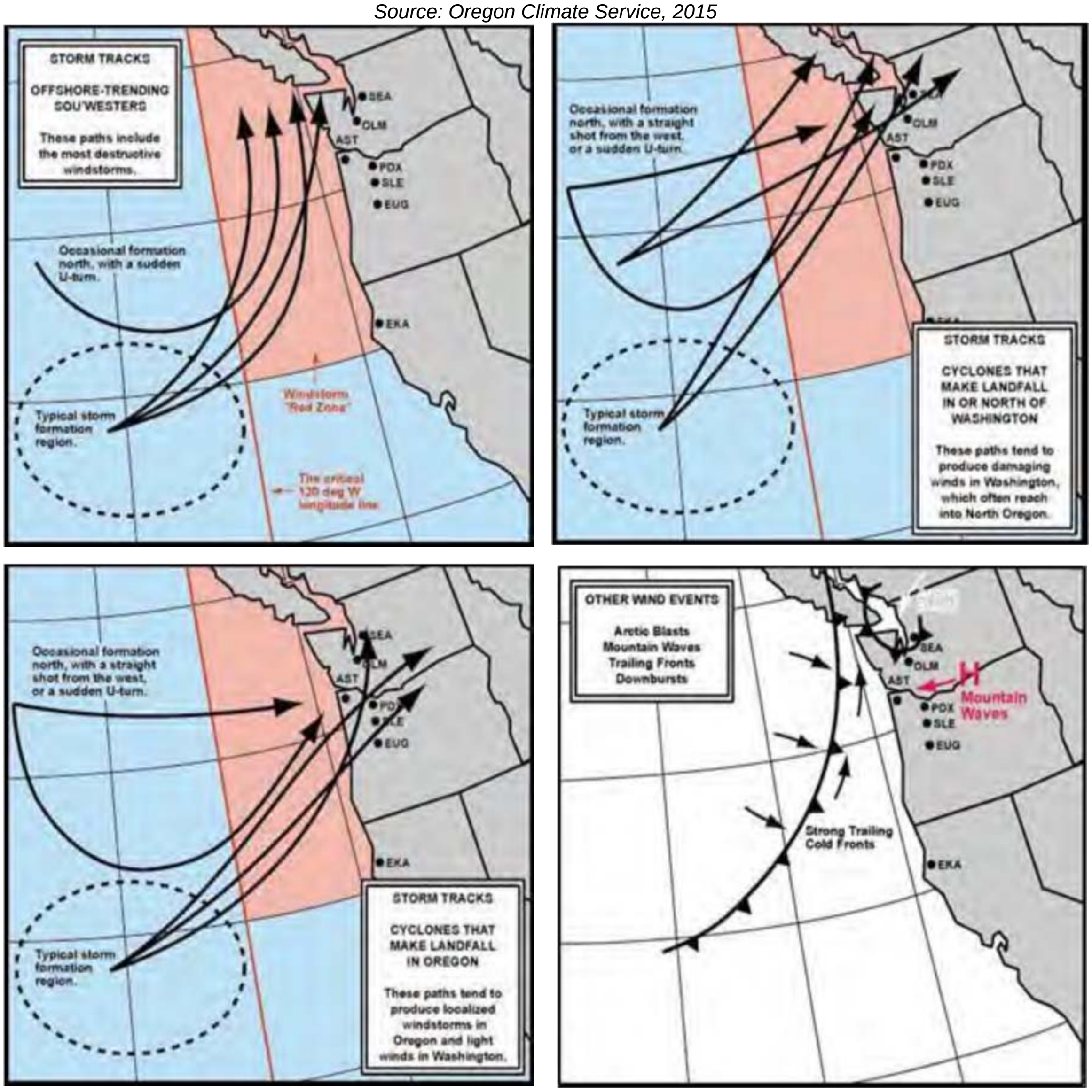


Figure 11-5. Windstorm Tracks Impacting the Pacific Northwest

In contrast, easterly wind events are more limited. High pressure on the east side of the Cascade Mountain Range creates airflow over the peaks and passes, and through the funneling effect of the valleys, the wind increases dramatically in speed. As it descends into these valleys and then exits into the lowlands, the wind can pick up enough speed to damage buildings, rip down power lines, and destroy fences. Once it leaves the proximity of the Cascade foothills, the wind tends to die down rapidly.

Windstorms impact all of Island County on a regular basis. The strongest winds are generally from the south or southwest and occur during fall and winter. Some are much more damaging than others. For those like the Hanukkah Eve Windstorm of 2006 (see Figure 11-6), the impact on the public can be severe. Island

County was significantly impacted, including all 36,000 Puget Sound Energy customers on Whidbey Island, who were without power for extended periods as 75% of Puget Sound Energy's circuits were damaged as a result of the storm, which had hurricane force winds, with peak wind gusts of 113 miles per hour recorded (WSDAHP, 2015).

Source: NOAA Satellite Photo

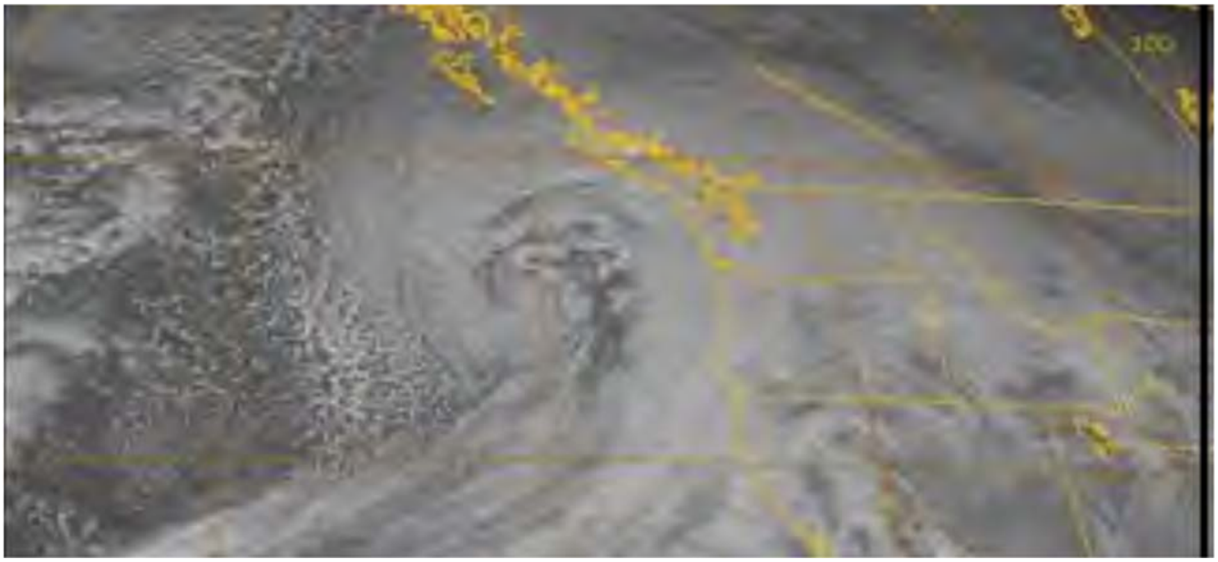


Figure 11-6. Hanukkah Eve Windstorm of December 13, 2006

11.1.5 Hail Storms

Hail occurs when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere where they freeze into ice. Recent studies suggest that super-cooled water may accumulate on frozen particles near the back side of a storm as they are pushed forward across and above the updraft by the prevailing winds near the top of the storm. Eventually, the hailstones encounter downdraft air and fall to the ground.

Hailstones grow two ways: by wet growth or dry growth. In wet growth, a tiny piece of ice is in an area where the air temperature is below freezing, but not super cold. When the tiny piece of ice collides with a super-cooled drop, the water does not freeze on the ice immediately. Instead, liquid water spreads across tumbling hailstones and slowly freezes. Since the process is slow, air bubbles can escape, resulting in a layer of clear ice. Dry growth hailstones grow when the air temperature is well below freezing and the water droplet freezes immediately as it collides with the ice particle. The air bubbles are "frozen" in place, leaving cloudy ice.

11.1.6 Ice Storms

The National Weather Service defines an ice storm as a storm that results in the accumulation of at least 0.25 inches of ice on exposed surfaces. Ice storms occur when rain falls from a warm, moist, layer of atmosphere into a below freezing, drier layer near the ground. The rain freezes on contact with the cold ground and exposed surfaces, causing damage to trees, utility wires, and structures (see Figure 11-7).

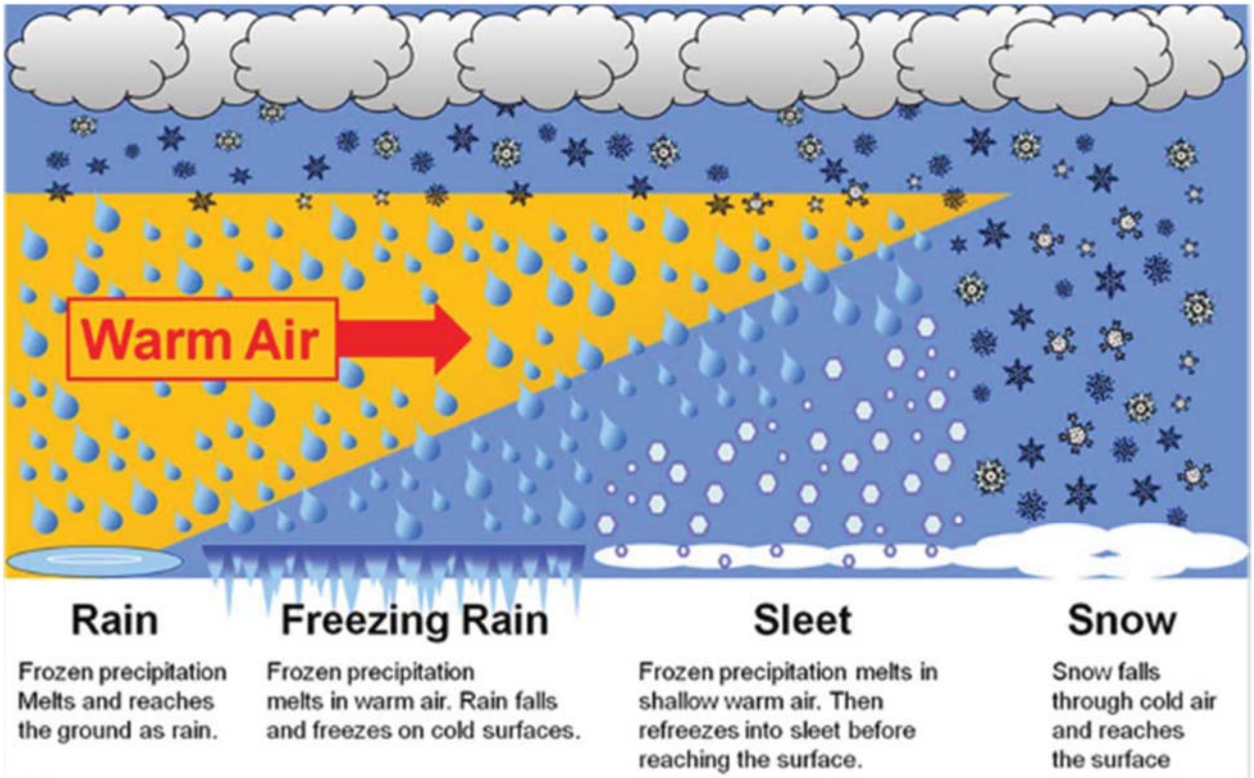


Figure 11-7. Types of Precipitation

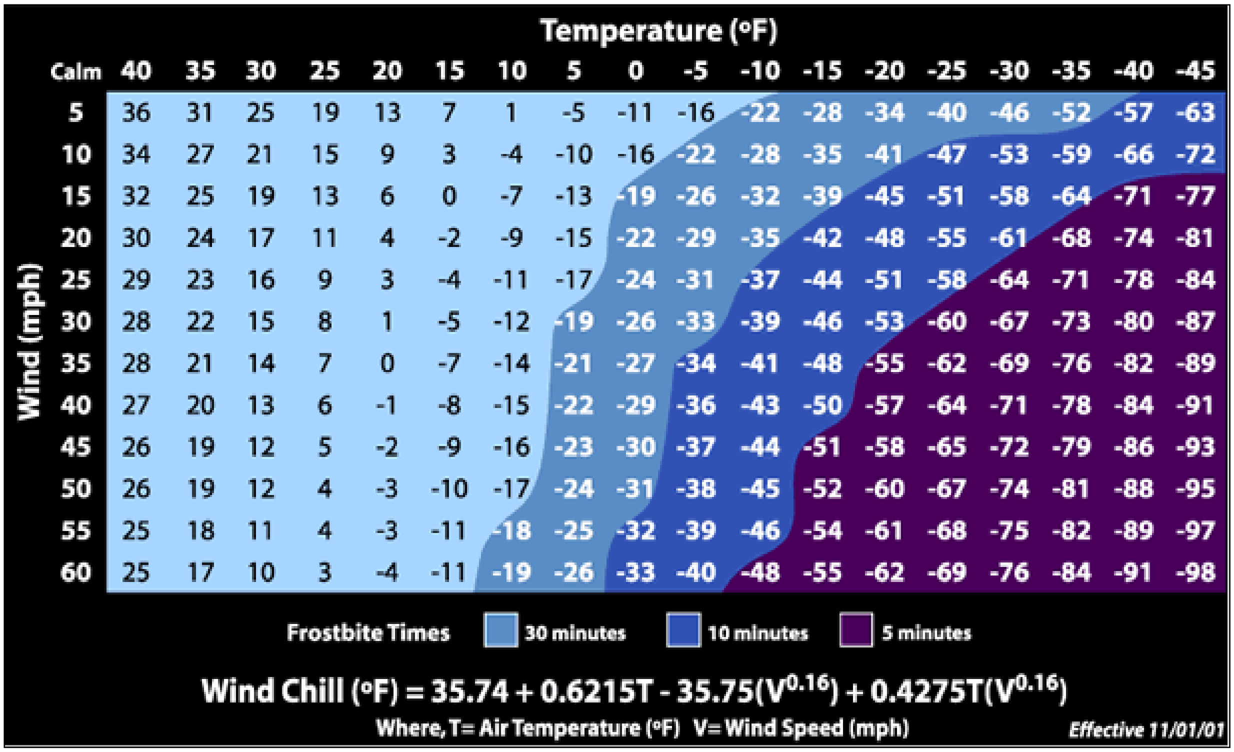
11.1.7 Extreme Temperatures

Extreme temperature includes both heat and cold events, which can have a significant impact on human health, commercial/agricultural businesses and primary and secondary effects on infrastructure (e.g., burst pipes and power failure). What constitutes "extreme cold" or "extreme heat" can vary across different areas of the country, based on what the population is accustomed to within the region (CDC, 2014).

Extreme Cold

Extreme cold events are when temperatures drop well below normal in an area. In regions relatively unaccustomed to winter weather, near freezing temperatures are considered "extreme cold." Extreme cold can often accompany severe winter storms, with winds exacerbating the effects of cold temperatures by carrying away body heat more quickly, making it feel colder than is indicated by the actual temperature (known as wind chill). Figure 11-8 demonstrates the value of wind chill based on the ambient temperature and wind speed.

Exposure to cold temperatures, whether indoors or outside, can lead to serious or life-threatening health problems such as hypothermia, cold stress, frostbite or freezing of the exposed extremities such as fingers, toes, nose and ear lobes. Hypothermia occurs when the core body temperature is <95ºF. If persons exposed to excessive cold are unable to generate enough heat (e.g., through shivering) to maintain a normal core body temperature of 98.6ºF, their organs (e.g., brain, heart, or kidneys) can malfunction. Extreme cold also can cause emergencies in susceptible populations, such as those without shelter, those who are stranded, or those who live in a home that is poorly insulated or without heat (such as mobile homes). Infants and the elderly are particularly at risk, but anyone can be affected.



Wind (mph) \ Temperature (°F)	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill } (^\circ F) = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T = Air Temperature (°F) V = Wind Speed (mph)

Effective 11/01/01

Figure 11-8. NWS Wind Chill Index

Extremely cold temperatures often accompany a winter storm, so individuals may have to cope with power failures and icy roads. Although staying indoors as much as possible can help reduce the risk of car crashes and falls on the ice, individuals may also face indoor hazards. Many homes will be too cold—either due to a power failure or because the heating system is not adequate for the weather. The use of space heaters and fireplaces to keep warm increases the risk of household fires and carbon monoxide poisoning.

During cold months, carbon monoxide may be high in some areas because the colder weather makes it difficult for car emission control systems to operate effectively. Carbon monoxide levels are typically higher during cold weather because the cold temperatures make combustion less complete and cause inversions that trap pollutants close to the ground (USEPA, 2009).

Extreme Heat

Temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks are defined as extreme heat (FEMA, 2006; CDC, 2006). An extended period of extreme heat of three or more consecutive days is typically called a heat wave and is often accompanied by high humidity (Ready America, Date Unknown; NWS, 2005). There is no universal definition of a heat wave because the term is relative to the usual weather in a particular area. The term heat wave is applied both to routine weather variations and to extraordinary spells of heat which may occur only once a century (Meehl and Tebaldi, 2004). A basic definition of a heat wave implies that it is an extended period of unusually high atmosphere-related heat stress, which causes temporary modifications in lifestyle and which may have adverse health consequences for the affected population (Robinson, 2000).

Depending on severity, duration and location; extreme heat events can create or provoke secondary hazards including, but not limited to, dust storms, droughts, wildfires, water shortages and power outages (FEMA, 2006; CDC, 2006). This could result in a broad and far-reaching set of impacts throughout a local area or entire region. Impacts could include significant loss of life and illness; economic costs in transportation, agriculture, production, energy and infrastructure; and losses of ecosystems, wildlife habitats and water resources (Adams, Date Unknown; Meehl and Tebaldi, 2004; CDC, 2006; NYSDPC, 2008).

Extreme heat is the number one weather-related cause of death in the U.S. On average, more than 1,500 people die each year from excessive heat. This number is greater than the 30-year mean annual number of deaths due to tornadoes, flooding, hurricanes and lightning combined (NOAA, Date Unknown). Figure 11-9 shows the number of weather fatalities based on a 10-year average and 30-year average[1]. Heat has the highest average of weather related fatalities between 2002 and 2012.

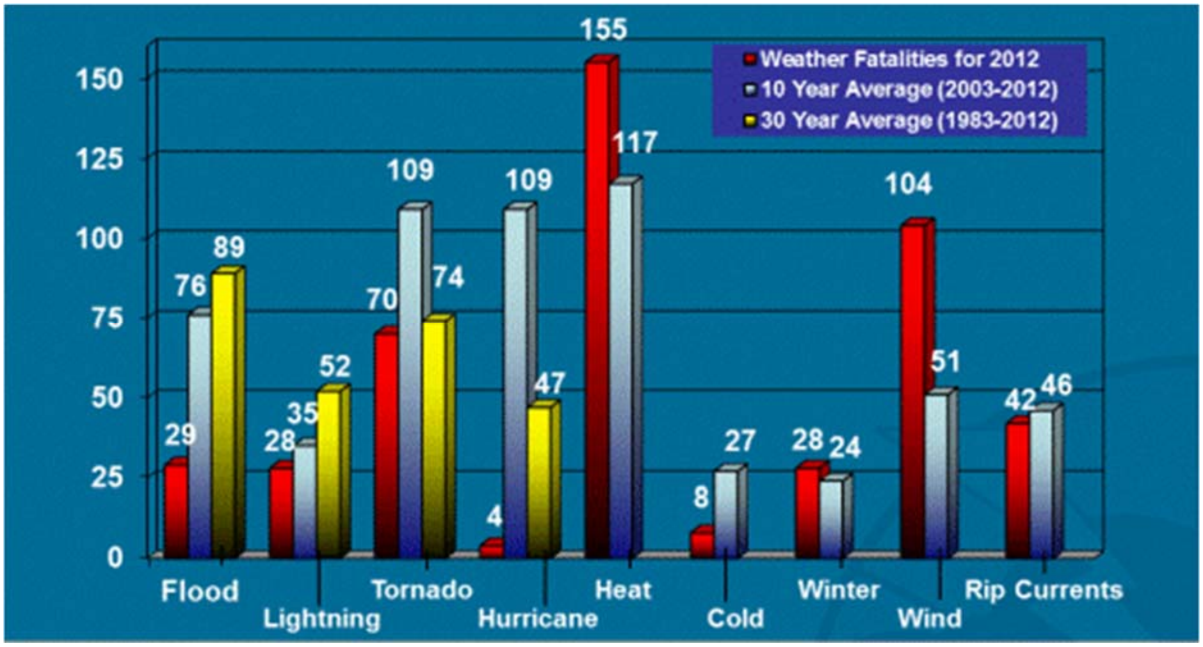


Figure 11-9. Average Number of Weather Related Fatalities in the U.S.

Certain populations are considered vulnerable or at greater risk during extreme heat events. These populations include, but are not limited to the following: the elderly age 65 and older, infants and young children under five years of age, pregnant woman, the homeless or poor, the overweight, and people with mental illnesses, disabilities and chronic diseases (NYS HMP, 2008).

11.2 HAZARD PROFILE

11.2.1 Extent and Location

The entire planning area is susceptible to the impacts of severe weather. Severe weather events customarily occur during the months of October to April, although they have occurred year round. The County has been impacted by strong winds, tornadoes, rain, snow, or other precipitation, and often are accompanied by thunder or lightening (Island County, 2008). Considerable snowfall does not customarily occur throughout the region.

Communities in low-lying areas next to coastlines, rivers, streams or lakes are more susceptible to flooding as a result of storm surge. Wind events are most damaging to areas of Island County. Winds coming off of the Pacific Coast can have a significant impact on the planning region as a result of both the wind and

[1] NOAA, 2014 (http://www.nws.noaa.gov/om/hazstats.shtml) (Most recently available at time of update.)

associated storm surge. For the planning region as a whole, wind events are one of the most common weather-related incidents to occur, often times leaving the area without power for extended periods.

Severe storms affect transportation and utilities. Access across certain parts of the County is unpredictable as roads are vulnerable to damage from severe storms, storm surges, and landslide/erosion. Severe storms and storm surges can also cause flooding and channel migration. The distribution of average weather conditions over the County is shown on Figure 11-10 through Figure 11-14.

11.2.2 Previous Occurrences

Table 11-1 summarizes severe weather events in the Island County since 1960, as recorded by the National Oceanic and Atmospheric Administration (NOAA), Spatial Hazard Events and Losses Database for the United States (SHELDUS), other local area plans, and FEMA websites. SHELDUS uses a variety of NOAA data sources, and covers severe weather events from 1960 through 2000 that caused more than $50,000 in property and/or crop damage. Data obtained from the National Climatic Data Center include weather events causing more than $100,000 in property and/or crop damage from 1993 through 2003 (except June and July 1993, for which data is not available), with the following exceptions:

- Tornado information is from 1950 to 1992.
- Thunderstorm wind and hail information is from 1955 to 1992.

In addition to the federally declared events, Island County regularly sustains impact from severe wind events which do not rise to the level of a declaration, but have significant impact on the region. Wind and associated storm effects impact a much greater area than associated floods in most instances.

- On February 4, 2006, a combination extreme wind event (68 mph recorded at NAS Whidbey) and seasonal extreme high tides caused exertive tidal flooding, erosion and surf damage, and debris accumulations. While this event did not rise to the level of a disaster declaration, parts of the County were without power for over two days.
- Great Coastal Gale of December 1-3, 2007 impacted the entire western coastline from northern California to Canada. Over a period of three days, two separate storms lashed the area with hurricane-force gusts and heavy rain. The region between Newport, OR and Hoquiam, WA received the strongest gale since the great Columbus Day Storm of 1962. Figure 11-15 compares the 1962 Columbus Day Storm to the 2007 event[2].
- In December 2012, high tides and severe winds battered Whidbey Island, causing a bulkhead behind an Oak Harbor home to fail. Debris accumulations caused several road closures, including along West Beach Road (Figure 11-16).[3] Citizens reported waves as high as telephone poles, with sustained winds of 45 miles per hour and gusts reaching 56 miles per hour as recorded at Whidbey Island Naval Air Station.
- December 11, 2014 windstorm recorded wind gusts at Whidbey Island Naval Air Station at 68 miles per hour, causing widespread power outages throughout the planning region.

[2] http://www.climate.washington.edu/stormking/

[3] http://www.whidbeynewstimes.com/news/184019861.html Image Credit: Nathan Whalen/Whidbey News-Times

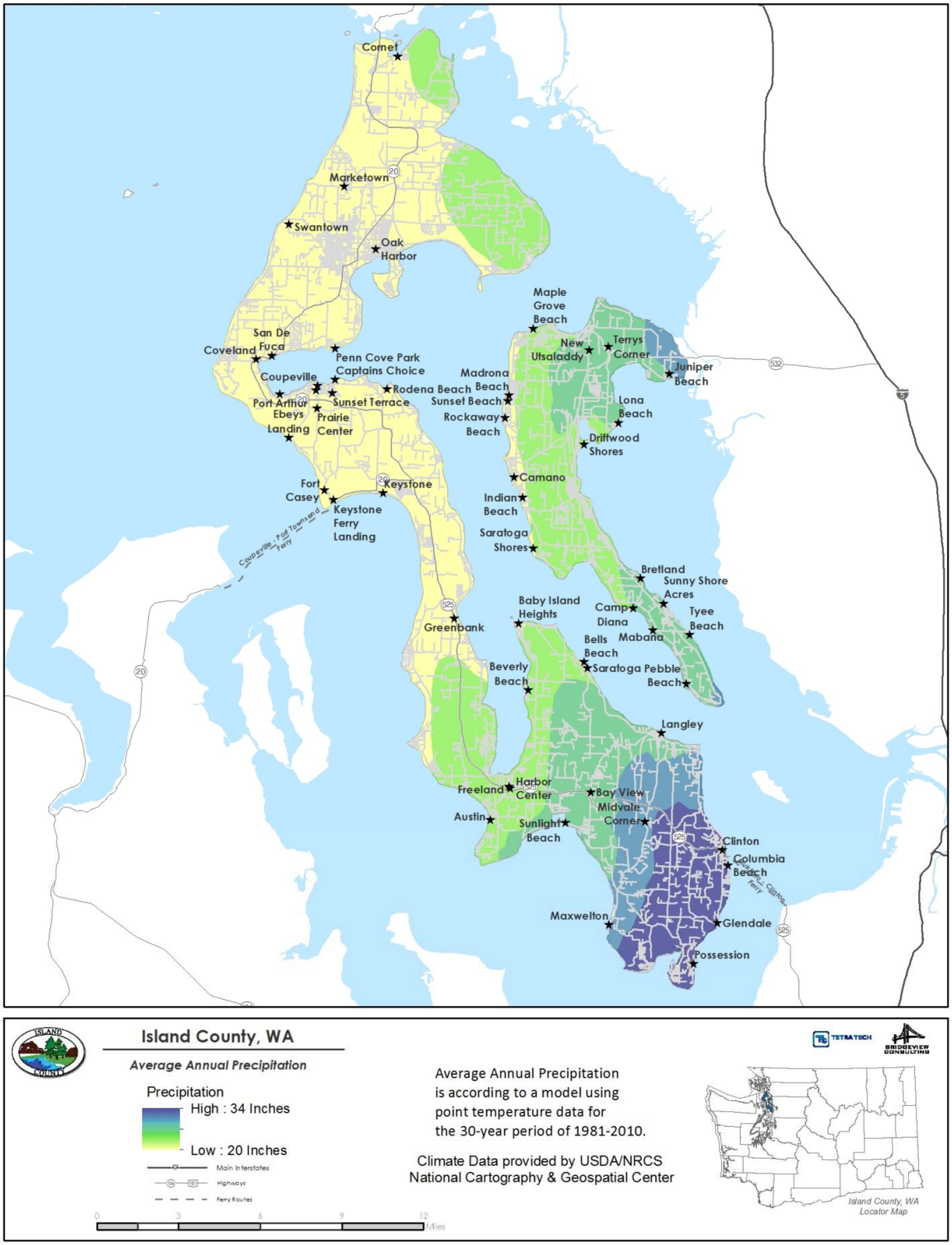


Figure 11-10. Island County Average Annual Precipitation

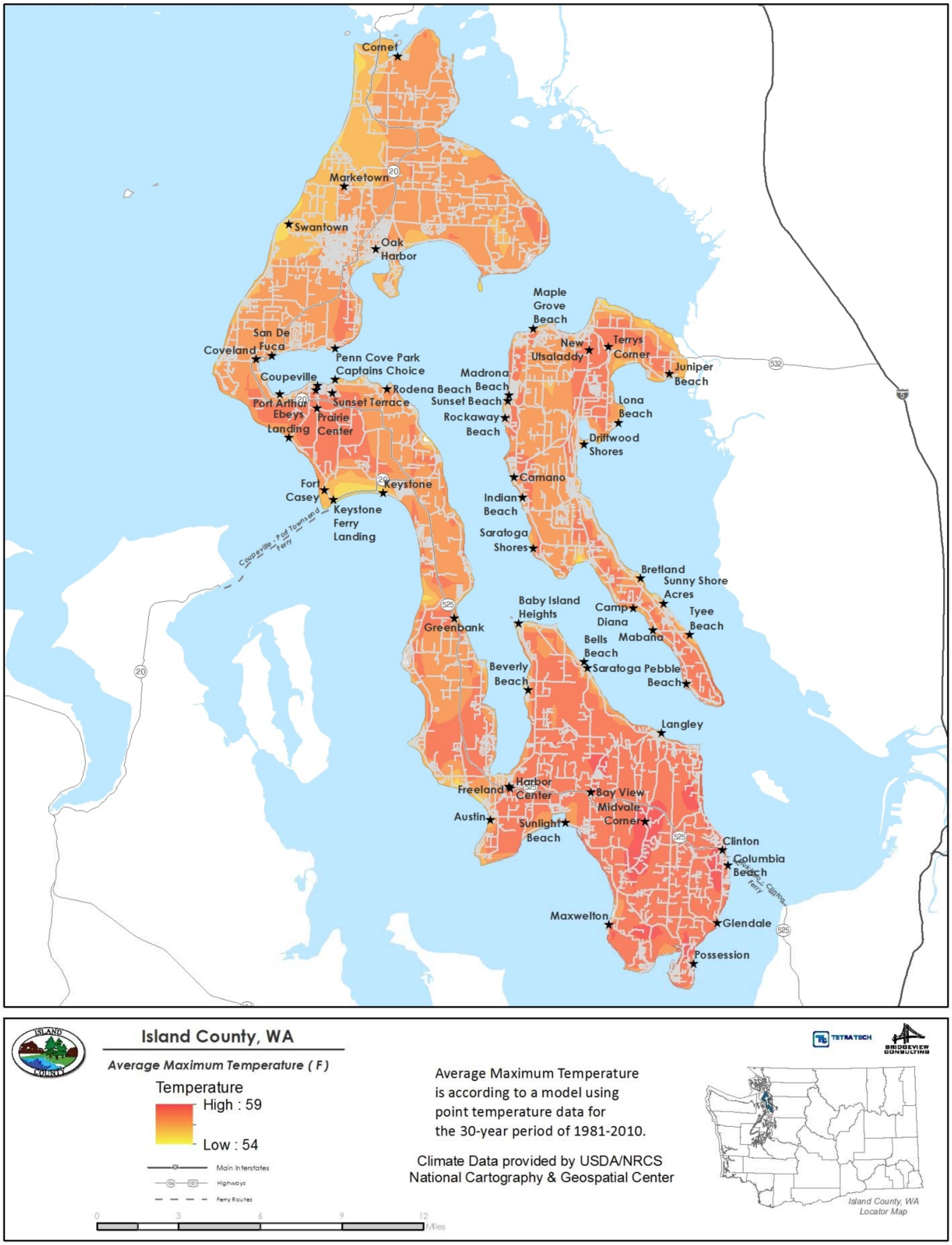


Figure 11-11. Island County Average Maximum Temperature

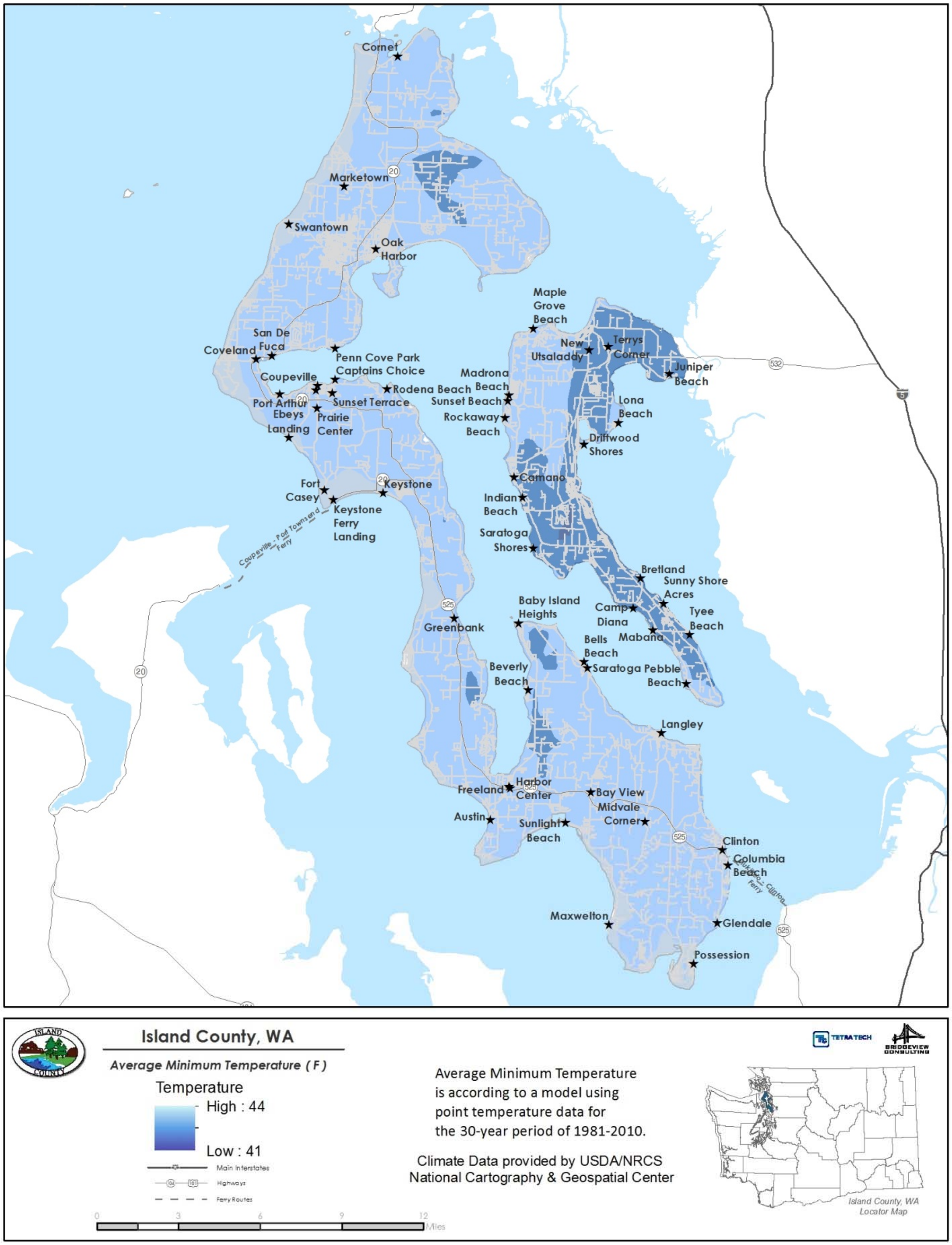


Figure 11-12. Island County Average Minimum Temperature

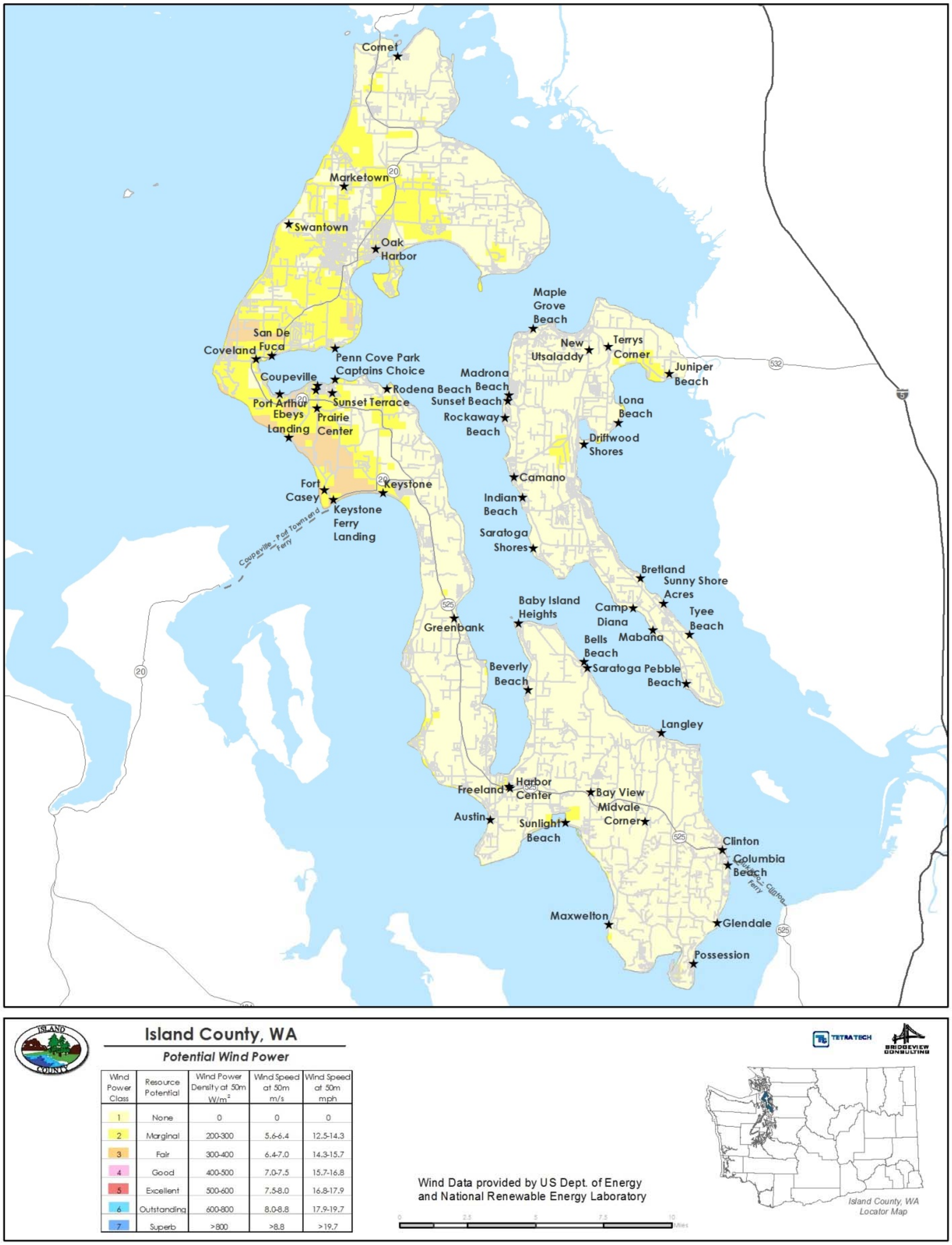


Figure 11-13. Island County Average Potential Wind Power

Source: USA.com, 2015

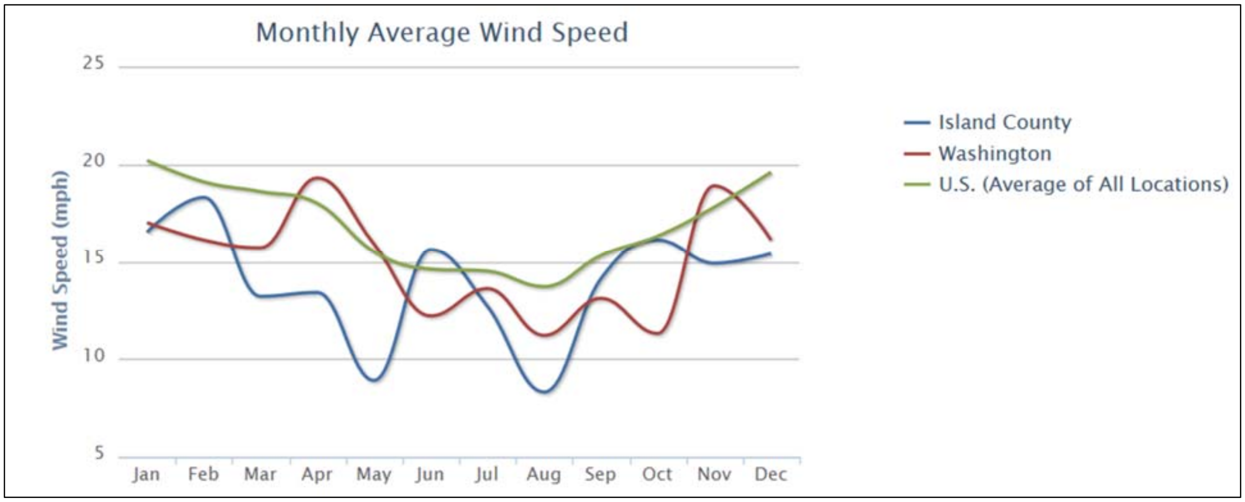


Figure 11-14. Island County Monthly Average Wind Speed

TABLE 11-1.
SEVERE WEATHER EVENTS IMPACTING PLANNING AREA SINCE 1960

Date	Type	Deaths or Injuries	Property Damage
October 1962 DR 137	Wind storm	7 in Washington; 46—combined all state's impacted	$235 million in property damage; 15 billion board feet of timber valued at $750 million
Description: Most powerful non-tropical storm to impact lower 48 states. Impact felt in Washington, Oregon and California. Damaged over 50,000 buildings throughout regions impacted. Power in some areas out for 3+ weeks. Wind speeds ranged from 88 mph in Tacoma to 160 mph in Naselle, WA. FEMA datasets provide no information on actual counties declared, other than the reference to Washington Counties.			
December 1990 (Disaster #896*)	Severe winter storm, flood, snow and high winds	Unknown	$5.1 million combined from all 10 affected counties*
Description: Strong winds, snowfall and flooding affected 10 counties in Washington.			
November 1990 (Disaster 883)	Severe Storms & Flooding	Unknown	Unknown
Description: Strong winds, snowfall and flooding affected 10 counties in Washington.			
January 1993 (Disaster 981*)	Severe winter storm, flood, snow and high winds	Unknown	
Description: A powerful low-pressure system swept through central Western Washington, causing great destruction, numerous injuries and the loss of five lives. Winds averaging 50 miles per hour with gusts to over 100 miles per hour caused trees to fall and knocked out power to 965,000 customers.* Island County was not included in Presidential Declaration			
November 1995 (Disaster 1079)	Flooding, severe storm, thunderstorm	Unknown	$556,000
Description: Heavy rains lead to flooding throughout the region. (SHELDUS figures)			

**TABLE 11-1.
SEVERE WEATHER EVENTS IMPACTING PLANNING AREA SINCE 1960**

Date	Type	Deaths or Injuries	Property Damage
Dec. 1996—Jan. 1997 (Disaster #1159)	Severe winter storm, snow, freezing rain; high winds; landslides.	24 deaths statewide	Statewide: Stafford Act assistance $83 million; SBA $31.7 million; total losses $140 million statewide
Description: Saturated ground combined with snow, freezing rain, rain, rapid warming and high winds within a five-day period produced flooding and landslides. 37 counties were impacted, with large power outages throughout the impacted counties.			
October 2003 (Disaster 1499)	Severe Storm and Flooding	Unknown	Statewide losses PA >$9 million IA >$5.5 million
Description: Heavy rains, severe storms.			
January 2006 (Disaster 1641)	Severe winter storm, flood, landslide, mudslide, tidal surge	Unknown	Unknown
Description: Heavy rains			
December 2006 DR 1682	Severe winter storm, wind, landslides and mudslides	Unknown	NAS Whidbey reported 69 mph peak gusts
Description: Severe winter storm caused landslides and mudslides throughout region.			
January 2009 (Disaster 1825)	Severe winter storm, record and near record snow, heavy rains, landslides, winds, tidal surge	Unknown	Public Assistance to all declared counties was over $5.5 million
Description: Severe winter storm, including record and near record snowfall and heavy rains and winds.			

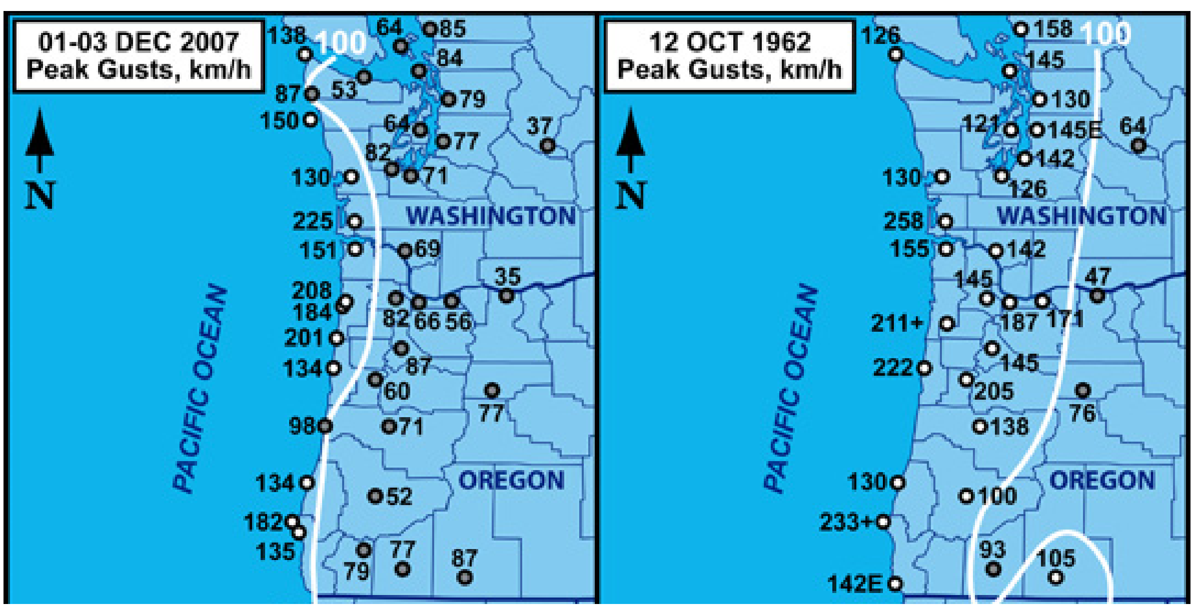


Figure 11-15. Peak Gust Comparison- 2007 Great Coastal Gale and 1962 Columbus Day Storm

Figure 11-16. West Beach Road Storm Debris - December 2012 Severe Storm Event

11.2.3 Severity

The most common problems associated with severe storms are immobility and loss of utilities. Fatalities are uncommon, but can occur. Roads may become impassable due to flooding, downed trees, ice or snow, or a landslide. Power lines may be downed due to high winds or ice accumulation, and services such as water or phone may not be able to operate without power. Lightning can cause severe damage and injury. Physical damage to homes and facilities caused by wind, or by accumulation of snow or ice can also occur. Due to the limited amount of snow we customarily receive in our region, even a small accumulation of ice or snow can, and has, caused havoc on transportation systems due to hilly terrain, the level of experience of drivers to maneuver in snow and ice conditions, and the lack of snow clearing equipment and resources within the region.

Ice storms, especially when accompanied by high winds, can have an especially destructive impact within the planning region, with both being able to close major transportation corridors and bridges. Accumulation of ice on trees, power lines, communication towers and wiring, or other utility services can be crippling, and create additional hazards for residents, motorists and pedestrians.

During the last 30 years, Western Washington has had an average annual snowfall of 11.4 inches per year, with the snowfall customarily occurring during November through March, although snow has fallen as late as April. Within Island County, snowfall ranges an average of 3-5 inches. Historical records in Western Washington are as follows:

- January 1950 – One day record for snow accumulation – 21 inches
- January 1950 – One month record for snow accumulation – 57 inches
- 1968-1969 – Winter season record for snow accumulation – 67 inches

Windstorms are common in the planning area and have been known to damage utilities. The predicted wind speed given in wind warnings issued by the National Weather Service is for a one-minute average; gusts may be 25 to 30 percent higher. Windstorms occur many times throughout the year within Island County.

Tornadoes are potentially the most dangerous of local storms, but they are not common in the planning area. If a major tornado were to strike within the planning are, damage could be widespread. As a result of building stock age, fatalities could be high, with many people homeless for an extended period of time. Routine services such as telephone or power could be disrupted. As a result, businesses could be forced to close for an extended period, impacting commodities available for citizens. As a result of the heavily forested areas, debris accumulations would be high, causing additional difficulties with access along major arterials connecting the area to other parts of the state, further impacting logistical support and commodities.

The extent (severity or magnitude) of extreme cold temperatures are generally measured through the wind chill temperature index. Wind Chill Temperature is the temperature that people and animals feel when outside and it is based on the rate of heat loss from exposed skin by the effects of wind and cold. As the wind increases, the body is cooled at a faster rate causing the skin's temperature to drop (NWS, 2009).

On November 1, 2001, the NWS implemented a new wind chill temperature index. It was designed to more accurately calculate how cold air feels on human skin. Figure 11-8 shows the new wind chill temperature index[4]. The Index includes a frostbite indicator, showing points where temperature, wind speed and exposure time will produce frostbite to humans. The chart shows three shaded areas of frostbite danger. Each shaded area shows how long a person can be exposed before frostbite develops (NWS, 2009).

The extent of extreme temperatures is generally measured through the heat index shown in Figure 11-17[5]. Created by the NWS, the Heat Index is a chart which accurately measures apparent temperature of the air as it increases with the relative humidity. The Heat Index can be used to determine what effects the temperature and humidity can have on the population (NCDC, 2000). Figure 11-18 describes the adverse effects that prolonged exposure to heat and humidity can have on an individual[6].

11.2.4 Frequency

The severe weather events for Island County shown in Table 11-1 are often related to high winds and associated other winter storm-type events such as heavy rains and landslides, and to a much lesser extent, snow and thunderstorms. The planning area can expect to experience exposure to some type of severe weather event at least annually. Figure 11-19 shows that severe weather events are the most common hazard events in Washington between 1960 and 2009 (represents most current analysis as of 2015 update). Winds are the most common event causing damage. This is based on the number of events reported, not the cost of damage sustained.

[4] NWS, 2008

[5] NCDC, 2000

[6] NYSDEC, 2008

Relative Humidity (%)	Temperature (°F)															
	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Figure 11-17. Heat Index Chart

Category	**Heat Index**	**Health Hazards**
Extreme Danger	130 °F – Higher	Heat Stroke / Sunstroke is likely with continued exposure.
Danger	105 °F – 129 °F	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Extreme Caution	90 °F – 105 °F	Sunstroke, muscle cramps, and/or heat exhaustions possible with prolonged exposure and/or physical activity.
Caution	80 °F – 90 °F	Fatigue possible with prolonged exposure and/or physical activity.

Figure 11-18. Adverse Effects of Prolonged Exposures to Heat on Individuals

Source: SHELDUS, 2014

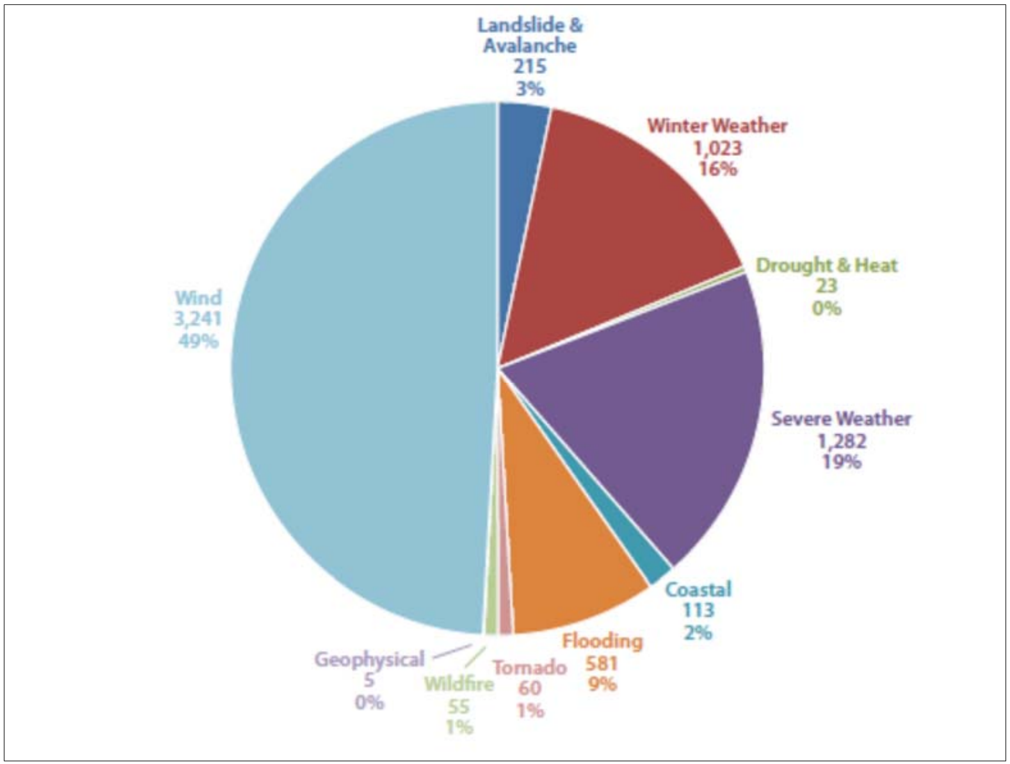


Figure 11-19. Distribution of Washington Events by Type (Number of Events), 1960—2009

11.3 VULNERABILITY ASSESSMENT

11.3.1 Overview

Severe weather incidents can and regularly do occur throughout the entire planning area. Similar events impact areas within the planning region differently, even though they are part of the same system. While in some instances some type of advanced warning is possible, as a result of climatic differences, topographic and relative distance to the coastline, the same system can be much more severe in certain areas of the County. Therefore, preparedness plays a significant contributor in the resilience of the citizens to withstand such events.

Methodology

A lack of data separating severe weather damage from flooding, windstorms and landslide damage prevented a detailed analysis for exposure and vulnerability. For planning purposes, it is assumed that the entire planning area is exposed to some extent to severe weather. Certain areas are more exposed due to geographic location and local weather patterns, as well as the response capabilities of local first responders.

Warning Time

Meteorologists can often predict the likelihood of some severe storms. In some cases, this can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm, and the rapid changes which can also occur significantly increasing the impact of a weather event.

11.3.2 Impact on Life, Health and Safety

The entire planning area is susceptible to severe weather events. Populations living at higher elevations with large stands of trees or above-ground power lines may be more susceptible to wind damage and black out conditions, while populations in low-lying areas are at risk for possible flooding and landslides associated with the flooding as a result of heavy rains. Increased levels of precipitation in the form of snow also vary by area, with higher elevations being more susceptible to increased accumulations. Resultant secondary impacts from power outages during cold weather event, when combined with the high population of retired and elderly residents significantly impacts response capabilities and the risk factor associated with such weather incidents. Within the densely wooded areas, increased fire danger during extreme heat conditions increases the likelihood of fire, which increases fire danger.

Particularly vulnerable populations are the elderly and very young, low income, linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Extreme temperature variations, either heat or cold, are of significant concern on both the elderly and the young, increasing vulnerability of those populations.

A number of storm events have cut off access to the south end of Camano Island for days at a time – these storm events include both declared and non-declared incidents, as even minor incidents have the potential to impact Camano's ingress and egress abilities. Such issues are of concern as a result of limited access for evacuation purposes by first responder if vital ALS is required, as well as for general evacuation purposes during a period where power is out, and individuals attempt to leave the area.

Puget Sound Energy provides electricity to the planning area. Severe weather events disrupt electricity in the planning area several times each year, often for several days.

As a result of the fairly large population of retirees, of significant concern to the planning partners throughout the region when severe weather events occur is the lack of citizens' ability to maintain an adequate supply of medicines, as well as oxygen. Wind debris and other severe weather events often cause blockage of primary transportation corridors. In an effort to address such issues as these, the Hospital District, along with the local fire districts and departments, are working to develop a Community Paramedic Program, which will work with local citizens to help ensure surplus amounts of medicines are stored.

On a number of occasions, the inability of citizens to be able to travel has required response from fire departments and medic units to refill in-home oxygen tanks; however, in many instances, this depletes the areas' supply. All of the fire departments and districts, as well as the Whidbey General Hospital District are attempting to develop a process and purchase equipment necessary to address this issue.

11.3.3 Impact on Property

All property is vulnerable during severe weather events. Currently data identifies that there are a total of 38,267 buildings in the planning area. Most of these buildings are residential. It is estimated that many of the residential structures were built without the influence of a structural building code with provisions for wind loads, as most residential structures were built pre-1974.

For planning purposes, all of the buildings within the planning area are considered to be exposed to the severe weather hazard, but structures in poor condition or in particularly vulnerable locations (hilltops or exposed open areas) may be at risk for the most damage. The frequency and degree of damage will depend on specific locations and severity of the weather pattern impacting the region. It is improbable to determine the exact number of structures susceptible to a weather event, and therefore emergency managers and public officials should establish a maximum threshold, or worst-case scenario, of susceptible structures.

Loss estimations for severe weather hazards are not based on modeling utilizing damage functions, as no such functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 11-2 shows loss estimates for the severe weather risk by jurisdiction at the identified percent damages, as well as the potential dollar losses for residential and non-residential structures.

TABLE 11-2.
POTENTIAL BUILDING LOSSES DUE TO SEVERE WEATHER HAZARD

Jurisdiction	Building Count	Exposed Value	10% Damage	30% Damage	50% Damage
Unincorporated County	29,097	$7,513,788,923	$751,378,892	$2,254,136,677	$3,756,894,461
Coupeville	797	$244,853,785	$24,485,378	$73,456,135	$122,426,892
Langley	632	$177,293,192	$17,729,319	$53,187,958	$88,646,596
Oak Harbor	7,750	$3,455,539,922	$345,553,992	$1,036,661,977	$1,727,769,961
Total	**38,276**	**$11,391,475,821**	**$1,139,147,582**	**$3,417,442,746**	**$5,695,737,911**

11.3.4 Impact on Critical Facilities and Infrastructure

No loss estimation of critical facilities was performed due to the lack of established damage functions for the severe weather hazard. Therefore, it should be assumed that all critical facilities are vulnerable to some degree. As many of the severe weather events include multiple hazards, information such as that identifying facilities exposed to flooding or landslides (see Flood and Landslide profiles) are also likely exposed to severe weather. Additionally, facilities on higher ground may also be exposed to wind damage or damage from falling trees. The most common problems associated with severe weather are loss of utilities. Downed power lines can cause blackouts, leaving large areas isolated. Phone, water and sewer systems may not function. Roads may become impassable due to ice or snow or from secondary hazards such as landslides. Also of concern in the planning area is the reliance on the Washington State Ferry services, which may be shut down due to severe weather events. The ferry system considered critical infrastructure within the planning region.

Incapacity and loss of roads are the primary transportation failures, most of which are associated with secondary hazards. Landslides that block roads are caused by heavy prolonged rains. High winds can cause significant damage to trees and power lines, with obstructing debris blocking roads, incapacitating transportation, isolating population, and disrupting ingress and egress. Snowstorms at higher elevations can impact the transportation system and the availability of public safety services. Of particular concern are roads providing access to isolated areas and to the elderly.

Severe windstorms, downed trees, and ice can create serious impacts on power and above-ground communication lines. Freezing of power and communication lines can cause them to break, disrupting both electricity and communication for households. Loss of electricity and phone connection would result in isolation because some residents will be unable to call for assistance.

11.3.5 Impact on Economy

Prolonged obstruction of major routes due to severe weather can disrupt the shipment of goods and other commerce, including ferry services. Severe windstorms, downed trees, and ice can create serious impacts on power and above-ground communication lines. Freezing rain/snow on power and communication lines can cause them to break, disrupting electricity and communication, further impacting business within the region. Prolonged outages would impact consumer and tax base as a result of lost revenue, (food) spoilage, lack of production, etc. Large, prolonged storms can have negative economic impacts for an entire region. All severe weather events have the potential to also impact tourism, an industry on which much of the planning region is dependent.

11.3.6 Impact on Environment

The environment is highly exposed to severe weather events. Natural habitats such as streams and trees are exposed to the elements during a severe storm and risk major damage and destruction. Prolonged rains can saturate soils and lead to slope failure. Flooding events caused by severe weather or snowmelt can produce river channel migration or damage riparian habitat, also impacting spawning grounds and fish populations for many years. Storm surges can erode beachfront bluffs and redistribute sediment loads. Extreme heat can raise temperatures of rivers, impacting oxygen levels in the water, threatening aquatic life.

11.4 FUTURE DEVELOPMENT TRENDS

All future development will be affected by severe storms. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. The County does have land use regulations in place, which includes implementation of the International Building Codes as well as additional land use authority. These codes are equipped to deal with the impacts of severe weather incidents by identifying construction standards which address wind speed, roof load capacity, elevation and setback restrictions.

While under the Growth Management Act, public power utilities are required by law to supply safe, cost effective and equitable service to everyone in the service area requesting service, most lines in the area are above-ground, causing them to be more susceptible to high winds or other severe weather hazards. However, growth management is also a constraint, which could possibly lead to increased outages or even potential shortages, as while most new development expects access to electricity, they do not want to be in close proximity to sub stations. The political difficulty in sighting these sub stations makes it difficult for the utility to keep up with regional growth.

Land use policies currently in place, when coupled with informative risk data such as that established within this mitigation plan and such other projects like FEMA's new flood maps, will also address the severe weather hazard. With the land use tools currently in place, the County and its planning partners will be well-equipped to deal with future growth and the associated impacts of severe weather.

11.5 CLIMATE CHANGE IMPACTS

Climate change presents a significant challenge for risk management associated with severe weather. The frequency of severe weather events has increased steadily over the last century. The number of weather-related disasters during the 1990s was four times that of the 1950s, and cost 14 times as much in economic losses. Historical data shows that the probability for severe weather events increases in a warmer climate (see Figure 11-20). The changing hydrograph caused by climate change could have a significant impact on the intensity, duration and frequency of storm events. All of these impacts could have significant economic consequences.

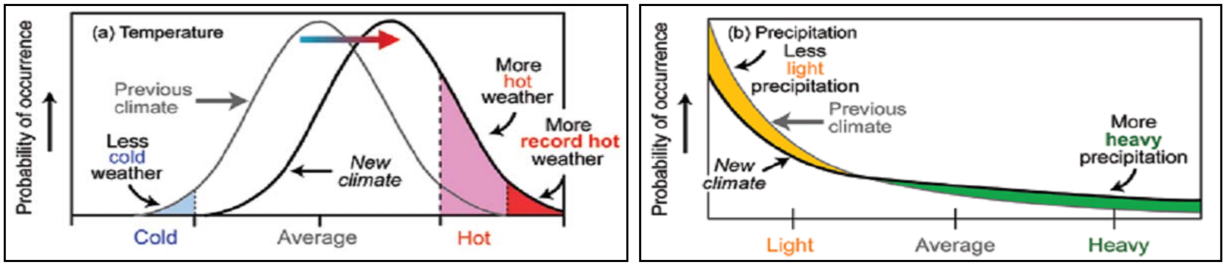


Figure 11-20. Severe Weather Probabilities in Warmer Climates

11.6 ISSUES

Important issues associated with a severe weather in the planning area include the following:

- Older building stock in the planning area is built to low code standards or none at all. These structures could be highly vulnerable to severe weather events such as windstorms.
- Redundancy of power supply must be evaluated and increased planning-region wide in order to more fully understand the vulnerabilities in this area.
- The capacity for backup power generation is limited and should be enhanced, especially in areas of potential isolation due to impact on major thoroughfares or evacuation routes.
- Isolated population centers exist.
- Climate change may increase the frequency and magnitude of winter flooding or storm surges, thus exacerbating severe winter events.
- Proximity to coastline enhances flooding potential through storm surges, as well as severe storms in general.

CHAPTER 12.
TSUNAMI

A tsunami is a series of high-energy waves radiating outward from a disturbance. Earthquakes may produce displacements of the sea floor that can set the overlying column of water in motion, initiating a tsunami.

Tsunamis are classified as local or distant. Distant tsunamis may travel for hours before striking a coastline, giving a community a chance to implement evacuation plans. Local tsunamis have minimal warning times, leaving few options except to run to high ground. They may be accompanied by damage resulting from the triggering earthquake due to ground shaking, surface faulting, liquefaction or landslides. As a result of the high probability of a Cascadia Subduction Zone-type earthquake, occupants of many parts of Washington's coastlines have minimal time to reach high ground, in some areas only 20-30 minutes.

DEFINITIONS

Tsunami—A series of traveling ocean waves of extremely long wavelength usually caused by displacement of the ocean floor and typically generated by seismic or volcanic activity or by underwater landslides.

Tidal bore – A tidal phenomenon in which the leading edge of the incoming tide forms a wave (or waves) of water that travel up a river or narrow bay against the direction of the river or bay's current.

Tsunami Advisory - The purpose of a Tsunami Advisory is to keep people away from rivers, beaches, and harbors for their own personal safety. Tsunami waves during a Tsunami Advisory can also appear as "sneaker waves."

Sneaker wave – A term used to describe disproportionately large coastal waves that can sometimes appear in a wave train without warning.

12.1 GENERAL BACKGROUND

12.1.1 Physical Characteristics of Tsunamis

All waves, including tsunamis, are defined by the following characteristics (see Figure 12-1; Earth Science, 2012):

- **Wavelength** is defined as the distance between two identical points on a wave (i.e., between wave crests or wave troughs). Normal ocean waves have wavelengths of about 300 feet. Tsunamis have much longer wavelengths, up to 300 miles.
- **Wave height** is the distance between the trough of a wave and its crest or peak.
- **Wave amplitude** is the height of the wave above the still water line; usually this is equal to 1/2 the wave height. Tsunamis can have variable wave height and amplitude that depends on water depth.
- **Wave frequency or period** is the amount of time it takes for one full wavelength to pass a stationary point.
- **Wave velocity** is the speed of a wave. It is equal to the wavelength divided by the wave period. Velocities of normal ocean waves are about 55 mph while tsunamis have velocities up to 600 mph (about as fast as jet airplanes).

Tsunamis are different from the waves most of us have observed on the beach, which are caused by the wind blowing across the ocean's surface. Wind-generated waves usually have periods of 5 to 20 seconds and a wavelength of 300 to 600 feet. A tsunami can have a period in the range of 10 minutes to 2 hours and wavelengths greater than 300 miles. Tsunamis are shallow-water waves, which are waves with very small ratios of water depth to wavelength.

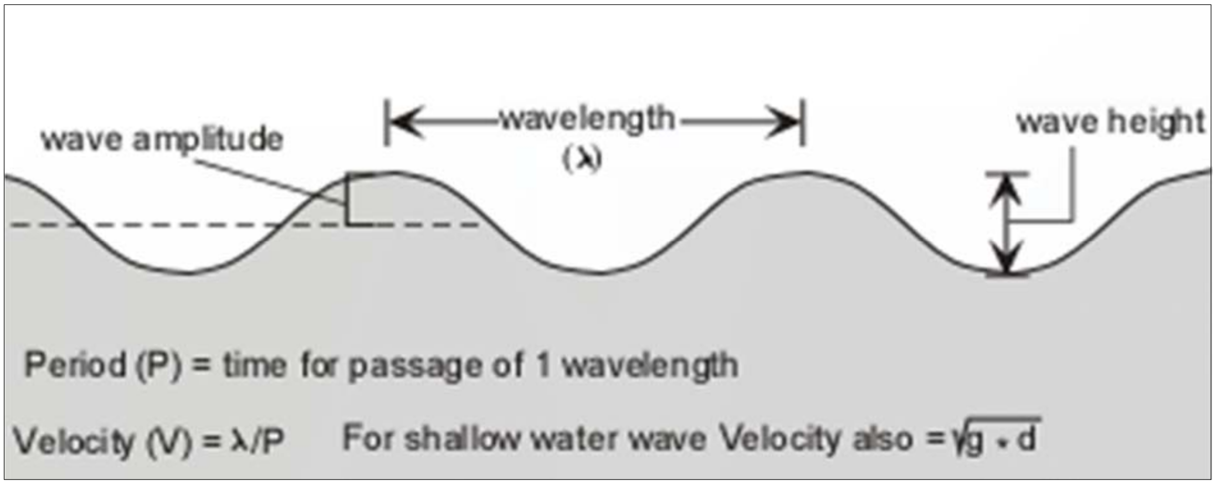


Figure 12-1. Physical Characteristics of Waves

The rate at which a wave loses its energy is inversely related to its wavelength. Since a tsunami has a very large wavelength, it loses little energy as it propagates. Thus, in very deep water, a tsunami will travel at high speeds with little loss of energy. For example, when the ocean is 20,000 feet deep, a tsunami will travel about 600 mph, and thus can travel across the Pacific Ocean in less than one day.

As a tsunami leaves the deep water of the open sea and arrives at shallow waters near the coast, it undergoes a transformation (see Figure 12-2; Earth Science, 2012). Since the velocity of the tsunami is also related to the water depth, as the depth of the water decreases, the velocity of the tsunami decreases. The change of total energy of the tsunami, however, remains constant. Furthermore, the period of the wave remains the same, so more water is forced between the wave crests, causing the height of the wave to increase.

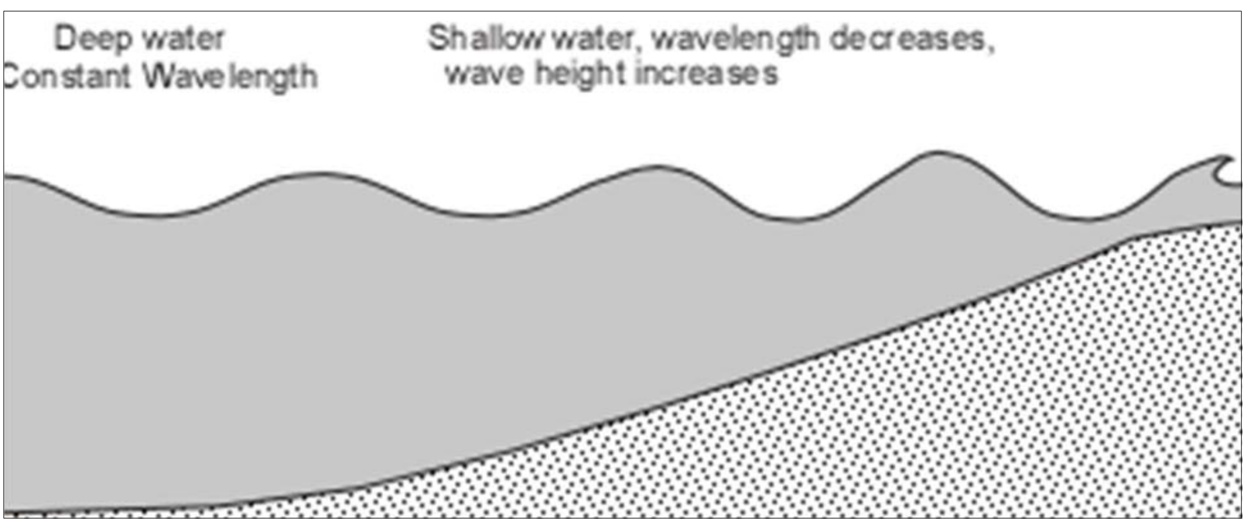


Figure 12-2. Change in Wave Behavior with Reduced Water Depth

Because of this "shoaling" effect, a tsunami that was imperceptible in deep water may grow to have wave heights of several meters. As a tsunami enters the shoaling waters near a coastline, its speed diminishes, its wavelength decreases, and its height increases greatly. The first wave usually is not the largest. Several larger and more destructive waves often follow. As tsunamis reach the shoreline, they may take the form of a fast-rising tide, a cresting wave, or a bore (a large, turbulent wall-like wave). The bore phenomenon resembles a step-like change in water level that advances rapidly (from 10 to 60 miles per hour).

The configuration of the coastline, the shape of the ocean floor, and the characteristics of advancing waves play roles in the destructiveness of tsunamis. Offshore canyons can focus tsunami wave energy and islands can filter the energy. The orientation of the coastline determines whether the waves strike head-on or are refracted from other parts of the coastline. A wave may be small at one point on a coast and much larger at other points. Bays, sounds, inlets, rivers, streams, offshore canyons, islands, and flood control channels may cause various effects that alter the level of damage. It has been estimated, for example, that a tsunami wave entering a flood control channel could reach a mile or more inland, especially if it enters at high tide.

The first indication of a tsunami to reach land may be a trough—called a drawdown—rather than a wave crest. The water along the shoreline recedes dramatically, exposing normally submerged areas. Drawdown is followed immediately by the crest of the wave, which can catch people observing the drawdown off guard. Rapid drawdown can create strong currents in harbor inlets and channels that can severely damage coastal structures due to erosive scour around piers and pilings. As the water's surface drops, piers can be damaged by boats or ships straining at or breaking their mooring lines. The vessels can overturn or sink due to strong currents, collisions with other objects, or impact with the harbor bottom.

Conversely, the first indication of a tsunami may be a rise in water level. The advancing tsunami may initially resemble a strong surge increasing the sea level like the rising tide, but the tsunami surge rises faster and does not stop at the shoreline. Even if the wave height appears to be small, 3 to 6 feet for example, the strength of the accompanying surge can be deadly. Waist-high surges can cause strong currents that float cars, small structures, and other debris. Boats and debris are often carried inland by the surge and left stranded when the water recedes.

When the crest of the wave hits, sea level rises (called run-up). Run-up is usually expressed in height above normal high tide. Run-ups from the same tsunami can vary with the shape of the coastline. One coastal area may see no damaging wave activity while in another area destructive waves can be large and violent. The flooding of an area can extend inland by 1,000 feet or more, covering large areas of land with water and debris. Tsunami waves tend to carry loose objects and people out to sea when they retreat. Tsunamis may reach a vertical height onshore above sea level, called a run-up height, of 100 feet.

At some locations, the advancing turbulent wave front will be the most destructive part of the wave. In other situations, the greatest damage will be caused by the outflow of water back to the sea between crests, sweeping all before it and undermining roads, buildings, bulkheads, and other structures. This outflow action can carry enormous amounts of highly damaging debris with it, resulting in further destruction. Ships and boats, unless moved away from shore, may be dashed against breakwaters, wharves, and other craft, or be washed ashore and left grounded after the withdrawal of the seawater.

Because the wavelengths and velocities of tsunamis are large, their period is also large. It may take several hours for successive crests to reach the shore. (For a tsunami with a wavelength of 125 miles traveling at 470 mph, the wave period is about 16 minutes). Thus people are not safe after the passage of the first large wave, but must wait several hours for all waves to pass. The first wave may not be the largest in the series of waves. For example, in several recent tsunamis, the first, third, and fifth waves were the largest.

12.2 HAZARD PROFILE

12.2.1 Extent and Location

Tsunamis affecting Washington may be induced by local geologic events or earthquakes at a considerable distance, such as in Alaska or South America. Approximately 80 percent of tsunamis originate in the Pacific Ocean and can strike distant coastal areas in a matter of hours, such as the 2011 earthquake and ensuing tsunami occurring in Japan which impacted Washington's coastlines, including within the planning area.

Most recorded tsunamis affecting the Pacific Northwest originated in the Gulf of Alaska. The landslide-generated tsunami in Lituya Bay, Alaska in 1958 produced a 200-foot-high wave. There is also geological evidence of significant impacts from tsunamis originating along the Cascadia subduction zone, which extends from Cape Mendocino, California to the Queen Charlotte Islands in British Columbia.

The Washington Department of Natural Resources (WDNR) has mapped the tsunami risk zone in the vicinity of the Island County as shown on Figure 12-3 and Figure 12-4 (WDNR, 2005). As illustrated in WDNR's maps, the computed tsunami inundation is shown in three color-coded depth ranges: 0–0.5 m, 0.5–2 m, and greater than 2 m. These depth ranges were chosen because they are approximately knee-high or less, knee-high to head-high, and more than head-high and so approximately represent the degree of hazard for life safety. The greatest tsunami flooding is expected to occur at Swantown Marsh on Whidbey Island and on the southern shores of Padilla Bay. Elsewhere, tsunami flooding is expected only in the immediate vicinity of the shoreline where evacuation to higher ground would be an easy matter. Large areas of inundation occur in areas of low topography surrounding Samish Bay, Padilla Bay, and the Swinomish Channel. Though not part of the modeling study, inundation also occurs within the vicinity of Fir Island. These areas are protected by dikes that were not resolved in the grid used for the modeling, but the height of the dikes suggests they would be overtopped by the modeled tsunami and so inundation shown there is probably appropriate (Venturato et al., 2004).

Current velocities (Figure 12-4) are shown in three zones—less than 1.5 m/s (~3 mph), which is the current speed at which it would be difficult to stand; 1.5–5 m/s, and greater than 5 m/s, which is a modest running pace. Within this zone, computed velocities locally exceed 20 m/s (~40 mph) in confined channels. The initial water disturbance is a trough or drop in sea level of about a meter at about 1½ hours after the earthquake at the westernmost end of Whidbey Island and about half an hour later in the narrow channels to the north. The first crest or rise in sea level arrives between 2 and 2½ hours after the earthquake, again earlier at Whidbey Island and later in Bellingham and Guemes Channels and at Padilla Bay. At about 2½ hours after the earthquake, another trough of about a meter occurs in the south, but water piles up in Padilla Bay and the crest remains for two cycles, indicating a prolonged period of flooding.

Mapped inundation zones in Island County for the Cascadia Scenario are shown on Figure 12-5.

12.2.2 Previous Occurrences

The 1964 Magnitude-9.2 earthquake in Prince William Sound, Alaska caused a tsunami that struck Washington, Oregon and California, killing 128 people, mostly in Alaska. There were no reported deaths in Washington, but there were reports of damaged boats and houses along the coastline. Wave heights along the Washington coastline were 1.5 feet at the mouth of the Hoh River; 5 feet in La Push; 10 feet in Ocean Shores; 23 feet in Tahola; 11 feet in Moclips, and 2 feet in Neah Bay (Sokolowski, undated).

The February 27, 2010 Chilean Magnitude-8.8 earthquake generated a small tsunami with no reported damage in Washington. NOAA reported increased wave heights above sea level as 5.5 inches in Westport, 7.5 inches in Port Angeles, 8.5 inches in La Push, and 9 inches in Neah Bay. (NOAA, 2011).

The March 2011 tsunami that resulted from a Magnitude-9.0 earthquake in Japan caused increased wave heights along the California, Oregon and Washington coastlines. Major declarations were issued in California and Oregon, but Washington sustained much less damage. Washington coastline wave heights above sea level were reported at La Push at 28 inches; Port Angeles at 23 inches; Westport at 18 inches; Toke Point at 13 inches; Port Townsend at 6 inches; and Neah Bay at 17 inches. No significant damage was reported, but this incident had the potential to be much worse. The County and its jurisdictions worked closely with the Pacific Marine Environmental Laboratory and the West Coast and Alaska Tsunami Warning Center, who provided wave predictions for coastal areas.

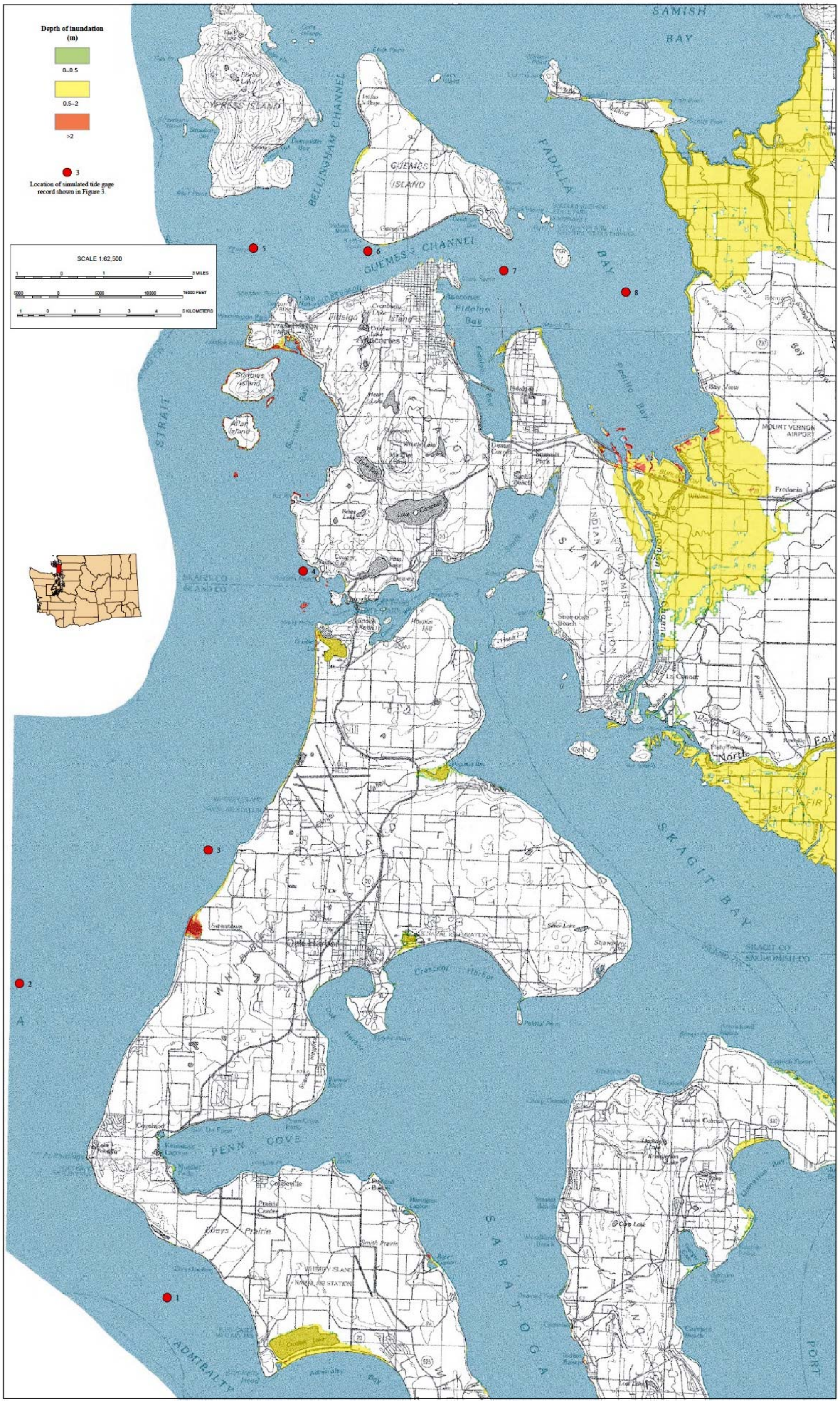


Figure 12-3. Inundation Depth Determined by Washington State Department of Natural Resources

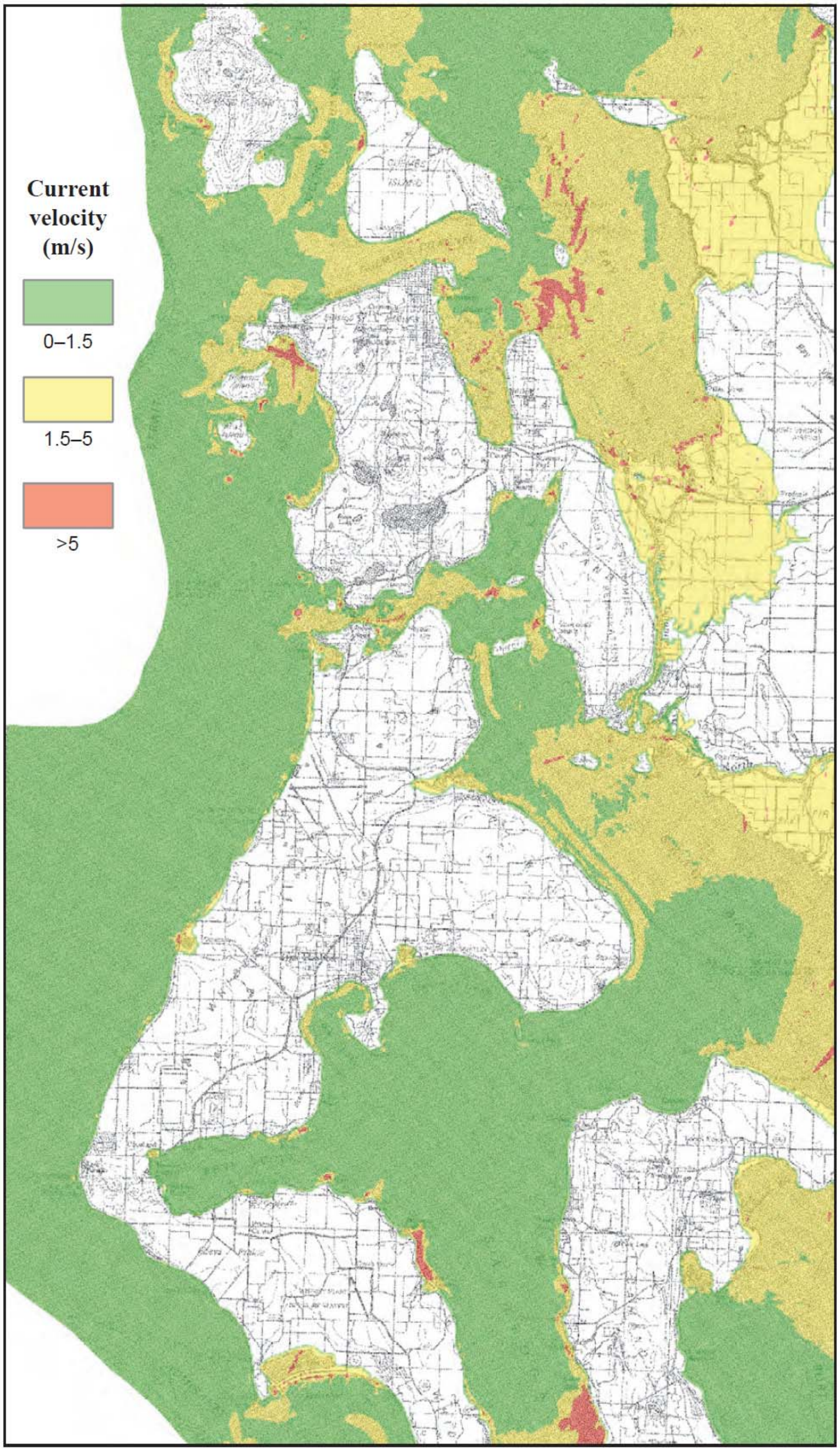


Figure 12-4. Velocity Zones as Defined by Washington State Department of Natural Resources

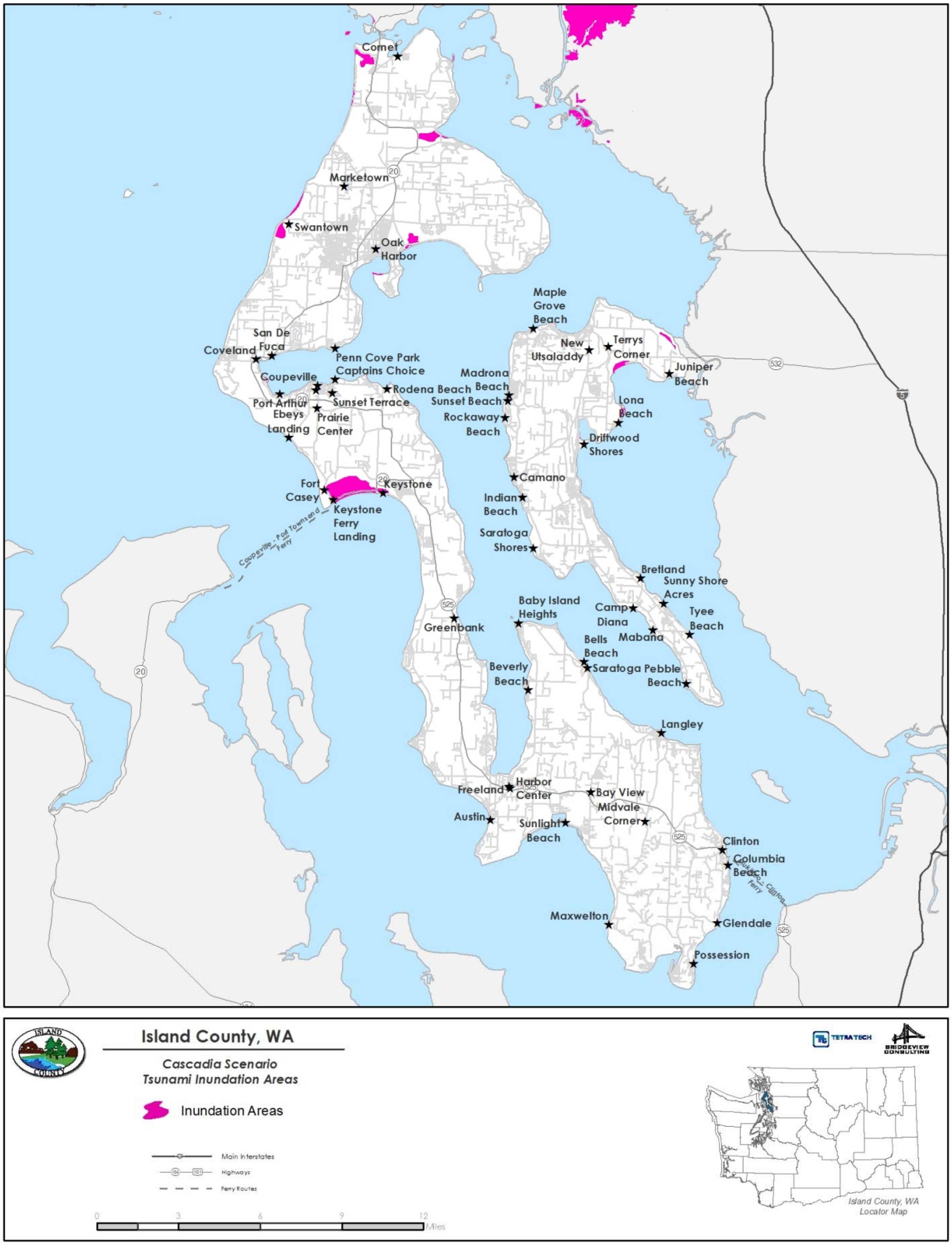


Figure 12-5. Island County Tsunami Inundation Areas

Evidence of tsunamis in the Puget Sound 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 Puget Sound faults. There is evidence that an earthquake around 900 A.D. on the Seattle Fault caused an uplift of up to 20 feet in some areas, triggering a tsunami in central Puget Sound (EMD, 2012). The tsunami deposited a sheet of sand across West Point in Seattle. Computer simulations suggest that wave height may have reached 20 feet at the Seattle waterfront. Sand sheets were also deposited as a result of this event on the southern portion of Whidbey Island and along some tributaries of the Snohomish River. There is also evidence of a past event on Possession Beach on Whidbey Island that caused sloughing and a tsunami.

12.2.3 Severity

Tsunamis are a threat to life and property to anyone living near the ocean. From 1950 to 2007, 478 tsunamis were recorded globally. Fifty-one of these events caused fatalities, to a total of over 308,000 coastal residents. The overwhelming majority of these events occurred in the Pacific basin. Recent tsunamis have struck Nicaragua, Indonesia, Thailand, and Japan, killing several hundred thousand people. Property damage due to these waves was nearly $1 billion. 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.

The Cascadia subduction zone will produce the state’s largest tsunami. The Cascadia subduction zone is similar to the Alaska-Aleutian trench that generated the Magnitude-9.2 1964 Alaska earthquake and the Sunda trench in Indonesia that produced the Magnitude-9.3 December 2004 Sumatra earthquake. Native American accounts of past Cascadia earthquakes suggest tsunami wave heights on the order of 60 feet, comparable to water levels in Aceh Province Indonesia during the December 2004 tsunami there. The Cascadia subduction zone last ruptured on January 26, 1700, creating a tsunami that left markers in the geologic record from Humboldt County, California, to Vancouver Island in Canada and is noted in written records in Japan. Water heights in Japan produced by the 1700 Cascadia earthquake were over 15 feet, comparable to tsunami heights on the African coast after the Sumatra earthquake. At least seven ruptures of the Cascadia subduction zone have been observed in the geologic record.

12.2.4 Frequency

Generally four or five tsunamis occur every year in the Pacific Basin, and those that are most damaging are generated off South America rather than in the northern Pacific. Pacific-wide tsunamis are rare, occurring every 10 to 12 years on average. Most of these tsunamis are generated by earthquakes that cause displacement of the seafloor, but a tsunami can also be generated by volcanic eruptions, landslides, underwater explosions, and meteorite impacts (Nelson, undated). The frequency of tsunamis is related to the frequency of the events that cause them.

12.3 VULNERABILITY ASSESSMENT

12.3.1 Overview

Aside from the tremendous hydraulic force of the tsunami waves themselves, floating debris carried by a tsunami can endanger human lives and batter inland structures. Ships moored at piers and in harbors often are swamped and sunk or are left battered and stranded high on the shore. Breakwaters and piers collapse, sometimes because of scouring actions that sweep away their foundation material and sometimes because of the sheer impact of the waves. Railroad yards and oil tanks situated near the waterfront are particularly vulnerable. Oil fires frequently result and are spread by the waves.

Methodology

The Level 2 Hazus-MH flood protocol was used to assess the risk and vulnerability to the tsunami inundation area. A user-defined facility model was developed, incorporating a depth grid developed in GIS, which has a level of accuracy acceptable for planning purposes. Where possible, the Hazus-MH default data was enhanced using local GIS data from the County, state and federal sources, as well as a comprehensive data management system update for critical facilities.

Warning Time

Typical signs of a tsunami hazard are earthquakes and/or sudden and unexpected rise or fall in coastal water. The large waves are often preceded by coastal flooding and followed by a quick recession of the water. Tsunamis are difficult to detect in the open ocean, with waves less than 3 feet high. The tsunami's size and speed, as well as the coastal area's form and depth, affect the impact of a tsunami. In general, scientists believe it requires an earthquake of at least a magnitude 7 to produce a tsunami. Figure 12-6 shows typical time for a tsunami to travel across the Pacific Ocean, based on the 1964 Alaska and 1960 Chile earthquakes and resulting tsunamis.

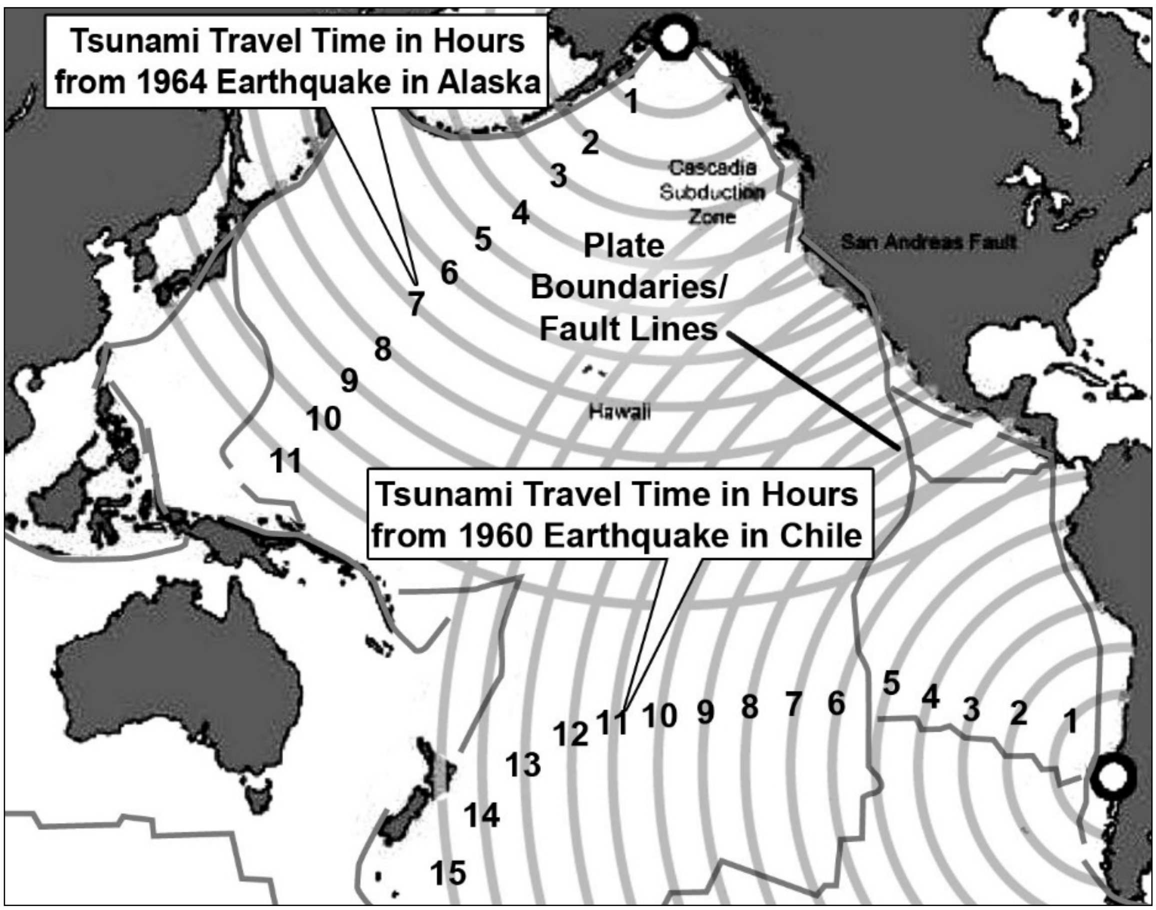


Figure 12-6. Tsunami Travel Times in the Pacific Ocean

Based on the 2005 WDNR report, a Tsunami based on a Cascadia Subduction Zone M9 earthquake would begin arriving in the planning area within 2-2.5 hours after occurrence (WDNR, 2005). The greatest flooding is expected to occur at Swanton Marsh on Whidbey Island, and on the southern shores of Padilla Bay. Other locations are expected only in the immediate vicinity of the shoreline, where evacuation to higher ground would be more easily achieved.

Deep-Ocean Assessment and Reporting of Tsunamis

NOAA's Deep-ocean Assessment and Reporting of Tsunamis system (see Figure 12-7) collects data that is relayed to the Pacific Tsunami Warning Center. These units generate computer models that predict tsunami arrival, usually within minutes of the arrival time. This information is relayed in real time. This system is not considered to be as effective for communities close to the tsunami because the first wave would arrive before the data were processed and analyzed. In this case, strong ground shaking would provide the first warning of a potential tsunami.

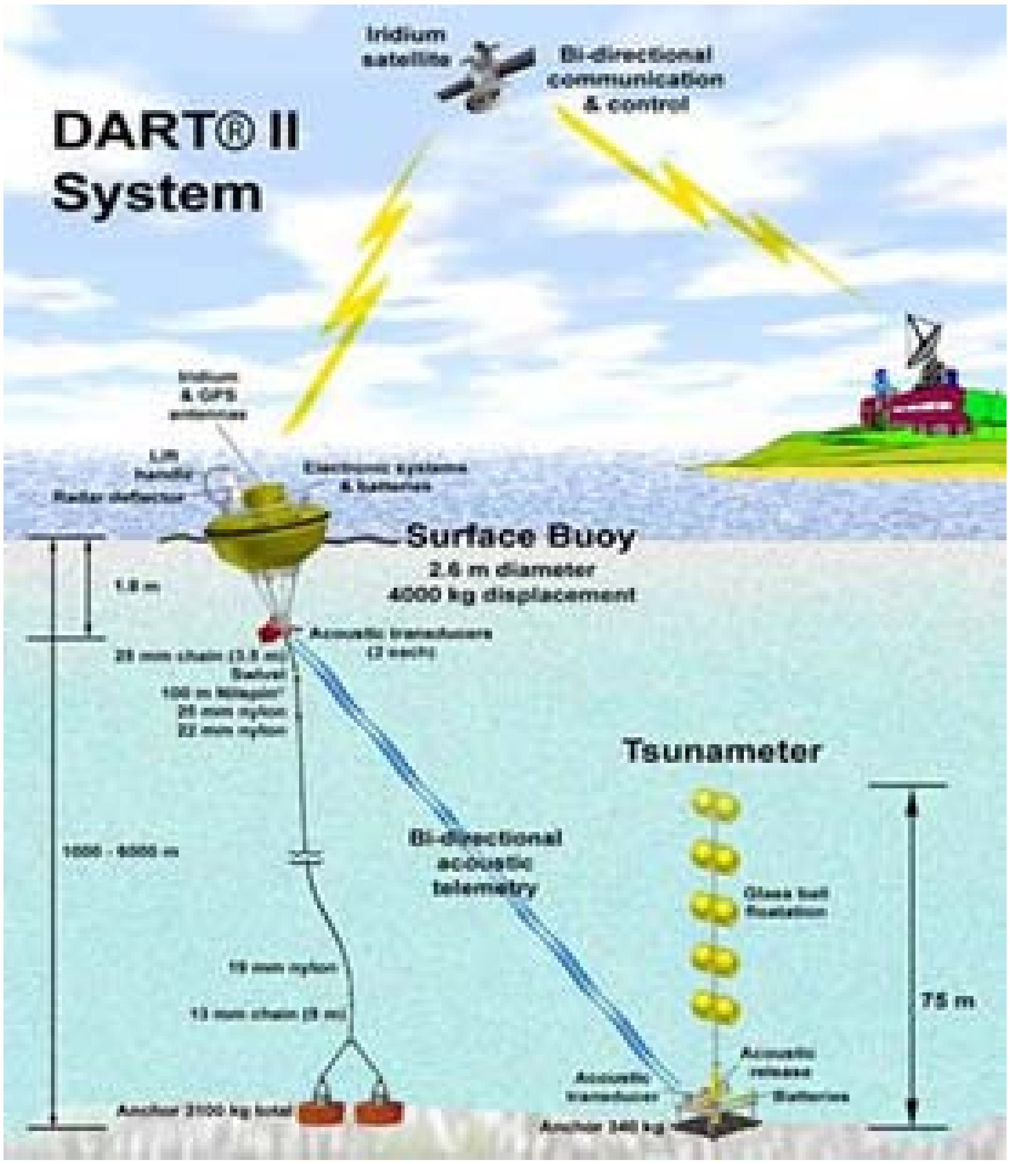


Figure 12-7. Deep-Ocean Assessment and Reporting of Tsunamis System

All-Hazard Alert Broadcasting Network

All-Hazard Alert Broadcast sirens have been installed along much of the Washington coast to provide warnings of tsunamis to outdoor populations (see Figure 12-8). The system provides rapid alert to citizens and visitors who are in the hazard zone, giving advanced warning for evacuation.

Figure 12-8. Washington All-Hazard Alert Broadcasting Network

Pacific Tsunami Warning System

The Pacific Tsunami Warning System evolved from a program initiated in 1946. It is a cooperative effort involving 26 countries along with numerous seismic stations, water level stations and information distribution centers. The National Weather Service operates two regional information distribution centers. One is located in Ewa Beach, Hawaii, and the other is in Palmer, Alaska. The Ewa Beach center also serves as an administrative hub for the system. When a Pacific basin earthquake of magnitude 6.5 or greater occurs, the following sequence of actions begins:

- Data is interpolated to determine epicenter and magnitude of the event.

- If the event is magnitude 7.5 or greater and located at sea, a TSUNAMI WATCH is issued.
- Participating tide stations in the earthquake area are requested to monitor their gages. If unusual tide levels are noted, the tsunami watch is upgraded to a TSUNAMI WARNING.
- Tsunami travel times are calculated, and the warning is transmitted to the disseminating agencies and thus relayed to the public.
- The Ewa Beach center will cancel the watch or warning if reports from the stations indicate that no tsunami was generated or that the tsunami was inconsequential.

12.3.2 Impact on Life, Health and Safety

The population living in tsunami hazard zones was generated by analyzing the County's total population and total households that intersect the inundation zone. The populations most vulnerable to the tsunami hazard are the elderly, disabled and very young who reside near beaches, low-lying coastal areas, tidal flats and river deltas that empty into ocean-going waters. In the event of a local tsunami generated in or near the planning area, there would be limited warning time, so more of the population would be vulnerable.

The degree of vulnerability of the population exposed to the tsunami hazard event is based on a number of factors:

- Is there a warning system?
- What is the lead time of the warning?
- What is the method of warning dissemination?
- Will the people evacuate when warned?

The exposed population was estimated by multiplying the average household size for the planning area (~2 persons per household) by the number of exposed residential buildings. Using this approach, it was estimated that 550 people, or 275 households, are exposed to the tsunami hazard zone (1.5 percent of the County's total population) as identified in Table 12-1.

TABLE 12-1.
POPULATION AND EXPOSURE IN TSUNAMI INUNDATION AREA

	Residential Building Count	Population Exposed (based on factor of 2 per person/household	Percent of Total Population in Planning Area
Unincorporated	275	550	2%
Coupeville	0	0	0%
Langley	0	0	0%
Oak Harbor	0	0	0%
Total	**275**	**550**	**1.5%**

Based on the 2005 WDNR report, a Tsunami based on a Cascadia Subduction Zone M9 earthquake would begin arriving in the planning area within 2-2.5 hours after occurrence, with the greatest flooding expected to occur at Swanton Marsh on Whidbey Island, and on the southern shores of Padilla Bay. Other locations are expected only in the immediate vicinity of the shoreline, where evacuation to higher ground would be more easily achieved.

12.3.3 Impact on Property

All structures along beaches, low-lying coastal areas, tidal flats and river deltas would be vulnerable to a tsunami, especially in an event with little or no warning time. The impact of the waves and the scouring associated with debris that may be carried in the water could be damaging to structures in the tsunami's path. Those that would be most vulnerable are those located in the front line of tsunami impact and those that are structurally unsound.

Table 12-2 summarizes the area (in acres) lying within the planning partners' boundaries, the amount of area within Tsunami Inundation Zone for each planning partner and the percent of area within the tsunami hazard zone.

**TABLE 12-2.
PERCENT OF LAND AREA IN TSUNAMI INUNDATION ZONE**

	Total Area (acres)	Area in Tsunami Zone (acres)	% of Total Planning Area
Unincorporated Island County	126,718	1,039	0.8
Coupeville	816	0	0
Langley	668	0	0
Oak Harbor	6,180	92	1.5
Total	**134,384**	**1,131**	**0.8**

The value of exposed buildings in the tsunami hazard zone within the planning area was generated using Hazus-MH at the user-defined level and is summarized in Table 12-3. The estimates include the value of both the buildings and their contents. This methodology estimates that that there are 291 structures exposed to the tsunami hazard within the planning area, with an assessed value of $59.4 billion.

**TABLE 12-3
ESTIMATED DOLLAR VALUE OF STRUCTURES EXPOSED TO TSUNAMI**

	Structures Impacted[a]	Assessed Value			% of AV
		Structure	Contents	Total	
Unincorporated Island County	290	$38,614,950	$20,131,606	$58,746,556	0.78
Coupeville	0	$0	$0	$0	0
Langley	0	$0	$0	$0	0
Oak Harbor	1	$275,000	$412,500	$687,500	0.02
Total	**291**	**$38,889,950**	**$20,544,106**	**$59,434,056**	**0.52**

a. Impacted structures are those structures expected to receive measureable damage from the scenario tsunami event because they have lowest floor elevations below the projected tsunami inundation height.

Hazus-MH calculates losses to structures from tsunami by looking at depth of flooding and type of structure and estimates the percentage of damage to structures and their contents by applying established coastal flood damage functions to an inventory. For this analysis, Island County building and assessor data was used in place of the default inventory data provided with Hazus-MH. The results are summarized in Table 12-4. It is estimated that there would be up to $1.29 million of loss in the planning area. This represents 2.2 percent of the total exposure to the Tsunami inundation area and 0.01 percent of the total assessed value for the county.

TABLE 12-4
LOSS ESTIMATES FOR TSUNAMI SCENARIO

	Estimated Loss Associated with Tsunami			% of Total Assessed Value
	Structure	Contents	Total	
Unincorporated County	$862,329.68	$436,029.40	$1,298,359.07	0.02%
Coupeville	$0	$0	$0	0.00%
Langley	$0	$0	$0	0.00%
Oak Harbor	$0	$0	$0	0.00%
Total	**$862,329.68**	**$436,029.40**	**$1,298,359.07**	**0.01%**

12.3.4 Impact on Critical Facilities and Infrastructure

Roads or railroads that are blocked or damaged can prevent access and can isolate residents and emergency service providers needing to get to vulnerable populations or to make repairs. Bridges washed out or blocked by tsunami inundation or debris from flood flows also can cause isolation. Water and sewer systems can be flooded or backed up, causing further health problems. Underground utilities can also be damaged during flood events. Table 12-5 provides an estimate of the number and types of critical facilities exposed to the tsunami hazard.

TABLE 12-5.
CRITICAL FACILITIES EXPOSED TO TSUNAMI HAZARD

Facility Type Identified	Number Identified
Medical and Health Services	0
Government Function	0
Protective Function	0
Schools	0
Hazmat	0
Transportation	3
Water	0
Waste Water	0
Communications	0
Other Critical Function	2
Total	**5**

Roads

Roads are the primary resource for evacuation to higher ground before and during a tsunami event. For low depth, low velocity flood events, roads can act as levees or berms and divert or contain flood flows. Highway 20 and 525 may be impacted by tsunami events, due to its proximity to the coastline along the entire length of the County. Likewise, the Deception Pass Bridge may also be impacted. These factors are of significant concern for evacuation purposes in certain areas, as these are the only major thoroughfares.

Docks

Docks exposed to tsunami events can be extremely vulnerable due to forces transmitted by the wave run-up and by the impact of debris carried by the wave action. Many docks are old and unstable, with rotting pilings. During an earthquake, there is a high probability that such structures could collapse or be severely weakened. Any ensuing tsunami would collapse the dock through the force of the water. The debris from the collapsed dock would then be pushed ashore, potentially injuring individuals and damaging structures and facilities. Two Port Districts operate within the planning region, which maintain docks and supporting infrastructure – the Port of Coupeville and the Port of South Whidbey.

Water/Sewer/Utilities

Water and sewer systems can be affected by the flooding associated with tsunami events. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can be backed up, causing wastes to spill into homes, neighborhoods, rivers and streams. The forces of tsunami waves can impact above-ground utilities by knocking down power lines and radio/cellular communication towers. Power generation facilities can be severely impacted by both the impact of the wave action and the inundation of floodwaters.

Using damage function curves to estimate the percent of damage to critical buildings and their contents, Hazus-MH correlates these estimates to estimated functional downtime. Functional downtime is the time it will take to restore a facility to 100 percent of its functionality.

Utilizing critical infrastructure established by the planning partners for the 2015 update, Hazus analysis utilizing the Cascadia Scenario established by USGS and WDNR estimated that the identified critical facilities would receive no damage during the Cascadia scenario tsunami incident, resulting in no functional downtime.

12.3.5 Impact on Economy

Port facilities, naval facilities, fishing fleets and public utilities are often the backbone of the economy of the affected areas, and these are the resources that generally receive the most severe damage. Until debris can be cleared, wharves and piers rebuilt, utilities restored, and fishing fleets reconstituted, communities may find themselves without fuel, food and employment. Wherever water transport is a vital means of supply, disruption of coastal systems caused by tsunamis can have far-reaching economic effects.

The inundation zone for the planning region is quite significant, and would have a devastating impact on the planning region’s economy. Loss of tax base, destruction of government facilities, destruction of private businesses, loss of land-base, loss of marine vessels for the fishing industry, among other items, all would be significant impacts to overcome to allow the economy to sustain itself. In addition to the County impact, all of Washington would be impacted as a result of the loss of connectivity with Canada to Washington, as well as the impact on major highways, the ferry system and the travel time associated with loss of the transportation infrastructure.

12.3.6 Impact on Environment

The vulnerability of aquatic habit and associated ecosystems would be highest in low-lying areas close to the coastline. Areas near gas stations, industrial areas and Tier II facilities would be vulnerable due to potential contamination from hazardous materials. In addition, aquatic species attached to debris from the Japan tsunami were brought to the Washington Coastline. These invasive species represent a significant environmental impact.

Tsunami waves can carry destructive debris and pollutants that can have devastating impacts on all facets of the environment. Millions of dollars spent on habitat restoration and conservation in the planning area could be wiped out by one significant tsunami. There are currently no tools available to measure these impacts. However, it is conceivable that the potential financial impact of a tsunami event on the environment could equal or exceed the impact on property. Community planners and emergency managers should take this into account when preparing for the tsunami hazard.

12.4 FUTURE DEVELOPMENT TRENDS

With tsunami wave heights estimated to reach as high as ~16.5 feet in some portions of the County, standard floodplain development regulation may not provide adequate risk protection for new development. Once the data and science can be applied to official mapping with assigned probabilities of occurrence, the County may want to consider regulatory provisions for new development in high-risk tsunami inundation areas.

Of additional concern is the potential for bluff washout as a result of Tsunami waves. The planning area has a significant amount of bluffs and steep hillsides. While the direct impact may not be from the wave flooding a structure, the direct influence of the wave on the shoreline could cause additional landslide and erosion, causing structures to slide which otherwise would not be impacted by Tsunami waves.

12.5 CLIMATE CHANGE IMPACTS

The impacts of climate change on the frequency and severity of tsunami events could be significant, especially in regions with vulnerable coastlines. Global sea-level rise will affect all coastal societies, especially densely populated low-lying coastal areas. *The Scientific Basis* estimates a sea level rise of 0.3 to 2.9 feet from 1990 to 2100. Currently sea level is rising at a rate of about 0.1 inches per year. This rise has two effects on low-lying coastal regions: any structures located below the new level of the sea will be flooded; and the rise in sea level may lead to coastal erosion that can further threaten coastal structures. As a rule-of-thumb, a sandy shoreline retreats about 100 feet for every 1-foot rise in sea level.

12.6 ISSUES

The worst-case scenario for the planning area is a local tsunami event triggered by a seismic event off the coast (a Cascadia scenario). Island County residents can expect waves to reach its boundaries within 2-2.5 hours of a Cascadia Subduction Zone earthquake. This could result in loss of life and property and cause severe environmental impacts.

The planning team has identified the following issues related to the tsunami hazard for the planning area:

- To measure and evaluate the probable impacts of tsunamis, new hazard mapping needs to be created based on probabilistic scenarios likely to occur for the County. The science and technology in this field are emerging. For tsunami hazard mitigation programs to be effective, probabilistic tsunami mapping will need to be a key component, with updated occurring as new data emerges.

- Some limitations associated with assessor's data relating to building codes, guidelines and building records provides limited information with respect to the impacts of tsunamis on structures.
- As tsunami warning technologies evolve, the tsunami warning capability within the planning area will need to be enhanced to provide the highest degree of warning to planning partners with tsunami risk exposure. The County has already taken proactive measures with the installation of one All Hazards Alert Broadcast (AHAB) siren. It is attempting to acquire funding for additional sirens which will be strategically located to allow for advanced warning in areas of concern.
- With the possibility of climate change, the issue of sea level rise may become an important consideration as probable tsunami inundation areas are identified through future studies.
- Special attention will need to be focused on the vulnerable communities in the tsunami zone and on hazard mitigation through public education and outreach.

CHAPTER 13.
VOLCANO

The Cascade Range of Washington, Oregon and California has volcanoes close to Island County. The primary effect of the Cascade volcanic eruptions on Island County would be ash fall, with some disruption of service due to impact on Whatcom and Snohomish Counties from Mt. Baker and Glacier Peak.

The distribution of ash from a violent eruption is a function of wind direction and speed, atmospheric stability, and the duration of the eruption. As the prevailing wind in this region is generally from the west, ash is usually spread eastward from the volcano. Exceptions to this rule do, however, occur. Ash fall, because of its potential widespread distribution, suggests some limited volcanic hazards.

> **DEFINITIONS**
>
> **Ash**—Ash is a harsh acidic with a sulfuric odor, consisting of small bits of pulverized rock and glass, less than 2 millimeters (0.1 in) in diameter. Ash may also carry a high static charge for up to two days after being ejected from a volcano. When an ash cloud combines with rain, sulfur dioxide in the cloud combines with the rainwater to form diluted sulfuric acid that may cause minor, but painful burns to the skin, eyes, nose, and throat.
>
> **Lahar**—A rapidly flowing mixture of water and rock debris that originates from a volcano. While lahars are most commonly associated with eruptions, heavy rains, and debris accumulation, earthquakes may also trigger them.
>
> **Lava Flow—**The least hazardous threat posed by volcanoes. Cascades volcanoes are normally associated with slow moving andesite or dacite lava.
>
> **Stratovolcano—**Typically steep-sided, symmetrical cones of large dimension built of alternating layers of lava flows, volcanic ash, cinders, blocks, and bombs, rising as much as 8,000 feet above their bases. The volcanoes in the Cascade Range are all stratovolcanoes.
>
> **Tephra—**Ash and fragmented rock material ejected by a volcanic explosion
>
> **Volcano**—A vent in the planetary crust from which magma (molten or hot rock) and gas from the earth's core erupts.

13.1 GENERAL BACKGROUND

Hazards related to volcanic eruptions are distinguished by the different ways in which volcanic materials and other debris are emitted from the volcano (see Figure 13-1). The molten rock that erupts from a volcano (lava) forms a hill or mountain around the vent. The lava may flow out as a viscous liquid, or it may explode from the vent as solid or liquid particles. Ash and fragmented rock material can become airborne and travel far from the erupting volcano to affect distant areas.

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

Volcanic events often differ from other natural hazards because the duration of unrest and eruptive activity are generally longer. Although volcanic unrest prior to eruptions can be only hours, these short timescales most frequently occur at volcanoes that have erupted in the recent past (years to decades). At volcanoes like Mount Baker and Glacier Peak (those in closest proximity to Island County), which have not erupted for more than a century, their conduit systems which convey magma to the surface have solidified and will have to be fractured and reopened for the next magma batch to reach the surface. Thus, it is anticipated that several days to weeks of warning before an eruption, although hazardous events such as small steam and ash explosions and expulsion of water to form lahars may occur before an eruption begins.

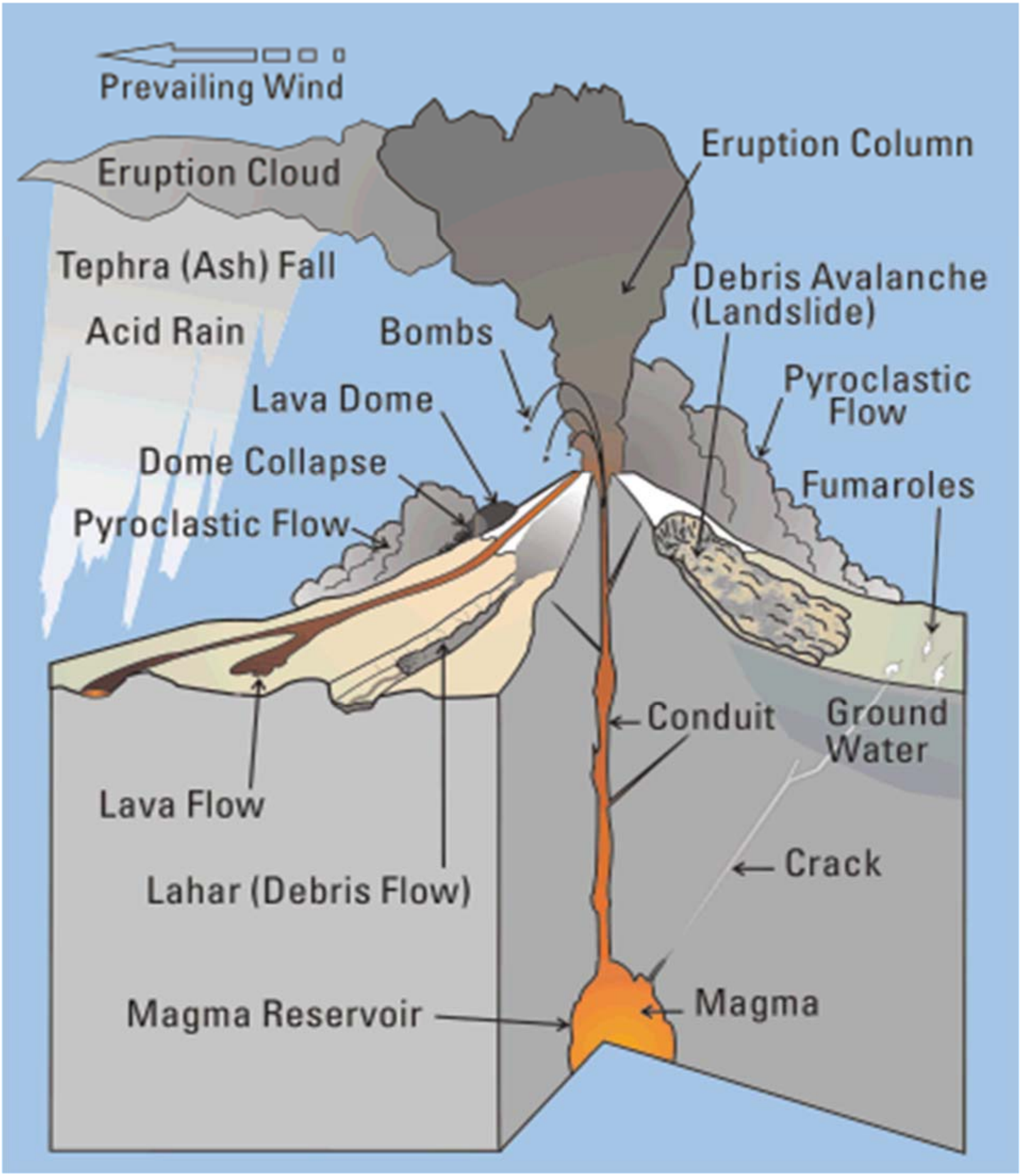


Figure 13-1. Volcano Hazard

The most recent eruption in Washington State, the eruption of Mt. St. Helens in 1980, is identified as a Plinian eruption, which are the most violent of types, including violent ejection of very large columns of ash, followed by a collapse of the central portion of the volcano. It should be noted that a volcano has the potential to exhibit various styles of eruption at different intervals, changing from one form or type to another as the eruption progresses.

13.2 HAZARD PROFILE

13.2.1 Extent and Location

The Cascade Range extends more than 1,000 miles from southern British Columbia into northern California and includes 13 potentially active volcanic peaks in the U.S. Figure 13-2 shows the location of the Cascade Range volcanoes, most of which have the potential to produce a significant eruption. The straight-line distance of the major volcanoes of potential impact on the planning region are as follows:

- Mount Baker—56 miles east/northeast Island County
- Glacier Peak— 72 miles east of Island County
- Mount Rainier—140 miles southeast of Island County

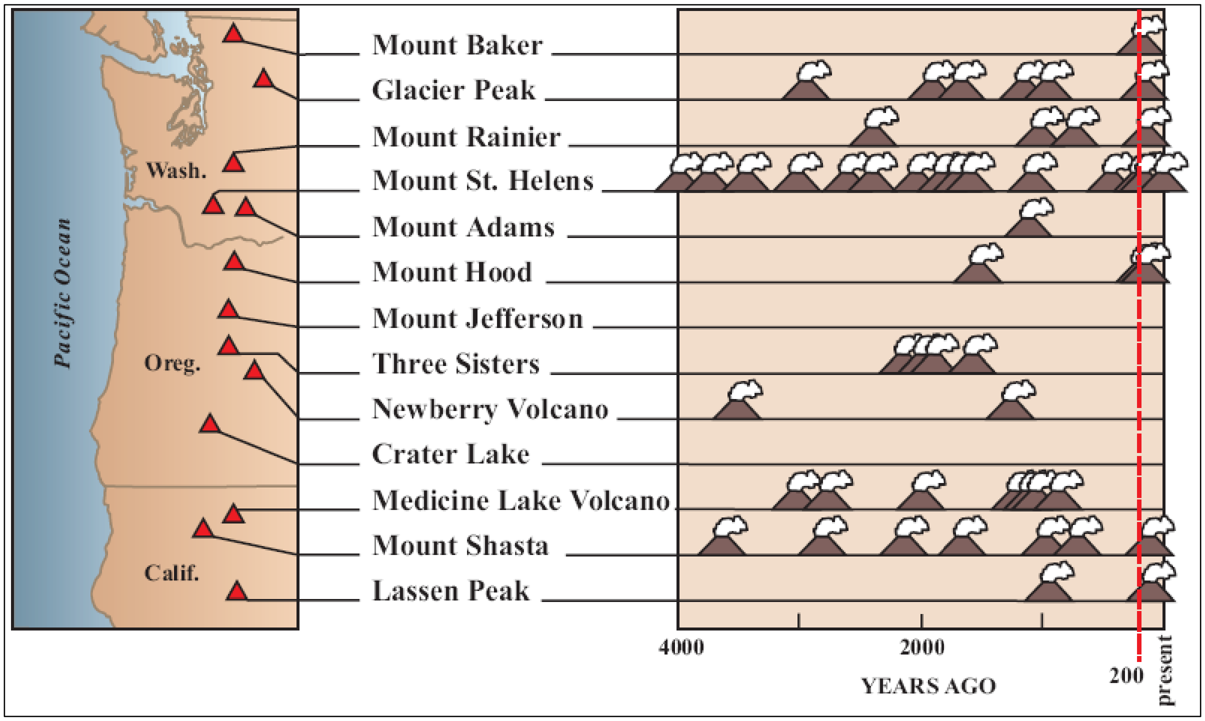


Figure 13-2. Past Eruptions of Cascade Volcanoes

Based on review, the volcanoes most likely to impact the planning area are Mount Baker and Glacier Peak. Mt. Baker is the youngest of the volcanic centers in the year, and one of the youngest volcanoes in the Cascade Range. Glacier Peak is the most remote of the five active volcanoes in Washington, not visibly prominent from any major population center. In previous times, it produced some of the largest and most explosive eruptions in the state.

13.2.2 Previous Occurrences

Figure 13-3 shows Glacier Peak from the west. Its eruption history is shown in Figure 13-4. Figure 13-5 depicts Mount Baker. Its eruption history is shown in Figure 13-6 and Table 13-1 summarize past eruptions in the Cascades. In the 1980 Mount St. Helens eruption, 23 square miles of volcanic material buried the North Fork of the Toutle River and there were 57 human fatalities.

Source: USGS files[7]

Figure 13-3. Glacier Peak, Seen from the West.

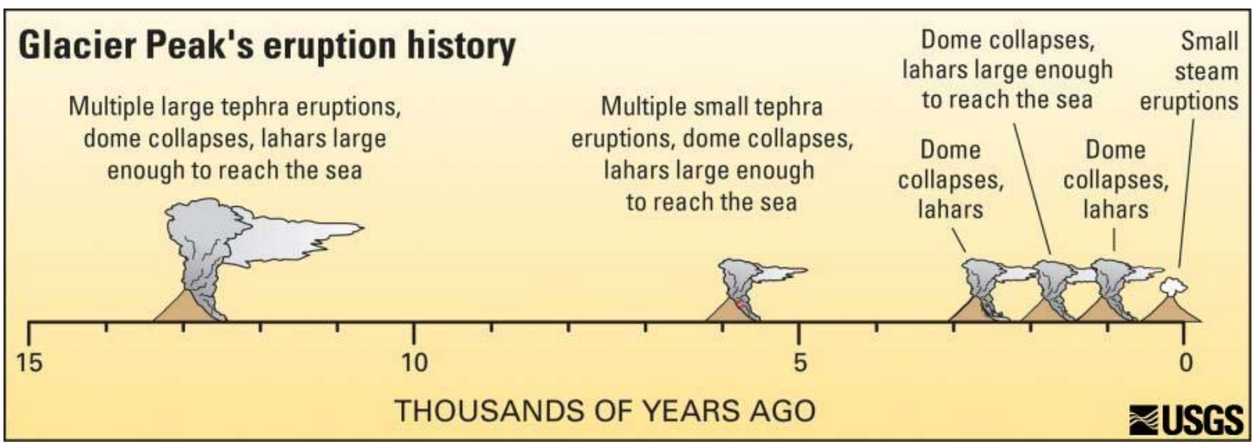


Figure 13-4. Glacier Peak Eruption History

[7] http://volcanoes.usgs.gov/volcanoes/glacier_peak/glacier_peak_gallery_39.html

Figure 13-5. A Crater Lake Formed on Mount Baker in 1976 Resulting from Increased Magma

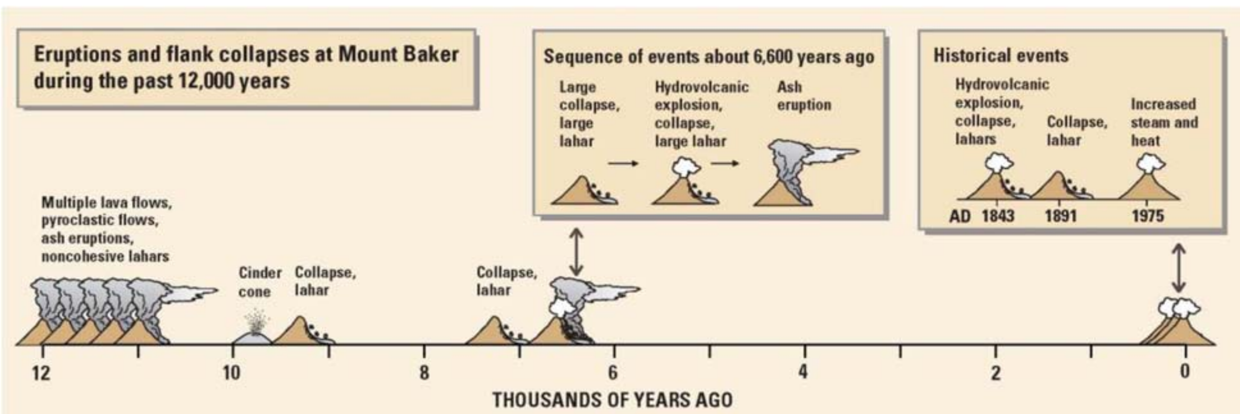


Figure 13-6. Mt. Baker Eruption History

**TABLE 13-1.
PAST ERUPTIONS IN WASHINGTON**

Volcano	Number of Eruptions	Type of Eruptions
Mount Adams	3 in the last 10,000 years, most recent between 1,000 and 2,000 years ago	Andesite lava
Mount Baker	5 eruptions in past 10,000 years; mudflows have been more common (8 in same time period)	Pyroclastic flows, mudflows, ash fall in 1843.
Glacier Peak	8 eruptions in last 13,000 years	Pyroclastic flows and lahars
Mount Rainier	14 eruptions in last 9000 years; also 4 large mudflows	Pyroclastic flows and lahars
Mount St Helens	19 eruptions in last 13,000 years	Pyroclastic flows, mudflows, lava, and ash fall

13.2.3 Severity

Eruption durations are quite variable, ranging from hours to decades. At present, when an eruption begins scientists cannot foretell when it will end or whether the activity will be intermittent or continuous. Worldwide, the average eruption duration is about two months, although the most recent eruptions in the Cascades have been of greater duration (Mount St. Helens, Washington: intermittent activity from 1980 to 1986 and continuous activity from late 2004 to early 2008; Lassen Peak, California: intermittent activity from 1914 to 1917).

The explosive disintegration of Mount St. Helens' north flank in 1980 vividly demonstrated the power that Cascade volcanoes can unleash. The thickness of tephra sufficient to collapse buildings depends on construction practices and on weight of the tephra (tephra is much heavier wet than dry). Past experience in several countries shows that tephra accumulation near 10 cm is a threshold above which collapses tend to escalate. A 1-inch deep layer of ash weighs an average of 10 pounds per square foot, causing danger of structural collapse.

Ash is harsh, acidic and gritty, and it has a sulfuric odor. Ash may also carry a high static charge for up to two days after being ejected from a volcano. When an ash cloud combines with rain, sulfur dioxide in the cloud combines with the rainwater to form diluted sulfuric acid that may cause minor, but painful burns to the skin, eyes, nose, and throat. Westerly winds dominate in the Pacific Northwest sending volcanic ash east and north–eastward about 80–percent of the time, though ash can blow in any direction.

Figure 13-7 shows probabilities of tephra accumulation from Cascade volcanoes in the Pacific Northwest (tephra is fragmented rock material ejected by a volcanic explosion). Wind in western Washington blows to the west, northwest and southwest only 10 percent of the time, so tephra from eruptions of Mt. Baker and Glacier Peak is far more likely on the east side of the volcano. Still, even a relatively small amount of ash in Island County could have a significant impact with respect to fish and other natural wildlife, as well as the forest and plant life. Figure 13-8 shows areas of the U.S. that have been covered by volcanic ash. Figure 13-9 and Figure 13-10 identify the volcano hazard zones from Mount Baker and Glacier Peak, respectively, as identified by the USGS.

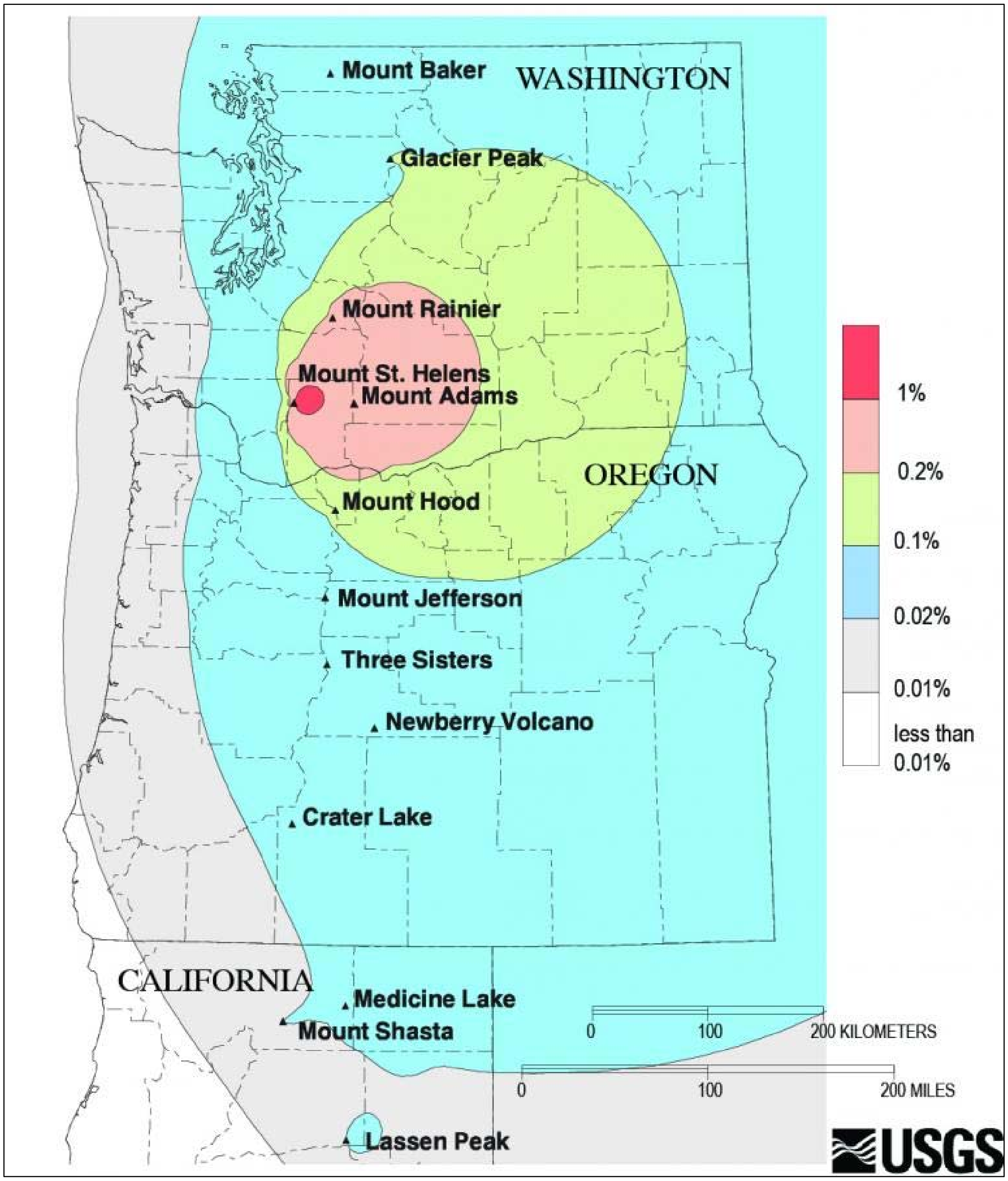


Figure 13-7. Probability of Tephra Accumulation in Pacific Northwest

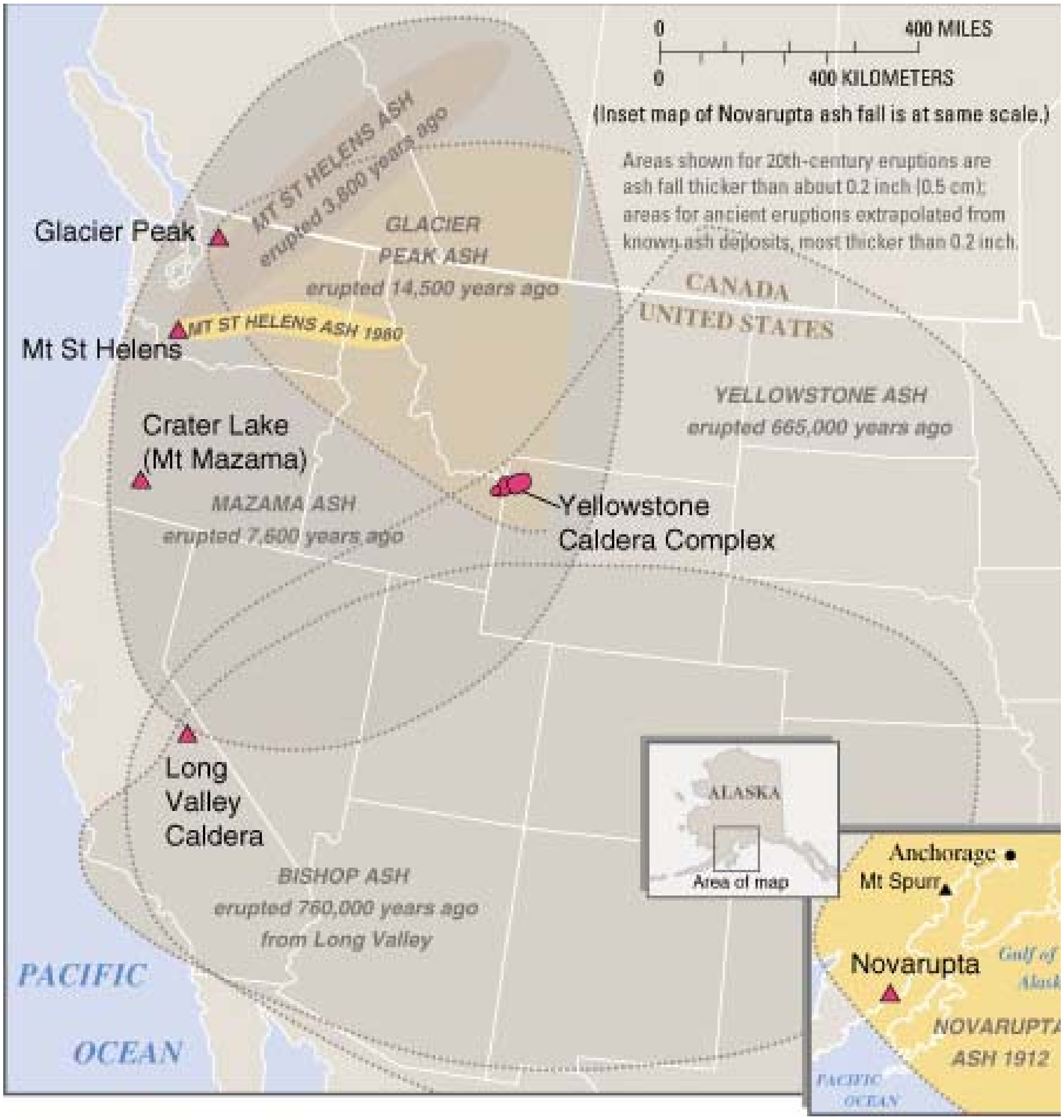


Figure 13-8. Defined Tephra Layers Associated with Historical Eruptions

Source: USGS. http://volcanoes.usgs.gov/vsc/multimedia/cvo_hazards_maps_gallery.html

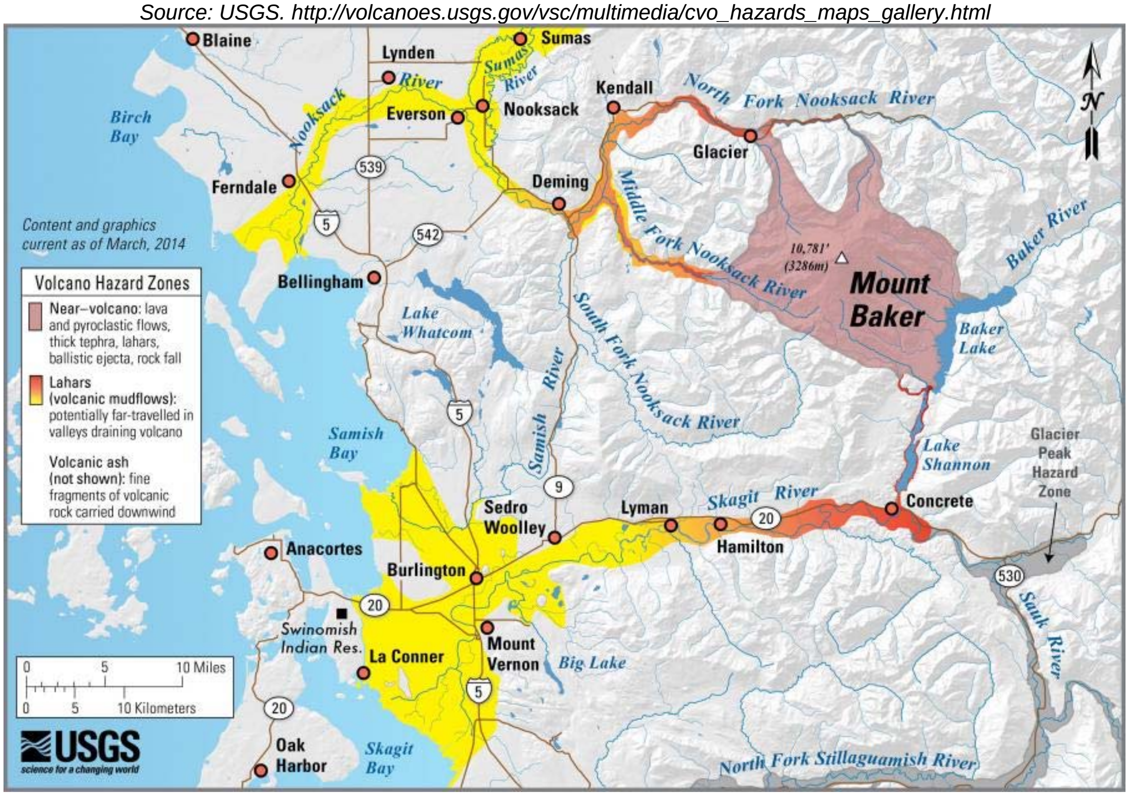


Figure 13-9. Volcano Hazard Zones From Mount Baker

Source: USGS. http://volcanoes.usgs.gov/vsc/multimedia/cvo_hazards_maps_gallery.html

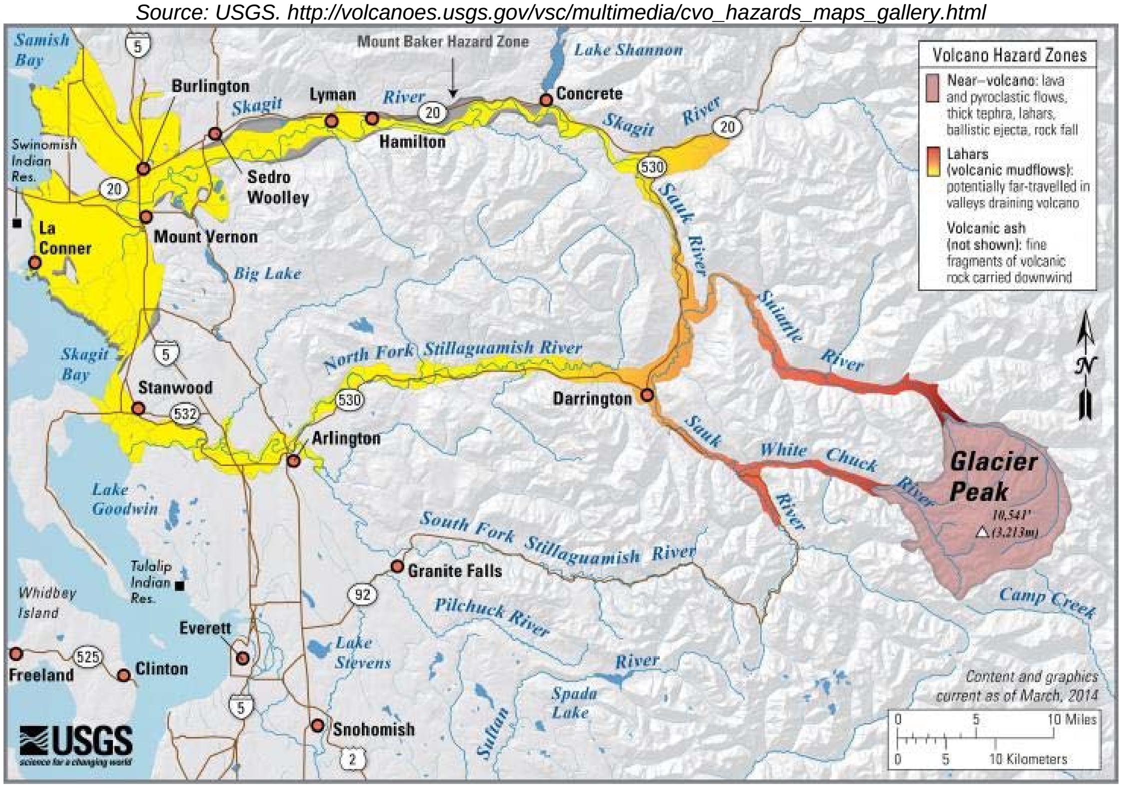


Figure 13-10. Volcano Hazard Zones from Glacier Peak

13.2.4 Frequency

Many Cascade volcanoes have erupted in the recent past and will be active again in the foreseeable future. Given an average rate of one or two eruptions per century during the past 12,000 years, these disasters are not part of everyday experience; however, in the past hundred years, California's Lassen Peak and Washington's Mount St. Helens have erupted with terrifying results. The U.S. Geological Survey classifies Glacier Peak, Mt. Adams, Mt. Baker, Mt. Hood, Mt. St. Helens, and Mt. Rainier as potentially active volcanoes in Washington State. Mt. St. Helens is by far the most active volcano in the Cascades, with four major explosive eruptions in the last 515 years. There is a one (1) in 500 probability that portions of two counties in the state will receive four (4) inches or more of volcanic ash from any Cascade volcano in any given year. The probability increases to one (1) in 1,000 that parts, or all, of three or more counties will receive same quantity. There is a one (1) in 100 annual probability that small lahars or debris flows will impact river valleys below Mount Baker and Mount Rainier, with a less than 1:1,000 annual probability that the largest destructive lahars would flow down Glacier Peak, Mount Adams, Mount Baker or Mount Rainier. Island County has a 0.02 to 0.01 percent probability of ash or tephra collection in any given year.

13.3 VULNERABILITY ASSESSMENT

13.3.1 Overview

No significant issues were reported in the planning region as a result of Mt. Saint Helen's eruption. The closest Cascade volcanoes to the planning area are Mt. Baker and Glacier Peak. A lahar is not of primary concern for those two volcanoes within the region as identified in Figures 05 and 0-6, but secondary impacts from ash and commodity flow could cause low to moderate issues.

According to the USGS analysis, westerly winds dominate in the Pacific Northwest sending volcanic ash east and north–eastward about 80–percent of the time, though ash can blow in any direction. However, even 10 percent of ash reaching the Island County or any of its coastlines could have a negative impact on the natural resources and the agricultural economy. The potential for fire danger also increases as a result of static charge contained within the ash.

Ash and chemical products in the Skagit River could contaminate a main water supply to Oak Harbor and Whidbey Island Naval Air Station. Transportation for ferries and vehicles traveling into the area could carry additional ash into the region, washing off during rains and contaminating the ground and water bodies, or potentially being impacted by ash with respect to visibility, and mechanically if large amounts of ash accumulate in engines' air intake systems. In addition, transportation interruptions as a consequence of eruption and impact on surrounding counties could cause moderate impact on the Island County region, as commodity flows would decrease, as well as interruptions to power transmission, telecommunications outages, and potentially medical services.

Methodology

As the planning area would have no direct impact from a lahar generated by any of the volcanos of potential concern, no dollar losses can be associated with that aspect of the hazard. No historical data was available specifically for Island County with respect to impact and losses associated with the eruption of Mount St. Helens on which an assessment could be based. In addition, there are currently no generally accepted damage functions for volcanic hazards in risk assessment platforms such as Hazus-MH or any GIS system for the ash fall associated with the hazard. There would also be too many variables to associate with any type of plume modeling for ash. Therefore, for planning purposes, it is assumed that the entire planning area is exposed to some extent to ash accumulations, and those structures could collapse under excessive weight of tephra and rainfall. Certain areas are more exposed due to geographic location and local weather patterns, as well as the response capabilities of local first responders.

Warning Time

Constant monitoring by the USGS and the Pacific Northwest Seismograph Network (PNSN) at the University of Washington of all active volcanoes means that there will be more than adequate warning time before an event. Newly standardized Alert Levels issued by USGS volcano observatories are based on a volcano's level of activity. These levels are intended to inform people on the ground and are issued in conjunction with the Aviation Color Code. The highest two alert levels (Watch and Warning) are National Weather Service terms for notification of hazardous meteorological events, terms already familiar to emergency managers that are becoming increasingly more familiar to the public.

The U.S. Geological Survey (USGS) volcanic alert-level system provides the framework for the preparedness activities of local jurisdictions, tribal governments and state and federal agencies. The USGS ranks the level of activity at a U.S. volcano using the terms "Normal", for typical volcanic activity in a non-eruptive phase; "Advisory", for elevated unrest; "Watch", for escalating unrest or a minor eruption underway that poses limited hazards; and, "Warning", if a highly hazardous eruption is underway or imminent. These levels reflect conditions at a volcano and the expected or ongoing hazardous volcanic phenomena. When an alert level is assigned by an observatory, accompanying text will give a fuller explanation of the observed phenomena and clarify hazard implications to affected groups[8]. The USGS Cascade Volcano Observatory works in conjunction with PNSN to provide constant monitoring and notification when activities increase. Figure 13-11 depicts one of the sensors used by USGS and PNSN for monitoring purposes. Figure 13-12 identifies the various types of remote sensing devises available.

Since 1980, Mount St. Helens has settled into a pattern of intermittent, moderate and generally non-explosive activity, and the severity of tephra, explosions, and lava flows have diminished. All episodes, except for one very small event in 1984, have been successfully predicted several days to three weeks in advance. However, scientists remain uncertain as to whether the volcano's current cycle of explosivity ended with the 1980 explosion. The possibility of further large-scale events continues for the foreseeable future.

13.3.2 Impact on Life, Health and Safety

The entire population of the planning area, as well as any tourists traveling through to the various tourist attractions could be exposed to ash and its side effects. When an ash cloud combines with rain, sulfur dioxide in the cloud combines with the rainwater to form diluted sulfuric acid that may cause minor, but painful burns to the skin, eyes, nose, and throat. Given the high amount of annual rainfall and the constant mist from the ocean waves, this increases the potential impact on the population. The elderly, very young and those who experience ear, nose and throat problems are especially vulnerable to the tephra hazard, as well as the ash itself causing respiratory issues. In addition, individuals traveling the ferry system would also be impacted, as ferry runs would undoubtedly be cancelled, at least initially. Such instances would strand travelers, potentially increasing the number of people to which the region would have to provide emergency services, housing and associated support.

[8] Mt. Baker and Glacier Peak Coordination Plan (2012). Accessed October 29, 2014. Available on-line at: http://www.emd.wa.gov/plans/documents/PromulgatedVersionMtBakerGlacierPeakCoordinationPlanAugust2012-Expanded.pdf

Figure 13-11. Glacier Peak Monitoring Equipment

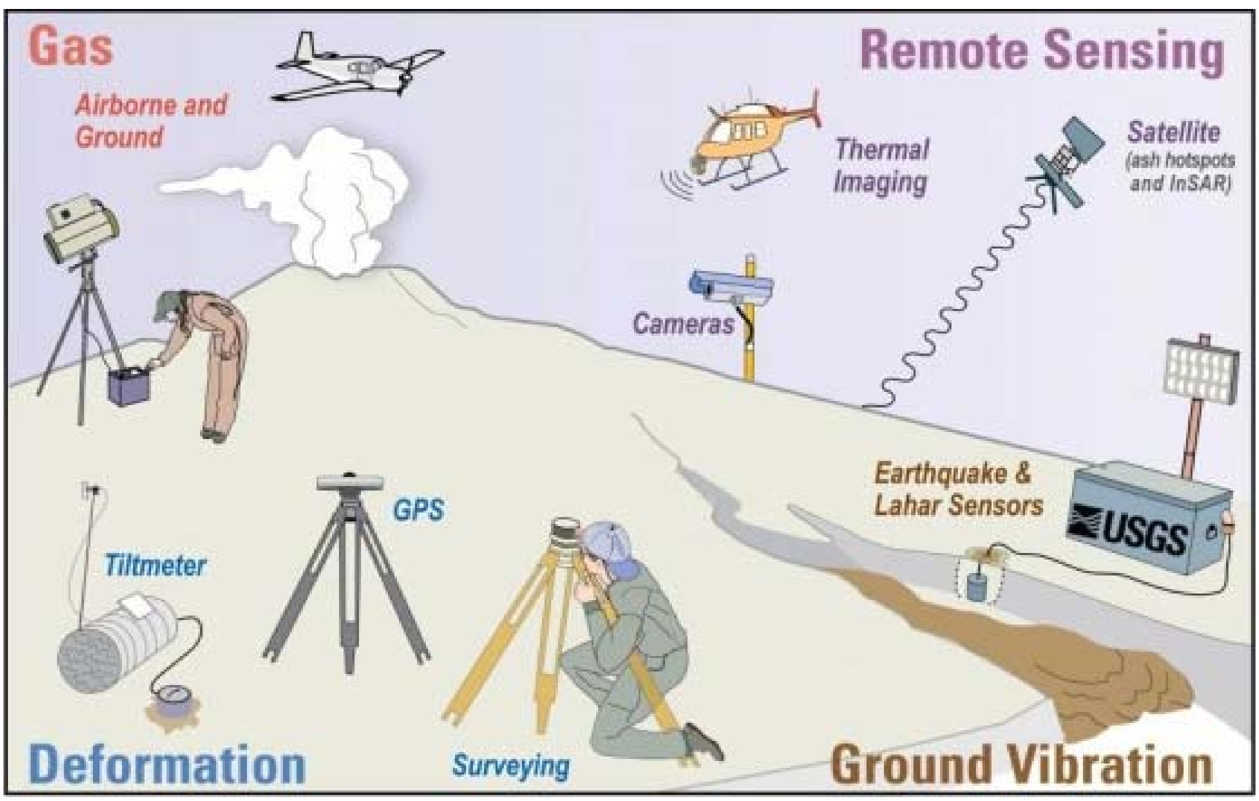


Figure 13-12. Remote Sensing Devices

13.3.3 Impact on Property

All of the planning area to some degree would be exposed to ash fall and tephra accumulation in the event of a volcanic eruption. The age of the current building stock does not lend itself to be able to withstand large amounts of accumulation of ash on rooftops, as a one-inch deep layer of ash weighs an average of 10 pounds per square foot. This added weight to the aged buildings would increase the danger of structural collapse. Additionally, ash is harsh, acidic and gritty, and may carry a high static charge for up to two days after being ejected from a volcano. This static charge has the potential for igniting forest fires in the densely forested areas.

As indicated, loss estimations for the volcano hazard could not be based on modeling utilizing damage functions, as no such functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of all structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 13-2 identifies the structural loss by count and assessed value (including content), at the identified percentages.

**TABLE 13-2.
POTENTIAL STRUCTURE IMPACT FROM ASH ACCUMULATION**

Jurisdiction	Building Count	Exposed Value	10% Damage	30% Damage	50% Damage
Unincorporated County	29,097	$7,513,788,923	$751,378,892	$2,254,136,677	$3,756,894,461
Coupeville	797	$244,853,785	$24,485,378	$73,456,135	$122,426,892
Langley	632	$177,293,192	$17,729,319	$53,187,958	$88,646,596
Oak Harbor	7,750	$3,455,539,922	$345,553,992	$1,036,661,977	$1,727,769,961
Total	**38,276**	**$11,391,475,821**	**$1,139,147,582**	**$3,417,442,746**	**$5,695,737,911**

13.3.4 Impact on Critical Facilities and Infrastructure

None of the critical facilities within the planning region would be exposed to lahar inundation, but all would be exposed to the weight of ash, and, because of the age of the building stock, may fail to withstand the weight of the ash. All transportation routes in the area would be exposed to ash fall and tephra accumulation, which could create hazardous driving conditions on roads and highways and hinder evacuations and response. Utilities, including water treatment plants and wastewater treatment plants are vulnerable to contamination from ash fall, as well as impact from the ash itself that could damage motors.

13.3.5 Impact on Economy

Economic impact could result from potential agricultural losses, the loss of tourism due to suspended ferry travel and visitors to the area, structural losses, including businesses and governmental offices/buildings. Lost tax revenues from businesses disrupted by structural damage or as a result of fewer patrons would impact the area’s economy. The tourism industry could also be impacted for a substantial amount of time if ash impacts the fishing industry.

13.3.6 Impact on Environment

The environment is highly exposed to the effects of a volcanic eruption. Even if the related ash fall from a volcanic eruption were to fall elsewhere, the watersheds, lakes, rivers and tributaries are vulnerable to damage due to ash fall since ash fall can be carried throughout the County by its rivers. A volcanic blast would expose the local environment to other effects, such as lower air quality, and many elements that could harm local vegetation and water quality, adversely impact wildlife and fish habitat. The sulfuric acid contained in volcanic ash could be very damaging to area vegetation, increasing the risk of wildfire danger, as well as wildlife.

13.4 FUTURE DEVELOPMENT TRENDS

Under the GMA, the County and its planning partners utilize the most recent building codes adopted by the State of Washington, which requires more stringent regulations with respect to support and payload structuring of facilities. Land use development has little influence as the area is not directly impacted by a Lehar zone. However, building codes with respect to load capacity does influence the ability to withstand impact. Island County and its planning partners have adopted current IBC standards, which address the load capacity.

13.5 CLIMATE CHANGE IMPACTS

Large-scale volcanic eruptions can reduce the amount of solar radiation reaching the Earth’s surface, lowering temperatures in the lower atmosphere and changing atmospheric circulation patterns. The massive outpouring of gases and ash can influence climate patterns for years. Sulfuric gases convert to sub-micron droplets containing about 75 percent sulfuric acid. These particles can linger three to four years in the stratosphere. Volcanic clouds absorb terrestrial radiation and scatter a significant amount of incoming solar radiation, an effect that can last from two to three years following a volcanic eruption.

13.6 ISSUES

In the event of a volcanic eruption, there would probably not be any direct loss of life in the planning area as a direct result of the eruption. However, there could be significant health issues related to ash fall and health concern (especially for the young, elderly and those with breathing issues). In addition, there is also the potential for the increased potential for motor vehicle accidents; and potential structural damage if large amounts of ash accumulate as a result of the weight of the ash on structures. The potential exists for impact on the agricultural community, which would have an economic impact on the planning region. There would also be the possibility of severe environmental impacts due to ash within area lakes and streams, with the water supply potentially impacted for Oak Harbor and the Naval Air Station if the Skagit River is contaminated with ash. A large area could be affected by this, and it is felt that the most severe impacts would be on the planning area’s environment and the water supply.

CHAPTER 14.
WILDFIRE

A wildfire is any uncontrolled fire occurring on undeveloped land that requires fire suppression. Wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use, and arson.

The wildfire season in Washington usually begins in early July and ends in late September; however, wildfires have occurred in every month of the year. Drought, snow pack, and local weather conditions can expand the length of the fire season.

People start most wildfires; major causes include arson, recreational fires that get out of control, smoker carelessness, debris burning, and children playing with fire. From 1992 to 2001, on average, people caused more than 500 wildfires each year on state-owned or protected lands; this compares to 135 fires caused by lightning strikes. Wildfires started by lightning burn more state-protected acreage than any other cause, an average of 10,866 acres annually; human caused fires burn an average of 4,404 state-protected acres each year. Fires during the early and late shoulders of the fire season usually are associated with human-caused fires; fires during the peak period of July, August and early September often are related to thunderstorms and lightning strikes.

14.1 GENERAL BACKGROUND

Wildland-Urban Interface Areas

The wildland urban-interface (WUI) is the area where development meets wildland areas. This can mean structures built in or near natural forests, or areas next to active timber and rangelands. The federal definition of a WUI community is an area where development densities are at least three residential, business, or public building structures per acre. For less developed areas, the wildland-intermix community has development densities of at least one structure per 40 acres. Review of the 2013 Washington State Enhanced Hazard Mitigation Plan does designate Island County as a WUI Community.

In 2001, Congress mandated the establishment of a Federal Register which identifies all urban wildland interface communities within the vicinity of Federal lands, including Indian trust and restricted lands that are at high-risk from wildfire. The list assimilated information provided from States and Tribes, and is intended to identify those communities considered at risk. Review of the Federal Registry does not list any communities within Island County at high-risk within the vicinity of Federal lands.

When identifying areas of fire concern, in addition to the Federal Register, the Washington Department of Natural Resources and its federal partners also determine communities at risk based on fire behavior potential, fire protection capability, and risk to social, cultural and community resources. These risk factors include areas with fire history, the type and density of vegetative fuels, extreme weather conditions, topography, number and density of structures and their distance from fuels, location of municipal watersheds, and likely loss of housing or business. The criteria for making these determinations are the same as those used in the National Fire Protection Association's *NFPA 299 Standard for Protection of Life and Property from Wildfire*. Based on these criteria, Island County is considered to be at high to moderate risk[9] (see Figure 14-1 and Figure 14-2). Camano Island is specifically referenced and indicated as a high-risk community in the State's 2013 Hazard Mitigation Plan.

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[9] http://mil.wa.gov/uploads/pdf/HAZ%20MIT%20PLAN/Wildland_Fire_Hazard_Profile.pdf

(WDNR 2012)

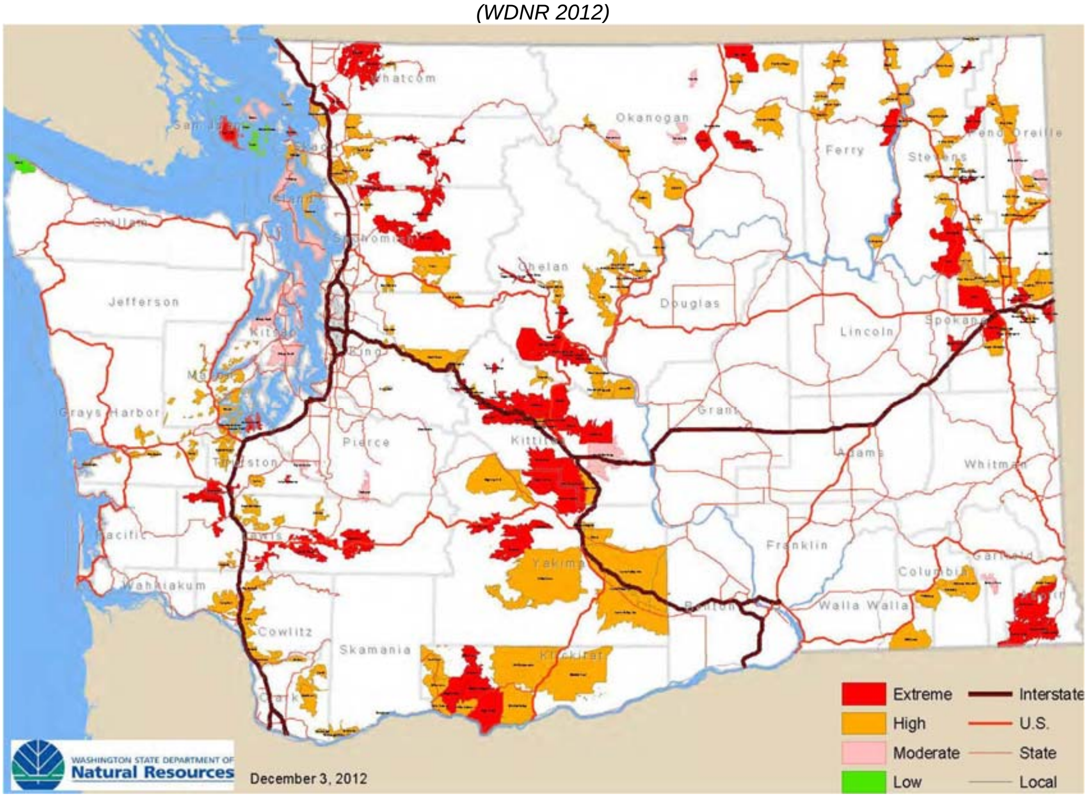

Figure 14-1. Level of Risk for Wildland Urban Interface Communities

(WDNR 2011)

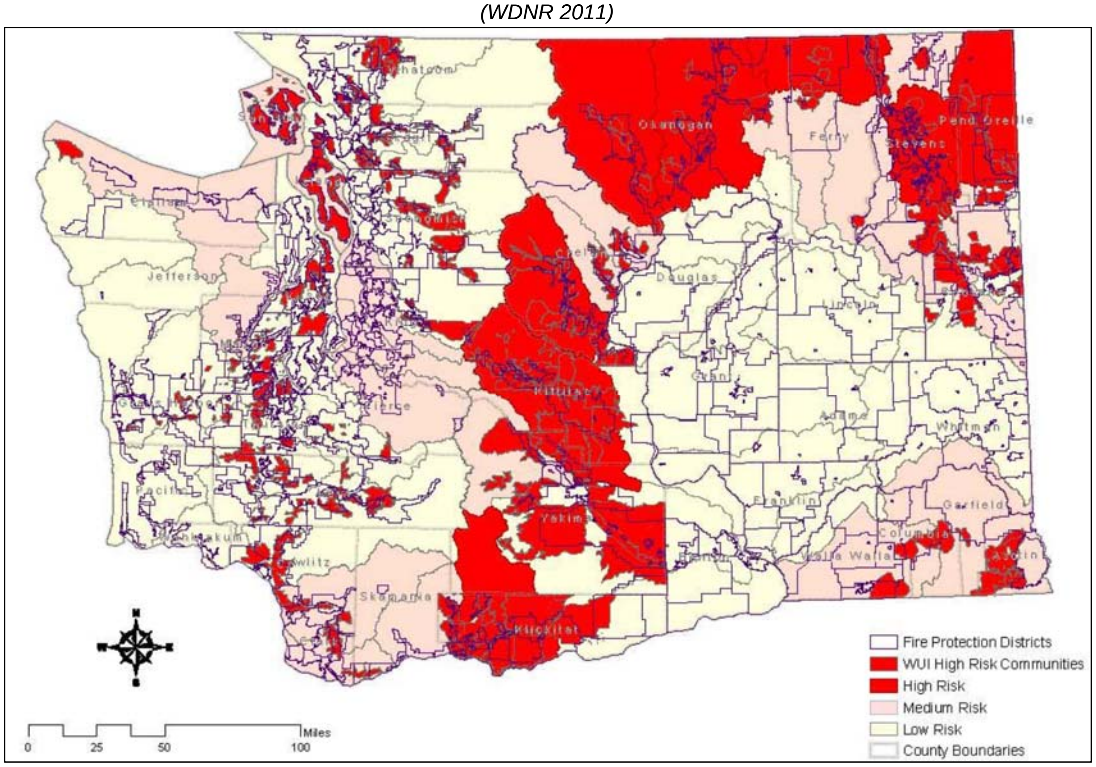

Figure 14-2. Washington WUI High Risk Communities, July 2011

The Planning Team for this 2015 update did not concur with WDNR's assessment of the level of risk, but rather felt it was of medium risk (comparatively to all risks). They based that determination on the fact that since 2003, the County has sustained a fairly low number of wildfires, 48, burning a total of 32.41 acres. Most of those fires occurred in 2003, during which season 13 fires burned, followed by eight fires in 2009, and six fires in 2012.

14.1.1 Wildfire Behavior

The wildfire triangle (see Figure 14-3; DeSisto et al., 2009) is a simple graphic used in wildland firefighter training courses to illustrate how the environment affects fire behavior. Each point of the triangle represents one of three main factors that drive wildfire behavior: weather, vegetation type (which firefighters refer to as "fuels"), and topography. The sides represent the interplay between the factors. For example, drier and warmer weather combined with dense fuel loads (e.g., logging slash) and steeper slopes will cause more hazardous fire behavior than light fuels (e.g., short grass fields) on flat ground.

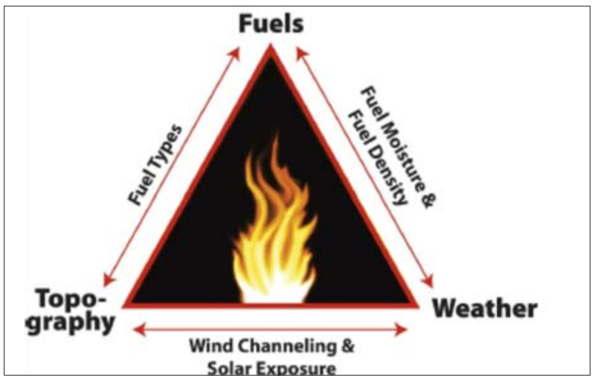

Figure 14-3. Wildfire Behavior Triangle

The following are key factors affecting wildfire behavior:

- **Fuel**—Lighter fuels such as grasses, leaves and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs and trunks take longer to warm and ignite. Snags and hazard trees—those that are diseased, dying, or dead—are larger but less prolific west of the Cascades than east of the Cascades. In 2002, about 1.8 million acres of the state's 21 million acres of forestland contained trees killed or defoliated by forest insects and diseases.
- **Weather**— Relevant weather conditions include temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount and duration, and the stability of the atmosphere. Of particular importance for wildfire activity are wind and thunderstorms:
  - Strong, dry winds produce extreme fire conditions. Such winds generally reach peak velocities during the night and early morning hours. East wind events can persist up to 48 hours, with wind speed reaching 60 miles per hour. Being a coastal community, the County experiences significant winds on a fairly regular basis during all times of the year.
  - The thunderstorm season typically begins in June with wet storms, and turns dry with little or no precipitation reaching the ground as the season progresses into July and August.
- **Topography—**Topography includes slope, elevation and aspect. The topography of a region influences the amount and moisture of fuel; the impact of weather conditions such as temperature and wind; potential barriers to fire spread, such as highways and lakes; and elevation and slope of land forms (fire spreads more easily uphill than downhill).

- **Time of Day**—A fire's peak burning period generally is between 1 p.m. and 6 p.m.
- **Forest Practices—**In densely forested areas, stands of mixed conifer and hardwood stands that have experienced thinning or clear-cut provide an opportunity for rapidly spreading, high-intensity fires that are sustained until a break in fuel is encountered.

Fires can be categorized by their fuel types as follows:

- **Smoldering**—Involves the slow combustion of surface fuels without generating flame, spreading slowly and steadily. Smoldering fires can linger for days or weeks after flaring has ceased, resulting in potential large quantities of fuel consumed. They heat the duff and mineral layers, affecting the roots, seeds, and plant stems in the ground. These are most common in peat bogs, but are not exclusive to that vegetation.
- **Crawling**—Surface fires that consume low-lying grass, forest litter and debris.
- **Ladder**—Fires that consume material between low-level vegetation or forest floor debris and tree canopies, such as small trees, low branches, vines, and invasive plants.
- **Crown—**Fires that consume low-level surface fuels, transition to ladder fuels, and also consume suspended materials at the canopy level. These fires can spread rapidly through the top of a forest canopy, burning entire trees, and can be extremely dangerous (sometimes referred to as a "Firestorm").

Wildfires may spread by jumping or spotting, as burning materials are carried by wind or firestorm conditions. Burning materials can also jump over roadways, rivers, or even firebreaks and start distant fires. Updraft caused by large wildfire events draw air from surrounding area, and these self-generated winds can also lead to the phenomenon known as a firestorm.

14.1.2 Wildfire Impact

Short-term loss caused by a wildfire can include the destruction of timber, wildlife habitat, scenic vistas, and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and destruction of cultural and economic resources and community infrastructure. Vulnerability to flooding increases due to the destruction of watersheds. The potential for significant damage to life and property exists in WUI areas, where development is adjacent to densely vegetated areas (DeSisto et al., 2009).

Forestlands in the planning area are susceptible to disturbances such as logging slash accumulation, forest debris due to weather damage, and periods of drought and high temperature. Forest debris from western red cedar, western hemlock, and Sitka spruce can be especially problematic and at risk to wildfires when slash is accumulated on the forest floor, because such debris resists deterioration. When ignited, these fuels can be explosive and serve as ladder fuels carrying fire from the surface to the canopy.

14.1.3 Identifying Wildfire Risk

Risk to communities is generally determined by the number, size and types of wildfires that have historically affected an area; topography; fuel and weather; suppression capability of local and regional resources; where and what types of structures are in the WUI; and what types of pre-fire mitigation activities have been completed. Identifying areas most at risk to fire or predicting the course a fire will take requires precise science. The following data sets are most useful in assessing risk in the area:

- **Topography (slope and aspect) and Vegetation (fire fuels)**—These are two of the most important factors driving wildfire behavior.

- **Weather**—Regional and microclimate variations can strongly influence wildfire behavior. Because of unique geographic features, weather can vary from one neighborhood to another, leading to very different wildfire behavior.
- **Critical Facilities/Asset Location**—A spatial inventory of assets—including homes, roads, fire stations, and natural resources that need protection—in relation to wildfire hazard helps prioritize protection and mitigation efforts.

14.1.4 Community Wildfire Protection Plan

In response to several significant fires occurring throughout the United States from 1995 to 2000, Congress implemented the National Fire Plan—now called the National Cohesive Wildland Fire Management Strategy (Cohesive Strategy)—to seek national solutions for wildfire management. To participate, a community must identify its WUIs and then develop strategies to reduce their impact. This often includes development of a Community Wildfire Protection Plan (CWPP).

A CWPP identifies communities at risk, prioritizes hazardous fuel treatments, and recommends ways to reduce structural ignitability. Island County currently does not have a Community Wildfire Protection Plan, but has listed the development of such a plan as a strategy within this document. For purposes of developing this update to its Hazard Mitigation Plan and in support of future CWPP development, some components of a CWPP are referenced in this plan, but a fire analysis was not conducted, rather, WDNR's assessment of moderate to high is deemed appropriate. Over the course of the next five years, the County and its planning partners may elect to pursue grant funding to pursue development of a CWPP.

14.1.5 Secondary Hazards

Wildfires can generate a range of secondary effects, which in some cases may cause more widespread and prolonged damage than the fire itself. Fires can cause direct economic losses in the reduction of harvestable timber and indirect economic losses in reduced tourism. Wildfires cause the contamination of reservoirs, destroy transmission lines and contribute to flooding. They strip slopes of vegetation, exposing them to greater amounts of runoff. This in turn can weaken soils and cause failures on slopes. Major landslides can occur several years after a wildfire. Most wildfires burn hot and for long durations that can bake soils, especially those high in clay content, thus increasing the imperviousness of the ground. This increases the runoff generated by storm events, thus increasing the chance of flooding.

14.2 HAZARD PROFILE

14.2.1 Extent and Location

According to the Washington State Enhanced Hazard Mitigation Plan (2013) and FEMA (2013), Island County has never received a state or federal disaster declaration for a fire event. During the time period referenced in the State's mitigation plan, 2003-2012, Island County as a whole has had 48 wildfires, burning a total of 32.41 acres. When averaged, that equates to 5.3 fires per year. That figure does not reflect the recurrence interval for fires within the County, but rather an average calculation as to the number of wildland fires which have historically occurred within the area during the period reflected. In addition, Figure 14-4 identifies the Type 1, 2, and 3 fires which have burned on public lands throughout the state, including the planning area, as identified by Washington State Department of Natural Resource. Significant fires in the region include the town of Oak Harbor, which was destroyed by a fire in July 1920. That fire left the town to struggle through the Great Depression, until 1941, when Naval Air Station Whidbey Island was constructed.

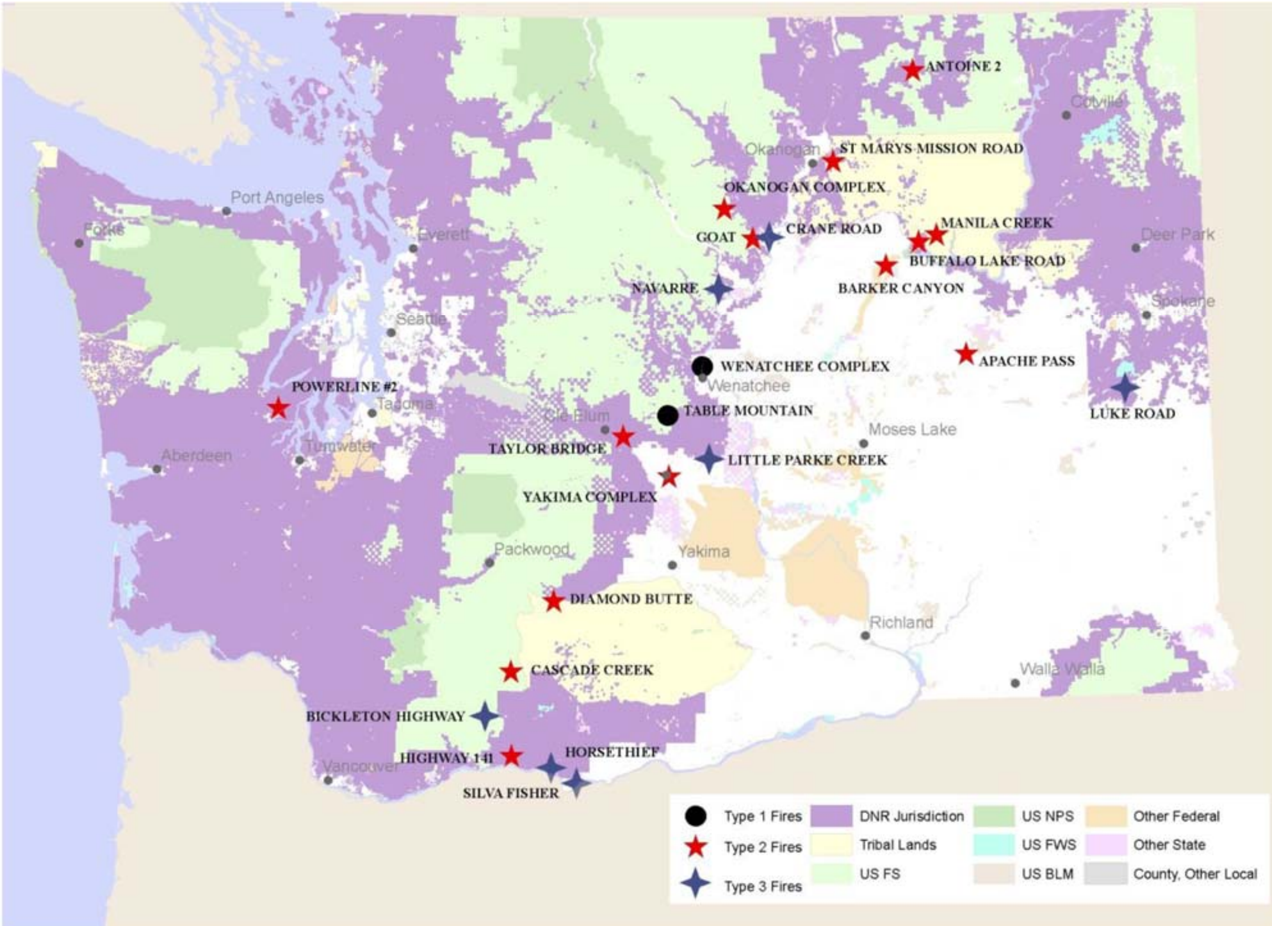

Figure 14-4. Washington Department of Natural Resources (2012)

14.2.2 Previous Occurrences

Wildfires have been a common occurrence throughout Washington as a whole for thousands of years. Evidence from tree rings or fire-scarred trees indicates cycles of prehistoric fires burned in many locations in both Eastern and Western Washington.

Natural fire occurrence is directly related, but not proportional, to lightning incidence levels. It is rare for a summer to pass without at least one period of lightning activity. Lightning incidence is greatest during July and August, though storms capable of igniting fires have occurred from early spring to mid-October. Lightning storms generally track across the park in a southwest to northeast direction.

At a national level, lightning starts over 4,000 house fires each year, which can ignite wildland fires through ember ignition and as a result of proximity to wildland areas. Lightning-caused fires cause over 10 times more acreage damage than human-caused fires, requiring great resource allocation.

Within Washington, lightning storms are typically followed by light to moderate amounts of precipitation. The rainfall may extinguish the fires, while high fuel moisture inhibits spread. However, prolonged periods of warm, dry weather, especially in combination with east winds, often reveal numerous latent "sleepers." While most lightning fires are less than a quarter acre in size, occasional large fires during dry periods account for most of the burned acreage.

14.2.3 Severity

Potential losses from wildfire include human life, structures and other improvements, and natural resources. Smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations such as children, the elderly and those with respiratory and cardiovascular diseases. Wildfire may also threaten the health and safety of those fighting the fires. Wildfire can lead to ancillary impacts such as landslides in steep ravine areas and flooding due to the impacts of silt in local watersheds. The destruction of forestlands can have a significant impact on salmon rearing for generations.

Extreme fires, when they occur, are characterized by more intense heat and preheating of surrounding fuels, stronger flame runs, potential tree crowning, increased likelihood of significant spot fires, and fire-induced weather (e.g., strong winds, lightning cells).

Extreme fire behavior is significantly more difficult to combat and suppress, and can drastically increase the threat to homes and communities. Several factors contribute to the severity of a fire, most of which are utilized when completing a Community Wildfire Protection Plan (CWPP), and developing a component based hazard ranking.

CWPP Component-Based Hazard Ranking

The following sections describe the components of a fire hazard rating system based on key individual elements of fire risk assessments. Identification of the components is intended to provide data necessary to assist in future development of a Community Wildfire Protection Plan by the County. Improvements to these elements could be made by further refining the fire input data, collecting new data, and working with fire managers to better understand how more complex factors create wildfire hazard or drive wildfire behavior. This analysis is not intended to predict fire, but rather to provide information for fire managers to assess what areas of Island County will most benefit from wildfire prevention and mitigation efforts, and what components determine the severity of a fire, which one occur. For this purpose, various LANDFIRE data is utilized in identification of hazard areas.

Fuels

The fuels component of risk customarily accounts for a large percent of the overall hazard rating, as it greatly influences the severity of a fire. Fuels are modeled using data from the federally funded LANDFIRE Project, which provides spatial data to wildland managers (LANDFIRE, 2012). The modeling is based on fuel models created by the U.S. Forest Service, linking vegetative type to a set of average fuel loadings. LANDFIRE provides data on a 30-meter grid with each pixel assigned a value corresponding to a fuel model code. The hazard levels for the fuels are based on the NFPA's *Standard for Protection of Life and Property from Wildfire* (NFPA 1144, 2002 edition), as listed in Table 14-1.

Historically, the area has had limited logging which has resulted in residual slash. Most logging as it currently occurs is the result of new development. Therefore, there remains little logging slash in place. Wooded areas of the County do have fuel consisting of brush, closed timber litter, hardwood litter and understory, which will burn with greater intensity.

Slope

Slope plays an important role in determining overall fire risk because of its influence on fire spread and the increased difficulty of fighting wildfire as slope steepens. Steep slopes increase a fire's rate of spread uphill and can create topographic influences on wind. The geologic makeup of Island County consists of valleys with minimal slopes, to areas of high bluffs/extreme slopes, especially along the coastline.

TABLE 14-1.
FUEL AND ASSOCIATED HAZARD LEVELS

Fuel Behavior Model	Vegetation	Hazard Points	Category
1	Short Grass (1 foot)	5	Low
2	Timber (grass and understory)	5	Low
5	Brush (2 feet)	5	Low
93	Agriculture	5	Low
6	Dormant brush, hardwood slash	10	Moderate
8	Closed timber litter	10	Moderate
9	Hardwood litter	10	Moderate
10	Timber (litter and understory)	10	High
11	Light logging slash	25	Extreme

The percent slope was derived from a 30-meter digital elevation model (DEM) supplied by WDNR and Island County GIS (the same data used for the landslide hazard analysis). Slope values were associated with hazard classes based on NFPA 1144, as listed in Table 14-2. The slope hazard for the planning area is shown in Figure 14-5.

TABLE 14-2.
SLOPE AND ASSOCIATED HAZARD LEVELS

Slope	Hazard Points	Category
<10%	1	Minimal
10—20%	4	Low
21—30%	7	Moderate
31—40%	8	High
>40%	10	Extreme

Aspect

Slope direction, or aspect, has a noticeable influence on humidity and vegetation type, particularly during the fire season months, due to the variation in exposure to sunlight. South- and west-facing slopes receive more solar radiation than slopes with a north aspect due to increased solar insolation at higher latitudes (Figure 14-6). Thus, these areas are drier, with varying types of vegetation and fuel patterns.

Aspect is derived from WDNR's 30-meter DEM. The majority of the planning region has moderate to extreme aspect, with some limited areas having low aspect. Hazard ratings for aspect are modified to local conditions. While important, aspect is not a major driver of fire behavior. Table 14-3 identifies the hazard component rating based on aspect. Figure 14-7 illustrates the countywide aspect for the planning area.

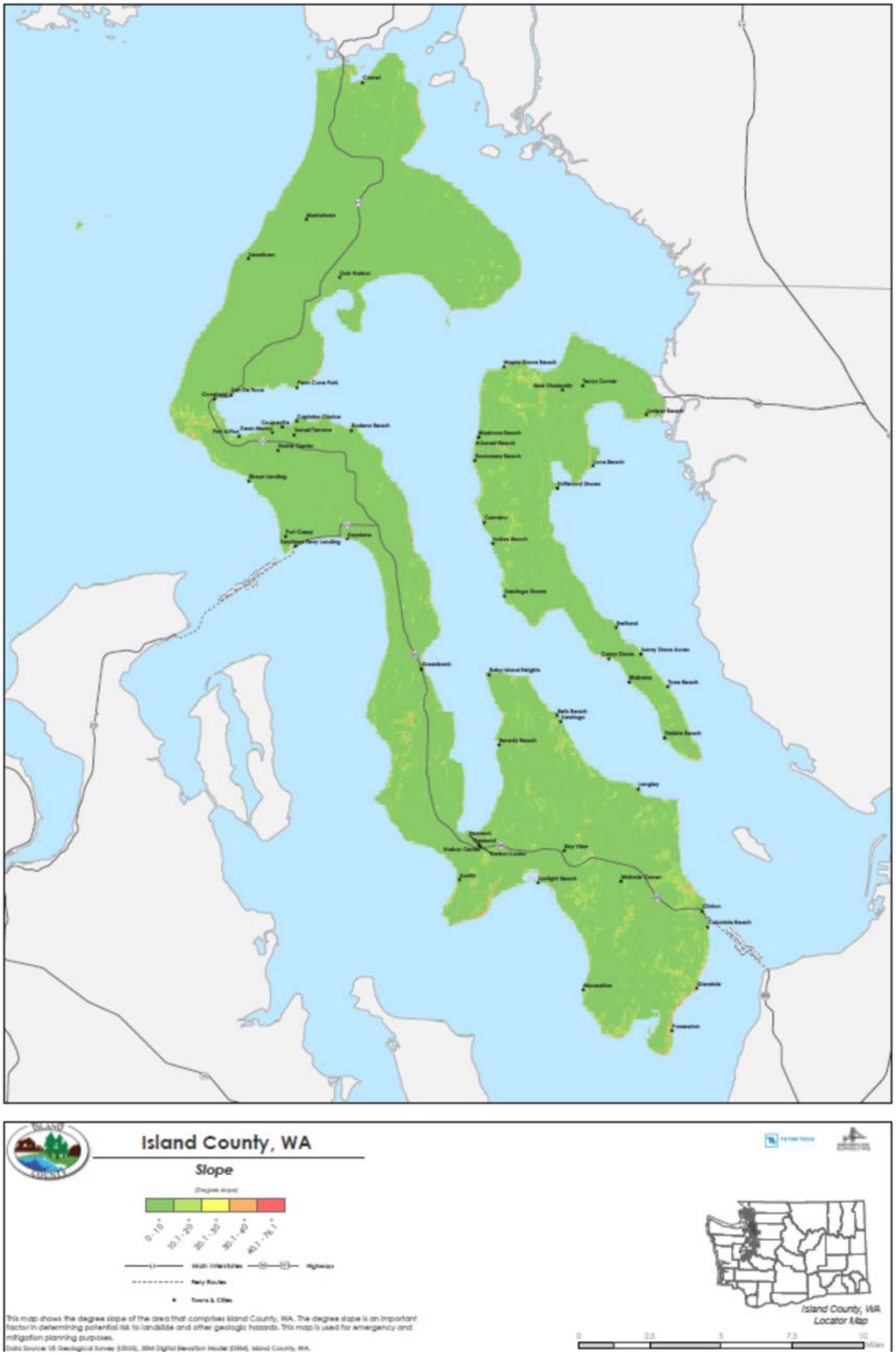

Figure 14-5. Slope

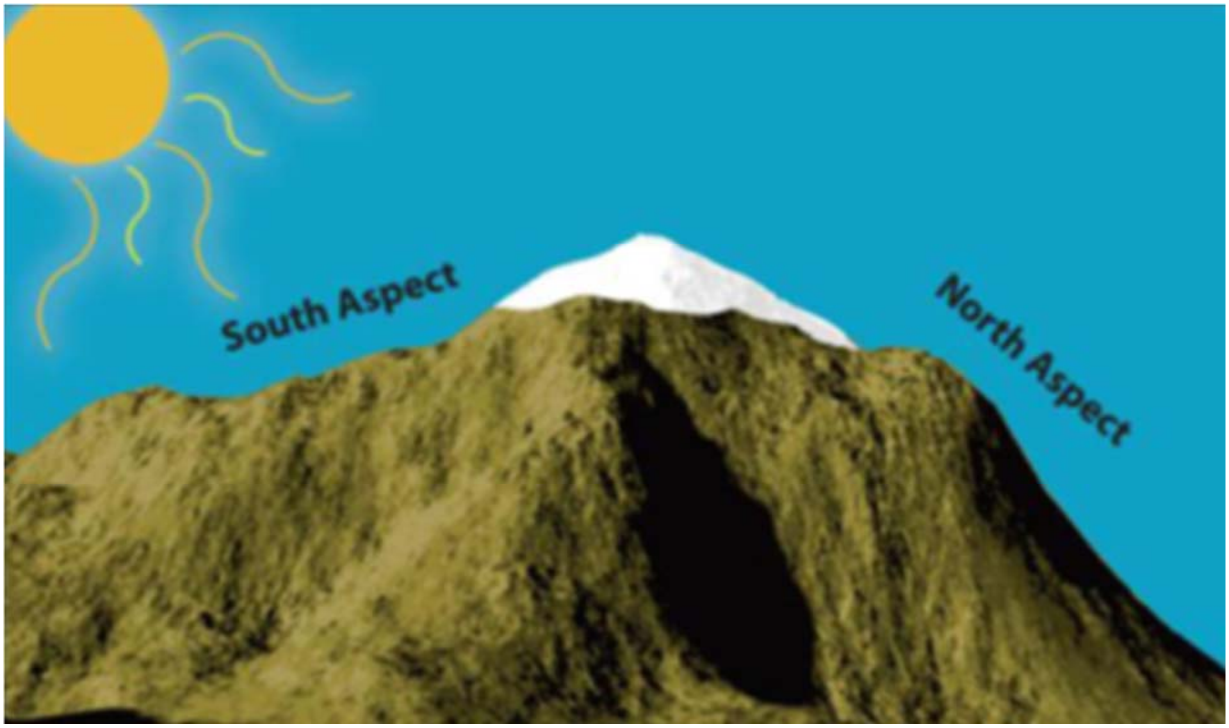

Figure 14-6. Effect of Aspect on Fire Hazard

TABLE 14-3.
ASPECT AND ASSOCIATED HAZARD LEVELS

Aspect	Degrees	Hazard Points	Category
N	315.01 – 45	0	Low
E	45.01 – 135	2	Moderate
W	135.01 – 225	3	High
S	225.02 – 315	5	Extreme

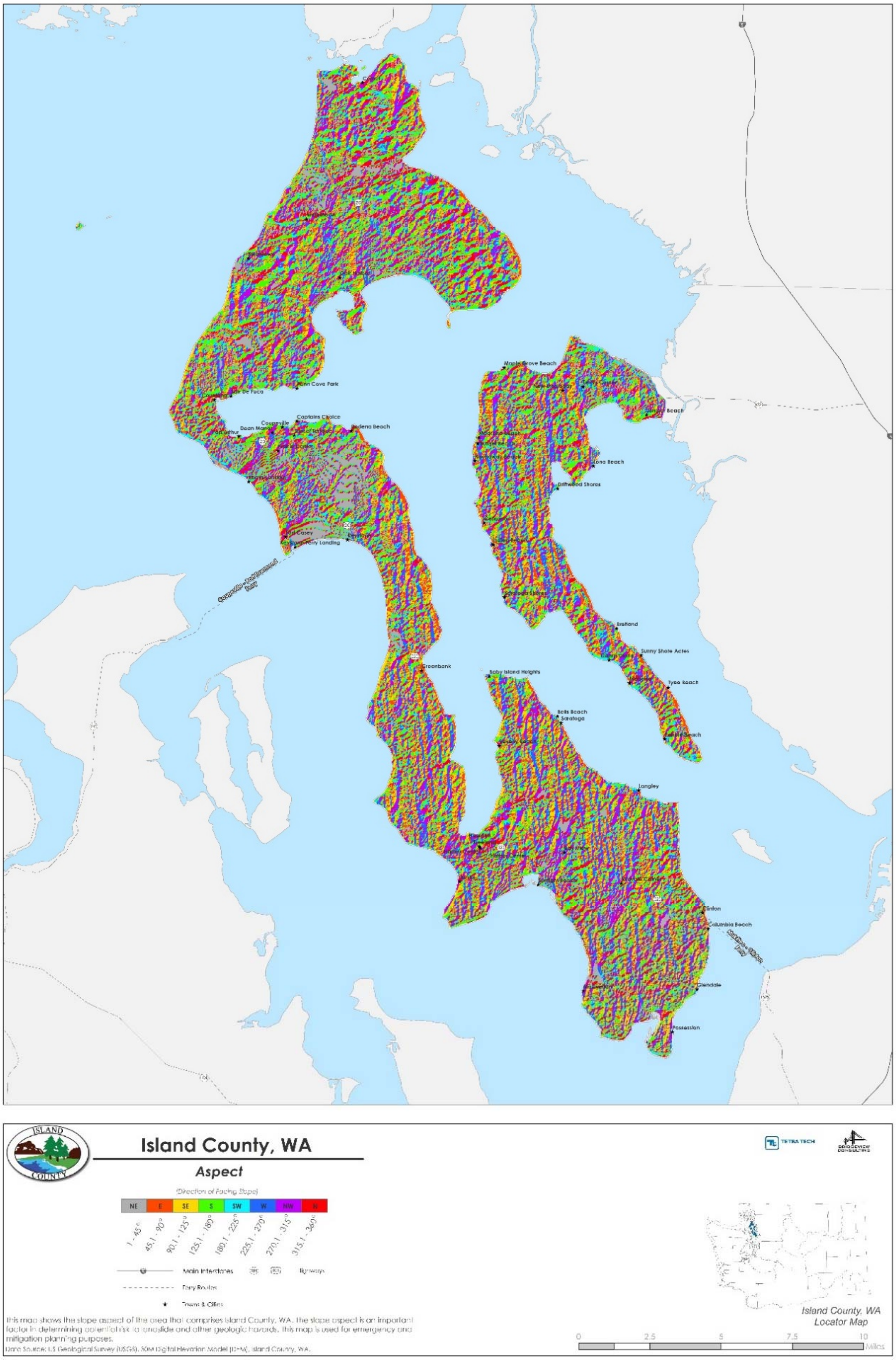

Figure 14-7. Countywide Aspect

Climate

Fuel moisture, air temperature, and relative humidity are the most important drivers of wildfire behavior. As no geographic datasets provide an overall picture of these variables for Island County, customarily monthly datasets of average maximum temperature and precipitation are combined into a single data set to gain this information. Within this plan update, climate and weather data can be found within both the Community Profile – Chapter 3, and the Severe Weather profile – Chapter 11.

Roads/Fire Response Network

A response network assessment based on ESRI's StreetMap dataset can assign higher hazard ratings to areas that are more distant from timely response. The hazard categories assigned to the response time ranges listed in Table 14-4 are based on local and generalized parameters, and are based on standards identifying that which qualifies as an appropriate response time. In addition to the response time, response area is considered. This is the average distance an engine can provide service from a location while parked along a road (about 500 feet).

TABLE 14-4.
RESPONSE TIME AND ASSOCIATED HAZARD LEVELS

Response Time	Hazard Points	Category
< 6 minutes	0	Minimal
6 – 10 minutes	1	Low
10 – 15 minutes	2	Moderate
15 – 60 minutes	3	High
> 60 minutes	5	Extreme

Response time throughout the County is not a factor, as stations are currently located within areas which allow for adequate response. Response time is customarily calculated from ESRI StreetMap data using the speed limit on each road segment, starting from each station. Emergency vehicles customarily travel 5 miles per hour over the speed limit, but slow down for traffic, for navigating traffic controls, and at dangerous intersections. Thus, the speed limit is a reasonable average speed. A 500-foot buffer is also customarily included around all roads, based on equipment capabilities (e.g., a Mark III pump can pump water 500 feet on a 30-percent slope).

Viewshed

The viewshed of areas visible from major roads provides an indication of areas where wildfire could be detected more quickly after ignition, because fires or smoke plumes might be more quickly seen from more frequently traveled roads. Faster detection can lead to better chances of earlier suppression by fire crews. Other factors are more important to overall fire hazard, so while this factor is considered in normal CWPP assessment, it accounts for only small percentage of the overall hazard rating. A viewshed analysis assesses the area visible from major roads, based on a 90-meter DEM. Major roadways are identified as all Class 2 roads in the ESRI StreetMap dataset. Locations visible from major roads have a reduced wildfire hazard because of early detection times.

While there are some remote locations throughout the County with somewhat limited travel to and from areas, the potential for early detection of fire is not limited in this capacity.

14.2.4 Frequency

As previously indicated, none of Washington State's most significant wildfires have occurred in Island County, although smaller fires have occurred in the region almost annually. Fires historically burn on a regular cycle, recycling carbon and nutrients stored in the ecosystem, and strongly affecting species within the ecosystem. The burning cycle in western Washington is approximately every 100 to 150 years.

Historically, drought patterns are related to large-scale climate patterns in the Pacific and Atlantic oceans. The El Niño–Southern Oscillation varies on a 5- to 7-year cycle, the Pacific Decadal Oscillation varies on a 20- to 30-year cycle, and the Atlantic Multidecadal Oscillation varies on a 65- to 80-year cycle. As these large-scale ocean climate patterns vary in relation to each other, drought conditions in the U.S. shift from region to region. El Niño years bring drier conditions to the Pacific Northwest and more fires.

Historical Fire Regime

Many ecosystems are adapted to historical patterns of fire. These patterns, called "fire regimes," include temporal attributes (e.g., frequency and seasonality), spatial attributes (e.g., size and spatial complexity), and magnitude attributes (e.g., intensity and severity), each of which have ranges of natural variability.

Alterations of historical fire regimes and vegetation dynamics have occurred in many landscapes in the U.S., including Island County through the combined influence of land management practices, fire exclusion, insect and disease outbreaks, climate change, and the invasion of non-native plan species. Anthropogenic influences to wildfire occurrence have been witnessed through arson, incidental ignition from industry (e.g., logging, railroad, sporting activities), and other factors. Likewise, wildfire abatement practices have reduced the spread of wildfires after ignition. This has reduced the risk to both the ecosystem and the urban populations living in or near forestlands, such as portions of Island County.

The LANDFIRE Project produces maps of simulated historical fire regimes and vegetation conditions using the LANDSUM landscape succession and disturbance dynamics model. The LANDFIRE Project also produces maps of current vegetation and measurements of current vegetation departure from simulated historical reference conditions. These maps support fire and landscape management planning outlined in the goals of the National Fire Plan, Federal Wildland Fire Management Policy, and the Healthy Forests Restoration Act. The simulated historical mean fire return interval data layer quantifies the average number of years between fires under the presumed historical fire regime. This data is derived from simulations using LANDSUM. LANDSUM simulates fire dynamics as a function of vegetation dynamics, topography, and spatial context, in addition to variability introduced by dynamic wind direction and speed, frequency of extremely dry years, and landscape-level fire characteristics. The historical fire regime groups simulated in LANDFIRE categorize mean fire return interval and fire severities into five regimes defined in the Interagency Fire Regime Condition Class Guidebook:

- Regime 1: 0-35 year frequency, low to mixed severity
- Regime II: 0-35 year frequency, replacement severity
- Regime III: 35-200 year frequency, low to mixed severity
- Regime IV: 35 -200 year frequency, replacement severity
- Regime V: 200+ year frequency, any severity

Large wildfires have historically been infrequent in the coastal regions of the Pacific Northwest. While 48 fires have occurred in the planning area since 2003, due to firefighting efforts, many have been contained with minimal impact on acreage burned (~34 acres). Fire regimes in Island County are shown on Figure 14-8.

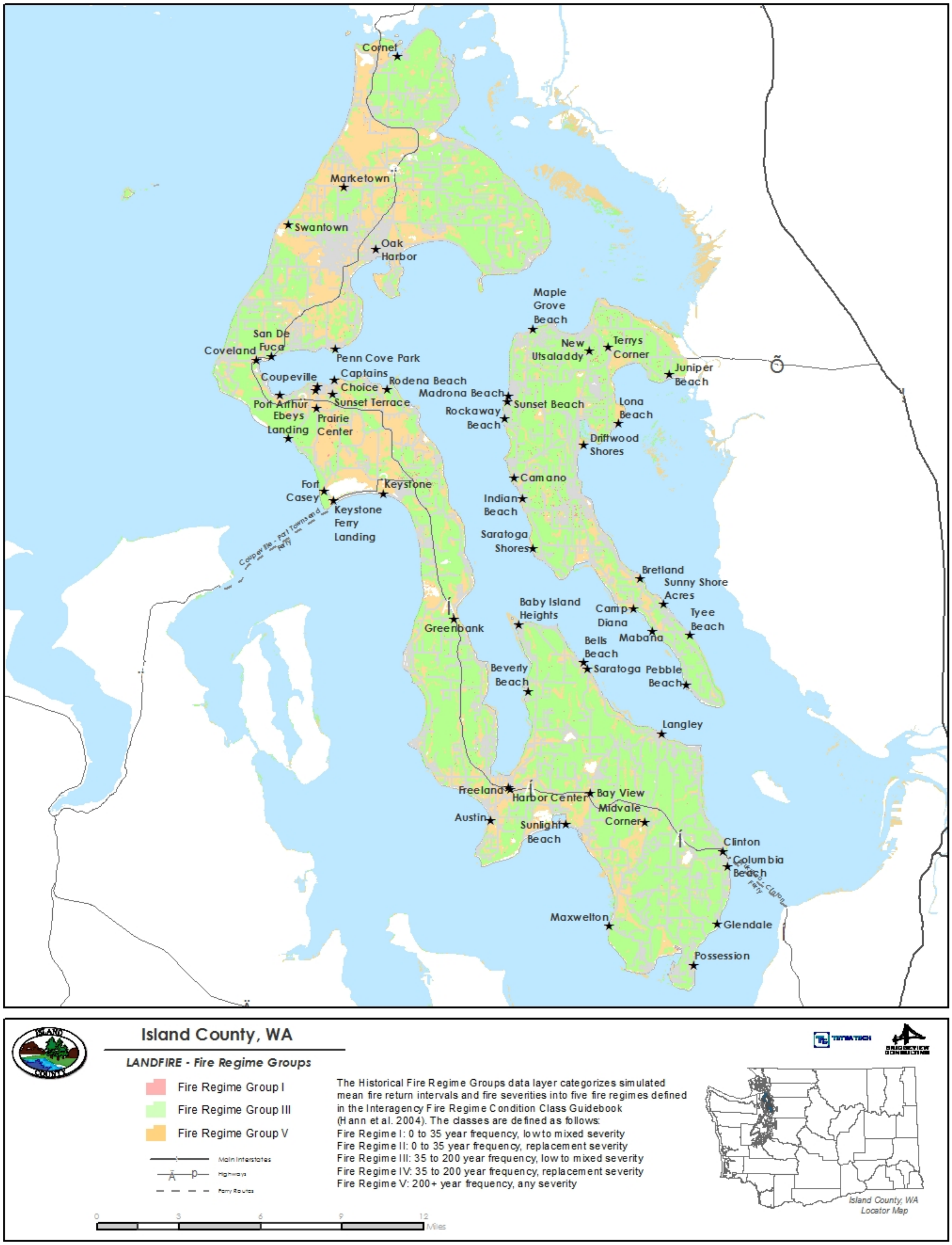

Figure 14-8. LANDFIRE Fire Regimes in Island County

14.3 VULNERABILITY ASSESSMENT

14.3.1 Overview

Structures, above-ground infrastructure, critical facilities and natural environments are all vulnerable to the wildfire hazard.

Methodology

There is currently no validated damage function available to support wildfire mitigation planning because no such damage functions have been generated. Instead, dollar loss estimates were developed by calculating the assessed value of exposed structures identified utilizing the various LANDFIRE Fire Regime (1-5) datasets. Population impact also utilized the various Fire Regimes, with population estimated using the exposed structure count of buildings in each Fire Regime area and applying the census value of two (2) persons per household for Island County.

Warning Time

Wildfires are often caused by humans, intentionally or accidentally. There is no way to predict when one might break out. Since fireworks often cause brush fires, extra diligence is warranted around the Fourth of July when the use of fireworks is highest. Dry seasons and droughts are factors that greatly increase fire likelihood. Dry lightning may trigger wildfires. Severe weather can be predicted, so special attention can be paid during weather events that may include lightning. Reliable National Weather Service lightning warnings are available on average 24 to 48 hours prior to a significant electrical storm.

Understanding the relationship between weather, potential fire activity, and geographical features enhances the ability to prepare for the potential of wildfire events. This knowledge, when paired with emergency planning and appropriate mitigation measures, creates a safer environment.

Wildfire studies can analyze weather data to assist firefighters in understanding the relationship between weather patterns and potential fire behavior. Fire forecasting examines similarities between historical fire weather and existing weather and climate values. These studies have determined that for areas such as Island County, any combination of two of the following factors can create more intense and potentially destructive fire behavior, known as extreme fire behavior:

- Sustained winds from the east
- Relative humidity less than 40 percent
- Temperature greater than 72º Fahrenheit
- Periods without precipitation greater than 14 days in duration
- 1,000-hour fuel moisture less than 17 percent.

If a fire breaks out and spreads rapidly, residents may need to evacuate within a short timeframe. A fire's peak burning period generally is between 1 p.m. and 6 p.m. In normal situations, fire alerting would commence quickly, helping to reduce the risk. However, in more remote locations of the County, or in areas where cell phone services are sporadic at times, warning time and calls for assistance may be reduced.

14.3.2 Impact on Life Health & Safety

While there are no recorded fatalities from wildfire in the planning area, a statistical number of the population vulnerable to impact from fire is impossible to determine with any accuracy, due to the high number of variables that impact fire scenarios. The population at risk must also take into consideration tourists given the County's proximity to the parklands and its proximity to Canada and other Washington high-tourist destinations. With its relatively high tourism rate, especially during summer months, there is an increase in the population vulnerability to fire. Given the increased in tourism during the summer months, when fire danger is at its greatest, increased consideration must be taken into account for fire response. Similarly, as in the case of Camano Island and the Twin City Foods fire, isolation as a result of restricted access can also occur, further increasing the vulnerability of populations in the area of the fire.

Smoke and air pollution from wildfires can be a severe health hazard, especially for sensitive populations, including children, the elderly and those with respiratory and cardiovascular diseases. Island County has a high population of retirees and individuals over 65, further increasing the potential impact on the fire hazard. Smoke generated by wildfire consists of visible and invisible emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, nitrogen oxides), and toxics (formaldehyde, benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather. Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility. Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke. The county does have a high number of elderly citizens.

Exposure to wildfire in Island County is dependent upon many factors. The maps used in the analysis show areas of relative importance in determining fire risk, though they do not provide sufficient data for a statistical estimation of exposed population. For purposes of this assessment, the various Fire Regimes were used with population estimated using the structure count of buildings exposed within the various Fire Regime areas, and applying the census value of two persons per household for Island County. These estimates are shown in Table 14-5. Not calculated into the potential impact is the number of tourists who may be visiting the area at any given time. These figures are for planning purposes only.

TABLE 14-5.
POPULATION WITHIN FIRE REGIME AREAS

	Fire Regime 1		Fire Regime 3		Fire Regime 5	
	Population	% of Total	Population	% of Total	Population	% of Total
Unincorporated	266	0.48%	36,946	67.06%	14,528	26.37%
Coupeville	8	0.42%	494	26.07%	740	39.05%
Langley	0	0.00%	762	70.88%	246	22.88%
Oak Harbor	36	0.16%	5,536	25.23%	7,402	33.74%
Total	**310**	**0.39%**	**43,738**	**54.67%**	**22,916**	**28.65%**

14.3.3 Impact on Property

Property damage from wildfires can be severe and can significantly alter entire communities. WDNR identifies Island County as being of Moderate risk for state owned or leased facilities at risk (Figure 14-9). The potential exposure of the structures in the County should a fire occur is low to moderate exposure, depending on the area, with the unincorporated county and the cities of Coupeville, Langley and Oak Harbor all having some degree of exposure to wildfire hazards. Details on the number and value of structures exposed to LANDFIRE Wildfire Regime areas are provided in Table 14-6 through Table 14-8

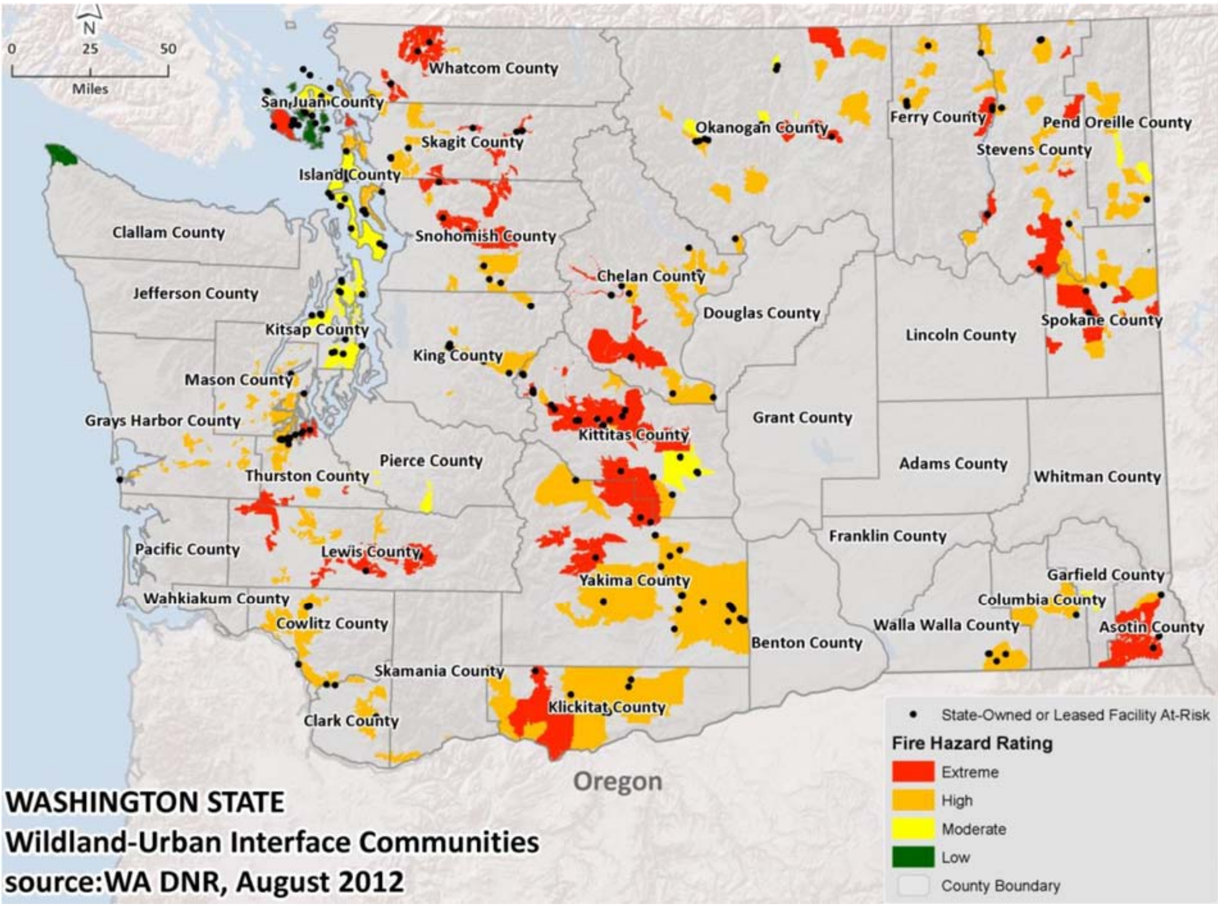

Figure 14-9. Wildland-Urban Interface Communities and State Facilities at Risk

TABLE 14-6.
PLANNING AREA STRUCTURES EXPOSED TO LANDFIRE FIRE REGIME 1

	Buildings Exposed	Estimated Value			% of Total Value
		Structure	Contents	Total	
Unincorporated	139	$20,648,358	$10,701,083	$31,349,441	0.42%
Coupeville	6	$1,158,218	$724,818	$1,883,036	0.77%
Langley	0	$0	$0	$0	0.00%
Oak Harbor	23	$4,090,149	$2,757,212	$6,847,361	0.20%
Total	**168**	**$25,896,725**	**$14,183,113**	**$40,079,838**	**0.35%**

TABLE 14-7.
PLANNING AREA STRUCTURES EXPOSED TO LANDFIRE FIRE REGIME 3

	Buildings Exposed	Estimated Value			% of Total Value
		Structure	Contents	Total	
Unincorporated	19292	$3,352,269,985	$1,755,656,375	$5,107,926,360	67.98%
Coupeville	320	$60,245,116	$37,981,186	$98,226,302	40.12%
Langley	456	$76,090,089	$46,217,806	$122,307,895	68.99%
Oak Harbor	3374	$1,055,942,123	$815,321,520	$1,871,263,643	54.15%
Total	**23442**	**$4,544,547,313**	**$2,655,176,886**	**$7,199,724,199**	**63.20%**

TABLE 14-8.
PLANNING AREA STRUCTURES EXPOSED TO LANDFIRE FIRE REGIME 5

	Buildings Exposed	Estimated Value			% of Total Value
		Structure	Contents	Total	
Unincorporated	7818	$1,199,510,408	$650,526,703	$1,850,037,111	24.62%
Coupeville	462	$84,688,738	$58,457,560	$143,146,298	58.46%
Langley	169	$31,808,243	$22,072,544	$53,880,787	30.39%
Oak Harbor	4372	$975,532,487	$648,399,416	$1,623,931,902	47.00%
Total	**12821**	**$2,291,539,876**	**$1,379,456,223**	**$3,670,996,098**	**32.23%**

Density and the age of building stock in Island County are contributing factors in assessing property vulnerability to wildfire. Many of the buildings in the planning area are of significant age, with many being constructed with wood frames and shingle roofs.

Loss estimations for the wildfire hazard are not based on damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. The loss estimates for the general building stock for jurisdictions that have an exposure to Fire Regime Areas are listed in Table 14-9 through Table 14-11.

TABLE 14-9.
ESTIMATED LOSS POTENTIAL FOR LANDFIRE FIRE REGIME 1

	Exposed Value	10% Damage	30% Damage	50% Damage
Unincorporated	$31,349,441	$3,134,944	$9,404,832	$15,674,721
Coupeville	$1,883,036	$188,304	$564,911	$941,518
Langley	$0	$0	$0	$0
Oak Harbor	$6,847,361	$684,736	$2,054,208	$3,423,681
Total	**$40,079,838**	**$4,007,984**	**$12,023,951**	**$20,039,919**

TABLE 14-10.
ESTIMATED LOSS POTENTIAL FOR LANDFIRE FIRE REGIME 3

	Exposed Value	10% Damage	30% Damage	50% Damage
Unincorporated	$5,107,926,360	$510,792,636	$1,532,377,908	$2,553,963,180
Coupeville	$98,226,302	$9,822,630	$29,467,890	$49,113,151
Langley	$122,307,895	$12,230,789	$36,692,368	$61,153,947
Oak Harbor	$1,871,263,643	$187,126,364	$561,379,093	$935,631,821
Total	$7,199,724,199	$719,972,420	$2,159,917,260	$3,599,862,100

TABLE 14-11.
ESTIMATED LOSS POTENTIAL FOR LANDFIRE FIRE REGIME 5

	Exposed Value	10% Damage	30% Damage	50% Damage
Unincorporated	$1,850,037,111	$185,003,711	$555,011,133	$925,018,556
Coupeville	$143,146,298	$14,314,630	$42,943,889	$71,573,149
Langley	$53,880,787	$5,388,079	$16,164,236	$26,940,394
Oak Harbor	$1,623,931,902	$162,393,190	$487,179,571	$811,965,951
Total	$3,670,996,098	$367,099,610	$1,101,298,829	$1,835,498,049

14.3.4 Impact on Critical Facilities and Infrastructure

Critical facilities of wood frame construction are especially vulnerable during wildfire events. In the event of wildfire, there would likely be little damage to most infrastructure. Most roads and railroads would be without damage except in the worst scenarios. Fueling stations could be significantly impacted. Power lines are also significantly at risk from wildfire because most poles are made of wood and susceptible to burning. Fires can create conditions that block or prevent access and can isolate residents and emergency service providers. Wildfire in Island County could also impact wood-structured bridges, peers and docks, which the County utilizes for ferry services, as well as to moor fishing vessels or other private boats associated with tourism. Table 14-12 identifies critical facilities exposed to the wildfire hazard.

Hazardous Material Involved Fire Impact on Critical Facilities and Infrastructure

Currently there are 101 registered Tier II hazardous material containment sites throughout Island County (based on 2013 reporting to Washington State Dept. of Ecology). During a wildfire event, hazardous material storage containers could rupture due to excessive heat and act as fuel for the fire, causing rapid spreading and escalating the fire to unmanageable levels. In addition the materials could leak into surrounding areas, saturating soils and seeping into surface waters, having a disastrous effect on the environment.

14.3.5 Impact on Economy

Wildfire impact on the economy can be far reaching, ranging from damage to ferry services, to non-use of park facilities and campsites impacting tourism, to loss of structures influencing tax base from lost revenue. Secondary hazards associated with wildfire, such as increased landslides and flooding potential, would further impact the economy.

TABLE 14-12.
CRITICAL FACILITIES AND INFRASTRUCTURE EXPOSED TO FIRE REGIME AREAS

	Regime 1	Regime 3	Regime 5
Medical and Health Services	0	1	11
Government Function	0	10	5
Protective Function	0	23	11
Schools	0	16	11
Hazmat	0	1	0
Other Critical Function	0	6	8
Transportation	0	8	7
Water	0	3	0
Wastewater	0	3	3
Power	0	5	7
Communications	0	6	7
Total	0	82	70

14.3.6 Impact on Environment

Fire is a natural and critical ecosystem process in most terrestrial ecosystems, dictating in part the types, structure, and spatial extent of native vegetation. However, wildfires can cause severe environmental impacts:

- Damaged Fisheries—Critical fisheries can suffer from increased water temperatures, sedimentation, and changes in water quality.
- Soil Erosion—The protective covering provided by foliage and dead organic matter is removed, leaving the soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitats.
- Spread of Invasive Plant Species—Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control.
- Disease and Insect Infestations—Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees.
- Destroyed Endangered Species Habitat—Catastrophic fires can have devastating consequences for endangered species.
- Soil Sterilization—Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost. It can take decades or even centuries for ecosystems to recover from a fire. Some fires burn so hot that they can sterilize the soil.

14.4 FUTURE DEVELOPMENT TRENDS

The County is optimistic that increased population growth will occur throughout the region. As areas of the County become more urbanized, the potential exists that the fire risk may increase as urbanization tends to alter the natural fire regime, and the growth will expand the urbanized areas into undeveloped wildland areas. However, the County feels that this expansion of the wildland-urban interface can be managed with strong land use and building codes. A growing body of research suggests that "the only effective home protection treatment is treatment in, on, and around the house (see Figure 14-10); homeowners must be responsible for protecting that property" (Nowicki 2001, p. 1:3). U.S. Forest Service research scientist, Jack Cohen has stated that "home ignitions are not likely unless flames and firebrand ignitions occur within 40 meters [131 feet] of the structure; the WUI fire loss problem primarily depends on the home and its immediate site".

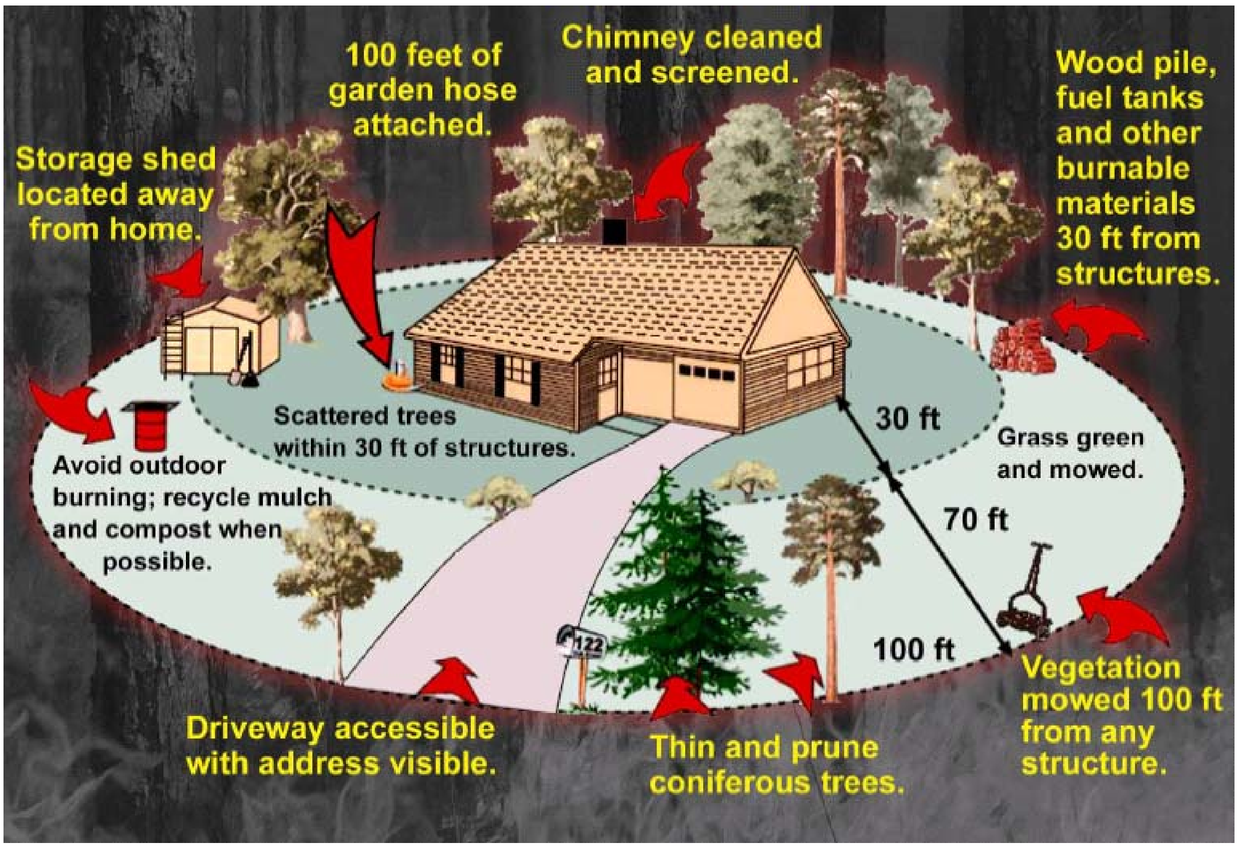

Figure 14-10. Measures to Protect Homes from Wildfire

14.5 CLIMATE CHANGE IMPACTS

Climate change could affect multiple elements of the wildfire system: fire behavior, ignition, fire management, and vegetation fuels. Hot dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

Climate scenarios project summer temperature increases between 2ºC and 5°C and precipitation decreases of up to 15 percent. Such conditions would exacerbate summer drought and further promote high-elevation wildfires, releasing stores of carbon and further contributing to the buildup of greenhouse gases. Forest response to increased atmospheric carbon dioxide—the so-called "fertilization effect"—could also contribute to more tree growth and, thus, more fuel for fires, but the effects of carbon dioxide on mature forests are still largely unknown. High carbon dioxide levels should enhance tree recovery after fire and young forest regrowth, as long as sufficient nutrients and soil moisture are available, although the latter is in question for many parts of the western United States because of climate change.

14.6 ISSUES

The major issues for wildfire in Island County are the following:

- Public education and outreach to people living in or near the fire hazard zones should include information about and assistance with mitigation activities such as defensible space, and advance identification of evacuation routes and safe zones.
- Wildfires could cause landslides as a secondary natural hazard.
- Climate change could affect the wildfire hazard.
- Future growth into interface areas should continue to be managed.
- Vegetation management activities should include enhancement through expansion of target areas as well as additional resources.
- Building code standards need to be enhanced, including items such as residential sprinkler requirements and prohibitive combustible roof standards.
- Increased fire department water supply is needed in high-risk wildfire areas.
- Obtain and maintain certifications and qualifications for fire department personnel. Ensure that all firefighters are trained in basic wildfire behavior, basic fire weather, and that all company officers and chief level officers are trained in the wildland command and strike team leader level.

A worst-case scenario would include an active fire season throughout the American west, spreading resources thin. Firefighting teams would be exhausted or unavailable. Many federal assets would be responding to other fires that started earlier in the season. While local fire districts would be extremely useful in the urban interface areas, they have limited wildfire capabilities or experience, and they would have a difficult time responding to the ignition zones. Even though the existence and spread of the fire is known, it may not be possible to respond to it adequately, so an initially manageable fire can become out of control before resources are dispatched.

To further complicate the problem, heavy rains could follow, causing flooding and landslides and releasing tons of sediment into rivers, permanently changing floodplains and damaging sensitive habitat and riparian areas. Such a fire followed by rain could release millions of cubic yards of sediment into streams for years, creating new floodplains and changing existing ones. With the forests removed from the watershed, stream flows could easily double. Floods that could be expected every 50 years may occur every couple of years. With the streambeds unable to carry the increased discharge because of increased sediment, the floodplains and floodplain elevations would increase.

CHAPTER 15.
HUMAN CAUSED HAZARDS

15.1 GENERAL BACKGROUND

Human-caused threats are those resulting from the intentional actions of an adversary, and can be either *threatened* or *actual*. These incidents are collectively referred to as terrorism. Terrorism incidents can include civil disturbance, cyber incident, sabotage, and an active shooter/standoff situation. Terrorism can also include chemical, biological, radiological, nuclear and explosive (CBRNE) devices.

DEFINITIONS

Terrorism—The unlawful use or threatened use of force or violence against people or property with the intention of intimidating or coercing societies or governments. Terrorism is either foreign or domestic, depending on the origin, base, and objectives of the terrorist or organization.

Threat – A man-made occurrence (human-caused incident), resulting from the intentional actions of an adversary that has or indicates the potential to harm life, information, operations, the environment and/or property.

Weapons of Mass Destruction—Any destructive device or weapon that is designed or intended to cause death or serious bodily injury through release, dissemination, or impact of toxic or poisonous chemicals. Any weapon involving chemical, biological, radiological, nuclear, and explosive (CBRNE) agents.

15.1.1 Characteristics

The three key elements to defining a terrorist event are as follows:

- Activities involve the use of illegal force.
- Actions are intended to intimidate or coerce.
- Actions are in support of political or social objectives.

Terrorism evokes very strong emotional reactions, ranging from anxiety, to fear, to anger, to despair, to depression. In the case of CBRNE agents, their presence may not be immediately obvious, making it difficult to determine when and where they may have been (or will be) released; who has been exposed, and what danger is present for first responders and emergency medical personnel.

15.1.2 Types of Terrorists

The Federal Bureau of Investigation (FBI) categorizes terrorism in the United States primarily as one of two types:

- International/foreign terrorism, which involves groups or individuals whose terrorist activities are foreign-based and/or directed by countries or groups outside the United States, or whose activities transcend national boundaries. Examples include the 1993 bombing of the World Trade Center, the U.S. Capitol, and Mobil Oil's corporate headquarters and the attacks of September 11, 2001 at the World Trade Center and the Pentagon.
- Domestic (homegrown) terrorism, which involves groups or individuals whose terrorist activities are directed at elements of our government or population without foreign direction. Domestic Terrorism as defined by the Congressional Research Service is described as "terrorist activity or plots perpetrated within the United States or abroad by American citizens, legal permanent residents, or visitors radicalized largely within the United States." (Zuckerman et al., 2013) The bombing of the Alfred P. Murrah federal building in Oklahoma City is an example of domestic terrorism. The FBI is the primary response agency for domestic terrorism. The FBI coordinates domestic preparedness programs and activities of the United States to limit acts posed by terrorists including the use of weapons of mass destruction (WMDs).

International terrorist (IT) organizations are said to be the result of a frustrated, extremist, culturally or mentally polarized group of individuals motivated by radical or unconventional thought. Extremists generally adopt converse concepts of violence, morality, and in the rationale of "means and ends" than that of mainstream Western societies. This characterization of International Terrorist organizations bears similar cognitive threads to those of Domestic Terrorist (DT) organizations. However, DT advocates and their organizations profess ideologies (left or right) which adamantly exaggerate extremist beliefs toward values held by Western democratic or American cultures. Such terrorists groups would include:

- Ethnic, religious & racial, sexual separatists
- Left-wing "issue/cause" organizations that embrace animal, environmental, religious, abortionist, anti-government, and anarchist (freedom)
- Right-wing, separatists, militants, survivalists, anti-government (freedom/rights protection and conformance); sovereignty, and militant anti-police and regulatory authority organizations.

For the individual homegrown terrorist, personal motives may vary greatly. It could be a desire for collective revenge against the U.S. for the purported "war on Islam," poverty or social alienation, or brainwashing. There is no one path to radicalization. As DHS's Office of Intelligence and Analysis has indicated, motives and paths to radicalization can vary significantly depending on one's ideology and religious beliefs, geographic location, or socioeconomic condition. Nevertheless, trends do seem to exist among those attempted homegrown terror plots thwarted since 9/11, most significantly a seeming aversion to suicide or martyrdom (Zuckerman et al., 2013).

When one hears the term *terrorism*, they often equate it to the use of weapons of mass destruction, which include chemical, biological, radiological, nuclear and explosive weapons. However, terrorism also includes arson, incendiary and explosive devices, school shootings, sabotage (including industrial sabotage), hazardous materials releases, agro-terrorism and cyber-terrorism.

15.1.3 Types of Cyber Incidents

In the United States, we define cyber incidents in terms of cyber-attacks and cyber espionage. "A cyber-attack is a non-kinetic offensive operation intended to create physical effects or to manipulate, disrupt, or delete data. It might range from a denial-of-service operation that temporarily prevents access to a website, to an attack on a power turbine that causes physical damage and an outage lasting for days. Cyber espionage refers to intrusions into networks to access sensitive diplomatic, military, or economic information" (Clapper, 2013).

Cyber Crimes/Cyber-criminals also threaten US economic interests, although their activities are not recognized necessarily as a terrorist-type event. Cyber criminals selling tools, via a growing black market, that might enable access to critical infrastructure systems or get into the hands of state and non-state actors. In addition, some commercial companies sell computer intrusion kits on the open market. These hardware and software packages can give governments and cybercriminals the capability to steal, manipulate, or delete information on targeted systems. Even more companies develop and sell professional-quality technologies to support cyber operations—often branding these tools as lawful-intercept or defensive security research products. Many individuals, groups and foreign governments already use some of these tools to target national and local systems.

15.1.4 Terrorism-Related Threats

Threats related to terrorism vary in nature and type. FEMA has provided guidance in developing and capturing information related to terrorist incidents. Table 15-1 provides a hazard profile summary for terrorism-related threats.

For each type of threat, the following factors are addressed:

- **Application Mode**—Application mode describes the human acts or events necessary to cause the threat to occur.
- **Duration/Hazard Impact**—Duration is the length of time the threat is present. For example, the duration of a tornado (a hazard) may be just minutes, but a chemical warfare agent (threat) such as mustard gas, if un-remediated, can persist for hours or weeks under the right conditions.
- **Severity/Characteristics**—These characteristics of a threat describe tendency, or that of its effects, to either expand, contract, or remain confined in time, magnitude, and space. For example, the physical destruction caused by an earthquake (hazard) is generally confined to the place in which it occurs, and it does not usually get worse unless aftershocks or other cascading failures occur. In contrast, a cloud of chlorine gas leaking from a storage tank can change location by drifting with the wind and can diminish in danger by dissipating over time.
- **Mitigating or Exacerbating Conditions**—Mitigating conditions are characteristics of the target and its physical environment that can reduce the effects of a threat. These can range from deterrence or interdiction capabilities, such as fencing or security cameras, to sunlight, which can render some biological agents ineffective. These are also mechanisms which can minimize the likelihood of someone approaching a target unseen, or can reduce its effectiveness. In contrast, exacerbating conditions are characteristics that can enhance or magnify the effects of a hazard. For example, depressions or low areas in terrain can trap heavy vapors, and a proliferation of street furniture (trash receptacles, newspaper vending machines, mailboxes, etc.) can provide hiding places for explosive devices.

TABLE 15-1.
EVENT PROFILES FOR TERRORISM

Threat	Application Mode	Duration/Threat Impact	Severity	Mitigating and Exacerbating Conditions
Conventional Bomb	Detonation of explosive device on or near target; delivery via person, vehicle, or projectile.	Instantaneous; additional “secondary devices, and/or diversionary activities may be used, lengthening the time duration of the hazard until the attack site is determined to be clear.	Extent of damage is determined by type and quantity of explosive. Effects generally static other than cascading consequences, incremental structural failure, etc.	Overpressure at a given standoff is inversely proportional to the area of the distance from the blast; thus, each additional increment of standoff provides progressively more protection. Terrain, forestation, structures, etc., can provide shielding by absorbing and/or deflecting energy and debris. Exacerbating conditions include ease of access to target; lack of barriers and shielding; poor construction; and ease of concealment of device.

**TABLE 15-1.
EVENT PROFILES FOR TERRORISM**

Threat	Application Mode	Duration/Threat Impact	Severity	Mitigating and Exacerbating Conditions
Chemical Agent	Liquid/aerosol contaminants can be dispersed using sprayers or other aerosol generators; liquids vaporizing from puddles/ containers; or munitions.	Chemical agents may pose viable threats for hours to weeks depending on the agent and the conditions in which it exists.	Contamination can be carried out of the initial target area by persons, vehicles, water, and wind. Chemicals may be corrosive or otherwise damaging over time if not remediated.	Air temperature and humidity can affect the composition of some chemicals agents, as well as evaporation of aerosols. Ground temperature affects evaporation of liquids. Humidity can enlarge aerosol particles. While precipitation can dilute agents, it can also further disperse agents, spreading contamination. Wind can disperse vapors, in some cases rendering them less dangerous, but also increase the spread of the chemical agent used. The micro-meteorological effects of buildings and terrain can alter travel and duration of agents, but can also increase dosage by enclosing the agent within a structure. Shielding in the form of sheltering in place can protect people from harmful effects.
Arson/ Incendiary Attack	Initiation of fire or explosion on or near target via direct contact or remotely via projectile.	Generally minutes to hours.	Extent of damage is determined by type and quantity of device, accelerant, and materials present at or near target. Effects generally static other than cascading consequences, incremental structural failure, etc.	Mitigation factors include built-in fire detection and protection systems and fire-resistive construction techniques, or security measures which reduce exposure. Inadequate security can allow easy access to target, easy concealment of an incendiary device, and undetected initiation of a fire. Non-compliance with fire and building codes, as well as failure to maintain existing fire protection systems, can substantially increase the effectiveness of a fire weapon.
Armed Attack	Tactical assault or sniping from remote location, or random attack based on fear, emotion, or mental instability.	Generally minutes to days.	Varies based on the perpetrators' intent and capabilities.	Inadequate security can allow easy access to target, easy concealment of weapons, and undetected initiation of an attack. Screening devices, such as cameras, pass-through metal detectors or limited searches at entrances may decrease the likelihood of a weapon in some mass gathering facilities.

TABLE 15-1.
EVENT PROFILES FOR TERRORISM

Threat	Application Mode	Duration/Threat Impact	Severity	Mitigating and Exacerbating Conditions
Biological Agent	Liquid or solid contaminants can be dispersed using sprayers, aerosol generators or by point or line sources such as munitions, covert deposits, and moving sprayers. Biological agents may also be introduced into food and water supplies, or through direct application to skin.	Biological agents may pose viable threats for hours to years depending on the agent and the conditions in which it exists.	Depending on the agent used and the effectiveness with which it is deployed, contamination can be spread via wind and water. Infection can spread via human or animal vectors.	Altitude of release aboveground can affect dispersion; sunlight is destructive to many bacteria and viruses; light to moderate wind will disperse agents but higher winds can break up aerosol clouds; the micro-meteorological effects of buildings and terrain can influence aerosolization and travel of agents.
Cyber-attack or Cyber-Espionage	Unlawful attacks and threats of attack against computers, networks and information stored therein.	Minutes to days.	Generally no direct effects on built environment; secondary impact from system attacked (e.g., SCADA system regulating water release)	Inadequate security can facilitate access to critical computer systems, allowing them to be used to conduct attacks, or gather information to support other terrorist-related activities.
Agro-terrorism	Direct, generally covert contamination of food supplies or introduction of pests and/or disease agents to crops and livestock.	Days, months, years.	Varies by type of incident. Food contamination events may be limited to specific distribution or growing sites, whereas pests and diseases may spread widely. Generally no direct impact on built environment, but may increase fire danger in urban interface areas.	Inadequate security can facilitate adulteration of food and introduction of pests and disease agents to crops and livestock.

**TABLE 15-1.
EVENT PROFILES FOR TERRORISM**

Threat	Application Mode	Duration/Threat Impact	Severity	Mitigating and Exacerbating Conditions
Radiological Agent	Radioactive contaminants can be dispersed using sprayers/ aerosol generators, or by point or line sources such as munitions. Direct contamination may also occur at site if structures are damaged.	Contaminants may remain hazardous for years depending on material used.	Initial effects will be localized to site of attack; depending on meteorological conditions, subsequent behavior of radioactive contaminants may be dynamic. Agent may also unknowingly be transferred to other areas.	Duration of exposure, type of radiation, distance from source of radiation, and the amount of shielding between source and target determine exposure to radiation.
Nuclear Bomb	Detonation of nuclear device underground, at the surface, in the air, or at high altitude.	Light/heat flash and blast/shock wave last for seconds; nuclear radiation and fallout hazards can persist for years. Electromagnetic pulse from a high-altitude detonation lasts for seconds and affects only unprotected electronic systems.	Initial light, heat, and blast effects of a subsurface, ground, or air burst are static and determined by the device's characteristics and employment; fallout of radioactive contaminants may be dynamic, depending on meteorological conditions.	Harmful effects of radiation can be reduced by minimizing the time of exposure. Light, heat, and blast energy decrease logarithmically as a function of distance from seat of blast. Terrain, forestation, structures, etc. can provide shielding by absorbing and/or deflecting radiation and radioactive contaminants.
Intentional Hazardous Material Release (fixed facility or transportation)	Solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers	Hours to days.	Chemicals may be corrosive or otherwise damaging over time. Explosion and/or fire may be subsequent. Contamination may be carried out of the incident area by persons, vehicles, water, and wind.	As with chemical weapons, weather conditions directly affect how the threat develops. The micro-meteorological effects of buildings and terrain can alter travel and duration of agents. In some instances, sheltering in place can protect people from harmful effects. Established safety codes and reporting requirements, as well as safety plans can decrease danger. Chemical-specific containment and suppression devices, as well as building codes and safety standards which address protection and containment features, can substantially decrease the damage from a hazardous materials release.

Source: FEMA 386-7 (in part)

Science and the Internet have made information related to weapons of mass destruction (WMD) technology widely available to an increasing audience. It is known that terrorists, terrorist cells and criminal organizations have used the Internet for actual WMD experimentation and research. Experts offer five classifications for "major" terrorist incident planning:

- **Biological agents** pose a serious threat due to their accessibility and the rapid manner in which they can be spread. Typical threats are anthrax (sometimes found in sheep and cattle), tularemia (rabbit fever), cholera, the plague (sometimes found in prairie dog colonies), and botulism. A biological incident is most likely first detected in a hospital emergency room, medical examiner's office, or within the public health community long after the terrorist act. The consequences present communities with a need for massive reactive and precautionary treatments to exposed populations, patient care facilities and to stage mass fatality management and environmental health clean-up operations, procedures and plans. Anthrax incidents in the U.S. in October 2001 demonstrated the potential for spreading terror through biological WMDs. The introduction of Newcastle disease in the United States demonstrates how an agent can be introduced to livestock, causing harm to public health and the economy.
- **Chemical agents** are compounds with unique chemical properties that can produce lethal or damaging effects in humans, animals, and plants. Most chemical agents can be introduced into an unaware population relatively easily using aerosol generator, explosive devices, container breakages, and other forms of covert application. Dispersed as an aerosol or inserted into a water system, chemical agents have their greatest potential for inflicting mass casualties. Within Island County, the agricultural community uses and stores a limited amount of chemicals for peaceful and productive means that could be used in destructive ways.
- **Nuclear threat** is the use, threatened use, or threatened detonation of a nuclear bomb or device. Presently, there is no known instance in which any non-governmental entity has been able to obtain or produce and assemble the components of a nuclear weapon. The most likely nuclear scenario is the detonation of a large conventional explosive that incorporates nuclear material or explosives detonation in close proximity to nuclear materials in use, storage, or transit. Of concern is the increasing frequency of radiological materials shipments throughout the U.S. and world. Major transportation arteries for vehicles or rail contribute to the risk of a radiological event as such products can unknowingly pass through any one of the regional transportation corridors. Eastern Washington's Hanford Nuclear site represents one of the world's largest nuclear use, waste storage, and potential radioactive contaminated sites. The site is approximately 300 miles east of Island County.
- **Incendiary devices** are either mechanical, electrical, or chemical devices used to intentionally initiate combustion and start fires. Their purpose is to destroy and ignite their target or other proximate materials and/or structures or as a diversion preceding an even larger terrorist or criminal act. These devices are detonated singularly or in series.
- **Explosive incidents** account for 70 percent of all terrorist attacks worldwide. Bombs are terrorist's weapon of choice. The Internet and even local libraries provide ample information for the design and construction of many forms of explosive devices. Elements necessary to construct a WMD are readily available. Additionally, the agricultural communities maintain sufficient products and quantities for use in explosive events. The FBI reported that from October 2012 through April 2013 172 explosive devices were reported in the United States. Residential properties are reported as one the most common bombing targets. According to a White House report released after the Boston Marathon bombing, such devices "remain one of the most accessible weapons available to terrorists and criminals to damage critical infrastructure and inflict casualties." (McClatchyDC.com, 2013)

WMD agents can be combined to have a greater total effect. When combined, the impacts of the event can be immediate and longer-term. Casualties will likely suffer from both immediate and long-term impact.

The effects of terrorism can vary from loss of life and injuries to property damage and disruptions in services such as electricity, water supplies, transportation, or communications. Any of the methods above may have an immediate effect or a delayed effect which lingers.

Potential Threat Elements

In dealing with intentional human-caused threats, the unpredictability of human beings must be considered. People with a desire to perform criminal acts may seek out targets of opportunity that may not fall into established lists of critical areas or facilities. First responders train not only to respond to organized terrorism events, but also to respond to random acts by individuals who, for a variety of reasons ranging from fear to emotional trauma to mental instability, may choose to harm others and destroy property.

Washington State has a fairly extensive list of potential threats in the form of recognized organizations. Some of these have a demonstrated violent history, have weapons of mass destruction capabilities (CBRNE or other), and who have extremist motivations. Table 15-2 identifies some of the known organizations in Washington. While the list represents statewide factions, it would not be out of the question that any of those listed could travel to Island County.

15.2 HAZARD PROFILE

15.2.1 Extent and Location

Terrorists often choose targets that offer limited danger to themselves and areas with relatively easy public access. Foreign terrorists look for visible targets where they can avoid detection before and after an attack such as international airports, large cities, major special events, and high-profile landmarks. Terrorists are also now known to advance two techniques of growing concern within the public safety arena: the targeting of first responders employing secondary timed (or multiple) explosive devices and Weapons of Mass Destruction (WMD) hoaxes

Communities nationwide are vulnerable to both IT and DT terrorist acts. While Island County communities, urban and rural, provide a relatively low target-rich landscape for these groups whether infrastructure or origin, the potential for an incident to occur would not be out of the question. While targets are often located near high traffic/high-visibility routes with convenient transportation access, examples of targets include (Island County possess all of these types of facilities):

- Military installations and suppliers;
- Government office buildings, court houses, schools, hospitals, and shopping centers – and “symbolic” targets whose operations, practices or associations represent values in conflict with the terrorists ideology;
- Ferries, railheads, interstate highways, tunnels, airports, bridges, seaports, overpasses;
- Dams, water supplies, electrical and gas distribution systems, pipelines, chemical facilities;
- Recreational facilities such as sports stadiums, theaters, parks, casinos, concert halls, public venues, and areas which have high-traffic volumes of tourists;
- Financial institutions and banks;
- Sites of historical and symbolic significance;

**TABLE 15-2.
POTENTIAL THREAT ELEMENTS**

	Violent History	WMD Capability	Motivation[a]	WMD Categories[b]
American Front				
American Nazi Party				
Animal Liberation Front			E	
Aryan Nation	X	X	Ra	
Earth First			E	
Earth Liberation Front (ELF)	X		E	
Haken Kreuz	X		Ra	
Hammerskins	X		P, Ra	
Ku Klux Klan	X	X	Ra	
National Alliance				
National Assoc. for the Advancement of White People				
Northwest Boot Boys	X		S	
National Socialist Movement	X		P, S	
Phineas Priesthood	X	X		
Public Enemy Number 1 (Prison)				
Saint Michael's Parish				
Second Amendment				
Skin Head	X		Ra	
Stormfront (Web-based organization)				
World Church of the Creator	X		Ra	
White Aryan Resistance			Ra	
Valhalla Bound Skinheads	X		Ra	
Volksfront	X		Ra	
The Order	X		P, R, Ra	

a. Motivation categories: P = Political R = Religious E = Environmental Ra = Racial S = Special Interest
b. WMD categories: C = Chemical B = Biological R = Radiological N = Nuclear E = Explosive O = Other

- Scientific research facilities, academic institutions, museums;
- Telecommunications, newspapers, radio and television stations;
- Chemical, industrial, and petroleum plants; business offices, convention centers;
- Law, fire, emergency medical services, and responder facilities and operations centers;
- Special events, parades, religious services, festivals, celebrations;
- Planned Parenthood facilities and abortion clinics.

The last decade has also seen increased civil disturbances, including rioting and looting following incidents such as the Michael Brown and Eric Garner shootings, immigration-related rulings, and major-league sports events throughout the United States. Larger jurisdictions within Washington, such as Seattle - home of major sport teams, have the potential to have similar disturbances. Island County, which is not home to any major or minor league sports teams, has much less potential for sports-related disturbances as they relate to rioting of these types. Although Island County has a potential vulnerability to civil disturbances as a result of the Naval Air Station and protesters associated with various military activities, the probability of an event is low, and resulting damage to critical facilities would more than likely be incidental and not intentional.

15.2.2 Previous Occurrences

Many of the terrorist events in the United States have been bombing attacks, involving detonated and undetonated explosive devices, tear gas, pipe bombs, and firebombs. During the time period of 1990-through year-end 2013, the Federal Bureau of Investigation reports that in excess of 50 bomb incidents have occurred nationwide (see Figure 15-1). According to the Global Terrorism Database maintained by the University of Maryland's National Consortium for the Study of Terrorism and Response to Terrorism, in excess of 200 terrorist related events (all incidents, regardless of doubt) have occurred during the time period 2001-2011[10]. These include active-shooter incidents, bombings, arson, etc.

Several of the incidents reported occurred in Washington State, and one in Island County. A brief description of significant incidents in the State and planning region follows. This list is not all-inclusive; it represents only open-source references.

- Smuggler's Cove on Whidbey Island, December 8, 1984 – Robert J. Mathews, founder of the white-supremacist group "The Order" was killed in a house fire after a 35-hour standoff with the FBI. In 1985, 23 members of the gang were indicted by a federal grand jury in Seattle for charges including murder, racketeering, conspiracy, counterfeiting and robbery. Annually, on the anniversary of the occurrence, splinter cells travel to the site.
- The American Front Skinheads detonated pipe bombs in Tacoma on July 20 and July 22 1993.
- In Spokane County, the Phineas Priesthood, a domestic terrorism organization, exploded a pipe bomb at the Valley Branch offices of Spokane *Spokesman Review* newspaper on April 1, 1996 and robbed a Spokane Valley branch of the US Bank ten minutes later. The Phineas Priesthood repeated this method of operation three months later when they placed a pipe bomb at a Planned Parenthood office in Spokane on July 12. They then robbed the same branch of the US Bank using an AK-47, a 12-gauge shotgun, a revolver, and a 25-pound propane tank bomb. The proceeds of the criminal acts committed by the Phineas Priesthood were used to further their domestic terrorist activity and ideology. In addition, there was the placement and explosion of a bomb at Spokane City Hall in 1996.
- The FBI and Bellingham Police interdicted a group of terrorists affiliated with the Washington State Militia on July 27, 1996. The group planned to bomb various infrastructure targets including a radio tower, bridge, and a train tunnel while the train was inside.
- In February 1999, the FBI and Spokane police, sheriff and fire departments responded to a hoax bioterrorism incident. The incident involved a tenant dental clinic in the Spokane Valley Planned Parenthood building that received a Christmas card containing an unidentified smudge. The card followed the modus operandi of 30-plus cards sent to Planned Parenthood offices and other businesses across the nation, some of which had explicit threats claiming exposure to anthrax spores. Seattle also had an anthrax hoax late that same year.

[10] University of Maryland Global Terrorism Data available at: http://www.start.umd.edu/gtd/

Source:http://www.fbi.gov/stats-services/publications/law-enforcement-bulletin/september-2011/the-evolution-of-terrorism-since-9-11 (Latest update of chart as of 2015)

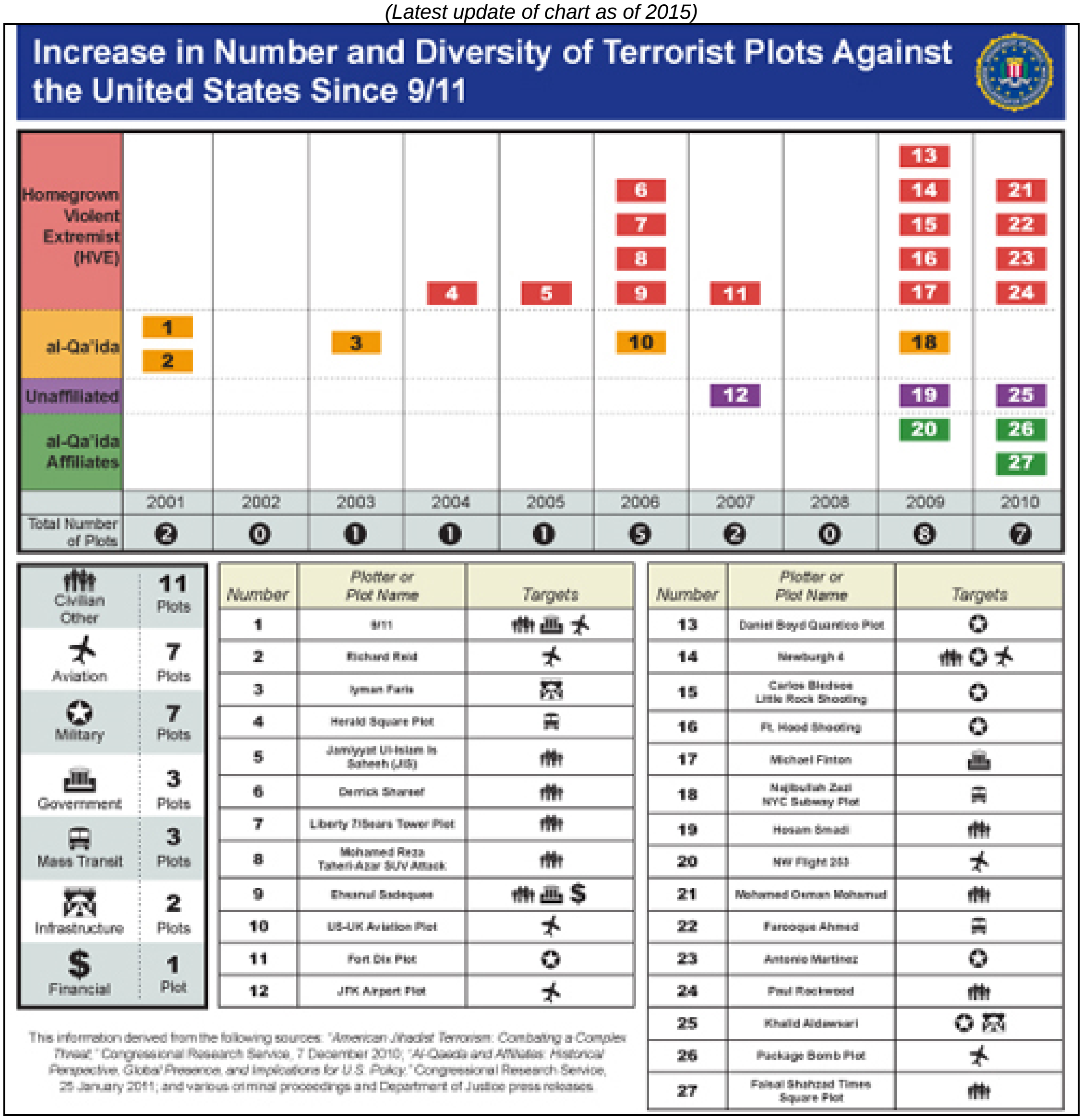

Figure 15-1. Number of Terrorist Plots against United States

- In December 1999, Ahmed Ressam was arrested while entering the United States in Port Angeles, Washington, aboard a ferry from Victoria, British Columbia. He was charged with smuggling explosive material into the United States. The CIA noted that the timing devices and nitroglycerine in his possession were the “signature devices” of groups affiliated with Afghan-based Osama bin Laden, who planned the 9/11 terrorist attacks. It was highly unlikely the explosive materials could be smuggled onto commercial aircraft; Ressam was scheduled to depart for Seattle the next day and he was booked into a motel blocks from Seattle Center. Law-enforcement officials investigated the possibility of a terrorist bombing during the Year 2000 New Year’s Eve celebration at the Space Needle, which traditionally draws tens of thousands of people. Ressam has since been sentenced. When interviewed during his custody, he became one of the nation’s most informative terrorism sources leading investigators to individuals and terrorist cells around the world.

- In 2005, two Hummers were damaged at the George Gee Auto Dealership in Liberty Lake. The joint terrorism task force determined it was domestic terrorism as someone claiming to be affiliated with the Environmental Liberation Front (ELF) claimed responsibility.
- January 17, 2006 - A $3 million dollar home under construction on Camano Island, was completely destroyed in an arson attack. The home belonged to Karla and Mark Verbarendse. There were no casualties and the Earth Liberation Front claimed responsibility[11].
- July 2006 gunman fires on women at the Jewish Federation of Greater Seattle
- In 2006 the US Postal Annex in the Eastern Washington city of Clarkston detected a powdery substance in a piece of mail addressed to President Bush. Investigation determined that identical letters were sent to several Post Offices throughout the US.
- September 4, 2009 - Assailants toppled two radio transmission towers belonging to the sports radio station KRKO with a bulldozer in Everett, Washington, United States, after assailants stole construction equipment from the site. The Earth Liberation Front claimed responsibility for the attack.
- January 17, 2011 – Kevin William Harpham placed improvised explosive devices along the planned route of the Martin Luther King Jr. Day Unity March in Spokane. The device was capable of inflicting serious injury or death according to laboratory analysis conducted by the FBI. The blast was intended to detonate during the march. Harpham pleaded guilty and faces 27-32 years in prison[12].
- In June 2011, the FBI raided a warehouse in Seattle, which housed two suspects who had arranged to purchase weapons from an anonymous informant in contact with the Seattle Police Department. Abu Khalid Abdul-Latif and Walli Mujahidh were seeking to purchase automatic machine guns and grenades in preparation for an attack on a military recruiting station in Seattle. After the arrests, authorities learned that Abdul-Latif, a felon and Muslim convert, had initially planned to attack the Joint Base Lewis–McChord with Los Angeles resident Mujahidh. The target was later changed to the Seattle Military Entrance Processing Station for undisclosed reasons.[13] The men were charged with conspiracy to murder officers and employees of the United States government, conspiracy to use a weapon of mass destruction, and possession of firearms in furtherance of crimes of violence. Abdul-Latif was also charged with two counts of illegal possession of firearms. Mujahidh pleaded guilty in December 2011 to a conspiracy to murder officers and agents of the United States, to a conspiracy to use weapons of mass destruction, as well as to being a felon in possession of a firearm. He was sentenced in April 2013 to 17 years in prison and 10 years of supervised release. Abu Khalid Abdul-Latif was sentenced to 18 years in prison and 10 years of supervised release.
- January 17, 2013 - An explosive device detonated outside of the City of Tacoma's Community Justice Center. There were no damages or injuries resulting from the blast. No group claimed responsibility for the incident[14].

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[11] "Terrorism: Criminal Nature," The Seattle Post-Intelligencer, January 19, 2006. Accessed 10 Dec. 2014. Available at: http://www.start.umd.edu/gtd/search/IncidentSummary.aspx?gtdid=200601170007

[12] FBI, Seattle Division (2011). Attempted Bomber Pleads Guilty to Federal Hate Crime Charge and Weapons Charge. (September 7, 2011). Available at: http://www.fbi.gov/seattle/press-releases/2011/attempted-bomber-pleads-guilty-to-federal-hate-crime-and-weapons-charges. Accessed August 17, 2013

[13] FBI Seattle Division (2011). "Two Men Charged in Plot to Attack Seattle Military Processing Center." June 23, 2011. Available: http://www.fbi.gov/seattle/press-releases/2011/two-men-charged-in-plot-to-attack-seattle-military-processing-center (Accessed August 17, 2013).

[14] University of Maryland. Global Terrorism Database. (Accessed December 10, 2014.) Available online at: http://www.start.umd.edu/gtd/search/IncidentSummary.aspx?gtdid=201301170006

- February 25, 2013 - Assailants set fire to a construction site in the City of Seattle. There were no casualties, but the fire caused $60,000 in damages. Anarchists claimed responsibility for the attack, stating that they started the fire to protest what they called the myth of sustainable development.
- May 2013, five letters containing active ricin were mailed from Spokane to various federal agencies, three of which were located in Spokane: a Federal District Court Judge in Spokane; the W. Riverside Post Office in Spokane, and the Fairchild Air Force Base, also in Spokane. The same suspect mailed similar letters containing ricin to the President of the United States and the Central Intelligence Agency[15].

Civil Disorders

The United States has a long history of civil disorders and civil unrest. It is part of our nation's history. Unlike other large-scale emergencies that bring communities together, civil disorders are divisive. Since the 1960s, this division is often racial. These disturbances often follow a protest or high profile event affecting local communities. These disturbances are classified as communal riots and are considered to be conflicts between two or more ethnic groups. At the time the incidents occurred, commodity riots emphasize the economic and political distribution of power among groups, and Congressional commissions in the 1960s attempted to categorize civil disorders based on size of crowds, the length of the violence, its intensity, and the level of force needed to restore order. Civil disorders have, and will continue to occur throughout Washington State:

- Washington State witnessed race riots in the 1960s, protests against the Vietnam War in the 1970s, abortion clinic demonstrations in the 1980s, and disturbances stemming from allegations of police brutality in the 1990s. In Seattle and Tacoma, small-scale riots occurred after the 1992 Rodney King verdict. On the night the jury rendered its decision, small groups of people roamed the downtown streets smashing windows, lighting dumpster fires, and overturning cars. The following day some Seattle residents went to Capitol Hill where they set fires and attacked the West Precinct Police Headquarters.
- On May 3, 1998, the Washington State Emergency Operations Center was activated in response to a civil disturbance that occurred at Washington State University in Pullman. The disturbance developed when student's end-of-year celebrations got out of hand. The disturbances consisted of large crowd of students throwing rocks, debris, beer bottles, and starting fires. Students lined the streets throwing bottles, rocks, and debris and starting fires. Local and state law enforcement officials were assembled to restore order and several officials were injured. Washington National Guard units were placed on standby status. The state Emergency Operations Center returned to normal operations later in the day.
- After Seattle's declaration of emergency created by disturbance and violence during the World Trade Organization meeting, the Washington State Emergency Operations Center activated on November 30, 1999. A Washington State proclamation of emergency allowed commitment of state resources to support affected local jurisdictions. Washington State Patrol, Department of Transportation, National Guard, department of Natural resources, Emergency Management Division, and an Incident Management Team provided support. The November 30, 2000 anniversary of Seattle's World Trade Organization meeting resulted in repeat disturbance, violence and property damage.

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[15] FBI, Seattle Division (2013). Additional Threatening Letters Now Part of Spokane, Washington Ricin Investigation (May 30, 2013). Available at: http://www.fbi.gov/seattle/press-releases/2013/additional-threatening-letters-now-part-of-spokane-washington-ricin-investigation (Accessed August 17, 2013)

- In November and December 2014, riots occurred nationwide in response to two Grand Jury decisions to not indict two police officers in the separate shooting deaths of two black males. Throughout Washington, and various other cities across the nation, protestors and large crowds of demonstrators assembled. In Seattle, several structures were damaged. Protests also occurred within Tacoma and Olympia, but no disruptive incidents occurred in response to these protests within Island County.

Island County does not have a history of civil disorders, with the exception of potential protestors associated with military operations positioned outside of the Whidbey Island Naval Air Station. The events that have occurred in the planning region have never reached the “major” classification; however, major events have occurred Western Washington’s Seattle metro corridor and within the Cities of Tacoma, Olympia and Spokane. While a fair distance away from Island County, these incidents do have the potential to impact Island County through requests for resources, mutual aid agreements for various assistance, and assistance of law enforcement officers statewide through memorandums of understanding. In addition, disruption of services and goods could also occur as a result of civil disorders which could impact the County.

Active Shooter

With active shootings occurring more frequently, the need for emergency management for them has expanded. As recently as October 2014, a neighboring community to Island County had such an incident occur, which cost the lives of four students, including the suspect.

According to a 2014 study completed by the Department of Justice, Federal Bureau of Investigation, the number of active shooter incidents within the United States increased from 2000-2013, with an average of 11.4 incidents annually and a total of 160 (see Figure 15-2). Of those 160 incidents, 1,043 causalities resulted (wounded or killed [shooters were not included in the total]), with 486 killed, and 557 wounded.

Source: http://www.fbi.gov/news/stories/2014/september/fbi-releases-study-on-active-shooter-incidents

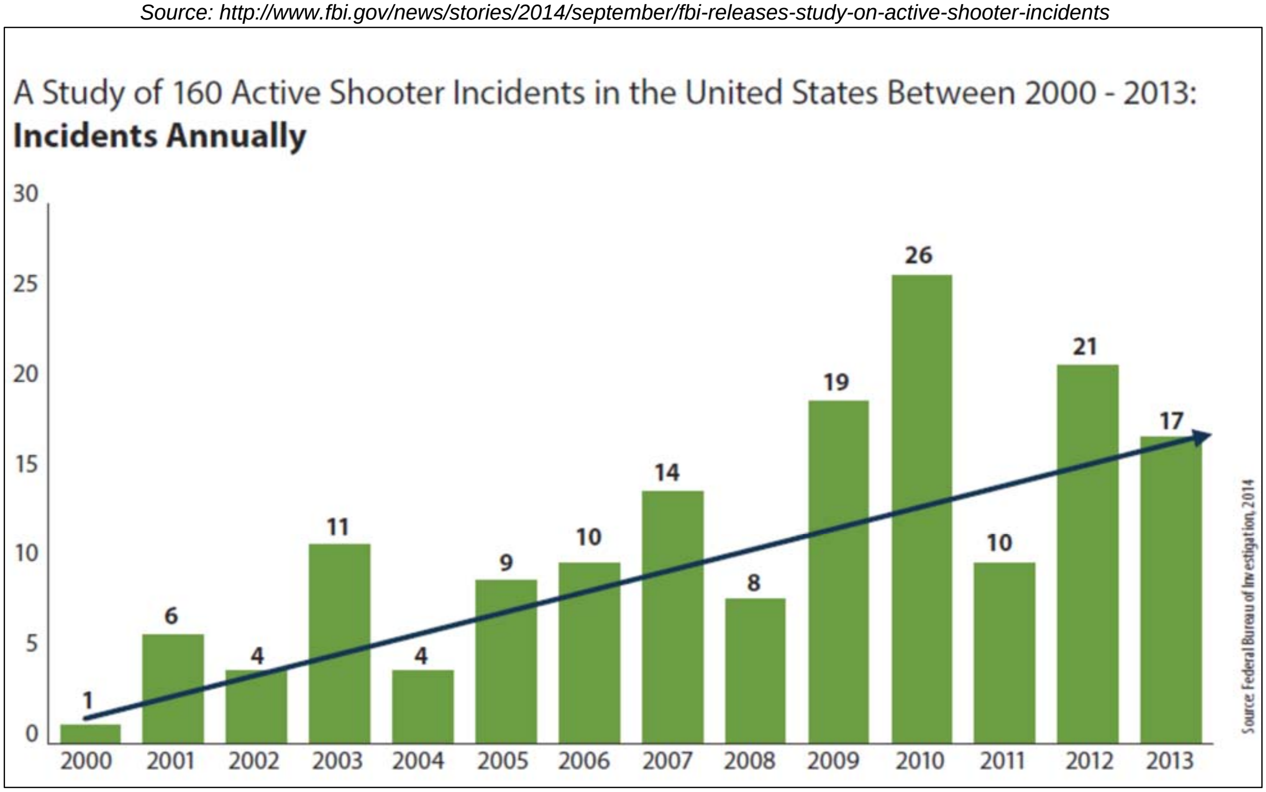


Figure 15-2. Accounting of Active Shooter Incidents Throughout the United States 2000-2013

Of the 160 incidents, the location of the shootings varied (see Figure 15-3), with the greatest number occurring in business which were open to pedestrian traffic (27.5% or 44 incidents). Businesses with closed pedestrian traffic had 23 incidents during that time period, with malls across our nation having six incidents, including Seattle and Tacoma. With respect to Educational facilities impacted, there were 27 incidents occurring in the Pre-K-12th grade, and 12 incidents occurring at institutions of higher learning.

Source: http://www.fbi.gov/news/stories/2014/september/fbi-releases-study-on-active-shooter-incidents

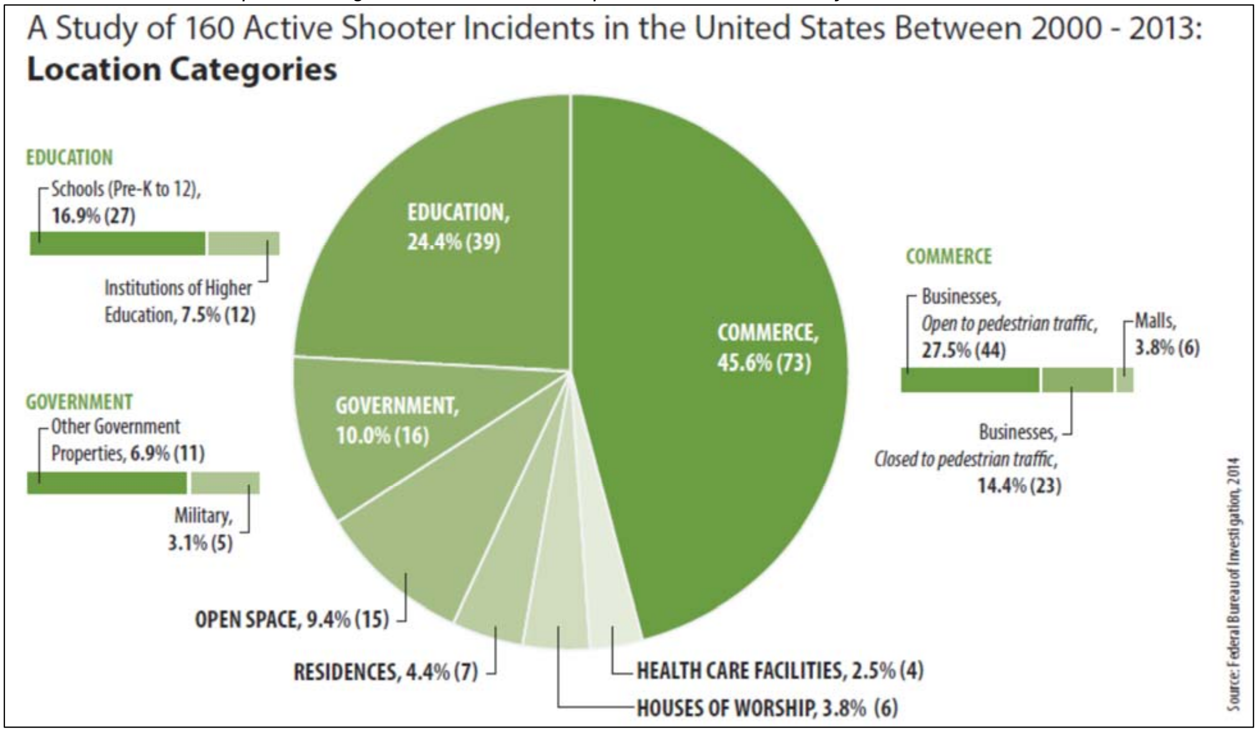


Figure 15-3. FBI Location Categories of Active Shooter Incidents 2000-2013

Cyber Incidents

Cyber-attacks on infrastructure can originate from adversaries such as hostile governments, criminal organizations, or lone individuals; however, it is important to differentiate a *cyber-attack* from that of *cyber-terrorism. As* a Nation, "the United States has not seen a cyber-terrorist threat from terrorists using information warfare techniques."[16] While there have been Cyber-attacks against governments, they have not been for the purpose of gaining warfare information or access. The Office of the Comptroller of the Currency, which regulates national banks, has issued warnings to banks and business of their potential risk. Since September 2012, "attacks have been increasingly aimed at businesses with fewer than 250 employees."[17] According to the same report, financial institutions are reluctant to provide details and information about potential cyber-attacks for fear of becoming a greater target; therefore, attacks often go unreported. Software manufactures estimate that cyber-attacks against U.S. businesses have increased 42 percent over the course of the last year.[18]

[16] http://www.crime-research.org/library/Cyber-terrorism.htm

[17] Associated Press. (2013). As Cyber Attacks Detonate, Banks Grid for Battle. Available at:

http://www.krem.com/news/national/215674771.html. Accessed August 22, 2014.

[18] ibid

FEMA characterizes a cyber-attack or cyber-espionage as follows:

- **Application Mode**—Unlawful attacks and threats of attack against computers, networks and information stored therein
- **Duration/Threat Impact**—Minutes to days
- **Severity**—Generally no direct effects on built environment; secondary impact from system attacked (e.g., computerized control system regulating water release)
- **Mitigating and Exacerbating Conditions**—Inadequate security can facilitate access to critical computer systems, allowing them to be used to conduct attacks, or gather information to support other terrorist-related activities.

According to the 2013 Intelligence Report:

> The Intelligence Agency determined "that there is a remote chance of a major cyber-attack against US critical infrastructure systems during the next two years that would result in long-term, wide-scale disruption of services, such as a regional power outage. The level of technical expertise and operational sophistication required for such an attack—including the ability to create physical damage or overcome mitigation factors like manual overrides—will be out of reach for most actors during this time frame.
>
> However, isolated state or non-state actors might deploy less sophisticated cyber-attacks as a form of retaliation or provocation. These less advanced but highly motivated actors could access some poorly protected US networks that control core functions, such as power generation, during the next two years, although their ability to leverage that access to cause high-impact, systemic disruptions will probably be limited. At the same time, there is a risk that unsophisticated attacks would have significant outcomes due to unexpected system configurations and mistakes, or that vulnerability at one node might spill over and contaminate other parts of a networked system.
>
> Within the past year, in a denial-of-service campaign against the public websites of multiple US banks and stock exchanges, company servers were flooded with traffic and prevented some customers from accessing their accounts via the Internet for a limited period, although the attacks did not alter customers' accounts or affect other financial functions.
>
> Hacktivists continue to target a wide range of companies and organizations in denial-of-service attacks, but we have not observed a significant change in their capabilities or intentions during the last year. Most hacktivists use short-term denial-of-service operations or expose personally identifiable information held by target companies, as forms of political protest. However, a more radical group might form to inflict more systemic impacts—such as disrupting financial networks—or accidentally trigger unintended consequences that could be misinterpreted as a state-sponsored attack. (Clapper, 2013)

Reports by the National Intelligence Agency to the Senate Intelligence Committee in March 2013 indicate that "U.S. agencies judge that there is only a 'remote chance' over the next two years of a 'major cyber-attack against US critical infrastructure' such as a regional power grid. Less sophisticated attacks, such as denial-of-service attacks against bank websites, could be more likely[19].

Recent victims include Sony Corp (Las Angeles, CA), which was breached at an unprecedented, well-planed level beginning November 24, 2014. Investigators have indicated that they feel the Sony attack was carried out by an organized group. While Guardians of Peace (GOP) have claimed responsibility for the

19 http://www.khq.com/story/21586758/spy-agencies-say-cyber-attacks-top-current-threats-against-us

hacking that has not been confirmed. Within days of the Sony Corp being struck by the initial attack, Sony PlayStation was also attacked with denial of service by patrons worldwide. In addition, Sony employees also received threatening emails from the GOP. While the primary suspect according to U.S. National Security sources is believed to be North Korea, the impact of the cyber-attack will have continued impacts on Sony and its employees, whose personal information was stolen during the incident.

Incendiary Attacks

From the standpoint of structural design, the vehicle bomb is the most important consideration and has been a favorite tactic of terrorists. Ingredients for homemade bombs are easily obtained on the open market, as are the techniques for making bombs. The severity of impact is based on the amount and type of explosive materials used. FEMA characterizes a terrorist attack involving an incendiary attack as follows:

- **Application Mode**—Initiation of fire or explosion on or near target via direct contact or remotely via projectile.
- **Duration/Threat Impact**—Generally minutes to hours.
- **Severity**—Extent of damage is determined by type and quantity of device, accelerant, and materials present at or near target. Effects generally static other than cascading consequences, incremental structural failure, etc.
- **Mitigating and Exacerbating Conditions**—Mitigation factors include built-in fire detection and protection systems and fire-resistive construction techniques, or security measures which reduce exposure. Inadequate security can allow easy access to target, easy concealment of an incendiary device, and undetected initiation of a fire. Non-compliance with fire and building codes, as well as failure to maintain existing fire protection systems, can substantially increase the effectiveness of a fire weapon.

It should also be noted that the likely target is often not the building under consideration by the risk assessment, but a high-risk building that is nearby. Historically, more building damage has been due to collateral effects than direct attack. Based on access to the agent, the degree of difficulty, and past experience, it can be stated that the chance of a large-scale explosive attack occurring is extremely low and that a smaller explosive attack is far more likely[20].

15.2.3 Severity

The severity of human-caused threats is challenging to measure due to the human nature involved and the unpredictability of the type of threat. In most cases, the intent behind a terrorist event is to cause high impact on people through death and injury, followed by economic impact (through property damage, loss of income, etc.) and loss of continuity of government.

In general, the largest credible explosive size of incendiary or explosive devices is a function of the security measures (deterrence mechanisms) in place. Each line of security may be thought of as a sieve, reducing the size of the weapon that may gain access. Therefore, the largest weapons are considered in totally unsecured public spaces (e.g., in a vehicle on the nearest public street), and the smallest weapons are considered in the most secured areas of a building (e.g., in a briefcase smuggled past the screening station). The FBI has provided Bomb Threat Stand-Off Distance calculations (Figure 15-4) for use in general emergency planning. Figure 15-5 provides additional information concerning potential impact.

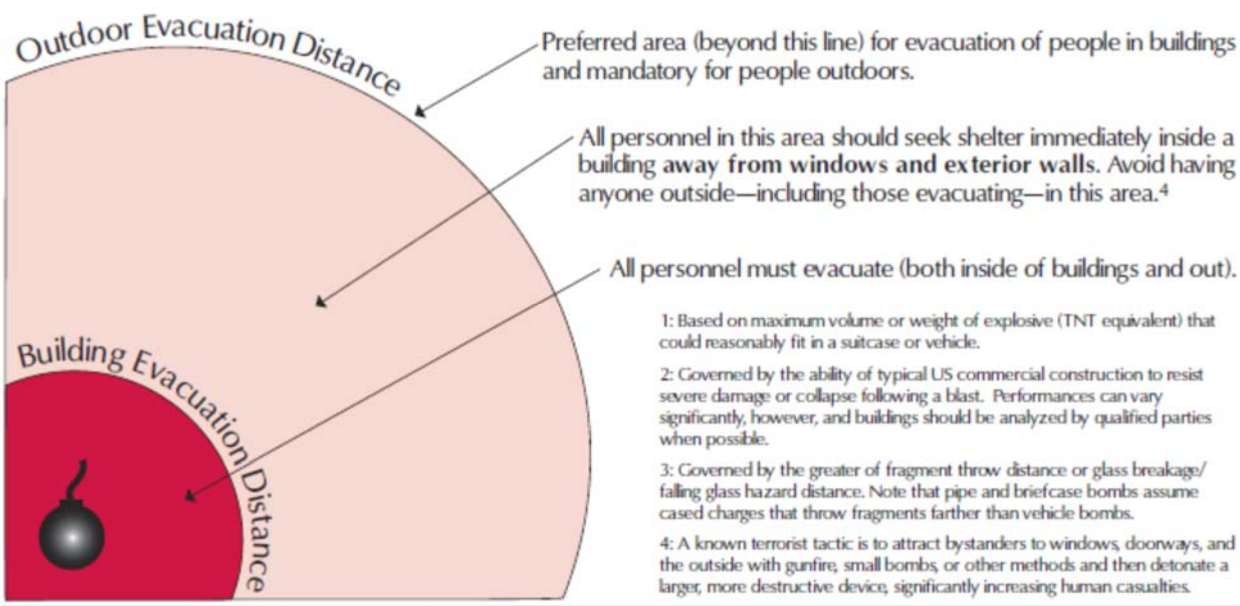
20 www.fema.gov/pdf/plan/prevent/rms/155/e155_unit_v.pdf FEMA 452: Risk Assessment: A How-To Guide to Mitigate Potential Terrorist Attacks

Source: http://www.nctc.gov/site/pdfs/ct_calendar_2014.pdf

Bomb Threat Stand-Off Distances

Threat Description	Explosives Capacity[1] (TNT Equivalent)	Building Evacuation Distance[2]	Outdoor Evacuation Distance[3]
Pipe Bomb	5 LBS/ 2.3 KG	**70 FT/ 21 M**	**850 FT/ 259 M**
Briefcase/ Suitcase Bomb	50 LBS/ 23 KG	**150 FT/ 46 M**	**1,850 FT/ 564 M**
Compact Sedan	500 LBS/ 227 KG	**320 FT/ 98 M**	**1,500 FT/ 457 M**
Sedan	1,000 LBS/ 454 KG	**400 FT/ 122 M**	**1,750 FT/ 533 M**
Passenger/ Cargo Van	4,000 LBS/ 1,814 KG	**600 FT/ 183 M**	**2,750 FT/ 838 M**
Small Moving Van/ Delivery Truck	10,000 LBS/ 4,536 KG	**860 FT/ 262 M**	**3,750 FT/ 1,143 M**
Moving Van/ Water Truck	30,000 LBS/ 13,608 KG	**1,240 FT/ 378 M**	**6,500 FT/ 1,981 M**
Semi-Trailer	60,000 LBS/ 27,216 KG	**1,500 FT/ 457 M**	**7,000 FT/ 2,134 M**

This table is for general emergency planning only. A given building's vulnerability to explosions depends on its construction and composition. The data in these tables may not accurately reflect these variables. Some risk will remain for any persons closer than the Outdoor Evacuation Distance.



1: Based on maximum volume or weight of explosive (TNT equivalent) that could reasonably fit in a suitcase or vehicle.

2: Governed by the ability of typical US commercial construction to resist severe damage or collapse following a blast. Performances can vary significantly, however, and buildings should be analyzed by qualified parties when possible.

3: Governed by the greater of fragment throw distance or glass breakage/ falling glass hazard distance. Note that pipe and briefcase bombs assume cased charges that throw fragments farther than vehicle bombs.

4: A known terrorist tactic is to attract bystanders to windows, doorways, and the outside with gunfire, small bombs, or other methods and then detonate a larger, more destructive device, significantly increasing human casualties.

Figure 15-4. FBI Bomb Threat Standoff Distance

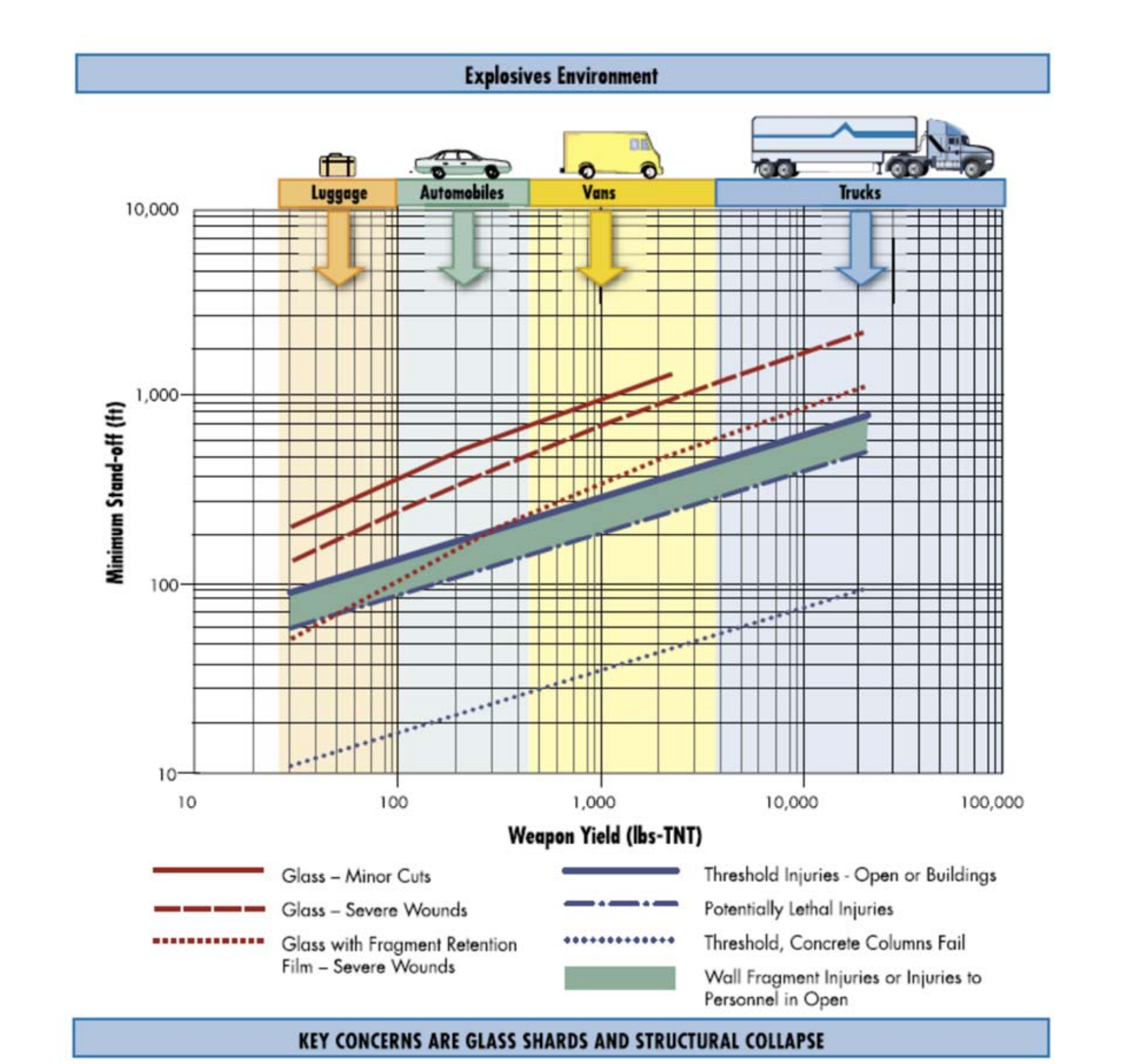


Figure 15-5. Explosive Impact

While these graphics provide information for use during an emergency situation, a building's given vulnerability to explosions depends on too many factors to determine a common, blanketed response determination. Construction and composition, as well as content, are also factors which pre-planning should take into consideration. This 2015 plan update provides general information for planning purposes only, and should not be used in making life-safety decisions. A much greater level of information would be necessary to determine safety measures, well beyond the scope of this planning document.

Mass-casualty incidents (MCI) could result from any human-caused threat, including random acts of violence such as shootings or hostage situations, detonation of explosive devices, such as the Boston Marathon bombing, or release of a WMD, including a chemical, biological or radiological incident, contaminating persons and requiring mass decontamination. Effects may include serious injuries, loss of life, and associated property damage. Because large numbers of patients may be involved, significant MCIs may tax local emergency medical and hospital resources, and therefore require a regional response.

15.2.4 Frequency

While education, heightened awareness, and early warning of unusual circumstances may deter crime and terrorism, intentional acts that harm people and property are possible at any time. Public safety entities would then react to the threat, locating, isolating, and neutralizing further damage and investigating potential scenes and suspects to bring criminals to justice.

Various terrorism trends have resulted in a threat environment more complex and diverse than ever before. In the past 4-5 years, al Qaeda, its affiliates, and homegrown terrorists all have attempted attacks on the homeland. New tactics and tradecraft have emerged that further complicate the myriad of threats facing the United States as a whole. The increased availability of information on the Internet has allowed terrorist groups to overcome their geographic limits and plays an increasing role in facilitating terrorist activities in any geographic location. Due to this more decentralized threat environment, the next attack could come at the hands of a well-trained al Qaeda operative equipped with a sophisticated improvised explosive device or a lone homegrown domestic terrorist using an automatic weapon to attack a shopping mall. In the past 14 years, terrorists have succeeded in attacking various areas in the United States several times, which have resulted in several fatalities and injuries, including:

- The intentional driving of an SUV into a crowd of students at the University of North Carolina–Chapel Hill in 2006
- The shooting at an army recruitment office in Little Rock, Arkansas, in 2009
- The shooting by U.S. Army Major Nidal Hasan at Fort Hood, also in 2009; and, most recently
- The bombings at the Boston City Marathon on April 15, 2013
- The Washington Navy Yard shooting which occurred on September 16, 2013, when lone gunman Aaron Alexis fatally shot 12 people and injured three others in a mass shooting at the headquarters of the Naval Sea Systems Command inside the Washington Navy Yard in southeast Washington, D.C.[21],[22].

As indicated, the number of active shooter situations has also increased, with targets including more businesses than any other industry type.

A large portion of attempts identified nationwide are considered homegrown terror plots. This means that one or more of the actors were American citizens, legal permanent residents, or visitors radicalized predominately in the United States when applying the Congressional definition of domestic or homegrown terrorist. Of 50 plots, primary target focal points included military facilities; highly populated targets, such as Seattle, and mass gatherings, such as the Boston Marathon, nightclubs and bars, and shopping malls[23].

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21 "Aaron Alexis easily passed two background checks, bought shotgun from Sharpshooters in Lorton, Va." The Washington Times. Retrieved November 23, 2014.

22 Yan, Holly; Duke, Alan (September 22, 2013). "Who were the victims of the Navy Yard shooting?" CNN. Retrieved November 23, 2014.

23 Jessica Zuckerman, Steve Bucci, Ph.D. and James Carafano, Ph.D. The Heritage Foundation. "60 Terrorist Plots Since 9/11: Continued Lessons in Domestic Counterterrorism, July 2013, http://www.heritage.org/research/reports/2013/07/60-terrorist-plots-since-911-continued-lessons-in-domestic-counterterrorism (Accessed November 17, 2014).

15.3 VULNERABILITY ASSESSMENT

15.3.1 Overview

In a study conducted by Purdue University, Island County was not identified within the group of 110 cities nationwide with the greatest probability to be the object of a terrorist incident, although Seattle, Tacoma and Spokane were identified. Terrorists go to great lengths to ensure their actions result in disproportionate impact, even if it means destroying an entire structure or killing and wounding thousands of persons proximate to the intended target. While the likelihood of a terrorist event is low, the fact that commercially available materials and agents can easily be developed into a WMD does not extinguish the potential for an incident to occur because the human factor involved is a constant variable. Additionally, anniversary dates often attempt to bring attention back to a specific issue, and are often viewed favorably by groups. Such is the case with members of the Order (Hammerskin), which annually travel to Island County on December 8.

Methodology

Terrorist targets can vary based on the intended outcome. A risk assessment for a terrorist incident is based on a system that measures a specific facility's or system's criticality and physical vulnerability. This type of analysis was not included within this project, but rather, information provided only to provide awareness of the types of incidents which have the potential to occur.

Warning Time

Only a very small percentage of all terrorism incidents are preceded by a warning from the terrorists themselves. However, in the case of the attempted bombings and various other terrorist activities nationwide, many have been thwarted as citizens are much more aware of their surroundings, and are providing key information to law enforcement, which greatly enhances the ability of public officials to provide critical advanced warning information. Likewise, law enforcement, through the sharing of information and establishment of new terrorist-related programs like state fusion centers, law enforcement personnel are able to gather intelligence information which is more reliable, allowing for precautionary measures to be taken to help reduce or eliminate the impact from terrorist incidents.

15.3.2 Impact on Life, Health and Safety

Impact on a human-caused event could range from an isolated incident to a highly coordinated act of destruction by multiple agents upon multiple targets. Large-scale incidents have the potential to kill or injure many citizens in the immediate vicinity, and may also affect people a relative distance from the initial event. The cost of a terrorist act would be felt in terms of loss of life, disruption of activity and long-term emotional impacts. Variables affecting exposure for a WMD attack include the type of product, the physical and chemical properties of the substance, the physical state of the product (solid, liquid, or gas), and the ambient temperature, wind speed, wind direction, barometric pressure, and humidity.

Although terrorism and civil disturbance have not resulted in a large number of deaths in this area, this type of hazard can be deadly and widespread, and has the potential to occur based on the unknown factor of human response and emotions. Any individuals exposed to these hazards are considered to be at risk, particularly those working as first responder professionals.

15.3.3 Impact on Property

Depending on the incident involved, property damage resulting from a human-caused threat could involve both private residences and business, and public facilities. According to the American Fact Finder[24], there are in excess of 40,279 housing units in the planning region (2010 data), with in excess of 22,986 units being owner-occupied and the remainder renter-occupied housing units. The majority of the structures are single-family units, the majority being built between 1970 and 2009.

The County has a total of four general purpose governments (cities/towns/county) and 39 special purpose districts (water, fire, hospital, schools, etc.), which own the majority of the governmental structures within the County. The Census also identifies approximately 8,000 businesses in the area (2007 Business Owner's Survey). The opportunity for access, unmonitored areas, and the proximity of many structures to transportation corridors and underground pipelines all have the potential to increase exposure of structures to human-caused threats.

15.3.4 Impact on Critical Facilities and Infrastructure

Critical infrastructure are customarily defined as assets, systems and networks, whether physical or virtual, so vital that the incapacity or destruction of such asset, system or network would have a debilitating impact on security, economy, public health or safety, or any combination of those matters[25].

There are a relatively high number of critical federal, state and local-government facilities within Island County, including several redundant systems.

All structures are physically vulnerable to human-caused threats. The emphasis on accessibility, the opportunity for roof access, driveways underneath some structures, unmonitored areas, the proximity of many structures to transportation corridors and underground pipelines, and the potential for a terrorist to strike any structure randomly all have an impact on the vulnerability of structures. In general terms, the majority of all critical facilities carry some level of risk because of their accessibility, including vehicle accessibility, and lack of a secure or hardened design.

15.3.5 Impact on Economy

Economic impacts from human-caused threats have demonstrated themselves to be significant as it includes not only the actual direct impact on businesses, but the potential for secondary economic loss from the inability of government to function fully. Recovery would take significant resources and expense at the local level. The impact from the World Trade Center bombings demonstrates how such a terrorist event can have global impacts on the economic front. While the primary impact of a terrorist act would be felt in terms of loss of life and injuries (mass casualties), property damage, disruption of business activity and long-term emotional impacts would take significant resources and expense at the local level, significantly impacting recovery.

15.3.6 Impact on Environment

Human-caused events have caused significant damage to the environment; however, estimating damage is difficult due to the variables of the threat itself. Loss estimation platforms such as ALOHA are able to measure potential environmental impacts based on inputs existing at the time of the event. For planning

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24 http://factfinder2.census.gov/faces/nav/jsf/pages/community_facts.xhtml

25 http://www.dhs.gov/what-critical-infrastructure

purposes, review of damages from past human-caused events provides credible information concerning potential environmental impact.

The risk of human-caused threats to the environment is considerable when considering the potential use of CBRNE materials. Reducing the exposure to the built environment will help mitigate potential losses to the natural environment.

CHAPTER 16.
TECHNOLOGICAL HAZARDS

16.1 GENERAL BACKGROUND

Technological hazards are associated with human activities during which an unintentional incident occurs with unintended consequences, or potentially resulting as a secondary impact from another hazard incident. Technological hazards are generally categorized as follows:

> **DEFINITIONS**
>
> ***Technological Hazards*****—**Hazards that result from accidents or failures of systems or structures.

- Hazardous materials incidents
- Infrastructure and utility losses
- Air, rail and highway transportation accidents
- Dam/levee failure
- Commodity flow

For purposes of this assessment, dam/levee failure is addressed within the dam and flood hazard profiles of the County's 2015 updated Hazard Mitigation Plan. Commodity flow is referenced within the various hazards discussed, but no commodity flow study has been conducted within the planning area, so the nature of discussion is based on a qualitative assessment.

16.1.1 Hazardous Materials Incidents

Title 49 of the Code of Federal Regulations lists thousands of hazardous materials, including gasoline, insecticides, household cleaning products, and radioactive materials. Entities are required to report use, manufacture and storage of hazardous materials based on the type and quantity of materials. The use of hazardous materials is associated with almost every industry to some degree, increasing the potential for a hazardous material incident. These hazardous materials incidents can be associated with the manufacture, transportation, storage and the daily use of hazardous materials. Within Island County, review of current facilities include industries ranging utilizing Methanol to sulfuric acid, with businesses ranging from communications to animal health facilities which utilizes hazardous materials. Figure 16-1 identifies the hazardous materials sites throughout the County.

As if 2014 filings, there are 112 Tier II facilities throughout Island County, including facilities that produce, store, or utilize chemicals as in course of business. For example, water treatment plants use chlorine on-site to eliminate bacterial contaminants. Hazardous materials are transported along interstate highways and railways daily. Even the natural gas used in every home and business is a dangerous substance when a leak occurs. The following are the most common type of hazardous material incidents:

- **Fixed-Facility Hazardous Materials Incident**—This is the uncontrolled release of materials from a fixed site capable of posing a risk to health, safety and property as determined by the Resource and Conservation Act. It is possible to identify and prepare for a fixed-site incident because federal and state laws require those facilities to notify state and local authorities about what is being used or produced at the site.

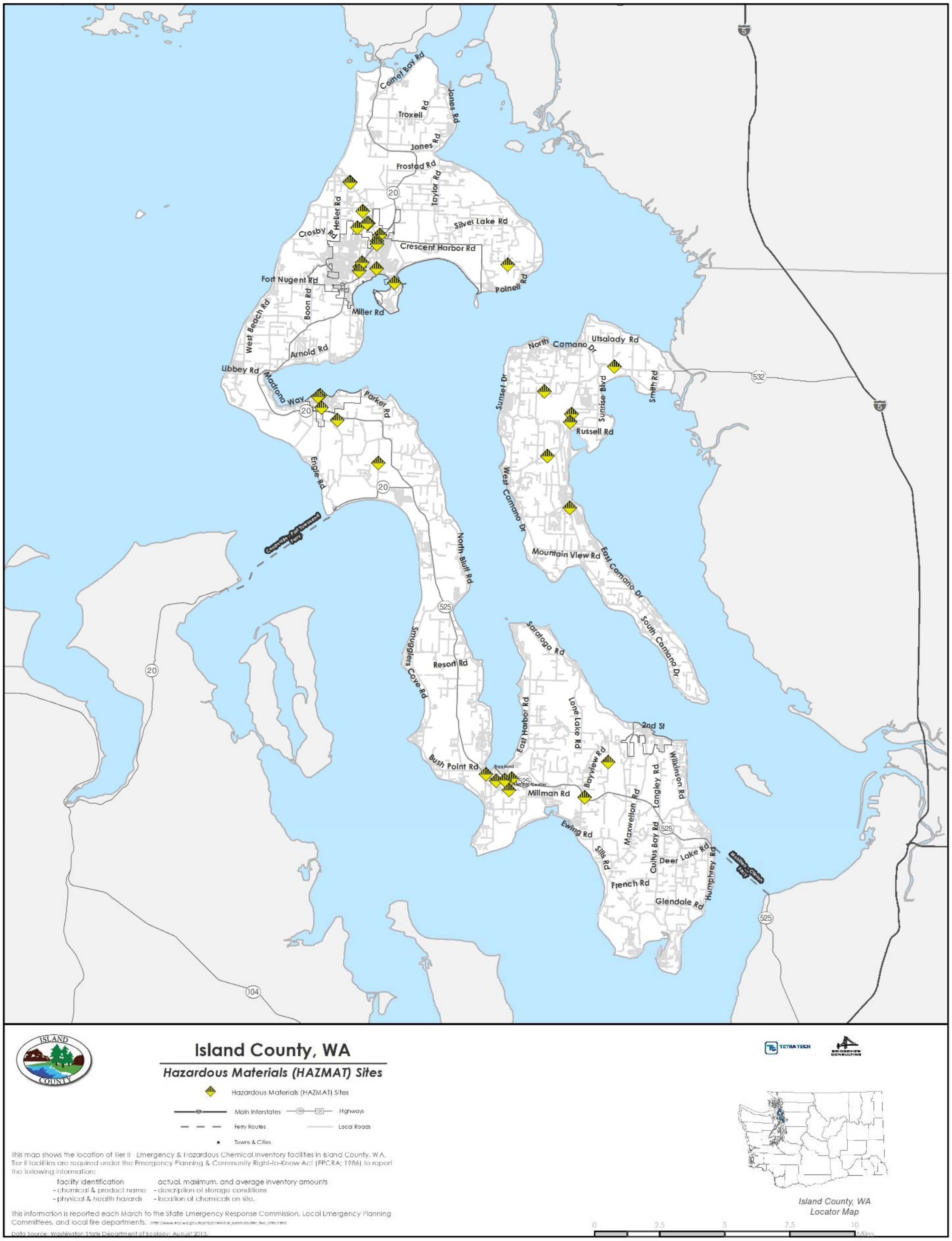

Figure 16-1. Hazardous Material Locations in Island County

- **Hazardous Materials Transportation Incident**—A hazardous materials transportation incident is any event resulting in uncontrolled release of materials during transport that can pose a risk to health, safety, and property as defined by Department of Transportation Materials Transport regulations. Transportation incidents are difficult to prepare for because there is little if any notice about what materials could be involved should an accident happen. Hazardous materials transportation incidents can occur at any place within the country, although most occur on the interstate highways or major federal or state highways, or on the major rail lines.

  In addition to materials such as chlorine that are shipped throughout the country by rail, thousands of shipments of radiological materials, mostly medical materials and low-level radioactive waste, take place via ground transportation across the United States. Many incidents occur in sparsely populated areas and affect very few people. Occasionally, however, accidents occur in areas with much higher population densities, such as the January 6, 2005 train accident in Graniteville, South Carolina that released chlorine gas killing nine, injuring 500, and causing the evacuation of 5,400 residents. Or the April 2013 West Fertilizer Company plant explosion in West, Texas which killed 15 people and injured hundreds more, flattening buildings and prompting widespread evacuations. Fortunately, such events are rare.

- **Interstate Pipeline Hazardous Materials Incident**—There are a significant number of interstate natural gas, heating oil, and petroleum pipelines providing natural gas to utilities and transporting these materials from production facilities to end-users.

The Washington State Hazardous Materials Program consists of several agencies, each responsible for specific elements of the program. A number of strategies have evolved to limit risk, response to, and recovery from hazardous materials releases, intentional discharges, illegal disposals, or system failures. A comprehensive system of laws, regulations, and resources are in place to provide for technical assistance, environmental compliance, and emergency management.

As of 2015, Island County and other planning partners do have an active local emergency planning committee according to State records. This committee, in concert with the Department of Emergency Management, conducts hazard identification, vulnerability analysis, and risk analysis activities for its jurisdiction. Federal and state statutes require local emergency planning committees to develop and maintain emergency response plans based on the volumes and types of substances found in, or transported through, their districts.

16.1.2 Infrastructure and Utility Failure

Technological hazards can impact all utilities within Island County. Figure 16-1 identifies the various types of energy consumption throughout Island County, which could be impacted by a utility failure. Impact can occur as a result of system failure – such as a Supervisory Control and Data Acquisition (SCADA) computer system which is used to monitor and control plant or equipment industries, or as a result of an accidental incident severing lines.

- **Electrical Power—**A power failure is any interruption or loss of electrical service due to disruption of power generation or transmission caused by an accident, natural hazards, equipment failure, or fuel shortage. These interruptions can last anywhere from a few seconds to several days. Power failures are considered significant only if the local emergency management organization is required to coordinate basic services such as the provision of food, water, and heating as a result. Power failures are common with severe weather and winter storm activity.
- **Natural Gas –** The loss of natural gas or interruption of service caused by an accident natural hazards, equipment failure – including lines or SCADA systems, or commodity shortage. These

interruptions can last a short period of time to several days. The loss of natural gas when a primary heat source can have significant impact on the population of Island County if the event occurs during periods of a cold-weather.

- **Cyber Failure, Data and Telecommunications—**The loss of data (non-terrorist related event) and/or telecommunications is often a secondary hazard to natural and or technological hazards. Data and telecommunications provide a primary method for service to the community by the government and the private sector. A loss of data and telecommunications could result in loss of emergency dispatch capabilities, emergency planning services, infrastructure monitoring capabilities, access to statistical data, and loss of financial and personnel records. Sustained loss of data could impact continuity of governmental operations. Random hackers are one source common to cyber-attacks, as are organized crime syndicates who also engage in cyber-attacks for monetary gain, primarily through the use of stealing personal information such as credit card numbers (identity theft).
- **Water Disruption—**A breach in water pipelines in the County would have significant temporary impacts until alternative water sources are obtained. Long-term disruption of the water supply would have significant impacts on residences and businesses should demand exceed secondary supplies and water conservation measures not provide enough relief to reduce demand to equal the secondary supplies.
- **Wastewater Disruption—**Disruption of wastewater collection and treatment would have significant regional impacts. Wastewater treatment plants may also have emergencies internal to the plant such as chlorine gas leaks or oxygen deficiencies that render them incapable of treating waste. The disruption of service may also have significant environmental impacts on the waterways adjacent to the treatment plants.

Loss of these services due to accidents would mean a potential life-threatening situation in the case of electricity for medically dependent residents, and a public health threat if the services are disrupted for some time. Loss of services could also impact the continuity of government operations.

16.1.3 Transportation Accidents

Transportation accidents are incidents involving air, roadway, or marine vessel passengers resulting in death or serious injury. Island County has several airports, two ferry systems, and several primary roadways which serve as the only ingress and egress to portions of the County (Figure 16-2). Incidents can occur on in the air, on waterways, highway/roadways, bridges and overpasses, all of which have the potential to shut down transportation for extended periods of time.

Airports

The region has five airports, which enhances the potential for an air disaster:

- Camano Island Airport
- Oak Harbor Air Park
- Coupeville Outlying Field
- Whidbey Air Park
- Ault Field (NASWI)

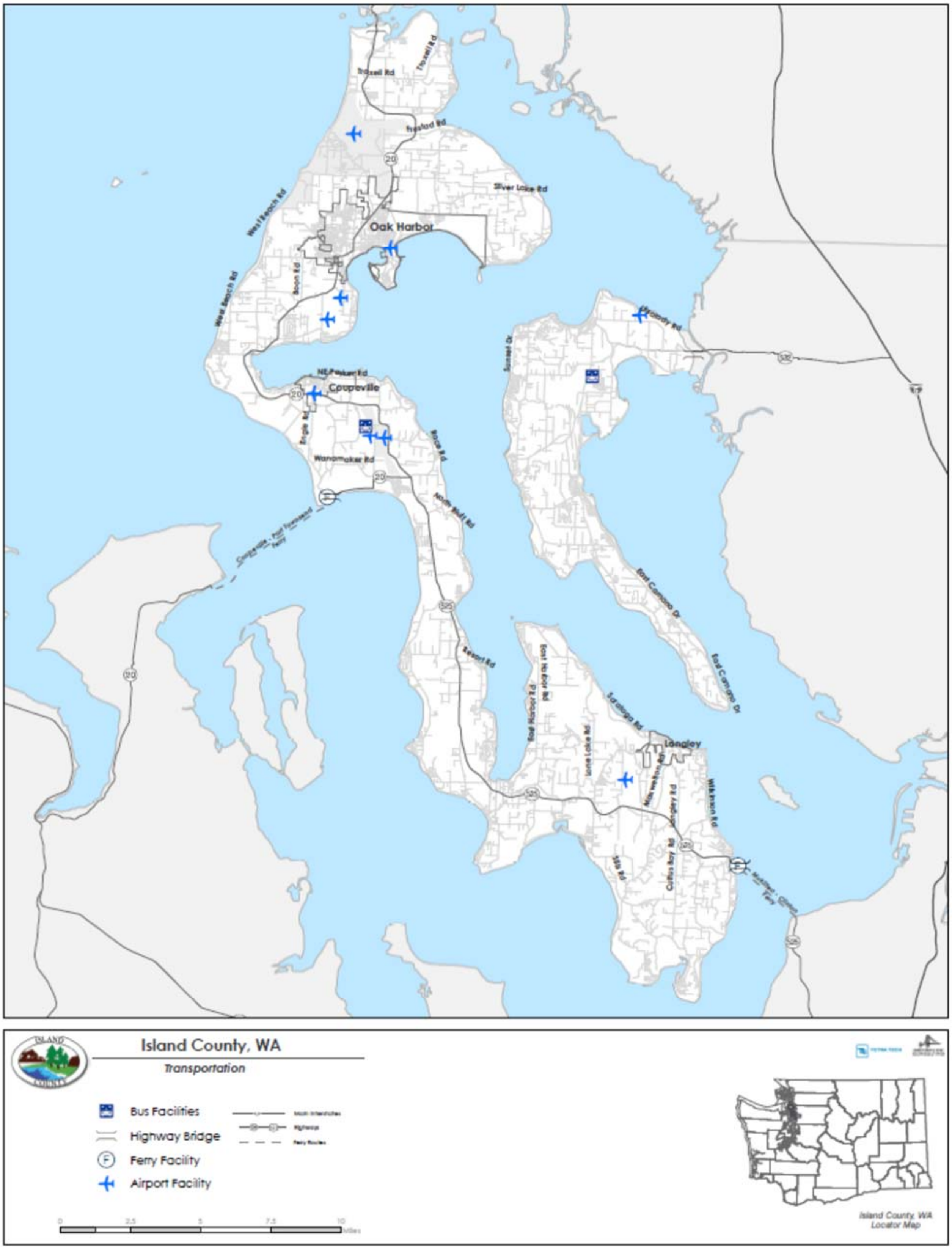

Figure 16-2. Island County Transportation

Ault Field, or Naval Air Station Whidbey Island (Figure 16-3), is the premier naval aviation installation in the Pacific Northwest, and home of the Navy tactical electronic attack squadrons. In addition to the designated airports, Whidbey Island General Hospital also has a heliport site for medical transportation purposes.

Figure 16-3. Naval Air Station Whidbey Island

Highways

Several major transportation routes, including SR 20, 525 and 532 run through the county. The potential for transportation accidents that block ingress, egress, and commodity-flow movement through the county is significant, as well as the likelihood of hazardous materials incidents resulting from a traffic accident.

Bridges

According to the U.S. Dept. of Transportation, Federal Highway Administration, Island County has seven bridges, covering an area of 12,897 square meters. Of the total bridges, five are considered functionally obsolete, but none are considered structurally deficient[26]. Of the seven bridges, four are considered critical transportation routes.

Rail

The County has no rail facilities traveling through its boundaries, although BNSF does have lines which come in close proximity to the shoreline and county boundaries (Figure 16-4). Spills associated with any BNSF shipment would have a significant environmental impact on the County.

[26] US Dept. of Transportation, Federal Highway Administration. Available at: http://www.fhwa.dot.gov/bridge/nbi/county09c.cfm#wa. Accessed December 11, 2014.

Figure 16-4. Washington State Rail System

Ferry Systems and Marinas

Two primary Washington State Ferry Terminals serve as critical transportation hubs for the County – the Keystone Ferry Terminal in Coupeville, and the Clinton Ferry Terminal in Clinton. The County also has three different marinas within the planning area: Cornet Bay, Oak Harbor and Langley.

16.2 HAZARD PROFILE

16.2.1 Overview

Hazardous Materials

All communities located near Island County's transportation corridors are subject to the probability of a significant hazardous materials release. Hazardous materials are transported over or near numerous wetlands, environmentally sensitive areas, and through densely populated centers. Proximity of critical infrastructure to hazardous materials facilities does increase the risk of exposure to such chemicals.

Natural disasters like floods, landslides, and earthquakes can also trigger hazardous material incidents. Illegal drug labs used for methamphetamine manufacturing, and illegal dumping of drug paraphernalia and items used to cook drugs present yet another hazardous materials concern. Recent history shows an increase in the national threat from terrorist use of hazardous materials. The combination of possible sources of exposure to our sizable population and workforce presents complex problems to responders.

Infrastructure and Utility Failure

Societal norms indicate that we are fully dependent upon information technology and information infrastructure. At the core of the information infrastructure upon which we rely is the Internet, which connects one computer to another, networking the nation's infrastructure and essential services. Services such as electrical transforms, water distribution centers, security systems (radar), and economic sectors (stock markets) all exist with the infrastructure at its nexus.

While a technological incident of cyber-failure can occur internal to organizations or be a widespread incidents due to an accident or resulting from a natural hazard, loss of information networks can have serious consequences, such as disruption of critical operations, loss of revenue or intellectual property, or loss of life. Of primary concern is the lack of redundant systems (or security measures) which could impact infrastructure to the extent capable of causing debilitating disruption, including compromising computer functions, and prolonged disruption of service. Those impacted by such cyber failures, including potential data loss, can include government and private sector owned control systems for transportation and communications, industrial processes, power and other utility generation and distribution.

Transportation

The range of magnitude of impact from transportation incidents varies depending on the mode of transportation involved. Incidents involving commercial vehicles carrying hazardous materials; impact from incidents involving structural integrity of bridges; incidents involving the ferry system, or air traffic traveling over jurisdictions can have a devastating impact on the County. Given the reliance on ferry travel, freight and other cargo moved over public access routes, the potential for a major transportation issue is relatively high.

16.2.2 Extent and Location

Hazardous Materials

With respect to locations of impact or concern from hazardous materials incidents, the most vulnerable areas are those associated with the storage of hazardous materials, and those areas adjacent to the major transportation corridors. Island County, being a moderate-to-high agricultural community, maintains minimal quantities (below 2013 reporting limits) of two of the most potentially dangerous fertilizers.

Major transportation corridors are often adjacent to highly populated commercial and residential centers. The greatest threat appears to be the transportation corridor through the City of Oak Harbor, which has 55 registered types of chemicals in quantities rising to the level of annual reporting. The majority of these are some type of fuel providers, including aviation fuel, diesel fuel and propane. Oak Harbor also has one facility which maintains Chlorine at a level which requires annual report to the State Dept. of Ecology. Other areas of the County, including the unincorporated areas also have reportable chemicals, with 100 sites maintaining high enough levels to file annual reports with the Department of Ecology. 10 sites maintain sulfuric accident at reportable levels. Coupeville has 13 regulated types of fuel, the majority associated with fueling stations; Langley has four, three of which are with the public works department.

Also of concern are illegal operations such as laboratories for methamphetamine pose a significant threat. Laboratory residues are often dumped along roadways, left in rented hotel rooms, transported in the back of vehicles, or cooked within residential structures. All of these scenarios create a serious health threat to unsuspecting individuals, first responders, hazmat clean-up entities, and to the environment.

Illegal dumping sites for hazardous wastes such as used motor oil, solvents, and paint often dumped in remote areas or along roadways, creating a potential health threat to unsuspecting individuals and to the environment. Chemicals leaking from containers seep into groundwater, or are carried distances by vehicles traveling through the sites. These chemicals also increase fire danger as many are highly flammable and can cause fires to spread more quickly by acting as a fuel source.

Accidental releases of pesticides, fertilizers, and other agricultural chemicals may be harmful to both humans and the environment. Agricultural pesticides are regularly transported in and around Island County. As a community with a moderate agricultural industry, Island County does maintain some levels of pesticides, fertilizers and other agricultural chemicals year round, with increased quantities during the growing seasons.

Licensed carriers also transport radioactive materials along transportation routes through and near Island County.

Infrastructure and Utility Failure

All areas of the County are susceptible to infrastructure failure or disruption of service as a result of technological hazards. The impact on computer systems can include government and private sector owned control systems for transportation and communications, financial disruptions, industrial processes, power and other utility generation and distribution.

Transportation Routes

All transportation facilities all have the potential for impact related to technological hazards, which have the potential to impact commodity flow. Island County Transportation routes include:

- Rail (proximity to county boundaries)
- Highway
- Marine
- Air
- Bridges
- Commodity Flow

All areas and modes of transportation can be impacted from the various technological hazards. Air and rail transportation can be disrupted through cyber-failures; highway and marine traffic can be impacted from hazardous materials incidents, as well as technological hazards. Bridges can be shut down as a result of a vehicle striking the bridge structure itself.

Commodity Flow

Pipelines

Pipeline statistics are difficult to assimilate, so limited data is available which demonstrates capacity and transport of the various substances transported through a region. The Washington State Utilities and Trade Commission has identified some pipeline activities which impacts Island County as identified in Figure 16-5. Pipelines distribute several different types of materials that are widely used throughout Island County with respect to heating fuel as identified in Table 16-1.

Commodities in general can be impacted from incidents occurring outside of the immediate vicinity. Such incidents have occurred previously within Washington on a number of occasions, including the 2006/2007 flooding along the I-5 corridor which required detours of in excess of 500 miles to Eastern Washington. More locally, such an incident occurred after the Tesoro (Anacortes) Refinery explosion, which occurred on April 2, 2010. As a result of the explosion, fuel prices rose significantly as a result of the disruption in production, and the fact that the transition was occurring between winter and summer fuels blends.

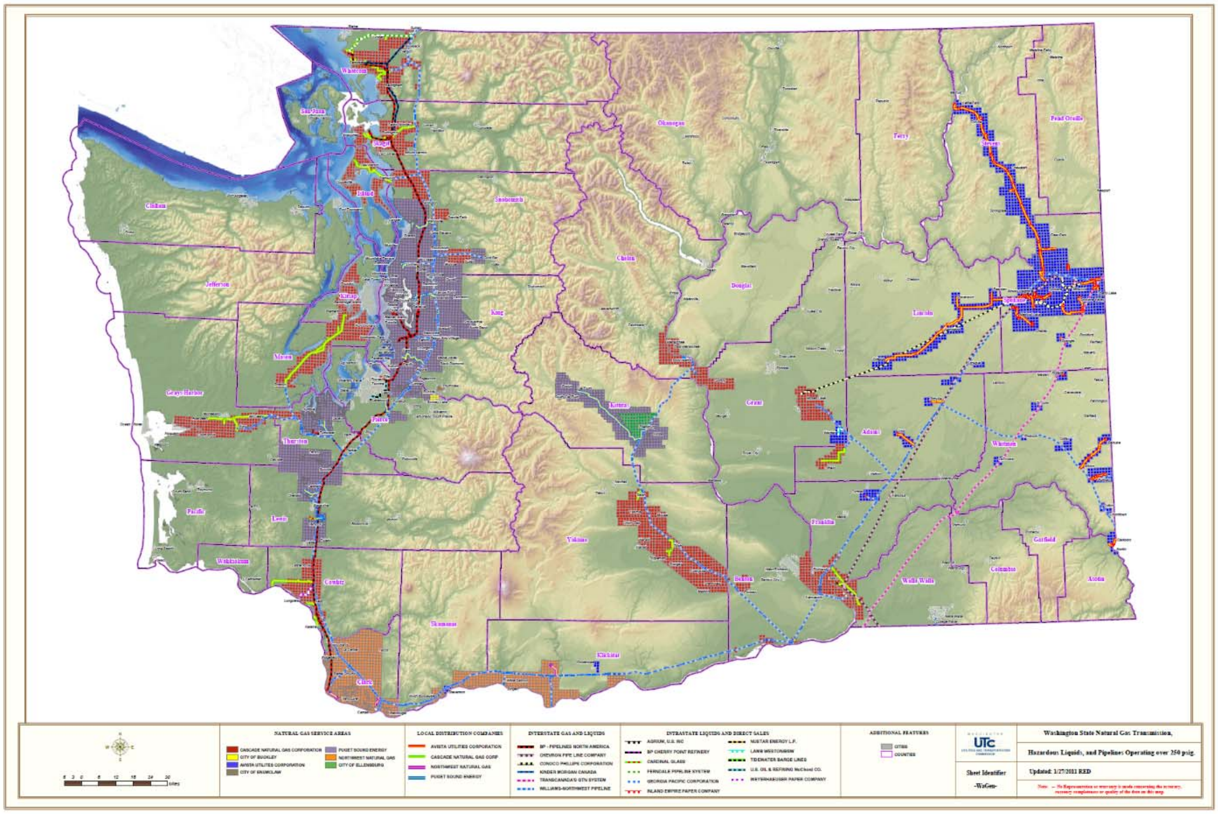

Figure 16-5. Washington State Utility Trade Commission Pipeline Data

TABLE 16-1.
HEATING FUEL USAGE BY TYPE, 2008-2012

Fuel Used by Housing Unit	No. of Units	Percent of Units	Usage Ranking	Percent Usage Statewide Totals	Percent Usage US Totals
Total Housing Units	33,190	100%		2,619,995	115,226,802
Utility Gas	5,657	17.04%	20	35.49%	49.42%
Bottled, Tank, or LP Gas	7,113	21.43%	1	3.25%	5.03%
Electricity	16,295	49.10	31	52.97%	35.51%
Fuel Oil, Kerosene, etc.	778	2.34%	19	2.89%	6.46%
Coal or Coke	0	0.00%	0	0.02%	0.12%
Wood	2,916	8.79%	18	4.46%	2.08%
Solar Energy	0	0.00%	0	0.03%	0.04%
Other Fuel	333	1.00%	12	0.63%	0.43%
No Fuel Used	98	0.30%	6	0.25%	0.90%

“0” Represents no reported usage to Census data
Based on 2008-2012 Data
Source: http://www.usa.com/island-county-wa-housing--historical-house-heating-fuel-data.htm

Fuel and Food

Given areas of potential isolation restricting the delivery of commodities during a significant incident, this is of moderate concern to the planning partners due to the limited resources available within the planning area. The planning team has identified two different mitigation strategies to address this potential issue:

- Gather information with respect to the number fueling stations and grocery stores which have generators to allow the continued pumping of fuel, as well as the ability to keep food products at the appropriate temperatures to avoid spoilage;
- Gather information on the number of days of surplus supply various distributors in the area maintain.

Once captured, this information will help for planning purposes with respect to fueling plans, and identifying other needs with respect to items such as water, and a system to deliver fresh water for drinking purposes. The lack of surplus water is of significant concern to all of the planning partners, as there are over 2,000 water purveyors on Island County, many of which are very small in nature (one or two homes), and the majority do not have generators to pump water. The County and its planning partners are looking at potential opportunities to ensure a continued supply of water should a significant incident occur.

16.2.3 Past Occurrences

Hazardous Materials[27] [28] [29]

Hazardous material incidents may occur at any time in Island County. During the time period January 1-December 31, 2014, there were 41 related spills reported to the Washington State Department of Ecology. These spills include vessels (marine and vehicles) and facilities. Of the 41 related spills reported, 16 were related to equipment failure, six were as a result of human error, four related to external conditions; and the cause to the remaining spills is unknown. Of the 43 reported incidents:

- 20 occurred in Unincorporated Island County (11 Camano Island, three Clinton; four Freeland; one Greenbank; one on Whidbey Island);
- 4 occurred in Coupeville (two equipment failures, one site release of unknown origin, and one was an algae phenomenon);
- 2 occurred in Langley (both commercial, one from the marina)
- 15 occurred in Oak Harbor (primarily petroleum; three at a facility, three from a vehicle, three from private vessels; one on private property, and one on public lands; three from unknown sources; one from an indoor burn).

In addition to the hazardous material releases, Washington State Department of Ecology has recorded 96 incidents of meth lab occurrences in Island County during the time period 1990-2012 (see Figure 16-6).

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[27] Department of Ecology - Spill Response Clandestine Drug Lab and Dump Site Cleanup Activity 1990-2012 http://www.ecy.wa.gov/programs/spills/response/drug_labs/County_Table_1990_to_2012.pdf

[28] Department of Ecology - Spill Response Clandestine Drug Lab and Dump Site Cleanup Activity 1990-2012

[29] Department of Ecology - Meth Incidents With Field Response By County/City *, Site Type

http://www.ecy.wa.gov/programs/spills/response/drug_labs/2010%20Meth%20Lab%20Response%20By%20County.pdf

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	TOTAL
Adams								1		1		3	4	4			1			2	2			18
Asotin										1	1	5	3	4						1				15
Benton				1		1	3	4	7	38	52	85	87	82	57	16	13	9	4				11	470
Chelan				1		1	1			2	14	34	15	13	9	3		6	1	1			1	102
Clallam					1	1	1	3	3		1	3	10	2	2		2	3	3		1		1	37
Clark	5	2	4	1	3	3	12	20	12	16	34	57	57	35	28	18	9	6	4	4	1	3	3	337
Columbia										1	3	2	1	4	1		1							13
Cowlitz			3	1		1	3	9	2	8	7	9	28	18	11	6	5	3	4	1				119
Douglas									1	1	6	5	7	4	8	6								38
Ferry											7	4												11
Franklin									1	8	10	15	11	13	14	3	1			1			2	79
Garfield										2			4	1		1								8
Grant			2			1				2	19	27	46	34	14	11	15			7	6		7	191
Grays Harbor	3	1		2	2	1	3	5	5	16	24	41	32	50	27	28	2	14		2	1	1	2	262
Island						1		1	2	5	1	5	5	14	18	5	6	4	4	22	2		1	96
Jefferson								1	1	2	7	6	4	12	2	1	5		1	1			1	44
King	6	10	2	7	7	10	23	17	48	107	231	271	241	202	199	123	63	42	37	16	11	5	7	1685
Kitsap	1	1	2	1			3		1	21	45	54	60	50	44	18	2	1	1		1	1	15	322
Kittitas				1		1			1	3		5	3	5	3	6		3			1		1	33
Klickitat			1			1	1	1	3		6	4	2	1		1	2	1	2		1			27
Lewis	3	1	1	2	3	4	7	9	31	33	43	61	83	67	30	22	14	3	5	6	3	1	2	434
Lincoln			1									5	3	2	1	1	1	1						15
Mason	3			2			4	4	10	21	32	30	22	15	32	32	6	4	7	3	3	1	1	232
Okanogan			1					2	3	2	2	3	3	1	4		3	1						25
Pacific						1		4	1	6	2	3	4	3	2	2							1	29
Pend Oreille				1				2	6	10	12	5	12	6	7	5	2				2			70
Pierce	10	18	18	12	17	17	53	42	129	318	545	589	438	466	542	349	148	76	71	56	35	16	14	3979
San Juan												1	1											2
Skagit				1		1			4	2	5	11	34	12	31	12	9	4	3		3	6		138
Skamania	1									2	1	2	3	3	1	1	2	2			1		1	20
Snohomish	2	2		2			7	6	5	13	37	69	83	98	102	43	14	15	12	19	11	8	1	549
Spokane					1	2	1	7	11	36	137	248	189	91	42	21	28	14	3	16	6	3	7	863
Stevens		1					1	1		5	4	15	10	3	5	5	3	2		3	1	1		60
Thurston	1	4	5	4	2	6	25	63	58	86	139	151	115	96	62	37	18	6	15	7	1		4	905
Wahkiakum										1		2	2	2		1	1							9
Walla Walla									2	8	12	16	15	16	9	4	1	8	2	3				96
Whatcom				1								5	9	24	25	14	6	2	3	4			1	94
Whitman											1	3	4		2	5				1	1			17
Yakima	3	3		2		1	5	1	2	12	14	36	43	27	7	9	7	7	2	10	1			192
TOTAL	**38**	**43**	**40**	**42**	**36**	**54**	**153**	**203**	**349**	**789**	**1454**	**1890**	**1693**	**1480**	**1341**	**809**	**390**	**237**	**184**	**186**	**95**	**46**	**84**	**11636**

Figure 16-6. Department of Ecology Report on Meth Lab Incidents 1990-2012

Infrastructure and Utility Failure

Infrastructure and utility failure can result from a multitude of incidents covering large areas. Incidents can range from computer input or operator error to a lone vehicle striking a major power distribution line as a result of an accident.

Cyber failure can and does occur throughout the County, including both public and private organizations, but most often goes unreported for tracking purposes. The most frequent local cyber issues involve disruption of service due to internal problems, and are more centralized in location of impact. However, with the reliability on fiber optic cables, the exchange of information relying on the Internet, and the reliability on control systems for delivery of service illustrates that impacts from technological incidents do not have to be focused on incidents occurring within Island County, or even Washington State, but can occur great distances away. Recent incidents involving large companies such as Sony is demonstrative of the vulnerability associated with cyber failure and security.

The 2003 failure of the Northeastern power grid resulting from operator error impacted 50 million customers in eight US states and the province of Ontario. The September 2011 event impacting portions of the Western power grid (Arizona, Southern California, Baja California and Mexico) affected nearly 3 million customers. Inter-dependence on critical infrastructure such as power generation affects mass areas susceptible to potential impact from a technological incident. Fortunately, neither Washington nor Island County has experienced similar type widespread disruptions. Rather, most disruptions occur as a result of natural hazard impact such as a severe weather event and are more locally focused.

Transportation Issues

Transportation issues occur regularly throughout the County. Daily accidents disrupt commutes. Ferry issues associated with weather events or reduction in the number of ferry runs have occurred, disrupting transportation throughout the County, shutting down both passenger and cargo lines. The airports throughout the County have also experienced flight cancelations and delays due to various types of events, including computer issues. Camano Island has been impacted two times as a result of road closures – once from a fire response and the second time as a result of severe weather impacting the roadway.

16.2.4 Severity

The severity of technological hazards is challenging to measure because of the multitude of variables that are involved, and in many instances, the lack of data supporting such incidents. Effects may include serious injuries or loss of life (mass casualty incident), associated property damage, impacts to commodity flow, and lack of continuity of government.

Due to a potentially large number of patients that may be involved in a technological incident, significant mass casualties may tax local emergency, medical and hospital resources, and therefore require a regional response. The first responders, including fire, police, emergency room personnel at local hospitals, and coroner's offices develop and plan for response of such incidents; however, as in most cases, resources are limited. Island County has mutual aid agreements in place should local officials be unable to respond appropriately with available personnel and equipment.

Hazardous Materials

Hazardous material incidents are a significant issue within Island County due, in part, to the unknown quantities and types being shipped through the County, as well as the amount of hazardous materials known to exist for the various purposes mentioned. While hazardous material incidents can be both intentional and/or unintentional releases of a material, because of their chemical, physical, or biological nature, they pose a potential greater risk to life, health, environment, or property. Each incident's impact and resulting response depend on a multitude of interrelated variables that range from the quantity and specific characteristic of the material to the conditions of the release and area/population centers involved. Releases may be small and easily handled with local response resources or rise to catastrophic levels with long-term consequences, such as was recently experienced in West, Texas with the destruction of the West Fertilizer Company. Fifteen people were killed as a result of the explosion, with hundreds injured. Approximately 37 square blocks of the surrounding community was destroyed, including businesses, schools, residences and a nursing home. The USGS recorded the explosion as a Magnitude-2.1 tremor. Damage from the explosion was estimated by the Insurance Council of Texas to exceed $100 million of insured losses; the town received a Presidential Disaster Declaration and sought recovery in excess of $57 million.

The Tesoro Refinery Explosion and Fire[30] on April 2, 2010 in Anacortes (see Figure 16-7) cost the lives of seven refinery workers (two women and five men). The fire impacted supplies within Washington, causing gas prices to increase as the incident occurred during the exchange from winter to summer fuels. To date, this is the largest fatal incident at a US petroleum refinery since the BP Texas City accident of March 2005.

Washington also experienced another tragic event on June 10, 1999 in Bellingham as a result of an explosion of a 16-inch fuel line owned by Olympic Pipe Line, spilling 277,200 gallons of gasoline into two local creek beds, and killed three young men.

30 http://www.csb.gov/assets/1/7/Tesoro_Anacortes_2014-May-01.pdf

Figure 16-7. Anacortes Refinery Fire

While no such events have previously occurred within Island County, the potential for a similar type event exists due to the amount of chemicals stored and transported throughout the region.

Infrastructure and Utility Failure

The length associated with the power disruption can vary from a few hours, to in excess of weeks as was the case with the 1996 power outage resulting from an ice storm. The issues surrounding the primary cause of the power failure has the potential to increase severity, such as extreme heat or cold weather, which has the potential to increase impact on health and safety.

Cyber Failure

Cyber-failure on information networks can have serious consequences, such as disruption of critical operations, loss of revenue or intellectual property, or loss of life. Of primary concern is the threat that malicious actors attack our critical information infrastructure to the extent capable of causing debilitating disruption, including compromising computer functions, and promoting fear. Cyber failures occur with some regularity to at least some degree. The severity of impact from such a failure is associated with damage to equipment and loss of data, as well as the system itself as would be the case for a system regulating power, water flow, etc. The time involved can range from minutes to days depending on the issue. The longer the system remains down, the greater the severity of impact.

Cyber-attacks are discussed in Chapter 15.

Transportation

Several primary critical infrastructure routes and other forms of transportation have the potential for a mass-casualty incident (MCI) because of the heavy volume of traffic. Adverse weather may play a role in transportation accidents, enhancing the potential for an MCI incident. However, MCIs can occur throughout the County at any time or day.

16.2.5 Frequency

Hazardous Materials

The locations of businesses and industry, hospitals, medical facilities and laboratories that use hazardous materials, as well as the presence of scattered illegitimate clandestine drug laboratories and the improper disposal of hazardous waste demonstrate unknown risk factors which make the determination of frequency of an occurrence in a quantitative manner impossible due to the unknown variables. However, based on the review of the existing data, in a qualitative assessment, the likelihood of occurrence of some level of hazardous material incident is moderate to high. With the increased transportation of various chemicals through the county, the potential exists for increased frequency of hazardous materials incidents.

Infrastructure and Utility Failure

The utility infrastructure may also be impacted as a result of various hazard-related events, or through accidental events. Routinely, the County and its jurisdictions can expect at least one incident of power failure annually based on review of historical records. The length associated with the power disruption can vary from a few hours, to in excess of weeks as was the case with the 1996 power outage resulting from an ice storm. As part of the Western Electricity Coordinating Council, major power distributors in the County work with regulatory agencies to ensure protection of our power distribution centers.

Cyber-infrastructure failure resulting from non-terrorist related attacks against computers, networks and/or information stored thereon, can occur at any time with no advanced warning. Cyber failure occurs with regular frequency as a result of server failure, power outages, lines being severed, etc. The time involved can be from minutes, to days depending on the issue.

Transportation

Over the course of time, the number of transportation conveyances has grown significantly throughout the County, with increased populations traversing the roadways; however, review of the National Highway Transportation Safety Administration statistics in Table 16-2 shows that since 1994, the number of fatalities resulting from vehicle accidents has decreased throughout the Washington State[31]. Nationally, the percentage decline in private vehicle (PV) occupant fatalities since 2005 was higher for age groups <16 (46%), 16 to 20 (43%) and 35 to 44 (41%), and lower for groups 45 to 64 (27%) and 65+ (22%). Driver fatalities declined by 30 percent compared to the 39-percent decline in passenger fatalities. Van occupant fatalities dropped by 46 percent, compared to the decline in fatalities to occupants of passenger cars (36%), pickups (30%) and SUVs (21%). Fatalities on interstate highways dropped more (38%) than fatalities on local roads (26%). Of the 10 largest annual percentage declines in occupant fatality rates per vehicle miles traveled during the 37 years of National Highway Traffic Safety Administration data collection, eight of them (1981-1983, 1991-1992, and 2008-2010) occurred either during or immediately following recessions.

[31] NHTSA http://www-fars.nhtsa.dot.gov/Trends/TrendsGeneral.aspx (Most current report available as of 2014 update.)

**TABLE 16-2.
NATIONAL HIGHWAY TRANSPORTATION SAFETY ADMINISTRATION FATALITIES 1994-2011**

Occupants by Vehicle Type								Nonmotorists					
Year	Passenger Cars	Light Trucks	Large Trucks	Motorcycles	Buses	Other/ Unknown	Total	Pedestrian	Pedalcyclist	Other	Total	Unknown Person Type	Total
1994	339	150	10	35	0	4	503	84	15	3	102	0	
1995	367	151	8	37	0	3	529	72	13	2	87	0	
1996	360	186	10	41	1	5	562	92	14	3	109	0	
1997	357	184	13	28	0	2	556	72	16	2	90	0	
1998	354	159	11	51	0	0	524	77	10	0	87	0	
1999	325	188	11	38	0	5	529	60	9	1	70	0	
2000	344	158	9	37	0	3	514	65	12	3	80	0	
2001	343	160	6	55	0	2	511	73	8	2	83	0	
2002	324	178	10	54	0	9	521	69	11	3	83	0	
2003	263	182	2	59	0	6	453	75	10	3	88	0	
2004	253	161	5	73	0	7	426	60	7	1	68	0	
2005	305	160	11	74	0	9	485	72	13	5	90	0	
2006	286	170	14	80	0	4	474	67	7	5	79	0	
2007	239	162	10	69	1	13	425	60	14	3	77	0	
2008	230	121	10	81	0	6	367	63	9	1	73	0	
2009	197	141	9	70	0	4	351	59	9	3	71	0	
2010	200	113	2	70	0	6	321	61	6	2	69	0	
2011	180	111	7	72	2	4	304	64	11	6	81	0	

The three largest annual percentage declines were 1982 (14.3%), 2008 (10.1%), and 2009 (9.5%), each occurring during a recession. Similarly, of the eight largest annual percentage declines in occupant fatality rates per vehicle miles traveled, six of them (1981-1983, 1992, 2008, and 2010) occurred either during or immediately following recessions. The three largest were 2008 (23.1% decline), 1982 (18.4% decline), and 1992 (18.5% decline), each occurring during a recession.

In addition to the relationship between economic recessions and passenger vehicle fatality rate declines, a relationship is also seen between high gas prices and passenger vehicle fatality rate declines. The calendar years 1980, 1981, 1982, 2006, 2007, 2008, 2010, and 2011 are the only years since 1976 where gas had average prices above $2.95/gallon (in 2013 dollars), and these years include many of the largest declines in PC and LTV fatalities seen since 1975[32].

Of concern throughout Island County is the potential for isolation as a result of a transportation failure or incident which will block ingress and egress from portions of the region.

Camano Island has been fully isolated due to the closure of HWY 532 on a number of occasions. Two specific examples include during extensive flooding (2006/2007) and during the Twin City Foods fire in Stanwood. Additionally, a number of storm events have cut off access to the south end of the island for a few days – these storm events include both declared and non-declared incidents, as even minor incidents have the potential to impact Camano's ingress and egress abilities.

[32] http://www-nrd.nhtsa.dot.gov/Pubs/812034.pdf

16.2.6 Secondary Hazards

Technological hazards are not like natural hazards that have measurable secondary impacts. Beyond casualties, the largest secondary impact caused by technological hazards would be economic impact. Economic impacts from technological hazards could be significant and include:

- Continuity of government could be impacted as a result of the loss of revenue to maintain specific services.
- Utility losses could cause a reduction in employment, wholesale and retail sales, utility repairs, and increased medical risks. Local jurisdictions may lose sales tax and property taxes and the finances of private utility companies and the businesses that rely on them would be disrupted.
- The economic impact of computer issues associated with data and telecommunications losses can be staggering.
- The economic impacts should a transportation facility be rendered impassable would be significant. The loss of a roadway or railway would have serious effects on the local economy and ability to provide services. Loss of travel routes on Highway 532 and over Deception Pass in particular would result in loss of commerce, and could impact emergency services by delaying response times or limiting routes for equipment such as fire apparatus, police vehicles, and ambulances. The ability to receive fuel deliveries would also be impacted.
- The effects of re-routed traffic could have a serious impact on local roadways. Heavy traffic on routes through urban areas already occurs at peak commute times. Traffic control may burden local public works departments. Mass transit services would also be impacted as routes may be delayed or forced to be detoured causing economic impacts.

16.3 VULNERABILITY ASSESSMENT

16.3.1 Overview

Exposure and impact from a technological hazard is based on a system that measures the potential consequence of the hazard based on varying factors, which may include:

- Casualty Impact – What is the potential for loss of life or serious injury to the population within the geographic area impacted?
- Economic Impact – To what extent does the loss of the facility impact the economy of region, state, or nation? This would also include the replacement cost of the facility, and the downtime or functionality of the structure or system.
- Hazardous Materials—Are flammable, explosive, biological, chemical and/or radiological materials present on site?
- Collateral Damage Potential—What are the potential consequences for the surrounding area if the asset is damaged?
- Public or Emergency Response Functions—Does the facility perform a function during an emergency? Is this facility or function capable of being replicated elsewhere?

Warning Time

Technological hazard accidents occur without predictability under circumstances that give responders little time to prepare.

16.3.2 Impact on Life, Health and Safety

Large-scale technological incidents have the potential to kill or injure many citizens in the immediate vicinity, but may also affect people a relative distance from the initial event. Each technological hazard identified has the potential to impact the population in varying ways. For instance, utility failures during extreme weather events have the potential to impact a significant amount of the population due to lack of heat or cooling systems. Transportation failure can significantly disrupt commodity flow, and cause isolation of vulnerable populations.

In terms of assessing the potential impact on population for general planning purposes, variables affecting exposure for a hazardous material accident include the type of product, the physical and chemical properties of the substance, the physical state of the product (solid, liquid, or gas), the ambient temperature, wind speed, wind direction, barometric pressure, and humidity. Computer models can be used to provide data to first responders to advise for evacuation planning purposes, or sheltering in place during an incident. Real time information of the variables would be used to make the assessment. Certain fixed facilities are also required to develop operational response plans to determine impact based on the chemicals on site. In addition, residences and business in close proximity to major transportation corridors are at enhanced risk for exposure as a result of a transportation incident.

In a response capacity, hazardous materials pose a significant risk to emergency response personnel. All potential first responders and follow-on emergency personnel must be properly trained to the level of emergency response actions required of their individual position at the response scene. Hazardous materials also pose a serious long-term threat to public health and safety, property and the environment.

16.3.3 Impact on Property

All property throughout the planning region has the potential for being impacted as a result of a technological hazard occurring. Disruption of service of utilities can increase fire danger due to diminished water-flow capacity. Reduced cyber capacity can impact infrastructure, while also leaving security features inoperable. A transportation accident involving hazardous materials can contaminate property for an extended period of time. In the case of agricultural lands and crops, or harvestable aquatic life, hazardous materials can potentially render entire areas useless for significant periods of time.

16.3.4 Impact on Critical Facilities and Infrastructure

Island County has a fairly significant number of critical facilities identified throughout the planning region which are vulnerable to technological hazards. Based on established vulnerability criteria, the majority of all critical facilities carry some level of exposure risk because of their potential impact from the various hazards of concern. A potential cyber failure could impact the majority of all transportation facilities, including air, ferries, and highways, potentially limiting accessibility, thereby impacting commodity flow. Utility infrastructure could disrupt water, wastewater and fuel and heating supplies.

16.3.5 Impact on Economy

Economic impacts from technological hazards could be significant. The cost of a hazardous materials incident would be felt in terms of loss of life and property, disruption of business activity and long-term emotional impacts. Recovery would take significant resources and expense at the local level.

Utility losses could cause a reduction in employment, wholesale and retail sales, utility repairs, and increased medical risks. Local jurisdictions may lose sales tax and property taxes, and the finances of private utility companies and the businesses that rely on them would be disrupted.

The economic impacts should a transportation facility be rendered impassable would be significant. The loss of a roadway or railway would have serious effects on the County's economy and ability to provide services. Loss of travel routes would result in loss of commerce, and may impact the County's ability to provide emergency services by delaying response times or limiting routes for equipment such as fire apparatus, police vehicles, and ambulances. The ability to receive fuel deliveries and other necessary commodities could also be impacted.

CHAPTER 17.
HAZARD RANKING

In ranking the hazards, the Planning Team completed a Calculated Priority Risk Index worksheet for each hazard (Table 17-1). The index examines four criteria for each hazard (probability, magnitude/severity, warning time, and duration), defines a risk index for each according to four levels, then applies a weighting factor. The result is a score that has been used to rank the hazards at the County level. All planning partners also completed their own hazard rankings, using the same process. Table 17-2 presents the results of the Calculated Priority Risk Index scoring for all hazards Countywide. Table 17-3 is a summary of the hazard ranking for the jurisdiction planning partners.

TABLE 17-1. CALCULATED PRIORITY RISK INDEX

CPRI Category	Degree of Risk			Assigned Weighting Factor
	Impact/ Level ID	**Description**	**Impact Factor**	
Probability	Unlikely	• Rare with no documents history of occurrences or events • Annual probability of less than 0.01 (~500 years or less)	1	45%
	Possibly	• Infrequent occurrences; at least one documented or anecdotal historic event. • Annual probability that is between 0.1 and 0.01 (~100 years or less)	2	
	Likely	• Frequent occurrences with at least two or more documented historic events. • Annual probability that is between 1 and 0.1. (~10 years or less)	3	
	Highly Likely	• Common events with a well-documented history of occurrence. • Annual probability that is greater than 1. (~Annually)	4	
Magnitude/ Severity	Negligible	• People – Injuries and illnesses are treatable with first aid; minimal hospital impact; no deaths. Negligible impact to quality of life. • Property – Less than 5% of critical facilities and infrastructure impacted and only for a short duration (less than 24-36 hours such as for a snow event); no loss of facilities, with only very minor damage/clean-up. • Economy – Negligible economic impact. • Continuity of government operating at 90% of normal operations with only slight modifications due to diversion of normal work for short-term response activity. Disruption lasts no more than 24-36 hours. • Special Purpose Districts: No Functional Downtime	1	30%
	Limited	• People – Injuries or illness predominantly minor in nature; some increased calls for service at hospitals; no deaths; 14% or less of the population impacted. Moderate impact to quality of life. • Property – Slight property damage -greater than 5% and less than 25% of critical and non-critical facilities and infrastructure; • Economy – Impact associated with loss property tax base limited; impact results primarily from lost revenue/tax base from businesses shut down during duration of event and short-term cleanup; increased calls for emergency services result in increased wages; • Continuity of government impacted slightly; 80% of normal operations; most essential services being provided. Disruption lasts >36 hours, but <1 week. • Special Purpose Districts: Functional downtime 179 days or less.	2	
	Critical	• People – Injuries or illness results in some permanent disability or significant injury; hospital calls for service increased significantly; no deaths. 15% to 29% of the population impacted. • Property – Moderate property damages (greater than 25% and less than 50% of critical and non-critical facilities and infrastructure) • Economy - Moderate impact as a result of critical and non-critical facilities and infrastructure impact, loss of revenue associated with tax base, lost income. • Continuity of government ~50% operational capacity; limited delivery of essential services. Services interrupted for more than 1 week, but <1 month. • Special Purpose Districts: Functional downtime 180-364 days	3	
	Catastrophic	• People - Injuries or illnesses result in permanent disability and death to a significant amount of the population exposed to a hazard. >30% of the population impacted. • Property – Severe property damage >50% of critical facilities and non-critical facilities and infrastructure impacted. • Economy – Significant impact as a result of loss of buildings and content, inventory, lost revenue, lost income. • Continuity of government significantly impacted; limited services provided (life safety and mandated measures only). Services disrupted for > than 1 month. • Special Purpose Districts: Functional Downtime 365 days or more	4	
Warning Time / Speed of Onset	<6 hours	Self-explanatory.	4	15%
	6 to 12 hours	Self-explanatory.	3	
	12 to 24 hours	Self-explanatory.	2	
	> 24 hours	Self-explanatory.	1	
Duration	< 6 hours	Self-explanatory.	1	10%
	< 24 hours	Self-explanatory.	2	
	<1 week	Self-explanatory.	3	
	>1 week	Self-explanatory.	4	

**TABLE 17-2.
COUNTYWIDE CALCULATED PRIORITY RANKING INDEX**

Hazard	Probability	Magnitude and/or Severity	Warning Time	Duration	Calculated Priority Risk Index Score
Coastal Erosion	4	1	1	4	2.65
Dam Failure	2	2	4	2	2.3
Drought	2	2	1	4	2.05
Earthquake	4	4	4	1	3.7
Flood	3	2	1	2	2.3
Hazardous Material	2	2	4	2	2.3
Human Caused (Terrorism)	2	2	4	1	2.2
Landslide	4	2	4	2	3.2
Severe Storm	4	2	1	2	2.75
Infrastructure/ Utility Failure (Technological Hazard)	2	1	4	1	1.9
Transportation Incident/ Accident	2	2	4	2	2.3
Tsunami	2	2	3	2	2.15
Volcano (Ash)	2	2	1	4	2.05
Wildfire	3	1	4	1	2.35

The Calculated Priority Risk Index scoring method has a range from 0 to 4. “0” being the least hazardous and “4” being the most hazardous situation.

**TABLE 17-3.
HAZARD RANKING SUMMARY**

Hazard	County		Coupeville		Langley		Oak Harbor	
	Rank	Score	Rank	Score	Rank	Score	Rank	Score
Coastal Erosion	4	2.65	4	2.65	3	2.65	4	2.65
Dam Failure	6	2.30	10	1.75	12	1.00	7	2.20
Drought	8	2.05	10	1.75	10	1.75	10	1.75
Earthquake	1	3.70	1	3.70	1	3.70	1	3.70
Flood	6	2.30	6	2.15	4	2.35	5	2.35
Hazardous Materials	6	2.30	8	1.90	8	1.90	7	2.20
Human Caused (Terrorism)	7	2.20	8	1.90	7	1.90	7	2.20
Landslide	2	3.20	2	3.40	1	3.70	2	3.40
Severe Storm	3	2.75	3	2.75	2	2.75	3	2.75
Infrastructure/ Utility Failure (Technological Hazard)	9	1.90	11	1.45	11	1.45	7	2.20
Transportation Incident/ Accident	6	2.30	5	2.20	6	2.20	4	2.65
Tsunami	6	2.15	9	1.85	9	1.85	9	1.85
Volcano (Ash)	8	2.05	7	1.75	10	1.75	10	1.75
Wildfire	5	2.35	9	1.85	5	2.30	6	2.30

CHAPTER 18.
MITIGATION STRATEGY

The development of a mitigation strategy allows the community to create a vision for preventing future disasters. This is accomplished by establishing a common set of mitigation goals and objectives, a common method to prioritize actions, and evaluation of the success of such actions. Specific mitigation goals, objectives and projects were developed for Island County and its planning partners by the Planning Team in their attempt to establish an overall mitigation strategy by which the jurisdictions would enhance resiliency of the planning area.

18.1 HAZARD MITIGATION GOALS AND OBJECTIVES

During the August 12, 2014 meeting, the Planning Team reviewed the 2008 existing goals and objectives. The goals describe the overall direction that Island County and its planning partners can take to work toward mitigating risk from natural and human-caused hazards and avoid long-term vulnerabilities to the hazards of concern. Mitigation goals for this plan are listed below. The 2008 Island County Hazard Mitigation Plan had four goals, with supporting objectives associated with each. For the 2015 update, the planning team used the existing goals as a base, making modifications to support a countywide effort of enhanced capabilities which support resilience through protection of life, property, the economy and the environment.

18.1.1 Goals

Goals for the 2015 mitigation strategy are as follows:

1. Protect life, property, the environment and the economy.
2. Reduce community risk through increased public awareness of the hazards of concern and mitigation opportunities.
3. Leverage public and private partnering opportunities.
4. Enhance community resilience through proactive measures.
5. Encourage and pursue multi-objective opportunities or solutions whenever possible to help reduce the impacts from hazards through sustainable, cost-effective and environmentally sound mitigation efforts and projects.

18.1.2 Objectives

The 2008 objectives were reviewed, and three became strategies for the 2015 update. The remainder were adjusted to be less tied to specific hazards, instead addressing multiple hazards. Objectives for the 2015 mitigation strategy are presented in Table 18-1.

**TABLE 18-1.
2015 HAZARD MITIGATION PLAN OBJECTIVES**

Objective Statement	Goal Addressed
1. Implement mitigation initiatives that will assist in protecting lives, property and the environment by making homes, businesses, infrastructure, and critical facilities more resistant / resilient to the hazards that impact the planning region.	1, 2, 4, 5
2. Encourage homeowners and businesses to take preventative measures in areas that are especially vulnerable to hazards.	All
3. Acquire, retrofit, or relocate structures currently in high hazard areas as funding opportunities are available through various grant programs.	1, 2, 4, 5
4. Encourage open space use in hazardous areas, or ensure that, if building occurs in these high-risk areas, it is done in a way to minimize risk.	5
5. Use best available data, science and technologies to improve understanding of location and potential impacts of hazards and to promote disaster-resilient communities by discouraging new development in hazardous areas by ensuring that development is done in such a way as to minimize risk.	2, 4, 5
6. Consider the impacts of hazards in all planning mechanisms that address current and future land use.	2, 4, 5
7. Educate residents and surrounding communities on the risk exposure to hazards and ways to increase individuals' capabilities to prepare, respond, recover and mitigate the impacts of these events.	2, 3, 4, 5
8. Increase resilience through the continuity of operations of identified critical facilities, government entities and businesses.	2, 3, 4
9. Explore creative tools to reduce risk and protect/rehabilitate natural and beneficial areas that interface with identified hazard areas.	1, 4, 5
10. Provide/improve flood protection through various means, such as with flood control structures and drainage maintenance where appropriate and feasible.	1, 2, 4, 5,
11. Provide/improve the structural integrity of structures through higher building standards to address geologic hazards of concern.	4, 5
12. Consider the Community Rating System (CRS) program, with the ultimate goal to lower the cost of flood insurance premiums throughout the County.	2, 4, 5
13. Establish and maintain partnerships among the public sector and local business leaders within the planning region to improve and implement methods to protect life, property, the economy and the environment.	3
14. Enhance community emergency management capabilities (i.e., prepare, plan, respond, recover, mitigate).	1, 2, 4
15. Encourage the development and implementation of long-term, cost-effective and environmentally sound mitigation projects by encouraging use of incentives.	5
16. Continue to develop or improve emergency warning, response, planning (including evacuation procedures), and communication systems.	1, 2, 3, 4
17. Provide/improve fire protection activities through various means, such as sprinkler systems, defensible space, spatial distribution of development, duel treatments, and enhanced water supply systems where appropriate and feasible.	4, 5
18. Continue to review and enhance (when possible) land use regulations and development trends to proactively reduce the impact of the hazards of concern.	4, 5
19. Encourage hazard mitigation measures that result in the least adverse impact on the natural environment and that use natural processes, while preserving and maintaining the cultural and natural resources within the area.	4, 5

18.2 HAZARD MITIGATION ALTERNATIVES

After the goals and objectives were established, the planning team developed specific action items to further increase resilience. FEMA's 2013 catalog of *Mitigation Ideas* was presented to the planning team. This document includes a broad range of alternatives to be considered for use in the planning area, in compliance with 44 CFR (Section 201.6.c.3.ii), and can be applied to both existing structures and new construction. The catalog provides a baseline of mitigation alternatives that are backed by a planning process, are consistent with the planning partners' goals and objectives, and are within the capabilities of the partners to implement. It presents alternatives that are categorized in two ways:

- By what the alternative would do:
  - Manipulate a hazard
  - Reduce exposure to a hazard
  - Reduce vulnerability to a hazard
  - Increase the ability to respond to or be prepared for a hazard
- By who would have responsibility for implementation:
  - Individuals
  - Businesses
  - Government.

Hazard mitigation initiatives recommended in this plan were selected from among the alternatives presented in the catalogs, as well as projects identified by the planning partners and interested stakeholders specific to their jurisdiction. Some were carried over from the previous plan. Some may not be feasible based on the selection criteria identified for this plan, but are included nonetheless as the planning team felt they are viable actions to be taken to reduce hazard influence in some manner.

18.3 SELECTED MITIGATION INITIATIVES

For the 2015 update, particular attention was given to new and existing buildings and infrastructure, and developing appropriate mitigation strategies for these facilities. The planning team determined that some initiatives from the mitigation catalogs could be implemented to provide hazard mitigation benefits countywide. Table 18-2 lists the recommended countywide initiatives, the lead and supporting agency for each project responsible for implementation of the initiative, and the proposed timeline. Table 18-3 identifies County-specific initiatives, also identifying the lead and supporting agency for each project responsible for implementation of the initiative, and the proposed timeline. The parameters for the timeline are as follows:

- Short Term = to be completed in 1 to 5 years
- Long Term = to be completed in greater than 5 years
- Ongoing = currently being funded and implemented under existing programs.

TABLE 18-2.
COUNTYWIDE HAZARD MITIGATION INITIATIVES

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline	Included in Previous Plan?
CW-1 Continue data gathering for facility information to continue to improve the risk assessment and identification of infrastructure countywide.							
New and Existing	All	1, 2, 3, 5	Island County EM, All planning partners	Low	HLS/EMPG, PDM, HMGP, HUD, General Funds	On-Going	No
CW-2 Work with County and state agencies to establish a protocol and advance permitting for transporting of contagions and other hazardous materials for identification during an incident.							
New	Human Caused, (Pandemic) Hazardous materials, Transportation	1, 6, 8, 13, 14, 16	Island County Public Health, Whidbey General Hospital, Island County Emergency Management, Island County Public Works, Washington State DOT	Low	General Funds, HLS (EMPG), CDC grants	Long-Term	No
CW-3 Develop points of distribution in areas of potential isolation							
New	All	1, 2, 6, 7, 13, 14, 16	Island County Public Works, Island County Emergency Management, Local Jurisdiction Emergency Managers	Low	EMPG, HUD	Short-Term	No
CW-4 Work with Public Health and Human Services to develop an information bank identifying individuals with access and functional needs. This will assist the County in determining shelter locations requiring specific resources to meet the needs of those individuals. NOTE: This is not an attempt to gather medical-related data, but rather to determine access and functional needs of citizens – e.g., citizens in wheel chairs need more space and shower/restroom facilities; hearing impaired need to have an area which allows them to be near to their signer, the use of oxygen tanks increases space requirements, etc.							
New	All	1, 2, 7, 13, 14, 16	Island County Emergency Management; Local Emergency Management Offices; Island County Public Health Department; Island County Human Services	Low	Health and Human Service Grants, HUD, HMGP	Long-Term	No

TABLE 18-2.
COUNTYWIDE HAZARD MITIGATION INITIATIVES

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline	Included in Previous Plan?
CW-5 Coordinating with Assessor's Office, Permitting and other County offices, update Assessor's parcel data to include more building-specific information which may be utilized within the GIS and Hazus programs for enhanced risk assessments to provide a detailed loss estimation.							
New and Existing	All	1, 2, 5, 7, 8, 13, 14, 16, 18	Island County Emergency Management, Island County Assessor's Office; Island County Public Works, Island County GIS, Island County Planning and Community Development, Local Building Officials, Local Community Development	Low	General Fund, HMGP	Short-Term	No
CW-6 Coordinate among all jurisdictions to seek out and apply for grants for site hardening of facilities.							
New and Existing	EQ, F, LS, SWS, T	1, 2, 5, 8, 10, 11, 13, 14, 15, 16, 17, 18, 19	Island County Emergency Management,	Low	Earthquake and Tsunami Program, HMGP, PDM, HUD, DOT, EPA	Long-Term	No
CW-7 Maintain and regularly update fire hydrant layer countywide.							
New and Existing	Fire	1, 2, 5, 7, 13, 14, 15, 16, 19	Island County Emergency Management, Island County GIS, all Fire Depts. and Districts	Low	HMGP, HUD	Long-Term	No
CW-8 Continue implementation of public education program within Island County to educate citizens about the hazards faced and the appropriate preparedness and response measures.							
New and Existing	All	All	County and Local Emergency Management Offices; Land Use Planning Depts.	Low	EMPG, General Fund	On-Going	Yes
CW-9 Continue to expand CERT training, involving local teams in exercises and training with first responders.							
New and Existing	All	1, 2, 7, 13, 14, 16	Local and County Emergency Management	Low	EMPG	On-Going	Yes

**TABLE 18-2.
COUNTYWIDE HAZARD MITIGATION INITIATIVES**

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline	Included in Previous Plan?
CW-10 Develop and prepare a fueling plan, addressing both automotive and heating fuels, in case of prolonged interruption of normal distribution to Island County locations.							
New and Existing	EQ, F, LS, SWS, T	1, 8, 13, 14, 16	Island County Emergency Management, Local Emergency Managers, Island County Sheriff's Dept. all local Police Depts., all Island County Fire Depts. and Districts, all County and Local Public Works Depts.	Low	General Fund, various grants.	Long-Term	No
CW-11 Evaluate current coverage and equipment and provide a strategic emergency communications plan that provides better coverage to all areas of Island County for first responders and emergency amateur radio communications.							
Existing	All	5, 8, 14, 16	Island County and Local Emergency Management, Communications Group (new multi-disciplined/agency group)	Low	General Funds	Short-Term	No
CW-12 Review designated emergency shelter structural and utility readiness for occupancy after a significant incident.							
New and Existing	All	1, 2, 5, 11, 13, 14, 16	Island County DEM	Medium	PDM, HMGP, General Funds	Short-Term	No
CW-13 Provide steep slope stability recommendations and education to owners of structures above steep bluffs or below steep bluffs. Increase monitoring of county bluffs involving beach communities or access to beach communities.							
New and Existing	CE, EQ, F, LS, SW	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 19	Island County DEM, County and Local Public Works, WDNR	Medium	PDM, HMGP, General Funds	Long-Term	No
CW-14 Obtain funding to provide tsunami evacuation maps, information, publications and road signage for Whidbey and Camano Islands. Obtain all hazard alert broadcast AHAB towers for areas of North Whidbey Island.							
New and Existing	T	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 19	Island County DEM, Local Emergency Management and Public Works, FEMA, WDNR	Medium	Earthquake and Tsunami Program Grant Funds	Short-Term	No
CW-15 Promote a "FireWise" program in Island County to increase fire safety zones around businesses and residences. Encourage owners to reduce woodland fuel loads on their property.							
New and Existing	D, WF	1, 2, 3, 5, 7, 9, 11, 13, 14, 15, 17, 18, 19	Island County DEM, Local EM, Fire Depts. & Districts	Low	Fire Grants, PDM, HMGP	On-Going	No

TABLE 18-2.
COUNTYWIDE HAZARD MITIGATION INITIATIVES

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline	Included in Previous Plan?
CW-16 Work with local jurisdictions and planning partners to develop various emergency planning efforts to ensure continuity of business and resiliency.							
New and Existing	All	1, 2, 4, 5, 6, 7, 8, 12, 13, 14, 16, 17, 18	Island County DEM, Local EM	Medium	EMPG Funds, General Funds	Long-Term	No
CW-17 Identify and establish redundant emergency operations center locations throughout the County in case of road closures which restrict access to areas of the County.							
New	All	1, 5, 8, 13, 14	Public Officials, County and Local EM	Medium	EMPG and General Funds	Short-Term	No
CW-18 Partner with Washington State Department of Transportation to expand and implement training and exercises throughout the county which support transportation-related issues and potential isolation.							
New and Existing	All	1, 3, 6, 7, 8, 13, 14	Island County DEM, Local EM, Island County PW – Roads, Local Jurisdiction Roads Depts.,	Medium	US DOT and WA DOT Grants, HLS	Long-Term	No
CW-19 Continue to promote and establish a countywide emergency management program, working with all jurisdictions and special purpose districts to enhance resiliency and maintain consistency in emergency management programs and capabilities.							
New and Existing	All	1, 14	Island County DEM, Local EM	Medium	General Funds, Grant Opportunities as they arise	Long-Term	No
CW-20 Continue to seek funding opportunities which may be utilized to enhance the emergency management programs of the county and all of the cities and towns to further expand capabilities, staffing and equipment.							
New and Existing	All	14	Island County and Local DEMs	Medium	Grant Funds	Long-Term	No
CW-21 Continue to enhance local emergency planning committee involvement with all fire organizations throughout the County with the goal of quarterly meetings.							
Existing	HazMat	9, 14	Island County DEM, Local EM, Fire Depts. & Districts	Low	General Funds	On-Going	No

**TABLE 18-2.
COUNTYWIDE HAZARD MITIGATION INITIATIVES**

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline	Included in Previous Plan?
CW-22 Seek grant funding to develop a countywide mass care and evacuation exercise, which includes all fire and police departments, Whidbey General Hospital, Island County Public Health, Island County Transit, the Navy Hospital, Emergency Management and search-and-rescue, as well as other planning partners as identified during exercise design.							
New and Existing	All	7, 8, 13, 14, 16	Island County DEM, Local EM, Fire Districts & Depts., Whidbey General Hospital, Island County Public Health, Transit, Whidbey Island Navy General Hospital, Sheriff, Local PD/Law Enforcement	High	EMPG, DOJ Grants, Fire Training Grants, EMPG	Long-Term	No
CW-23 Work with FEMA to determine possibility of conducting a loss avoidance study on the seismic retrofit projects which have been completed within the County to date to help demonstrate effectiveness to the citizens and public officials.							
Existing	EQ, LS	1, 3, 5, 7, 8, 14, 15, 18	Island County DEM	Low	FEMA	Short-Term	No
CW-24 Develop countywide mutual aid agreements with both public and private agencies in support of preparedness and response activities.							
New	All	1, 7, 11, 13, 14, 15	Island County DEM	Low	General Funds	On-Going	No
CW-25 Capture data concerning the number of portable generators at fueling stations and local grocery outlets to determine need to acquire generators to ensure fuel availability and food items during significant events which may impact transportation flows, reducing commodities in the planning area. If necessary, seek grant opportunities to purchase generators for use during such events.							
New and Existing	All	1, 2, 7, 8, 13, 14, 15, 16	Island County DEM	Low	General Funds	On-Going	No
CW-26 Capture information concerning the surplus supply maintained by local fueling stations and grocery outlets to determine quantities available should commodities be interrupted as a result of a significant incident.							
New and Existing	All	1, 2, 7, 8, 13, 14, 15, 16	Island County DEM	Low	General Funds	On-Going	No
CW-27 Develop countywide debris management plan.							
New and Existing	EQ, F, LS, SW, T, V, WF	13, 14, 16	Island County DEM	High	Grant Sources TBD	Long-Term	No

TABLE 18-3.
COUNTY-SPECIFIC HAZARD MITIGATION ACTION PLAN MATRIX

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline	Included in Previous Plan?
C-1 Study and retrofit county-owned facilities to better withstand damage from a major earthquake.							
Existing	EQ	1, 2, 3, 6, 8, 10, 11, 16	Planning	High	General Fund, HMGP, HUD	Short-Term	N
C-2 Analyze options and acquire resources for alternate forms of transportation access to Camano Island should SR 532 or either of the two highway bridges become unserviceable.							
Existing	All	1, 3, 5, 6, 8, 10, 11, 14, 17	PW-Roads	High	PDM, HMGP, WADOT, USDOT	Long-Term	N
C-3 Evaluate and enhance the current capital improvements program for county roads and drainage projects to provide better flood control in known tidal flood problem areas.							
New and Existing	CE, F, LS, SW	1, 3, 5, 6, 8, 10, 11, 14, 17	PW - Roads & Surface Water	High	State Ecology FCAAP, PDM, HMGP, DOT	Long-Term	N
C-4 Seek steep slope stability project funding or relocation funding for county roads with histories of instability.							
Existing	F, LS, SW	1, 3, 5, 6, 7, 8, 10, 11, 14, 17	PW - Roads & Surface Water	High	PDM, HMGP, USDOT, WADOT	Long-Term	N
C-5 Seek grant funding for acquisition of properties within high-hazard areas.							
Existing	EQ, F, LS, SW, WF	2, 3, 14	DEM, Commissioners	High	PDM, HMGP	Long-Term	N
C-6 Develop database of grocery stores and fueling stations who have generators in order to determine potential need.							
New and Existing	All	1, 7, 13, 14	DEM	Low	General Fund	On-Going	N
C-7 Work toward becoming a StormReady & TsunamiReady community.							
New and Existing	F, EQ, LS, SW, T	14	EM	Low	General Fund	Short-Term	N
C-8 Work with Public Health to determine suitable points of distribution.							
New	All	14	PH and EM	Low	General Fund, Department of Health (DOH)	Short-Term	N
C-9 Conduct a needs assessment to determine logistical requirements for equipment and parts for wells and water distribution sources to ensure a surplus allowing for continued supply of water in case commodity flow is impacted by a major event.							
New and Existing	All	1, 3, 8, 11, 13, 14,17	PH, Surface Water	Medium	General Fund, DOH, EPA, Ecology	Short-Term	N

**TABLE 18-3.
COUNTY-SPECIFIC HAZARD MITIGATION ACTION PLAN MATRIX**

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline	Included in Previous Plan?
C-10 Seek grant funding to construct a new emergency operations center location which can support countywide efforts.							
New	All	13, 14	DEM, Commissioners	High	HLS	Long-Term	Y- Modified
C-11 Continue to design and build facilities to meet or exceed seismic standards, including redundant essential equipment. Apply current seismic standards to all renovation or replacement of existing facilities, and/or equipment.							
New and Existing	EQ, LS	1, 8, 11, 14	Planning	Medium	PDM, HMGP	Long-Term	No
C-12 Conduct activities that support mitigation efforts to reduce the negative influence of natural hazards impacting Island County, such as appropriate hazard identification, warning, dissemination of relevant information and data, and public outreach.							
New	All	All	DEM, Planning, PH	Low	General Fund, HLS, PH	On-Going	Y – Modified
C-13 Conduct threat identification and risk assessment of identified critical infrastructure to determine potential risk.							
New and Existing	HC, Techno, HazMat,	5, 8, 14, 16	DEM, Sherriff	Medium	DOJ Grants, HLS	Short-Term	N
C-14 Work with local public and private entities to review infrastructure control systems and ensure appropriate level of security and protection measures are in place. As appropriate, conduct audit of policies and procedures to ensure consistency and accuracy in application of security devices in place.							
New and Existing	HC, Techno, HazMat Infrastructure	1, 2, 8, 13, 14	DEM, PSE, SnoPUD, County IT	Medium	General Funds	Long-Term	N
C-15 Implement cost-effective measures to address vulnerability of facilities at risk to sea level rise, extreme high tides and storm surges as they relate to potential inflow of saltwater. This includes working with local private water purveyors.							
New and Existing	CE, F, SW	All	DEM, PH, Surface Water	High	Ecology, DOH, HLS, PDM, HMGP	Long-Term	Y- Modified
C-16 Utilize data gathered during risk assessment to identify capital projects that, when modified, increase the resilience of the County's structures and conveyances to damage, or that allow a more expedited process for recovery from the impact of disaster incidents.							
New and Existing	All	1, 3, 5, 6, 8, 11, 14, 16	DEM	Low	General Funds, Grants	Long-Term	N

TABLE 18-3.
COUNTY-SPECIFIC HAZARD MITIGATION ACTION PLAN MATRIX

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline	Included in Previous Plan?
C-17 Consider projects enhancing resistance of country structures to impact from hazards of concern, such as seismic bracing of equipment, piping and fixtures, removal of high hazard beams, access road reinforcement, or seismic upgrades of underwater interceptors.							
New and Existing	EQ	1, 3, 5, 6, 8, 11, 14, 16	Building & Planning, PW, DEM	High	General Funds, WA DOT, US DOT, PDM, HMGP	Long-Term	N
C-18 Implement a recovery system to ensure maximum FEMA reimbursement for disaster response, repair, mitigation and recovery, which will capture and track emergency activities, associated expenses (mileage, supplies, expendables, outside vendors, etc.), employee time and dedicated resources.							
New and Existing	All	14, 16	Auditor, DEM	Medium	EMPG, General Fund	On-Going	N
C-19 Develop a web-based application to capture damage assessment from citizens, which can be verified by emergency personnel to expedite damage assessment. This may include an interface between the Assessor's office for property values, as well as a mechanism for rapid windshield assessment by first responders.							
New and Existing	All	5, 14, 16	IT, DEM, Auditor, Sheriff	Medium	HLS, General Fund, HMGP, HUD	On-Going	N
C-20 Utilize data from the current risk assessment and comprehensive land use planning effort currently underway to update GIS capacity and capabilities.							
New and Existing	All	8, 14	Planning, PW, DEM	Low	General Fund, HMGP	On-Going	N
C-21 Assess the County's communications systems to determine its current vulnerability. This will include a review of the number of radios necessary to allow for adequate communications during emergency situations with field units, emergency response personnel, and emergency managers.							
New and Existing	All	14, 16	DEM, Emergency Communications Group IT	Low	General Fund	Short-Term	N
C-22 In accordance with OSHA/WISHA requirements for all employees performing emergency response activities (post-disaster), identify and train County staff and volunteers that will be utilized for these efforts. Training to be considered includes: ATC 20/45, Disaster Site Worker Training, and Emergency Response Training, Damage Assessment.							
New	All	7, 13, 14, 16	DEM, Risk Manager, Sherriff	Medium	General Fund, HLS	On-Going	N
C-23 Work with Island County Transit to develop an exercise related to evacuation of citizens or other type event.							
New	All	7, 13, 14, 16	DEM, Human Services, IC Transit	Medium	DOT, HMEP, EMPG, Fire Grants, HUD, DOH	Short-Term	N

TABLE 18-3.
COUNTY-SPECIFIC HAZARD MITIGATION ACTION PLAN MATRIX

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline	Included in Previous Plan?
C-24 Leverage resources and partnerships to train and exercise together to ensure continuity during real world events.							
New	All	7, 13, 14, 16	DEM	Medium	General Budget, Grants	On-Going	N
C-25 Develop (or update) plans to ensure response and recovery efforts. This includes working with the Board of Commissioners to develop appropriate committees, such as a continuity of operations team, which will develop a countywide continuity of operations plan, and an emergency communications team which will look at communications and interoperability issues.							
New and Existing	All	7, 13, 14, 16	Commissioners & DEM	Medium	Various depending on plan	On-Going	N
C-26 Work with county agencies to establish a foundation for expanded service offerings to local jurisdictions which lack the ability to perform specific functions, such as mapping/GIS, emergency management services.							
New	All	5, 13, 14, 16	DEM, PW, Commissioners	Low	General Fund, Enterprise System	Short-Term	N
C-27 Conduct public outreach on risk-reduction techniques for communicable diseases through public education campaigns which increase awareness of healthy behaviors, including during times when shelters are established.							
New	All	1, 7, 14, 16	PH, DEM, Human Services	Low	General Fund	Short-Term	N
C-28 Replace outdated telephone infrastructure to a modern unified communications system at all County facilities.							
New	All	8, 16	IT	High	General Fund, available grants depending on Dept.	Short-Term	N
C-29 Develop public outreach which supports community participation in incentive-based programs, such as FireWise, StormReady, and TsunamiReady.							
New and Existing	F, LS, SW, T, WF	8, 12, 14, 15, 16, 17,	DEM	Low	General Fund	Short-Term	N

18.4 ANALYSIS OF MITIGATION INITIATIVES

Each planning partner reviewed its recommended initiatives to classify them based on the hazard it addresses and the type of mitigation it involves. Mitigation types used for this categorization are as follows.

- **Prevention**—Government, administrative or regulatory actions that influence the way land and buildings are developed to reduce hazard losses. Includes planning and zoning, floodplain laws, capital improvement programs, open space preservation, and stormwater management regulations.

- **Property Protection**—Modification of buildings or structures to protect them from a hazard or removal of structures from a hazard area. Includes acquisition, elevation, relocation, structural retrofit, storm shutters, and shatter-resistant glass.
- **Public Education and Awareness**—Actions to inform citizens and elected officials about hazards and ways to mitigate them. Includes outreach projects, real estate disclosure, hazard information centers, and school-age and adult education.
- **Natural Resource Protection**—Actions that minimize hazard loss and preserve or restore the functions of natural systems. Includes sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.
- **Emergency Services—**Actions that protect people and property during and immediately after a hazard event. Includes warning systems, emergency response services, and the protection of essential facilities.
- **Structural Projects—**Actions that involve the construction of structures to reduce the impact of a hazard. Includes dams, setback levees, floodwalls, retaining walls, and safe rooms.

Table 18-4 and Table 18-5 identify the mitigation types and hazard addressed by each identified countywide and county-specific mitigation initiative.

18.5 BENEFIT/COST REVIEW

44 CFR requires the prioritization of the initiatives or action items according to a benefit/cost analysis of the proposed projects and their associated costs (Section 201.6.c.3iii). The benefit/cost analysis conducted during this planning process is not of the detailed variety required by FEMA for project grant eligibility under the Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation (PDM) grant program. Rather, parameters were established for assigning subjective ratings (high, medium, and low) to the costs and benefits of these projects. Cost ratings were defined as follows:

- **High** —Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).
- **Medium**—The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
- **Low**—The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.

Benefit ratings were defined as follows:

- **High—**Project will provide an immediate reduction of risk exposure for life and property.
- **Medium—**Project will have a long-term impact on the reduction of risk exposure for life and property, or project will provide an immediate reduction in the risk exposure for property.
- **Low—**Long-term benefits of the project are difficult to quantify in the short term.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-beneficial and are prioritized accordingly. Prioritization of the projects in such a manner serves as a guide for choosing and funding projects.

TABLE 18-4.
ANALYSIS OF COUNTYWIDE MITIGATION INITIATIVES

	Initiative Addressing Hazard, by Mitigation Type[a]					
Hazard Type	1. Prevention	2. Property Protection	3. Public Education and Awareness	4. Natural Resource Protection	5. Emergency Services	6. Structural Projects
Coastal Erosion	3, 24, 25	1, 5, 6, 12, 13, 25	3, 4, 8, 22, 24		1, 3, 4, 6, 9, 11, 19, 20, 22, 24, 25, 26, 27	6, 12
Dam Failure	3, 24, 25	1, 5, 6, 12, 25	3, 4, 8, 22, 24		1, 3, 4, 6, 9, 11, 19, 20, 22, 24, 25, 26, 27	6, 12
Drought	3, 15, 24, 25	1, 5, 6, 12, 15, 25	3, 4, 8, 15, 22, 24	15	1, 3, 4, 6, 9, 11, 15, 19, 20, 22, 24, 25, 26, 27	6, 12, 15
Earthquake	3, 23, 24, 25	1, 5, 6, 12, 13, 25	3, 4, 8, 13, 22, 23, 24	13	1, 3, 4, 6, 9, 11, 19, 20, 22, 24, 25, 26, 27	6, 12, 23
Flood	3, 24, 25	1, 5, 6, 12, 13, 25	3, 4, 8, 13, 22, 24	13	1, 3, 4, 6, 9, 11, 19, 20, 22, 24, 25, 26, 27	6, 12
Hazardous Materials	3, 24, 25	1, 5, 6, 12, 25	3, 4, 8, 21, 22, 24		1, 2, 3, 4, 6, 9, 11, 19, 20, 21, 22, 24, 25, 26, 27	6, 12
Human Caused	3, 24, 25	1, 5, 6, 12, 25	3, 4, 8, 22, 24		1, 3, 4, 6, 9, 11, 19, 20, 21, 22, 24, 25, 26, 27	6, 12
Infrastructure/ Utility	3, 24, 25	1, 5, 6, 12, 25	3, 4, 8, 22, 24		1, 3, 4, 6, 9, 11, 19, 20, 22, 24, 25, 26, 27	6, 12
Landslide	3, 23, 24, 25	1, 5, 6, 12, 13, 25	3, 4, 8, 13, 22, 23, 24	13	1, 3, 4, 6, 9, 11, 19, 20, 22, 24, 25, 26, 27	6, 12, 23
Severe Weather	3, 24, 25	1, 5, 6, 12, 13, 25	3, 4, 8, 13, 22, 24	13	1, 3, 4, 6, 9, 11, 19, 20, 22, 24, 25	6, 12
Transportation Incident/Accident	3, 24, 25	1, 5, 6, 12, 25	3, 4, 8, 22, 24		1, 2, 3, 4, 6, 9, 11, 19, 20, 21, 22, 24, 25	6, 12
Tsunami	3, 14, 24, 25	1, 5, 6, 12, 25	3, 4, 8, 14, 22, 24		1, 3, 4, 6, 9, 11, 14, 19, 20, 22, 24, 25, 26, 27	6, 12
Volcano	3, 24, 25	1, 5, 6, 12, 25	3, 4, 8, 22, 24		1, 3, 4, 6, 9, 11, 19, 20, 22, 24, 25, 26, 27	6, 12
Wildfire	3, 7, 15, 24, 25	1, 5, 6, 12, 15, 25	3, 4, 7, 8, 15, 22, 24	15	1, 3, 4, 6, 9, 11, 15, 19, 20, 22 , 24, 25, 26, 27	6, 7, 12, 15

a. See Section 18.3 for explanation of mitigation types.

TABLE 18-5.
ANALYSIS OF COUNTY-SPECIFIC MITIGATION INITIATIVES

	Initiative Addressing Hazard, by Mitigation Type[a]					
Hazard Type	1. Prevention	2. Property Protection	3. Public Education and Awareness	4. Natural Resource Protection	5. Emergency Services	6. Structural Projects
Coastal Erosion	2, 3, 11, 15, 25, 26	2, 3, 11, 15, 28, 29	2,3, 6, 8, 12, 15, 25, 26, 27	2, 3, 9, 12, 15	2, 3, 6, 8, 10, 12, 15, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26	2, 3, 12, 15
Dam Failure	12, 25, 26	12, 28	6, 8, 12, 25, 26, 27	9, 12	6, 8, 10, 12, 1618, 19, 20, 21, 22, 23, 24, 25, 26	12
Drought	12, 25, 26	12, 28	6, 7, 8, 12, 25, 26, 27	9, 12	6, 7, 8, 10, 12, 1618, 19, 20, 21, 22, 23, 24, 25, 26	12
Earthquake	5, 11, 12, 25, 26	5, 11, 12, 17, 28	6, 7, 8, 12, 25, 26, 27	5,9, 11, 12, 17	5,6, 7, 8, 10, 11, 12, 16, 1718, 19, 20, 21, 22, 23, 24, 25, 26	5, 11, 12, 17
Flood	3, 4, 12, 15, 25, 26	3, 4, 12, 15, 28, 29	3, 4, 6, 7, 8, 12, 15, 25, 26, 27	3, 4,9, 12, 15	3, 4, 6, 7, 8, 10, 12, 15, 1618, 19, 20, 21, 22, 23, 24, 25, 26	3, 4, 12, 15
Hazardous Materials	12, 14, 25, 26	12, 13, 14	6, 8, 12, 13, 14, 25, 26, 27	9, 12,	6, 8, 10, 12, 13, 14, 16,18, 19, 20, 21, 22, 23, 24, 25, 26	12, 13, 14
Human Caused	12, 13, 14, 25, 26	12, 13, 14	6, 8, 12, , 25, 26, 27	9, 12	6, 8, 10, 12, 13, 14, 16, 18, 19, 20, 25, 26	12, 13, 14
Infrastructure/ Utility	12, 13, 14, 25, 26	12, 13, 14	6, 8, 12, 25, 26, 27	9, 12	6, 8, 10, 12, 13, 14, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26	12, 13, 14
Landslide	3, 4, 11, 12, 25, 26	3, 4, 11, 12	3, 4, 6, 7, 8, 11, 12, 25, 26, 27	3, 4,9, 11, 12	3,4,6, 7, 8, 10, 11, 12, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26	3,4, 11
Severe Weather	3,4, 12, 15, 25, 26	3,4, 12, 15, 28, 29	3, 4, 6, 7, 8, 12, 15, , 25, 26, 27	3,4,9, 12, 15	3,4, 6, 7, 8, 10, 12, 15, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26	3, 4, 15
Transportation Incident/Accident	12, 13, 14, 25, 26	12, 13, 14	6, 8, 12, , 25, 26, 27	9, 12,	6, 8, 10, 12, 13, 14, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26	12, 13, 14
Tsunami	12, 25, 26	12, 28, 29	6, 7, 8, 12, 25, 26, 27	9, 12	6, 7, 8, 10, 12, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26	12
Volcano	12, 25, 26	12, 28	6, 8, 12, 25, 26, 27	9, 12	6, 8, 10, 12, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26	12
Wildfire	12, 25, 26	12, 28, 29	6, 8, 12, 25, 26	9, 12	6, 8, 10, 12, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26	12

a. See Chapter Section 18.3 for explanation of mitigation types.

18.6 PRIORITIZATION OF INITIATIVES

The method utilized for prioritization of initiatives for the 2015 update differs slightly from the method used for the 2008 mitigation initiatives in that there was no consistent value placed on the factors identified for prioritization, which did not allow for a unified method by all planning partners. While the factors involved in the ranking remain similar, there is now a consistent category or level (high/medium/low) assigned with those identified factors to ensure consistency. Table 18-6 lists the priority of each countywide initiative. Table 18-7 lists the priority for each county-specific initiative. A qualitative benefit-cost review as described above was performed for each of these initiatives. The priorities are defined as follows:

- **High Priority**—A project that meets multiple objectives (i.e., multiple hazards), has benefits that exceed cost, has funding secured or is an ongoing project and meets eligibility requirements for the HMGP or PDM grant program. High priority projects can be completed in the short term (1 to 5 years).
- **Medium Priority**—A project that meets goals and objectives, that has benefits that exceed costs, and for which funding has not been secured but that is grant eligible under HMGP, PDM or other grant programs. Project can be completed in the short term, once funding is secured. Medium priority projects will become high priority projects once funding is secured.
- **Low Priority—**A project that will mitigate the risk of a hazard, that has benefits that do not exceed the costs or are difficult to quantify, for which funding has not been secured, that is not eligible for HMGP or PDM grant funding, and for which the time line for completion is long term (1 to 10 years). Low priority projects may be eligible for other sources of grant funding from other programs.

For many of the strategies identified in this action plan, the partners may seek financial assistance under the HMGP or PDM programs, both of which require detailed benefit/cost analyses. These analyses will be performed on projects at the time of application using the FEMA benefit-cost model. For projects not seeking financial assistance from grant programs that require detailed analysis, the partners reserve the right to define "benefits" according to parameters that meet the goals and objectives of this plan.

Because this is a multi-jurisdictional plan, the prioritization of initiatives specific to the remaining jurisdictions must also be done at the individual level based on the needs and programs of that body, and accomplished as resources can be secured. Funding to complete any initiative will likely be acquired from a variety of sources, with the lack of funding alone preventing an initiative from being implemented. As such, the less formal approach used during this process is more appropriate because some projects may not be implemented for up to 10 years, and associated costs and benefits could change dramatically in that time.

The method of prioritization utilized also allows for the inclusion of new projects throughout the life cycle of this plan without having to numerically re-value each of the projects based on an assigned value of 1, 2, 3, etc. Further, it supports the plan maintenance strategy for review, addition, and reprioritization of initiatives on an annual basis, reducing the level of effort involved in a numeric system of ranking, and enhancing the likelihood that the annual review will occur as a reduced level of effort will be required.

2008 ACTION PLAN STATUS

A comprehensive review of the 2008 action plan was performed to determine which countywide actions were completed, which should carry over to the updated plan, and which were no longer feasible and should be removed from the plan. Table 18-8 identifies the results of this review. Each jurisdictions' annex contains information concerning their strategies.

TABLE 18-6.
PRIORITIZATION OF COUNTYWIDE MITIGATION INITIATIVES

Initiative #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Project Grant eligible?	Can Project Be Funded under Existing Programs/ Budgets?	Priority (High, Med., Low)
1	4	H	L	Y	Y	Y	H
2	6	H	L	Y	Y	Y	H
3	7	H	L	Y	Y	Y	H
4	6	H	L	Y	Y	Y	H
5	9	H	L	Y	N	Y	H
6	13	H	M	Y	N	Y	M
7	8	M	L	Y	N	Y	M
8	19	H	L	Y	Y	Y	H
9	6	H	L	Y	Y	Y	H
10	4	H	L	Y	N	Y	H
11	4	H	L	Y	N	Y	H
12	7	H	M	Y	Y	Y	H
13	16	H	M	Y	Y	Y	H
14	16	M	M	Y	Y	N	M
15	13	M	L	Y	Y	N	L
16	13	M	M	Y	Y	Y	M
17	5	H	M	Y	Y	Y	M
18	7	M	M	Y	Y	N	M
19	2	H	H	Y	N	N	M
20	1	H	H	Y	Y	N	H
21	2	M	L	Y	N	Y	M
22	5	H	H	Y	Y	N	M
23	8	L	M	N	Y	N	L
24	6	H	M	Y	N	Y	M
25	8	M	L	Y	N	Y	M
26	8	M	L	Y	N	Y	M
27	3	H	H	Y	Y	N	M

TABLE 18-7.
PRIORITIZATION OF COUNTY-SPECIFIC MITIGATION INITIATIVES

Initiative #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Project Grant eligible?	Can Project Be Funded under Existing Programs/ Budgets?	Priority (High, Med., Low)
1	8	H	H	Y	Y	N	H
2	9	M	H	N	Y	N	M
3	9	H	H	Y	Y	Y	H
4	10	M	H	Y	Y	Y	M
5	3	H	H	Y	Y	N	H
6	4	M	L	Y	N	Y	M
7	1	H	L	Y	N	Y	H
8	1	H	L	Y	Y	Y	M
9	7	H	H	Y	N	N	L
10	7	H	H	Y	Y	N	H
11	4	H	M	Y	Y	Y	H
12	19	H	L	Y	Y	Y	H
13	4	M	L	Y	Y	N	M
14	5	M	M	Y	N	N	L
15	19	H	H	Y	Y	N	H
16	8	H	L	Y	N	Y	H
17	8	H	H	Y	Y	Y	H
18	2	H	M	Y	Y	Y	H
19	3	M	M	Y	Y	Y	M
20	2	M	L	Y	N	Y	M
21	2	M	H	Y	N	Y	M
22	4	H	M	Y	N	Y	M
23	4	H	M	Y	Y	N	M
24	4	H	M	Y	Y	Y	H
25	4	H	M	Y	Y	Y	H
26	4	M	L	Y	N	Y	M
27	4	H	L	Y	N	Y	H
28	2	M	H	Y	N	Y	M
29	6	H	L	Y	N	Y	H

TABLE 18-8.
2015 STATUS OF 2008 HAZARD MITIGATION ACTION PLAN

	Associated Hazards									2015 Status			
Mitigation Strategy	Coastal Erosion	Earthquakes	Floods	Landslides	Severe Weather	Tsunami	Wildland Fire	2010 Timeline	2015 Project Status	Completed	Continual /Ongoing Nature	Removed /No Longer Relevant /No Action	Carried Over to 2015 Plan
1—Continue implementation of public education program within Island County to educate citizens about the hazards faced, and the appropriate preparedness and response measures			✓					Short term	The county and its planning partners continue to have an extensive outreach program. Several CERT classes were conducted since the last plan completion; several annual safety fairs have occurred; council presentations of various types are used by all planning partners to provide information on hazards and associated efforts to enhance resiliency of the County.	✓	✓		✓
2—Continue to expand CERT training, involving local teams in exercises and training with first responders	✓	✓	✓	✓	✓	✓	✓	Short term	Five classes have been conducted, with an average of 15 students per class have been conducted since the 2008 plan. The county and its planning partners utilize CERT members to augment personnel for emergency management activities	✓	✓		✓
3—Implement program to provide emergency power for all critical facilities and infrastructure to include telecommunications systems, water utilities and designated emergency shelters	✓	✓	✓	✓	✓	✓	✓	Short term	While some new generators have been purchased, this remains an ongoing effort. For the 2015 update, this strategy will be a focus of the Water Resource Advisory Committee to address the needs of the water purveyors in the County and its jurisdictions.	✓		✓	
4—Prepare a coordinated plan for emergency control and distribution of fuels, both automotive and heating fuels, in case of prolonged interruption of normal distribution to Island County locations	✓	✓	✓	✓	✓	✓	✓	Short term	The county is in the process of developing a memorandum of understanding with local vendors to provide services and contractual obligations to such delivery during an incident. For the 2015 edition, the County will explore the possibility of developing a fueling plan as a potential annex to its CEMP.	✓			✓

TABLE 18-8.
2015 STATUS OF 2008 HAZARD MITIGATION ACTION PLAN

	Associated Hazards									2015 Status			
Mitigation Strategy	Coastal Erosion	Earthquakes	Floods	Landslides	Severe Weather	Tsunami	Wildland Fire	2010 Timeline	2015 Project Status	Completed	Continual /Ongoing Nature	Removed /No Longer Relevant /No Action	Carried Over to 2015 Plan
5—Plan and implement an expanded solid waste facility on Camano Island to accommodate debris. Current facility cannot accommodate the collection and storage of storm debris in any above-normal capacity.	✓	✓	✓	✓	✓	✓	✓	Long term	The County does have a transfer station which can be utilized, but it is limited in size. Over the course of the life cycle of this plan, the County and its planning partners will look at the development of a debris management plan which will further address this issue.				✓
6—Evaluate current coverage and equipment and provide a strategic emergency communications plan that provides better coverage to all areas of Island County for first responders and emergency amateur radio communications	✓	✓	✓	✓	✓	✓	✓	Long term	The County has begun upgrading some of its towers to increase ICOM capacity. The County has utilized funding from different grant programs, including SHSP and DHS grants, as well as general funds. The County will continue to seek funds for further enhancement of the communications network within the planning region.	✓			✓
7.—Implement a review of designated emergency shelter structural and utility readiness for occupancy after a significant earthquake.		✓		✓	✓			Long term	The County has identified several shelters, including Red Cross Shelters which have undergone some level of review. Some County service providers and personnel have also completed the ATC 20 Training, which will be beneficial after an earthquake event; the County has also acquired mobile trailers to store emergency equipment and supplies, which will provide logistical and resource support after a significant incident. This effort will be carried forward into the 2015 update.	✓	✓		✓

TABLE 18-8.
2015 STATUS OF 2008 HAZARD MITIGATION ACTION PLAN

	Associated Hazards									2015 Status			
Mitigation Strategy	Coastal Erosion	Earthquakes	Floods	Landslides	Severe Weather	Tsunami	Wildland Fire	2010 Timeline	2015 Project Status	Completed	Continual /Ongoing Nature	Removed /No Longer Relevant /No Action	Carried Over to 2015 Plan
8—Study and retrofit county owned facilities to better withstand damages from a major earthquake		✓		✓	✓			Long-term	Since the 2008 plan was completed, this effort was expanded to not only focus on County facilities and the earthquake hazard, but also other jurisdictions' facilities and multiple hazards. Studies such as a tsunami dig by USGS have supported efforts such as this; the County conducted a landslide assessment to identify slopes greater than 40 degrees to help identify potential areas of concern. The County raised $10,000 in donations to sponsor a study conducted by a master's student to analyze historical tsunami events. These efforts will be carried forward for the 2015 plan and be inclusive of all of the planning partners.	✓	✓		✓
9—Analyze options and acquire resources for alternate forms of transportation access to Camano Island should SR 532 or either of the two highway bridges become unserviceable.	✓	✓	✓	✓	✓	✓	✓	Long term		✓			✓
10—Evaluate and enhance the current capital improvements program for county roads and drainage projects to provide better flood control in known tidal flood problem areas.	✓		✓		✓			Long term	The County and its planning partners have made progress in this area of development. Since completion of the 2008 plan, the Camano Gateway Project was established, which was constructed to seismic standards; the David Slew segment of the roadway was raised 6 inches, and widened significantly. Public Works is regularly working with citizens and business impacted by the Ledgewood landslide (2013) on drainage issues. This effort will be carried forward in 2015, with information from this edition of the mitigation plan further supporting this initiative.	✓	✓		✓

TABLE 18-8.
2015 STATUS OF 2008 HAZARD MITIGATION ACTION PLAN

	Associated Hazards									2015 Status			
Mitigation Strategy	Coastal Erosion	Earthquakes	Floods	Landslides	Severe Weather	Tsunami	Wildland Fire	2010 Timeline	2015 Project Status	Completed	Continual /Ongoing Nature	Removed /No Longer Relevant /No Action	Carried Over to 2015 Plan
11—Provide steep slope stability project funding or relocation funding for county roads with histories of instability.	✓	✓		✓	✓			Long term	The County completed several projects in this area since completion of the 2008 plan. Several areas were stabilized through spiral nailing reinforcement. These projects were completed using general funds. This effort will be carried forward for the 2015 plan.	✓	✓		✓
12—Provide steep slope stability advice and education to owners of structures above steep bluffs or below steep bluffs. Increase monitoring of county bluffs involving beach communities or access to beach communities.	✓			✓		✓		Long term	The County hosted an earthquake symposium in spring 2014, which included presentations by experts such as Tim Walsh (WDNR) Brian Sherrod (USGS) and others who provided information on steep slopes and earthquake hazards. The County has hosted several public meetings since the 2008 plan's completion	✓	✓		✓
13—Obtain funding to provide tsunami evacuation maps, information, publications and road signage for both Whidbey and Camano Islands. Obtain all hazard alert broadcast AHAB towers for areas of North Whidbey Island.						✓		Long term	A new AHAB system was installed in Oak Harbor in 2014; all AHABs are tested monthly countywide; flood maps, tsunami inundation maps and various other information are available at all times for review; the County regularly displays these items at public meetings. For the 2015 update, the County is in the process of obtaining a new FEMA flood study, which may provide assistance in determining tsunami inundation as well.	✓	✓		✓
14—Promote a "Firewise" program in Island County to increase fire safety zones around businesses and residences. Encourage owners to reduce woodland fuel loads on their property.							✓	Long-term	The County and all of its fire departments and districts have made progress in fire prevention programs since the 2008 plan, but no significant progress has been made with respect to establishing FireWise Communities. The County and its jurisdictions feel that this is still a viable strategy, and will continue to look at these opportunities with the development of the 2015 update.			✓	✓

18.7 FUNDING OPPORTUNITIES

Although a number of the mitigation projects listed may not be eligible for FEMA funding, Island County and its planning partners may secure alternate funding sources to implement these projects in the future including federal and state grant programs, and funds made available through the county. In order to be eligible for some of those grant funds, completion of a hazard mitigation plan may be required. Table 18-9 identifies some of those grant requirements. Additional funding sources identified in Table 18-10 are also available which support various types of mitigation efforts on a countywide basis.

TABLE 18-9.
GRANT OPPORTUNITIES

Program	Enabling Legislation	Funding Authorization	Hazard Mitigation Plan Requirement	
			Grantee	Sub-Grantee
Public Assistance, Categories A-B (e.g., debris removal, emergency protective measures)	Stafford Act	Presidential Disaster Declaration	☐	☐
Public Assistance, Categories C-G (e.g., repair of damaged infrastructure, publicly owned buildings)	Stafford Act	Presidential Disaster Declaration	☑	☐
Individual Assistance (IA)	Stafford Act	Presidential Disaster Declaration	☐	☐
Fire Management Assistance Grants	Stafford Act	Fire Management Assistance Declaration	☑	☐
Hazard Mitigation Grant Program (HMGP) Planning Grant	Stafford Act	Presidential Disaster Declaration	☑	☐
HMGP Project Grant	Stafford Act	Presidential Disaster Declaration	☑	☑
Pre-Disaster Mitigation (PDM) Planning Grant	Stafford Act	Annual Appropriation	☐	☐
PDM Project Grant	Stafford Act	Annual Appropriation	☑	☑
Flood Mitigation Assistance (FMA)	National Flood Insurance Act	Annual Appropriation	☑	☑
Severe Repetitive Loss (SRL)	National Flood Insurance Act	Annual Appropriation	☑	☑
Repetitive Flood Claims (RFC)	National Flood Insurance Act	Annual Appropriation	☑	☐
Homeland Security	Dept. of Homeland Security	Annual Appropriation	☑	☐

☑ = Hazard Mitigation Plan Required
☐ = No Hazard Mitigation Plan Required

TABLE 18-10.
COUNTYWIDE FISCAL CAPABILITY

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Y
Capital Improvements Project Funding	Y
Authority to Levy Taxes for Specific Purposes	Y
User Fees for Water, Sewer, Gas or Electric Service	N
Incur Debt through General Obligation Bonds	Y
Incur Debt through Special Tax Bonds	Y
Incur Debt through Private Activity Bonds	Y
Withhold Public Expenditures in Hazard-Prone Areas	N
State Sponsored Grant Programs	Y
Development Impact Fees for Homebuyers or Developers	Y

Alternate funding sources which may further support mitigation efforts of various types include, but are not limited to, the following:

- **U.S. Department of Housing and Urban Development, Community Development Block Grants (CDBG)**—The CDBG program is a flexible program that provides communities with resources to address a wide range of community development needs. CDBG money can be used to match FEMA grant money. More information: http://www.hud.gov/offices/cpd/communitydevelopment/programs/
- **U.S. Fish & Wildlife Service Rural Fire Assistance Grants**—Each year, the U.S. Fish & Wildlife Service provides Rural Fire Assistance grants to neighboring community fire departments to enhance local wildfire protection, purchase equipment, and train volunteer firefighters. U.S. Fish & Wildlife Service fire staff also assist directly with community projects. These efforts reduce the risk to human life and better permit U.S. Fish & Wildlife Service firefighters to interact and work with community fire organizations when fighting wildfires. The Department of the Interior receives a budget each year for the Rural Fire Assistance grant program. The maximum award per grant is $20,000. The assistance program targets rural and volunteer fire departments that routinely help fight fire on or near Department of Interior lands. More information: http://www.fws.gov/fire/ living_with_fire/rural_fire_assistance.shtml
- **U.S. Department of Homeland Security**—Enhances the ability of states, local and tribal jurisdictions, and other regional authorities in the preparation, prevention, and response to terrorist attacks and other disasters, by distributing grant funds. Localities can use grants for planning, equipment, training and exercise needs. These grants include, but are not limited to areas of critical infrastructure protection, equipment and training for first responders, and homeland security. More information: http://www.dhs.gov/
- **FEMA, Hazard Mitigation Grant Program (HMGP)**—The HMGP provides grants to states, Indian tribes, local governments, and private non-profit organizations to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. More information: http://www.fema.gov/ government/grant/hmgp/

- **FEMA, Pre-Disaster Mitigation (PDM) Competitive Grant Program—**The PDM program provides funds to states, territories, Indian tribal governments, communities, and universities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations. PDM grants are to be awarded on a competitive basis and without reference to state allocations, quotas, or other formula-based allocation of funds. More information: http://www.fema.gov/government/grant/pdm/index.shtm
- **U.S. Bureau of Land Management (BLM), Community Assistance Program—**BLM provides funds to communities through assistance agreements to complete mitigation projects, education and planning within the wildland urban interface. More information: http://www.blm.gov/nifc/st/en/prog/fire/community_assistance.html
- **U.S. Department of Agriculture Community Facilities Loans and Grants—**Provides grants (and loans) to cities, counties, states and other public entities to improve community facilities for essential services to rural residents. Projects can include fire and rescue services. Funds have been provided to purchase fire-fighting equipment for rural areas. No match is required.
- **General Services Administration Sale of Federal Surplus Personal Property—**This program sells property no longer needed by the federal government. The program provides individuals, businesses and organizations the opportunity to enter competitive bids for purchase of a wide variety of personal property and equipment. Normally, there are no restrictions on the property purchased. More information: http://www.gsa.gov/portal/category/21045
- **FEMA Readiness, Response and Recovery Directorate, Fire Management Assistance Grant Program—**Program provides grants to states, tribal governments and local governments for the mitigation, management and control of any fire burning on publicly (non-federal) or privately owned forest or grassland that threatens such destruction as would constitute a major disaster. The grants are made in the form of cost sharing with the federal share being 75 percent of total eligible costs. Grant approvals are made within 1 to 72 hours from time of request. More information: http://www.fema.gov/government/grant/fmagp/index.shtm
- **Hazardous Materials Emergency Preparedness Grants—**Grant funds are passed through to local emergency management offices and Hazmat teams having functional and active local emergency planning committees. More information: http://www.phmsa.dot.gov/hazmat/grants

CHAPTER 19.
CAPABILITY ASSESSMENT

19.1 MITIGATION-RELATED REGULATORY AUTHORITY

Hazard mitigation builds on a community's existing capabilities in place, including financial, regulatory, programmatic and planning capabilities. Island County's capabilities to implement mitigation projects include community planners, engineers, floodplain managers, GIS personnel, emergency managers, and financial, legal and regulatory requirements (zoning, building codes, subdivision regulations, and floodplain management ordinances). These resources have the responsibility to provide overview of past, current, and ongoing pre- and post-disaster mitigation planning projects, including capital improvement programs, wildfire mitigation programs, stormwater management programs, and NFIP compliance projects. Regulatory capabilities currently available are summarized in Table 19-1 through Table 19-4. Each planning partner also completed a similar type assessment within their annex document.

TABLE 19-1.
MITIGATION-RELATED REGULATORY AUTHORITY; COUPEVILLE MUNICIPAL CODE

Location	Description
Title 8, Health and Safety, Section 8.08.030 D	A burn pile shall not contain prohibited materials.
Title 13, Pubic Services, Section 13.08.120	It is the policy of the Town to promote water conservation dated 26 August 1993
Title 13, Public Services, Section 13.12.080	Prohibit the discharge of hazardous or detrimental substances into the sewer system.
Title 13, Pubic Services, Section 13.20.010 B	Actions to minimize water, erosion and sedimentation in creeks, streams, ponds, Penn Cove, and other bodies of water. Decrease stream water related damage to public and private property
Title 15, Building and Construction, Section 15.12.010	Utilize, protect, restore, and preserve the states most valuable and fragile natural resources.
Title 16, Environment, Section 16.08.010	B. To promote social and economic stability of existing and future land use by regulating the use of individual parcels of land to prevent any unreasonable detrimental effects or encroachment by incompatible uses on neighboring properties.
Title 16, Environment, Section 16.20.010	Prevent land erosion and flood damage by preventing the indiscriminate removal, or destruction of trees, and ground cover, and/or movements of earth; to minimize surface water runoff and erosion and the siltation of storm water systems.
Title 16, Environment, Section 16.36.010	Coupeville adoption of the State Environmental policy Act (SEPA), RCW 43.21C.120 and WAC 197-11-904
Title 16, Environment, Section 16.40.010	The purpose of this chapter is to promote the public health, safety, and general welfare, and to minimize public and private losses due to flood conditions
Title 16, Environment, Sections 16.32.101	Environmental Protection.

**TABLE 19-2.
MITIGATION-RELATED REGULATORY AUTHORITY; ISLAND COUNTY CODE**

Location	Description
Island County Code Title XI Land Development Standards, 11.01.010 C Purpose and Intent	The purpose of these provisions is to minimize nuisances associated with development practices, which are dysfunctional to the orderly development of Island County. Fulfill the objectives of comprehensive planning policies of Island County in promoting the health, safety, and welfare of the general public, as well as fulfilling the county's responsibilities as trustees of the environment as provided by law;
Island County Code Title XI Land Development Standards, 11.02.270	Grading permit requirements shall be established on a case-by-case basis, following a field inspection/evaluation of slopes and their relative stability, of topography and existing natural, constructed, or planned drainage ways/systems, of soils and their susceptibility to erosion, of forest and vegetative cover as exists and planned, and of critical areas.
Island County Code Title XI Land Development Standards, 11.03.010 Declaration of Purpose	The purpose of this chapter is to regulate and control drainage or storm water to safeguard the public health, safety, and general welfare. The objectives of this chapter are as follows: A. To promote sound, practical, and economic development practices and construction procedures which minimize impacts to the County's waters; the purpose of this chapter is to regulate and control drainage or storm water to safeguard the public health, safety, and general welfare. B. To minimize degradation of water quality and to control the sedimentation of streams, rivers, lakes, wetlands, and other surface water; C. To control storm water runoff originating on developing land; D. To preserve the suitability of water for recreation and fishing.
Island County Code Title XI Land Development Standards, 11.03.380	Whenever the Director/County Engineer determines that a condition caused by a development activity regulated by this chapter creates a present or imminent hazard, or is likely to create a hazard to the public safety, health, or welfare, the environment, or public or private property, the Director/County Engineer may declare such condition a public nuisance and may direct the property owner or persons causing or contributing to the hazardous condition to abate the hazard within a specified period, or the Director/County Engineer may take action to abate the hazard and recover all costs incurred from responsibilities.
Island County Code Title XIII Public Works, I 13.02A.010 Purpose	The purpose of this chapter is to establish a comprehensive county-wide program for solid waste handling and solid waste recovery and/or reclamation which will prevent land, air, and water pollution and conserve the natural, economic, and energy resources of the county. To do so requires effective control of the disposal of all non-exempt solid waste generated and collected within the unincorporated areas of Island County at a site or sites consistent with its Comprehensive Plan.
Island County Code Title XIV, Buildings and Construction, Section 11.03.010, Page 53 of 106,	The purpose of this chapter is to regulate and control drainage or storm water to safeguard the public health, safety, and general welfare. The objectives of this chapter, in part, are as follows: (C) To control storm water runoff originating on developing land. (G) To minimize the adverse effects caused by alterations in surface water or ground water quality, quantities, locations, and flow patterns. (I) To protect public safety by reducing slope instability and landslides.
Island County Code Title XIV Buildings and Construction, 14.03B.010 Findings	The regulation of outdoor burning. This ordinance providing for a burn ban is in the interests of the public safety and welfare by reducing the risk of spread of fire. (Ord. C-57-90, May 7, 1990, vol. 31, p. 121).

**TABLE 19-2.
MITIGATION-RELATED REGULATORY AUTHORITY; ISLAND COUNTY CODE**

Location	Description
Island County Code Title XIV Buildings and Construction, Chapter 14.02A.010B	The flood hazard areas of Island County are subject to periodic inundation which results in loss of life and property, health and safety hazards, disruption of commerce and governmental services, extraordinary public expenditures for flood protection and relief and impairment of the tax base, all of which adversely affect the public health, safety and general welfare. 2. These flood losses are caused by the cumulative effect of obstructions in areas of special flood hazards, which increase flood heights and velocities and when inadequately anchored, damage uses in other areas. Uses that are inadequately flood-proofed, elevated or otherwise protected from flood damage also contribute to the flood loss.
Island County Code Title XIV, Buildings and Construction, Section 14.02A.010C	C. Statement of Purpose: It is the purpose of this ordinance to promote the public health, safety, and general welfare and to minimize public and private losses due to flood conditions in specific areas by provisions designed to; 6. To help maintain a stable tax base by providing for the sound use and development of areas of special flood hazard so as to minimize future flood blight areas. D. Methods of Reducing Flood Losses. 3. Controlling the alteration of natural flood plains, stream channels, and natural protective barriers, which help accommodate or channel floodwaters. 4. Controlling the filling, grading, and other development, which may increase flood damage, and 5. Losses preventing or regulating the construction of flood barriers, which will unnaturally divert floodwaters or may increase flood hazards in other areas.
Island County Code Title XV Utilities Purpose + Management, Chapter 15.02 Section 15.02.010	The County finds that real property in the Marshall Drainage Basin contributes to a common drainage problem resulting from storm and surface water run-off.
Island County Code Title XV Utilities Purpose, Chapter 15.01 Section 15.01.010	The purpose of this ordinance is to establish a storm water management program and create a method to fund storm water control facilities.
Island County Code Title XVI Planning and Subdivisions, 16.14C.160 Substantive Authority	A. The policies and goals set forth in this Chapter are supplementary to those in the existing authorization of Island County.
Island County Comprehensive Emergency Management Plan, Page 1, Introduction, B,	This document establishes a comprehensive plan for countywide mitigation, preparedness, response, and recovery, operations for natural and technological hazards and disasters impacting Island County
Island County Comprehensive Land Use Plan, Page 1-16	To set goals and policy to guide growth in the county through the year 2020; to develop future land use patterns and maps; and to establish a specific program for plan implementation.

**TABLE 19-2.
MITIGATION-RELATED REGULATORY AUTHORITY; ISLAND COUNTY CODE**

Location	Description
Island County Comprehensive Land Use Plan, Shoreline Management Element pg. 3-12, VI Conservation Element	Encourage the use of open spaces, buffers, and accepted erosion control methods to retard surface and underground runoff for protection of shoreline lands and waters;
Island County Comprehensive Plan, Aquifer Recharge Areas	Groundwater resource and recharge protection. GMA requires the designation of critical areas such as aquifer recharge areas per ICC 8.09.097 Critical Recharge Area Requirements, land use proposals are reviewed for the potential to impact groundwater contamination.
Island County Comprehensive Plan, Element 8 – Section II – Transportation Planning Goals (Page 11-12)	Minimize negative environmental impacts created by County transportation facilities and activities by: a. Appropriately designing, constructing, operating, and maintaining transportation facilities to minimize degradation of existing environmental conditions.
Island County Critical Areas Ordinance, Section 17.02.020	The purpose of this Chapter is to regulate the division of land and to promote the public health, safety, and general welfare in accordance with standards established by the State of Washington; to promote effective use of land; to facilitate adequate provision for water, sewer, utilities, drainage, parks and recreation areas, sites for schools and school grounds and other public requirements; to provide for proper ingress and egress; and to require uniform monumenting of Land Divisions and conveyance by accurate legal description. This Chapter implements Chapter 58.17 RCW; serves as an official control pursuant to Chapter 36.70 RCW and serves as a development regulation pursuant to Chapter 36.70A RCW. (Ord. C-85-98 [PLG-020-98], September 29, 1998, vol. 43, p. 11; accepted by Res. C-133-98 [PLG-043-98], October 19, 1998, vol. 43, p. 38)
Island County Critical Areas Ordinance, Section 17.02.A Purpose	The purpose of the Island County Zoning Code is to divide the County into land use zones with standards within each zone for the use of Island County land resources which will: (G) Protect the public health, safety, and general welfare of the residents of Island County. (J) Preserve the integrity of water resources by ensuring a balanced program controlling storm water runoff and ground water recharge. (K) Prevent pollution of surface and subsurface water resources. O. Minimize the hazards incident to development on adjacent to steep slope or geologically hazardous areas.

TABLE 19-3.
MITIGATION-RELATED REGULATORY AUTHORITY; LANGLEY MUNICIPAL CODE

Location	Description
Title 4, Section 4.01.050, Disaster and Response Plan.	Plans and programs for executing emergency powers including a disaster readiness and response plan shall be prepared and kept current under the direction of the Mayor who shall submit such plans and programs and proposed amendments thereto to the City Council for review and approval by resolution. Upon such approval the Mayor shall be authorized to exercise in accordance with such plans and programs the powers provided therein. (Ord. 793, 2001) Section 4.01.060. Disaster Response Committee. There shall be a Disaster Response Committee consisting of such number of members as shall be appointed by the Mayor. The Mayor shall serve as the chairman thereof.
Title 9, Section 9.05.010	Findings; A. The State of Washington has experienced an unusually dry winter and all indications are that the summer will be hot. B. Last October (1991) there was a major disaster in the Spokane area resulting in hundreds of acres and homes burned by fires. C. Much of the state is experiencing a water shortage and forest and building fires require a tremendous amount of resources to control and extinguish. We need to save these vital resources rather than waste them fighting fires that could be prevented. One way to help protect against fires is to limit the time of discharge of fireworks. D. The city of Langley declares an emergency due to the severe water shortage and extreme fire danger. (Ord. 624, 1992) Section 9.05.020.
Title 13, Section 13.01.020 Purpose	The purpose of this article is to establish fees for service, and general rules and regulations for service and the extension of service from the City water supply system, and to promote the public health, safety and general welfare of the users of the system, in accordance with the standards established by the City, County, State and Federal governments. (Ord. 744, 1997) Section 13.01.370 Shortage of water……..
Title 13, Section 13.50.020 Purpose and policy	This chapter establishes requirements for wastewater discharge into the City of Langley wastewater treatment system. It enables the Public Works Department to protect the public health consistent with applicable local, state and federal laws. The objectives of this chapter are: 1. To prevent the discharge of untreated pollutants into the wastewater treatment system that will pass into Saratoga Passage or the atmosphere or otherwise be incompatible with the system; 2. To prevent the discharge of untreated pollutants……

**TABLE 19-3.
MITIGATION-RELATED REGULATORY AUTHORITY; LANGLEY MUNICIPAL CODE**

Location	Description
Title 13, Section 13.62.010 Purpose	The city council finds that an expanding population and increased development of land has and will continue to increase demands on the city's present storm and surface water drainage system; that the present storm and surface water drainage system is inadequate to meet this increased demand; that storm water runoff has caused significant damage to parts of the city; that floodwater during a major storm carries a higher concentration of pollutants which may contaminate the city's water supply; that uncontrolled water runoff on streets poses a safety hard to both lives and property. Therefore, the recognition of the city's storm and surface water drainage system as a municipal utility service of the city is necessary to provide for the proper management and funding of the storm and surface water drainage system and for the orderly accomplishment of needed new facilities and to the rehabilitation and maintenance of existing facilities. (Ord. 540, 1989) Section 13.62.020 Established. There is created and established in the city a storm and surface water drainage utility in accordance with state law (RCW Chapter 35.67). This utility shall have equal status with other utility services provided by the city. The utility shall be known as the storm and surface water drainage utility…………….
Title 14, Building, Chapter 14.03B.010	This ordinance providing for a burn ban is in the interest of public safety and welfare by reducing the risk of spread of Fire.
Title 15, Section 15.01.005 Purpose and intent	The provisions of this ordinance are intended to accomplish these purposes. 1. Facilitate the development of properly designed and constructed public and private roadways and utilities, so as to provide an efficient integrated roadway and utility system for Langley. 2. Protect public rights-of-way, natural resources, scenic and open space from undue degradation due to poor development practices 3. Protect, to the greatest extent possible, life, limb and property from loss and damage by flooding, landscapes, accelerated soil creep, settlement and subsidence, abnormal erosion and other potential natural hazards. 4. Protect the public interest in management of surface water drainage, ground water recharge, and related functions of drainage basins, watercourses and shoreline areas. 5. Protect streams, creeks, ponds, wetlands, lakes, coastal areas, and drainage facilities from mechanical damage, excessive flows and other conditions which increase erosion turbidity, siltation, and other forms of pollution, or which reduce low water level and/or flow rates endangering aquatic and benthic life

TABLE 19-3.
MITIGATION-RELATED REGULATORY AUTHORITY; LANGLEY MUNICIPAL CODE

Location	Description
Title 15.24. Flood Hazard Areas	Definitions. As used in this chapter: "Flood hazard areas" means those areas subject to inundation by the "base flood" as identified in the flood insurance rate map. The "base flood" means a flood having a one percent chance of being equaled or exceeded in any given year. It is referred to as the "one hundred year flood." A flood hazard area consists of the following components: 1. Floodplain. This is the total area subject to inundation by the base flood. 2. Flood Fringe. This is that portion of the floodplain outside of the floodway, which is covered by floodwaters during the base flood. 3. Floodway. The channel of the stream and that portion of the adjoining floodplain which is necessary to contain and discharge the base flow without any measurable in-crease in flood heights. B. Protected and Permitted Alterations. 1. Development proposals on sites containing a flood hazard area shall conform to the conditions of this section. In addition, requirements for buffers, critical area tracts, building setback lines, permitted alterations, mitigation, and maintenance for a development proposal site on or adjacent to a flood hazard area shall be established in his chapter for the wetlands, streams, or other areas which form the constituent elements of the floodplain.
Title 15, Building and Construction, Section 15.24.010	Basis for establishing areas of special flood hazard; A. The areas of special flood hazard identified by the Federal Insurance Administration rate map on file at the City Hall and adopted by reference are declared as part of this chapter. B. The service director Planning Official and/or Building Official is appointed to administer and implement this chapter by granting, with restrictions, or denying development in flood-prone areas. (Ord. 880, 2006) Section 15.24.020 Flood hazard protection standards. In all areas of special flood hazard the following standards are required: A. All new construction and substantial improvement shall be anchored to prevent flotation, collapse or lateral movement of structures. B. All new construction and substantial improvements shall be constructed using materials, methods and practices that minimize flood damage. C. All subdivision……..
Title 16, Environment, Definitions	Wetlands and streams "Mitigation" means steps taken to avoid, minimize or compensate for adverse wetland or stream impacts. Mitigation, in the following order of preference is: 1. Avoiding the impact altogether by not taking a certain action or parts of an action; 2. Minimizing impacts by limiting the degree or magnitude of the action and its implementation, by using appropriate technology, or by taking affirmative steps to avoid or reduce impacts; 3. Rectifying the impact by repairing, rehabilitating or restoring the affected environment; 4. Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
Title 16, Environment, Section 16.04.010 SEPA.	The city adopts the model ordinance, WAC Chapter 173-806, to implement SEPA rules, WAC Chapter 197-11. (Ord. 440, 1984) Section 16.04.020 Additional provisions adopted. The city adopts the optional sections of the model ordinance, as codified in this chapter. (Ord. 440, 1984) Section 16.04.100 Mitigated DNS…….

TABLE 19-3.
MITIGATION-RELATED REGULATORY AUTHORITY; LANGLEY MUNICIPAL CODE

Location	Description
Title 16, Environment, Section 16.20.010 Purpose.	The purpose of this chapter is to: A. Comply with the Washington State Growth Management Act requirement that cities adopt interim regulations to designate and regulate resource lands and environmentally sensitive (critical) areas; B. Protect the public health, safety, and welfare by preventing the adverse impacts of development on resource lands and environmentally sensitive (critical) areas; C. Preserve and protect resource lands and environmentally sensitive (critical) areas by regulating development within and adjacent to them, etc.. (Ord. 861, 2005; 619, 1992).
Title 16, Zoning, Section 16.20.045(A) Designation of geologically hazardous areas	Geologically hazardous areas susceptible to erosion, sliding, earthquake, or other geological events. They pose a threat to the health and safety of citizens when incompatible development is sited in areas of significant hazard. Such incompatible development may not only place itself at risk, but also may increase the hazard to surrounding development and use. Areas susceptible to one or more of the following types of hazards shall be designated as a geologically hazardous area: 1. Erosion hazard; 2. Landslide hazard; 3. Seismic hazard; 4. Other geological events including tsunamis, mass wasting, debris flow, rock falls, and differential settlement. B. Designation of specific hazard areas 1. Erosion hazard areas. Erosion hazard areas are at least those areas identified by the U.S. Department of Agriculture's Natural Resources Conservation Service as having a "moderate to severe", "severe", or "very severe" rill and inter-rill erosion hazard. 2. Landslide hazard areas. Landslide hazard areas are areas potentially………
Title 17, Subdivisions, Section 17.04.020 Purpose of Permit provisions.	The purpose of this chapter is to regulate the subdivision of land and to promote the public health, safety, and welfare of the city and its citizens in accordance with state law and the city's comprehensive plan. To carry out this purpose for the subdivision of land for residential uses, this chapter establishes a flexible lot process, which will facilitate the fair and predictable division of land, maintain the current character of the city, and provide for greater flexibility in the division and establishment of residential lots. A further purpose of this chapter is to prevent the overcrowding of land; to lessen congestion in the streets; to provide for adequate light and air; to facilitate adequate provision for water, sewage, storm water drainage, parks and recreation areas, and sites for public facility needs; to provide for proper ingress and egress, including future traffic circulation needs of the immediate and surrounding area; and to provide for a variety of housing opportunities.
Title 18, Zoning, 18.01.010 Purpose.	The purpose of this title includes, but is not limited to, promoting the health, safety and general welfare by guiding the development of the city by means of the comprehensive land use plan which is, in part, carried out by the provisions of this title. It is further intended to provide regulations and standards, which will: A. Encourage high standards of development; B. Prevent the overcrowding of land; C. Provide adequate light and air, D. Avoid excessive concentration of population; E. Lessen congestion on the streets; F. Facilitate adequate provisions for transportation, utilities, schools, parks and other necessary public needs; G. Preserve the small town character of Langley and direction for orderly growth and development, together with flexibility to respond to changing economic circumstances.(527, Added, 01/25/1989)

**TABLE 19-3.
MITIGATION-RELATED REGULATORY AUTHORITY; LANGLEY MUNICIPAL CODE**

Location	Description
Title 18, Shoreline Regulations Section 18.31 Purpose	Protection of private property rights consistent with public interest associated with the shorelines of the state requires that local, state and federal governments join in a concerted effort to utilize, protect, restore and preserve the shorelines as among the state's most valuable and fragile natural resources. To prevent the inherent harm in an uncoordinated and piecemeal development of the state's shorelines, the city council deems the procedures, standards, controls and penalties set forth in this chapter to be essential to the protection of the public health, safety and general welfare of the citizens of the city. (Ord. 334, 1981: Ord. 240, 1973) Section 16.08.020 Authority. By enacting Chapter 286, Laws of 1971, First Extraordinary Session, the Legislature has prescribed a method for accomplishing the purposes set forth in Section 16.08.010, and has vested cities with the responsibility for the preparation of programs controlling the development of shorelines within their jurisdiction. (Ord. 334, 1981: Ord. 240, 1973).

**TABLE 19-4.
MITIGATION-RELATED REGULATORY AUTHORITY; OAK HARBOR MUNICIPAL CODE**

Location	Description
Chapter 1.10, Emergency Management, 1.10.010	The declared purposes of this chapter are to provide for the preparation and carrying out of plans for emergency mitigation, preparedness, response and recovery for persons and property within the city in the event of an emergency or disaster, and to provide for the coordination of emergency functions and services of this city with all other public agencies and affected private persons, corporations and organizations. Any expenditures made in connection with such emergency management activities, including mutual aid activities, shall be deemed conclusively to be for the direct protection and benefit of the inhabitants and property of the city of Oak Harbor. It is the policy of this city to make effective preparation and use of manpower, resources, and facilities for dealing with any emergency or disaster that may occur. Disasters and emergencies by their very nature, may disrupt or destroy existing systems and the capability of the city of Oak Harbor to respond to protect life, public health and public property, and essential city services. Therefore, citizens are advised to be prepared to be on their own for up to 72 hours should an emergency or disaster occur. (Ord. 1295 § 1, 2002).

TABLE 19-4.
MITIGATION-RELATED REGULATORY AUTHORITY; OAK HARBOR MUNICIPAL CODE

Location	Description
Chapter 2.40, Development Services, 2.40.030 Powers and duties of the department,	The department of development services shall perform the following functions: Administer and enforce all city codes, as now in effect or as hereafter amended concerning the construction of buildings and development of land including those concerning building ordinances of the city, including but not limited to, the provisions of the building code, plumbing code, mechanical code, abatement of dangerous building code, housing and building maintenance code, zoning code, platting code and SEPA codes. Assure proper processing applications for construction permits, for grading permits, for use permits, for conditional use permits, variances and other zoning code permits, for subdivisions, short subdivisions, condominium plats, site plans and for other land use approvals, including those related to shoreline management. Conduct reviews of the effects of proposed projects on the environment, as contemplated in the State Environmental Policy Act and city ordinances. Promote compliance with permit reform requirements under Chapter 36.70B RCW. Promote compliance with the Growth Management Act under Chapter 36.70A RCW. Maintain appropriate records regarding property, permits and structures. Develop and maintain compliance program for nuisance abatement in the city. Discharge such other responsibilities as may be directed by the Mayor or ordinance consistent with the laws of the State of Washington. (Ord. 1256 4, 2001)
Title 8, Fire, 8.03.020 Adoption of International Fire Code	The most recent version of the International Fire Code, adopted by the State Building Council pursuant to Chapter 19.27 RCW and as amended in this chapter of the Oak Harbor Municipal Code, shall be in effect in the city of Oak Harbor. A copy of the most recent International Fire Code together with applicable appendices is on file in the office of city clerk and is available for public inspection. (Ord. 1596 § 1, 2010; Ord. 1515 § 1, 2007).
Chapter 12.10 Storm and Surface Water Utility Code, 12.10.020 Purpose	The purpose of this code is to provide for the planning, design, construction, use, maintenance, repair and inspection of the storm and surface water system; to establish programs and regulations to assure the quality of the water in such system and to minimize the chance of flooding; and to provide for the enforcement of the provisions of this code. This code supplements other city ordinances and regulations regarding protection of the storm and surface water system, including but not limited to the critical land and zoning code regulations of the city of Oak Harbor. (Ord. 1085 § 3, 1997).

TABLE 19-4.
MITIGATION-RELATED REGULATORY AUTHORITY; OAK HARBOR MUNICIPAL CODE

Location	Description
Chapter 13.10 Water Conservation, 13.10.010 Findings and purpose.	The city's water supply is subject to weather conditions, water contamination, interruption of supply and other emergencies and, therefore, usage reductions may be required to assure an adequate supply for essential needs; and The city is supplied water in part by the city of Anacortes water department, and this water supplier has requested that the city of Oak Harbor provide for measures and authority to impose emergency water restrictions and sanctions to conserve water consumption during such emergency in accordance with a water shortage response plan; and The unrestricted water use for non-essential purposes during water emergencies will endanger the adequacy of the water supply for essential needs; and Compliance with said restrictions will be encouraged by imposition of additional charges for water usage in excess of authorized usage during an emergency; and The city council recognizes the critical importance of an immediate response by the city in the event of any water supply emergency; and to provide this response, and mayor or his/her designee, shall be granted authority to implement the water shortage response plan, hereinafter referred to as the plan; and This chapter is necessary for the health, safety and welfare of the city of Oak Harbor. (Ord. 1263 § 2, 2001).
Title 14, Sewers, 14.01.010 Purpose	This title covers regulations concerning the Oak Harbor sewer system. Its purpose is to assure that the system is operated in compliance with state and federal regulations concerning the disposal of sewage and the maintenance of clean water and a healthy, safe environment.
Chapter 14.07 Prohibited Discharges, 14.07.010 Prohibited discharge standards	General Prohibitions. No person shall introduce or cause to be introduced into the OHSS any pollutant or waste water which causes pass- through or interference. These general prohibitions apply to all users of the OHSS whether or not they are subject to categorical pretreatment standards or any other national, state or local pretreatment standards or requirements.
Chapter 15.16 Unlawful Disposal of Garbage, 15.16.020 Duty Exceptions – Liability	(1) It is the duty of every person to assure that any solid waste, toxic waste or hazardous substance which is generated, created, made, transported, controlled, stored, possessed or owned by such person is not collected, deposited, burned, placed, disposed of or dumped on any public or private property, except in accordance with other provisions of this chapter, in the city of Oak Harbor.
Title 17 Buildings	Buildings this chapter applies to identified on Federal Insurance 17.20.060 Land to which adopts special flood hazards as All Permit Administration Flood Insurance Maps. "No structure or land shall hereafter be constructed, located extended, or altered without full compliance of this chapter."
Title 17 Buildings, 17.05.010 Adoption of Codes	Adoption of International Building Code and other standardized building and utility codes
Title 17 Buildings, Chapter 17.20 Flood Damage Prevention	It is the purpose of this chapter to promote the public health, safety, and general welfare and to minimize public and private losses due to flood conditions in specific areas.

**TABLE 19-4.
MITIGATION-RELATED REGULATORY AUTHORITY; OAK HARBOR MUNICIPAL CODE**

Location	Description
Chapter 18 Planning, 18.10.010 Comprehensive Plan	The comprehensive plan, a copy of which is on file with the city clerk, and is available for inspection, is hereby adopted on December 18, 2012, as Oak Harbor's comprehensive plan, amending and revising the comprehensive plan as adopted under Ordinance No. 1594. (Ord. 1647 § 1, 2012; Ord. 1594 § 1, 2010; Ord. 1564 § 1, 2009; Ord. 1542 § 1, 2008; Ord. 1488 § 1, 2007; Ord. 1439 § 1, 2005; Ord. 1396 § 2, 2004; Ord. 1340 § 1, 2003; Ord. 1287 § 1, 2001; Ord. 1215 § 1, 2000; Ord. 1161 § 1, 1999; Ord. 1100 § 1, 1997; Ord. 1027 § 1, 1995).
Chapter 18 Planning, 18.10.025, Shoreline Master Plan	The city of Oak Harbor shoreline master program, a copy of which is on file with the clerk's office and shall be made available for public inspection, is hereby adopted as an element of the Oak Harbor comprehensive plan as if fully set out herein. As part of the shoreline master program, there shall be maintained a map showing the areas of Oak Harbor which fall under the jurisdiction of the shoreline master program. The map entitled "City of Oak Harbor Shoreline Master Program Designated Environments" is attached to the city of Oak Harbor shoreline master program and by this reference is made a part hereof. The city clerk shall maintain a copy of the map along with the shoreline master program. The planning department shall make copies of this map available for inspection and purchase. (Ord. 1033 § 1, 1996).

The County and its planning partners have additional proactive mechanisms in place. All planning partners identified those capabilities within their annex documents. Results for the county are summarized in Table 19-5.

In addition to the financial and regulatory capabilities which all planning partners have identified, there are other programs available, some of which provide incentives for citizens. Such programs further enhance resiliency throughout Island County. Two such programs include the National Flood Insurance Program, and the Community Rating System, both of which are discussed in detail in Chapter 9 – Flood.

TABLE 19-5
ISLAND COUNTY LEGAL AND REGULATORY CAPABILITY

	Local Authority	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements				
Building Code	Yes	Yes	Yes	Identified in Table 19-2
Zonings	Yes	No	No	Identified in Table 19-2
Subdivisions	Yes	No	No	Identified in Table 19-2
Stormwater Management	Yes	No	No	Identified in Table 19-2
Post Disaster Recovery	Yes	No	No	Beginning Process 2015
Real Estate Disclosure	Yes	Yes	Yes	RCW 42.56
Growth Management	Yes	Yes	Yes	GMA Enacted Statewide 1990; Currently being updated – Island County Comprehensive Land Use Plan further Identified in Table 19-2
Site Plan Review	Yes	Yes	Yes	Identified in Table 19-2
Public Health and Safety	Yes	No	Yes	Island County Health Department; Island County Sherriff's Dept. Public Peace and Safety;
Environmental Protection	Yes	Yes	Yes	Various types of regulatory authority identified in Table 19-2
Planning Documents				
General or Comprehensive Plan *Is the plan equipped to provide linkage to this mitigation plan?* Yes				
Floodplain or Basin Plan	Yes			
Stormwater Plan	Yes			
Capital Improvement Plan	Yes			
Habitat Conservation Plan	Yes			
Economic Development Plan	Yes			
Shoreline Management Plan	Yes			
Community Wildfire Protection Plan	No			
Response/Recovery Planning				
Comprehensive Emergency Management Plan	Yes			Update occurring 2015
Threat and Hazard Identification and Risk Assessment	No			
Terrorism Plan	No			
Post-Disaster Recovery Plan	Yes			Regional Catastrophic Plan
Continuity of Operations Plan	Yes			Portions completed but not assimilated into one document
Public Health Plans	Yes			Island County Public Health has several incident specific plans developed

19.2 WASHINGTON STATE RATING BUREAU LEVELS OF SERVICE

In Washington, the Washington State Rating Bureau (WSRB) helps determine standards on which insurance rates are set. WSRB, like most other states, utilizes the Insurance Service Office, Inc. (ISO) to determine levels of protection based on a prescribed level of service. Two such levels of services assessed are the Public Protection Classification Program and the Building Code Effectiveness Grading Schedule.

19.2.1 Public Protection Classification Program

The Public Protection Classification (PPC) program recognizes the efforts of communities to provide fire protection services for citizens and property owners. A community's investment in fire mitigation is a proven and reliable predicator of future fire losses. Insurance companies use PPC information to help establish fair premiums for fire insurance — generally offering lower premiums in communities with better protection. By offering economic benefits for communities that invest in their firefighting services, the program provides an additional incentive for improving and maintaining public fire protection.

In order to establish appropriate fire insurance premiums for residential and commercial properties, insurance companies utilize up-to-date information about the Community's fire-protection services. Through analysis of relevant data, communities are able to evaluate their public fire-protection services, and secure lower fire insurance premiums for communities with better protection. This program provides incentives and rewards in those areas with improved firefighting services. This program has gathered extensive information on more than 46,000 fire-response jurisdictions. Once all of the data is reviewed and analyzed, communities are assigned a PPC from 1 to 10. Class 1 generally represents superior property fire protection, while Class 10 indicates that the area's fire-suppression program is not as robust.

The most significant benefit of the PPC program is its effect on losses. Statistical data on insurance losses bears out the relationship between excellent fire protection — as measured by the PPC program — and low fire losses. PPC helps communities prepare to fight fires effectively. The program also provides help for fire departments and other public officials as they plan, budget for, and justify improvements.

Table 19-6 identifies the Public Protection Classification for Island County and its planning partners.

TABLE 19-6.
COUNTYWIDE PUBLIC PROTECTION CLASSIFICATION

Community	Protection Class Grade
Coupeville	5
Island County F.P.D. 1	6
Island County F.P.D. 2	6
Island County F.P.D. 3	6
Island County F.P.D. 5	7
Langley	5
Oak Harbor	4
U.S. Naval Air Station (Whidbey Island)	4

19.2.2 Building Code Effectiveness Grading Schedule

The Building Code Effectiveness Grading Schedule (BCEGS) assesses building codes and amendments adopted in a community and evaluates that community's commitment to enforce them. The concept is simple: Municipalities with well-enforced, up-to-date codes should demonstrate better loss experience, and insurance rates can reflect that. The prospect of reducing damage and ultimately lowering insurance costs provides an incentive for communities to enforce their building codes rigorously. Table 19-2 identifies the BCEGS for the planning partnership.

TABLE 19-7.
BUILDING CODE EFFECTIVENESS GRADING

Community	Commercial	Dwelling
Coupeville	4	4
Langley	3	3
Oak Harbor	2	3
Unincorporated County	99	99

*Unincorporated Island County is Class 99 because they chose not to participate in the CBEGS Program

CHAPTER 20.
PLAN MAINTENANCE STRATEGY

In accordance with 44 CFR 201.6(c)(4), a hazard mitigation plan must present a plan maintenance process that includes the following:

- A section describing the method and schedule of monitoring, evaluating and updating the mitigation plan over its five year life-cycle
- A process by which local governments incorporate the requirements of mitigation plans into other planning mechanisms, such as comprehensive land use plans (as appropriate)
- A discussion on how the community will continue to engage public participation in mitigation planning `efforts.

This section of the plan is focused on the plan maintenance strategy, and details the formal process that will ensure that the Island County hazard mitigation plan remains an active and relevant document and that the planning partners maintain their eligibility for applicable funding sources. The maintenance process identified for Island County and its planning partners includes a schedule for monitoring and evaluating the plan and producing a plan revision every five years. This chapter also describes how public participation will be integrated throughout the plan maintenance and implementation process. It also explains how the mitigation strategies outlined in this plan will be incorporated into existing planning mechanisms and programs, such as comprehensive land-use planning processes, capital improvement planning, and building code enforcement and implementation. The plan's format allows sections to be reviewed and updated when new data become available, resulting in a plan that will remain current and relevant.

The Deputy Directory of the Island County Department of Emergency Management will maintain lead responsibility for overseeing the plan implementation and maintenance strategy. Plan implementation and evaluation will be a shared responsibility among all planning partnership members and agencies identified as lead agencies in the mitigation action plans (see planning partner annexes in Volume 2 of this plan).

20.1 MONITORING, EVALUATION AND UPDATING THE PLAN

20.1.1 Progress Report - 2008 Plan Status

The 2008 Hazard Mitigation Plan identified a maintenance strategy which included regular reviews during the life cycle of the plan; however, due to lack of staffing and transition of emergency management personnel, the plan was not reviewed as originally intended. While the plan review did not occur as intended, the County and its planning partners were effective in completing several of the strategies and action items identified in the 2008 plan. Lists of the completed action items are provided within each jurisdiction's annex. The status of countywide mitigation projects is shown in Table 18-8. Significant projects completed since 2008 include the following:

- Initiative #1: Public Education—The County and its planning partners have been very active in this area. Regular (almost monthly) outreach sessions have occurred where risk maps and current, best available science on hazard specific data are discussed. During the spring of 2014, the County was involved in a project which included a geologic dig conducted by, among others, USGS and WDNR to capture information on earthquake and tsunami impacts. This information also supported hazard maps and information on steep slopes and landslide data.

- Initiative #2: Community Emergency Response Team (CERT) Training—The County and its planning partners have continued to provide CERT training throughout the area, with the CERT team now reaching well in excess of 100 trained individuals who will be able to provide safe and effective assistance to their communities after a disaster incident occurs.
- Initiative #4: Fuels Plan—The County has worked with local fuel providers and is in the process of development memorandums of understanding with several organizations to ensure an adequate supply and availability of fuel is available throughout the County should a regional event occur. This will help ensure fuel availability for generators, as well as vehicles needed for response and recovery efforts.
- Initiative #6: Transportation Issues—The County, through the Regional Catastrophic Preparedness Grant Program, in conjunction with eight other Washington counties, developed a transportation plan addressing accessibility along SR 532 on Camano Island, as well as other areas of the county with limited access. Involvement in the Catastrophic Planning Group required an extensive level of commitment on the part of the County, and involvement in this capacity has increased the resilience of the planning area by developing plans to support recovery and response activities.
- Initiative #6: Transportation Issues—Camano Gateway Project allowed for the reconstruction of sections of SR 532 on Camano Island to higher seismic building standards. The construction includes raising the roadway by 6 inches, reducing the impact from flooding events, and widening the roadway (Island County, 2014).
- Initiative #6: Flood Hazard; Enhance county roads and drainage projects—The Island County Public Works Department has completed several upgrades to enhance county roads and drainage issues, and continues to work with citizens throughout the county to help ensure safety. One example is the Ledgewood Beach area, which has previously been impacted by slides. Public works is working with homeowners to provide information concerning proper drainage to reduce slides resulting from hydrologic issues associated with high water tables and large amounts of water traveling through the ground, causing and exacerbating slides in the area.

20.1.2 Plan Implementation and Maintenance

The effectiveness of the hazard mitigation plan depends on its implementation and incorporation of its action items into partner jurisdictions' existing plans, policies and programs. Together, the action items in the plan provide a framework for activities that the partnership can implement over the next 5 years. The planning partners have established goals and objectives and have prioritized mitigation actions that will be implemented through existing plans, policies, and programs.

44 CFR requires that local hazard mitigation plans be reviewed, revised if appropriate, and resubmitted for approval in order to remain eligible for benefits under the DMA (Section 201.6.d.3). The Island County partnership intends to update the hazard mitigation plan on a 5-year cycle from the date of initial plan adoption. This cycle may be accelerated to less than 5 years based on the following triggers:

- A presidential disaster declaration that impacts the planning area
- A hazard event that causes loss of life
- A comprehensive update of the County or participating city/town's comprehensive plan

It will not be the intent of future updates to develop a complete new hazard mitigation plan for the planning area. The update will, at a minimum, include the following elements:

- The update process will be convened through a planning team.
- The hazard risk assessment will be reviewed and, if necessary, updated using best available information and technologies.
- The action plans will be reviewed and revised to account for any initiatives completed, dropped, or changed and to account for changes in the risk assessment or new partnership policies identified under other planning mechanisms (such as the comprehensive plan).
- The draft update will be sent to appropriate agencies and organizations for comment.
- The public will be given an opportunity to comment on the update prior to adoption.
- The partnership governing bodies will adopt their portions of the updated plan

The hazard mitigation plan will be reviewed annually and a progress report prepared. These reviews may be more or less frequent, as deemed necessary by the Deputy Director, but there will be a minimum of one review per year. The minimum task of each planning partner will be the evaluation of the progress of its individual action plan during a 12-month performance period. This review will include the following:

- Summary of any hazard events that occurred during the performance period and the impact these events had on the planning area.
- Review of mitigation success stories.
- Review of continuing public involvement.
- Brief discussion about why targeted strategies were not completed.
- Re-evaluation of the action plan to determine if the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term one because of new funding).
- Recommendations for new projects.
- Changes in or potential for new funding options (grant opportunities).
- Impact of any other planning programs or initiatives that involve hazard mitigation.

A template to guide the planning partners in preparing a progress report has been created as part of this planning process (see Appendix D). The Deputy Director will then prepare a formal annual report on the progress of the plan. This report should be used as follows:

- Posted on the Island County website page dedicated to the hazard mitigation plan.
- Provided to the local media through a press release.
- Presented to planning partner governing bodies to inform them of the progress of actions implemented during the reporting period.

Use of the progress report will be at the discretion of each planning partner. Annual progress reporting is not a requirement specified under 44 CFR. However, it may enhance the planning partnership's opportunities for funding. While failure to implement this component of the plan maintenance strategy will not jeopardize a planning partner's compliance under the DMA, completion of the annual review will reduce the level of effort involved in future plan updates, and is highly encouraged by FEMA.

In addition to the annual review, three years after adoption of the hazard mitigation plan, the Deputy Director may decide to apply for a planning grant through FEMA to start the 2020 update. Upon receipt of funding, the County will solicit bids under applicable contracting procedures and hire a contractor to assist with the project. The proposed schedule for completion of the plan update is one year from award of a contract, to coincide with the five-year adoption date of the 2015 hazard mitigation plan update.

The Deputy Director will be responsible for the plan update. Before the end of the five-year period, the updated plan will be submitted to FEMA for approval. When concurrence is received that the updated plan complies with FEMA requirements, it will be submitted to the Board of County Commissioners and City/Town Councils for adoption. The Deputy Director will send an e-mail to individuals and organizations on the stakeholder list to inform them that the updated plan is available on the County website.

20.2 IMPLEMENTATION THROUGH EXISTING PROGRAMS

Island County will have the opportunity to implement hazard mitigation projects through existing programs and procedures through plan revisions or amendments. The hazard mitigation plan will be incorporated into the plans, regulations and ordinances as they are updated in the future or when new plans are developed.

The Island County Comprehensive Plan and the comprehensive plans of the partner cities and towns are considered to be integral parts of this plan. The County and partner cities and towns, through adoption of comprehensive plans and zoning ordinances, have planned for the impact of natural hazards. The plan development process provided the County and the cities and towns with the opportunity to review and expand on policies contained within these planning mechanisms. The planning partners used their comprehensive plans and the hazard mitigation plan as complementary documents that work together to achieve the goal of reducing risk exposure to the citizens of the Island County. An update to a comprehensive plan may trigger an update to the hazard mitigation plan.

All municipal planning partners are committed to creating a linkage between the hazard mitigation plan and their individual comprehensive plans by identifying a mitigation initiative to do so and giving that initiative a high priority. Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan include the following:

- Partners’ emergency response plans
- Capital improvement programs
- Municipal codes
- Building codes
- Critical areas regulation
- Growth management
- Water resource inventory area planning
- Basin planning
- Community design guidelines
- Water-efficient landscape design guidelines
- Stormwater management programs
- Water system vulnerability assessments
- Master fire protection plans
- Coastal Zone Atlas information
- Island County Feeder Bluff reports
- Evacuation planning
- Transportation planning.

Some action items do not need to be implemented through regulation. Instead, these items can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation. As information becomes available from other planning mechanisms that can enhance this plan, that information will be incorporated via the update process.

20.3 CONTINUED PUBLIC INVOLVEMENT

Island County is dedicated to involving the public directly in review and updates of the hazard mitigation plan. The public will continue to be apprised of the plan's progress through the Island County website and the annual progress reports that will be provided to the media. All planning partners have agreed to provide links to the County hazard mitigation plan website on their individual jurisdictional websites to increase avenues of public access to the plan. The Island County Department of Emergency Management has agreed to maintain the hazard mitigation plan website. This site will not only house the final plan, it will become the one-stop shop for information regarding the plan, the partnership and plan implementation. Upon initiation of future update processes, a new public involvement strategy will be initiated. This strategy will be based on the needs and capabilities of the planning partnership at the time of the update. At a minimum, this strategy will include the use of social media and local media outlets within the planning area.

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Island County

Multi-Jurisdiction Hazard Mitigation Plan 2015 Update

APPENDIX A
ACRONYMS AND DEFINITIONS

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ACRONYMS

ASHRAE—American Society of Heating, Refrigerating, and Air-Conditioning Engineers
BOR—U.S. Bureau of Reclamation
CFR—Code of Federal Regulations
cfs—cubic feet per second
CIP—Capital Improvement Plan
CRS—Community Rating System
DFIRM—Digital Flood Insurance Rate Maps
DHS—Department of Homeland Security
DMA —Disaster Mitigation Act
DSO—Dam Safety Office
EAP—Emergency Action Plan
EPA—U.S. Environmental Protection Agency
ESA—Endangered Species Act
FCAAP—Flood Control Assistance Account Program
FCMP—Flood Control Maintenance Program
FEMA—Federal Emergency Management Agency
FERC—Federal Energy Regulatory Commission
FIRM—Flood Insurance Rate Map
FIS—Flood Insurance Study
GIS—Geographic Information System
GMA—Growth Management Act
Hazus-MH—Hazards, United States-Multi Hazard
HMGP—Hazard Mitigation Grant Program
IBC—International Building Code
IRC—International Residential Code
MM—Modified Mercalli Scale
NEHRP—National Earthquake Hazards Reduction Program
NFIP—National Flood Insurance Program
NFPA—National Fire Protection Association
NFR—Natural fire rotation
NOAA—National Oceanic and Atmospheric Administration
NWS—National Weather Service
PDM—Pre-Disaster Mitigation Grant Program
PDI—Palmer Drought Index
PGA—Peak Ground Acceleration
PHDI—Palmer Hydrological Drought Index
RCW—Revised Code of Washington
SCS—U.S. Department of Agriculture Soil Conservation Service
SFHA—Special Flood Hazard Area
SHELDUS—Special Hazard Events and Losses Database for the US
SPI—Standardized Precipitation Index
USGS—U.S. Geological Survey

WAC—Washington Administrative Code
WDFW—Washington Department of Fish and Wildlife
WUI— Wildland Urban Interface

DEFINITIONS

100-Year Flood: The term "100-year flood" can be misleading. The 100-year flood does not necessarily occur once every 100 years. Rather, it is the flood that has a 1 percent chance of being equaled or exceeded in any given year. Thus, the 100-year flood could occur more than once in a relatively short period of time. The Federal Emergency Management Agency (FEMA) defines it as the 1 percent annual chance flood, which is now the standard definition used by most federal and state agencies and by the National Flood Insurance Program (NFIP).

Acre-Foot: An acre-foot is the amount of water it takes to cover 1 acre to a depth of 1 foot. This measure is used to describe the quantity of storage in a water reservoir. An acre-foot is a unit of volume. One acre foot equals 7,758 barrels; 325,829 gallons; or 43,560 cubic feet. An average household of four will use approximately 1 acre-foot of water per year.

Asset: An asset is any constructed or natural feature that has value, including, but not limited to, people; buildings; infrastructure, such as bridges, roads, sewers, and water systems; lifelines, such as electricity and communication resources; and environmental, cultural, or recreational features such as parks, wetlands, and landmarks.

Base Flood: The flood having a 1% chance of being equaled or exceeded in any given year, also known as the "100-year" or "1% chance" flood. The base flood is a statistical concept used to ensure that all properties subject to the National Flood Insurance Program (NFIP) are protected to the same degree against flooding.

Basin: A basin is the area within which all surface water—whether from rainfall, snowmelt, springs, or other sources—flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains, and ridges. Basins are also referred to as "watersheds" and "drainage basins."

Benefit: A benefit is a net project outcome and is usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of benefit-cost analysis of proposed mitigation measures, benefits are limited to specific, measurable, risk reduction factors, including reduction in expected property losses (buildings, contents, and functions) and protection of human life.

Benefit/Cost Analysis: A benefit/cost analysis is a systematic, quantitative method of comparing projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

Building: A building is defined as a structure that is walled and roofed, principally aboveground, and permanently fixed to a site. The term includes manufactured homes on permanent foundations on which the wheels and axles carry no weight.

Capability Assessment: A capability assessment provides a description and analysis of a community's current capacity to address threats associated with hazards. The assessment includes two components: an inventory of an agency's mission, programs, and policies, and an analysis of its capacity to carry them out. A capability assessment is an integral part of the planning process in which a community's actions to reduce losses are identified, reviewed, and analyzed, and the framework for implementation is identified. The following capabilities were reviewed under this assessment:

- Legal and regulatory capability
- Administrative and technical capability
- Fiscal capability

Community Rating System (CRS): The CRS is a voluntary program under the NFIP that rewards participating communities (provides incentives) for exceeding the minimum requirements of the NFIP and completing activities that reduce flood hazard risk by providing flood insurance premium discounts.

Critical Area: An area defined by state or local regulations as deserving special protection because of unique natural features or its value as habitat for a wide range of species of flora and fauna. A sensitive/critical area is usually subject to more restrictive development regulations.

Critical Facility: Facilities and infrastructure that are critical to the health and welfare of the population. These become especially important after any hazard event occurs. For the purposes of this plan, critical facilities include:

- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic and/or water reactive materials;
- Hospitals, nursing homes, and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a hazard event.
- Police stations, fire stations, vehicle and equipment storage facilities, and emergency operations centers that are needed for disaster response before, during, and after hazard events, and
- Public and private utilities, facilities and infrastructure that are vital to maintaining or restoring normal services to areas damaged by hazard events.
- Government facilities.

Cubic Feet per Second (cfs): Discharge or river flow is commonly measured in cfs. One cubic foot is about 7.5 gallons of liquid.

Dam: Any artificial barrier or controlling mechanism that can or does impound 10 acre-feet or more of water.

Dam Failure: Dam failure refers to a partial or complete breach in a dam (or levee) that impacts its integrity. Dam failures occur for a number of reasons, such as flash flooding, inadequate spillway size, mechanical failure of valves or other equipment, freezing and thawing cycles, earthquakes, and intentional destruction.

Debris Avalanche: Volcanoes are prone to debris and mountain rock avalanches that can approach speeds of 100 mph.

Debris Flow: Dense mixtures of water-saturated debris that move down-valley; looking and behaving much like flowing concrete. They form when loose masses of unconsolidated material are saturated, become unstable, and move down slope. The source of water varies but includes rainfall, melting snow or ice, and glacial outburst floods.

Debris Slide: Debris slides consist of unconsolidated rock or soil that has moved rapidly down slope. They occur on slopes greater than 65 percent.

Disaster Mitigation Act of 2000 (DMA); The DMA is Public Law 106-390 and is the latest federal legislation enacted to encourage and promote proactive, pre-disaster planning as a condition of receiving financial assistance under the Robert T. Stafford Act. The DMA emphasizes planning for disasters before they occur. Under the DMA, a pre-disaster hazard mitigation program and new requirements for the national post-disaster hazard mitigation grant program (HMGP) were established.

Drainage Basin: A basin is the area within which all surface water- whether from rainfall, snowmelt, springs or other sources- flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains and ridges. Drainage basins are also referred to as **watersheds** or **basins**.

Drought: Drought is a period of time without substantial rainfall or snowfall from one year to the next. Drought can also be defined as the cumulative impacts of several dry years or a deficiency of precipitation over an extended period of time, which in turn results in water shortages for some activity, group, or environmental function. A hydrological drought is caused by deficiencies in surface and subsurface water supplies. A socioeconomic drought impacts the health, well-being, and quality of life or starts to have an adverse impact on a region. Drought is a normal, recurrent feature of climate and occurs almost everywhere.

Earthquake: An earthquake is defined as a sudden slip on a fault, volcanic or magmatic activity, and sudden stress changes in the earth that result in ground shaking and radiated seismic energy. Earthquakes can last from a few seconds to over 5 minutes, and have been known to occur as a series of tremors over a period of several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties may result from falling objects and debris as shocks shake, damage, or demolish buildings and other structures.

Exposure: Exposure is defined as the number and dollar value of assets considered to be at risk during the occurrence of a specific hazard.

Extent: The extent is the size of an area affected by a hazard.

Fire Behavior: Fire behavior refers to the physical characteristics of a fire and is a function of the interaction between the fuel characteristics (such as type of vegetation and structures that could burn), topography, and weather. Variables that affect fire behavior include the rate of spread, intensity, fuel consumption, and fire type (such as underbrush versus crown fire).

Fire Frequency: Fire frequency is the broad measure of the rate of fire occurrence in a particular area. An estimate of the areas most likely to burn is based on past fire history or fire rotation in the area, fuel conditions, weather, ignition sources (such as human or lightning), fire suppression response, and other factors.

Flash Flood: A flash flood occurs with little or no warning when water levels rise at an extremely fast rate

Flood Insurance Rate Map (FIRM): FIRMs are the official maps on which the Federal Emergency Management Agency (FEMA) has delineated the Special Flood Hazard Area (SFHA).

Flood Insurance Study: A report published by the Federal Insurance and Mitigation Administration for a community in conjunction with the community's Flood Insurance rate Map. The study contains such background data as the base flood discharges and water surface elevations that were used to prepare the FIRM. In most cases, a community FIRM with detailed mapping will have a corresponding flood insurance study.

Floodplain: Any land area susceptible to being inundated by flood waters from any source. A flood insurance rate map identifies most, but not necessarily all, of a community's floodplain as the Special Flood Hazard Area (SFHA).

Floodway: Floodways are areas within a floodplain that are reserved for the purpose of conveying flood discharge without increasing the base flood elevation more than 1 foot. Generally speaking, no development is allowed in floodways, as any structures located there would block the flow of floodwaters.

Floodway Fringe: Floodway fringe areas are located in the floodplain but outside of the floodway. Some development is generally allowed in these areas, with a variety of restrictions. On maps that have identified and delineated a floodway, this would be the area beyond the floodway boundary that can be subject to different regulations.

Fog: Fog refers to a cloud (or condensed water droplets) near the ground. Fog forms when air close to the ground can no longer hold all the moisture it contains. Fog occurs either when air is cooled to its dew point or the amount of moisture in the air increases. Heavy fog is particularly hazardous because it can restrict surface visibility. Severe fog incidents can close roads, cause vehicle accidents, cause airport delays, and impair the effectiveness of emergency response. Financial losses associated with transportation delays caused by fog have not been calculated in the United States but are known to be substantial.

Freeboard: Freeboard is the margin of safety added to the base flood elevation.

Frequency: For the purposes of this plan, frequency refers to how often a hazard of specific magnitude, duration, and/or extent is expected to occur on average. Statistically, a hazard with a 100-year frequency is expected to occur about once every 100 years on average and has a 1 percent chance of occurring any given year. Frequency reliability varies depending on the type of hazard considered.

Fujita Scale of Tornado Intensity: Tornado wind speeds are sometimes estimated on the basis of wind speed and damage sustained using the Fujita Scale. The scale rates the intensity or severity of tornado events using numeric values from F0 to F5 based on tornado wind speed and damage. An F0 tornado (wind speed less than 73 miles per hour (mph)) indicates minimal damage (such as broken tree limbs), and an F5 tornado (wind speeds of 261 to 318 mph) indicates severe damage.

Goal: A goal is a general guideline that explains what is to be achieved. Goals are usually broad-based, long-term, policy-type statements and represent global visions. Goals help define the benefits that a plan is trying to achieve. The success of a hazard mitigation plan is measured by the degree to which its goals have been met (that is, by the actual benefits in terms of actual hazard mitigation).

Geographic Information System (GIS): GIS is a computer software application that relates data regarding physical and other features on the earth to a database for mapping and analysis.

Hazard: A hazard is a source of potential danger or adverse condition that could harm people and/or cause property damage.

Hazard Mitigation Grant Program (HMGP): Authorized under Section 202 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, the HMGP is administered by FEMA and provides grants to states, tribes, and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to disasters and to enable mitigation activities to be implemented as a community recovers from a disaster

Hazards U.S. Multi-Hazard (Hazus-MH) Loss Estimation Program: Hazus-MH is a GIS-based program used to support the development of risk assessments as required under the DMA. The Hazus-MH software program assesses risk in a quantitative manner to estimate damages and losses associated with natural hazards. Hazus-MH is FEMA's nationally applicable, standardized methodology and software program and contains modules for estimating potential losses from earthquakes, floods, and wind hazards. Hazus-MH has also been used to assess vulnerability (exposure) for other hazards.

Hydraulics: Hydraulics is the branch of science or engineering that addresses fluids (especially water) in motion in rivers or canals, works and machinery for conducting or raising water, the use of water as a prime mover, and other fluid-related areas.

Hydrology: Hydrology is the analysis of waters of the earth. For example, a flood discharge estimate is developed by conducting a hydrologic study.

Intensity: For the purposes of this plan, intensity refers to the measure of the effects of a hazard.

Inventory: The assets identified in a study region comprise an inventory. Inventories include assets that could be lost when a disaster occurs and community resources are at risk. Assets include people, buildings, transportation, and other valued community resources.

Landslide: Landslides can be described as the sliding movement of masses of loosened rock and soil down a hillside or slope. Fundamentally, slope failures occur when the strength of the soils forming the slope exceeds the pressure, such as weight or saturation, acting upon them.

Lightning: Lightning is an electrical discharge resulting from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a "bolt," usually within or between clouds and the ground. A bolt of lightning instantaneously reaches temperatures approaching 50,000ºF. The rapid heating and cooling of air near lightning causes thunder. Lightning is a major threat during thunderstorms. In the United States, 75 to 100 Americans are struck and killed by lightning each year (see http://www.fema.gov/hazard/thunderstorms/thunder.shtm).

Liquefaction: Liquefaction is the complete failure of soils, occurring when soils lose shear strength and flow horizontally. It is most likely to occur in fine grain sands and silts, which behave like viscous fluids when liquefaction occurs. This situation is extremely hazardous to development on the soils that liquefy, and generally results in extreme property damage and threats to life and safety.

Local Government: Any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity.

Magnitude: Magnitude is the measure of the strength of an earthquake, and is typically measured by the Richter scale. As an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Mass movement: A collective term for landslides, mudflows, debris flows, sinkholes and lahars.

Mitigation: A preventive action that can be taken in advance of an event that will reduce or eliminate the risk to life or property.

Mitigation Actions: Mitigation actions are specific actions to achieve goals and objectives that minimize the effects from a disaster and reduce the loss of life and property.

Objective: For the purposes of this plan, an objective is defined as a short-term aim that, when combined with other objectives, forms a strategy or course of action to meet a goal. Unlike goals, objectives are specific and measurable.

Peak Ground Acceleration: Peak Ground Acceleration (PGA) is a measure of the highest amplitude of ground shaking that accompanies an earthquake, based on a percentage of the force of gravity.

Preparedness: Preparedness refers to actions that strengthen the capability of government, citizens, and communities to respond to disasters.

Presidential Disaster Declaration: These declarations are typically made for events that cause more damage than state and local governments and resources can handle without federal government assistance. Generally, no specific dollar loss threshold has been established for such declarations. A Presidential Disaster Declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, designed to help disaster victims, businesses, and public entities.

Probability of Occurrence: The probability of occurrence is a statistical measure or estimate of the likelihood that a hazard will occur. This probability is generally based on past hazard events in the area and a forecast of events that could occur in the future. A probability factor based on yearly values of occurrence is used to estimate probability of occurrence.

Repetitive Loss Property: Any NFIP-insured property that, since 1978 and regardless of any changes of ownership during that period, has experienced:

- Four or more paid flood losses in excess of $1000.00; or
- Two paid flood losses in excess of $1000.00 within any 10-year period since 1978 or
- Three or more paid losses that equal or exceed the current value of the insured property.

Return Period (or Mean Return Period): This term refers to the average period of time in years between occurrences of a particular hazard (equal to the inverse of the annual frequency of occurrence).

Riverine: Of or produced by a river. Riverine floodplains have readily identifiable channels. Floodway maps can only be prepared for riverine floodplains.

Risk: Risk is the estimated impact that a hazard would have on people, services, facilities, and structures in a community. Risk measures the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate, or low likelihood of sustaining damage above a particular threshold due to occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Risk Assessment: Risk assessment is the process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards. This process assesses the vulnerability of people, buildings, and infrastructure to hazards and focuses on (1) hazard identification; (2) impacts of hazards on physical, social, and economic assets; (3) vulnerability identification; and (4) estimates of the cost of damage or costs that could be avoided through mitigation.

Risk Ranking: This ranking serves two purposes, first to describe the probability that a hazard will occur, and second to describe the impact a hazard will have on people, property, and the economy. Risk estimates for the City are based on the methodology that the City used to prepare the risk assessment for this plan. The following equation shows the risk ranking calculation:

Risk Ranking = Probability + Impact (people + property + economy)

Robert T. Stafford Act: The Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-107, was signed into law on November 23, 1988. This law amended the Disaster Relief Act of 1974, Public Law 93-288. The Stafford Act is the statutory authority for most federal disaster response activities, especially as they pertain to FEMA and its programs.

Sinkhole: A collapse depression in the ground with no visible outlet. Its drainage is subterranean. It is commonly vertical-sided or funnel-shaped.

Special Flood Hazard Area: The base floodplain delineated on a Flood Insurance Rate Map. The SFHA is mapped as a Zone A in riverine situations and zone V in coastal situations. The SFHA may or may not encompass all of a community's flood problems

Stakeholder: Business leaders, civic groups, academia, non-profit organizations, major employers, managers of critical facilities, farmers, developers, special purpose districts, and others whose actions could impact hazard mitigation.

Stream Bank Erosion: Stream bank erosion is common along rivers, streams and drains where banks have been eroded, sloughed or undercut. However, it is important to remember that a stream is a dynamic and constantly changing system. It is natural for a stream to want to meander, so not all eroding banks are "bad" and in need of repair. Generally, stream bank erosion becomes a problem where development has limited the meandering nature of streams, where streams have been channelized, or where stream bank structures (like bridges, culverts, etc.) are located in places where they can actually cause damage to downstream areas. Stabilizing these areas can help protect watercourses from continued sedimentation, damage to adjacent land uses, control unwanted meander, and improvement of habitat for fish and wildlife.

Steep Slope: Different communities and agencies define it differently, depending on what it is being applied to, but generally a steep slope is a slope in which the percent slope equals or exceeds 25%. For this study, steep slope is defined as slopes greater than 33%.

Sustainable Hazard Mitigation: This concept includes the sound management of natural resources, local economic and social resiliency, and the recognition that hazards and mitigation must be understood in the largest possible social and economic context.

Thunderstorm: A thunderstorm is a storm with lightning and thunder produced by cumulonimbus clouds. Thunderstorms usually produce gusty winds, heavy rains, and sometimes hail. Thunderstorms are usually short in duration (seldom more than 2 hours). Heavy rains associated with thunderstorms can lead to flash flooding during the wet or dry seasons.

Tornado: A tornado is a violently rotating column of air extending between and in contact with a cloud and the surface of the earth. Tornadoes are often (but not always) visible as funnel clouds. On a local scale, tornadoes are the most intense of all atmospheric circulations, and winds can reach destructive speeds of more than 300 mph. A tornado's vortex is typically a few hundred meters in diameter, and damage paths can be up to 1 mile wide and 50 miles long.

Vulnerability: Vulnerability describes how exposed or susceptible an asset is to damage. Vulnerability depends on an asset's construction, contents, and the economic value of its functions. Like indirect damages, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power. Flooding of an electric substation would affect not only the substation itself but businesses as well. Often, indirect effects can be much more widespread and damaging than direct effects.

Watershed: A watershed is an area that drains down gradient from areas of higher land to areas of lower land to the lowest point, a common drainage basin.

Wildfire: These terms refer to any uncontrolled fire occurring on undeveloped land that requires fire suppression. The potential for wildfire is influenced by three factors: the presence of fuel, topography, and air mass. Fuel can include living and dead vegetation on the ground, along the surface as brush and small trees, and in the air such as tree canopies. Topography includes both slope and elevation. Air mass includes temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount, duration, and the stability of the atmosphere at the time of the fire. Wildfires can be ignited by lightning and, most frequently, by human activity including smoking, campfires, equipment use, and arson.

Windstorm: Windstorms are generally short-duration events involving straight-line winds or gusts exceeding 50 mph. These gusts can produce winds of sufficient strength to cause property damage. Windstorms are especially dangerous in areas with significant tree stands, exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and aboveground utility lines. A windstorm can topple trees and power lines; cause damage to residential, commercial, critical facilities; and leave tons of debris in its wake.

Zoning Ordinance: The zoning ordinance designates allowable land use and intensities for a local jurisdiction. Zoning ordinances consist of two components: a zoning text and a zoning map.

APPENDIX B
PUBLIC OUTREACH MATERIALS AND RESULTS

Q1 In which area do you live or work:

Answered: 226 Skipped: 0

Answer Choices	Responses	
Unincorporated Island County	**45.13%**	102
City of Langley	**34.96%**	79
City of Oak Harbor	**15.93%**	36
Town of Coupeville	**3.98%**	9
Total		**226**

Q2 Which of the following hazard events have you or has anyone in your household experienced in the past 20 years? (Check all that apply)

Answered: 226 Skipped: 0

Answer Choices	Responses	
Coastal Erosion	**12.39%**	28
Dam Failure	**0.44%**	1
Drought	**8.85%**	20
Earthquake	**43.81%**	99
Flood	**10.18%**	23
Hazardous Materials	**3.54%**	8
Household Fire	**7.52%**	17
Landslide	**10.18%**	23
Severe Weather (wind, lightning, winter storm, etc.)	**72.57%**	164
Tsunami/Seiche (waves generated by wind or seismic activity)	**1.33%**	3
Volcanic Eruption (lahar, ash fall)	**0.88%**	2
Wildland Fire	**7.96%**	18
None	**18.14%**	41
Other (please specify)	**3.98%**	9
Total Respondents: 226		

Q3 How many times have you been impacted by disaster events?

Answered: 222 Skipped: 4

Answer Choices	Responses	
0	**33.33%**	74
1-3	**45.95%**	102
4-5	**9.46%**	21
5 or more	**11.26%**	25
Total		**222**

Q4 Have these occurred while you have lived (or worked) in Island County?

Answered: 226 Skipped: 0

Answer Choices	Responses	
Yes	**32.74%**	74
No	**49.12%**	111
Lived	**16.81%**	38
Worked	**1.33%**	3
Total		**226**

Q5 If the answer to the preceding question is in the affirmative, has the hazard event impacted your ability to use your residence because of damages?

Answered: 226 Skipped: 0

Answer Choices	Responses	
Yes	**8.41%**	19
No	**91.59%**	207
Total		**226**

Q6 How prepared is your household to deal with a natural hazard event?

Answered: 210 Skipped: 16

	Not at all prepared	Somewhat prepared	Adequately prepared	Well prepared	Very well prepared	Total	Weighted Average
Check one:	**7.14%** 15	**52.86%** 111	**28.10%** 59	**9.52%** 20	**2.38%** 5	210	2.47

Q7 Is your home address easily visible and displayed (can you easily see the house number from the street)?

Answered: 207 Skipped: 19

Answer Choices	Responses	
Yes	**85.99%**	178
No	**14.01%**	29
Total		**207**

Q8 Which of the following methods do you think are most effective for providing hazard and disaster information? (Check all that apply)

Answered: 210 Skipped: 16

Answer Choices	Responses	
Newspaper	**43.33%**	91
Informational Brochures	**30.95%**	65
Newsletters	**21.90%**	46
Public Meetings	**37.62%**	79
Workshops	**21.90%**	46
Schools	**28.10%**	59
TV News	**34.76%**	73
TV Ads	**8.10%**	17
Radio News	**41.90%**	88
Radio Ads	**12.38%**	26
Internet	**72.86%**	153
Outdoor Advertisements	**10.48%**	22
Fire Department/Rescue	**22.38%**	47
Church (faith-based institutions)	**17.62%**	37
CERT Classes	**6.19%**	13
Public Awareness Campaign (e.g., Flood Awareness Week, Winter Storm Preparedness Month)	**39.05%**	82
Books	**5.71%**	12
Academic Institutions	**3.81%**	8
Public Library	**35.71%**	75
Red Cross Information	**18.10%**	38
Community Safety Events	**30.00%**	63

Booths at Gatherings	**27.14%**	57
Word of Mouth	**30.48%**	64
NOAA Radios	**18.57%**	39
Other (please specify)	**10.00%**	21
Total Respondents: 210		

Q9 Which of the following steps has your household taken to prepare for a hazard event? (Check all that apply)

Answered: 205 Skipped: 21

Answer Choices	Responses	
Received first aid/CPR training	**57.07%**	117
Have a family emergency plan in place	**31.22%**	64
Designated a meeting place	**24.88%**	51
Prepared a disaster supply kit for family and pets	**42.93%**	88
Designated an out-of-area contact	**31.71%**	65
Provided out-of-area-contact information to family members	**21.46%**	44
Know evacuation routes for your community in case of emergency	**37.56%**	77
Made a fire escape plan	**26.83%**	55
Have a ladder in place for fire escape from 2nd floor	**13.66%**	28
Removed/reduced vegetation 100 feet from immediate area of house	**21.46%**	44
Planted fire resistant landscaping	**8.29%**	17
Cleared Roof/Gutters	**58.05%**	119
Installed smoke detectors on each level of the house	**89.76%**	184
Have a regularly scheduled date to change batteries in smoke detectors	**47.32%**	97
Affixed tall items to wall to stop them from tipping over	**24.39%**	50
Identified utility shutoffs	**57.07%**	117
Have sandbags for flooding	**3.90%**	8
Stored food and water in vehicles	**19.51%**	40
Maintain a cash supply at home in case of power outage and no ATM availability	**32.20%**	66
Stored flashlights and batteries	**79.02%**	162
Stored a battery-powered radio	**54.63%**	112
Stored a fire extinguisher	**67.80%**	139

Stored medical supplies (first aid kit, medications)	**67.80%**	139
Have generator	**41.46%**	85
Other (please specify)	**4.88%**	10
Total Respondents: 205		

Q10 Do you own or rent your place of residence?

Answered: 204 Skipped: 22

Answer Choices	Responses	
Own	**74.02%**	151
Rent	**25.98%**	53
Total		**204**

Q11 Do you have homeowner's or renter's insurance?

Answered: 193 Skipped: 33

Answer Choices	Responses	
Homeowners	**77.72%**	150
Renters	**22.28%**	43
Total		**193**

Q12 What type of hazard insurance to you have?

Answered: 184 Skipped: 42

Answer Choices	Responses	
General	**96.74%**	178
Flood Policy (NFIP)	**4.89%**	9
Earthquake Policy	**19.57%**	36
Wildfire/Fire	**2.17%**	4
Total Respondents: 184		

Q13 Are you aware of the hazards that may impact your residence or place of business?

Answered: 193 Skipped: 33

Answer Choices	Responses

Yes	84.97%	164
No	15.03%	29
Total		**193**

Q14 How concerned are you about the following natural hazards in Island County? (Check one response for each hazard)

Answered: 207 Skipped: 19

	Not Concerned	Somewhat Concerned	Concerned	Very Concerned	Extremely Concerned	Total	Weighted Average
Climate Change	**27.45%** 56	**25.49%** 52	**23.04%** 47	**15.20%** 31	**8.82%** 18	204	2.52
Coastal Erosion	**16.24%** 32	**22.84%** 45	**35.03%** 69	**14.21%** 28	**11.68%** 23	197	2.82
Dam/Levee Failure	**82.87%** 150	**12.15%** 22	**3.31%** 6	**1.10%** 2	**0.55%** 1	181	1.24
Drought	**57.07%** 109	**22.51%** 43	**10.47%** 20	**8.38%** 16	**1.57%** 3	191	1.75
Earthquake	**8.33%** 17	**22.55%** 46	**27.45%** 56	**26.47%** 54	**15.20%** 31	204	3.18
Flood	**52.13%** 98	**30.32%** 57	**13.30%** 25	**3.72%** 7	**0.53%** 1	188	1.70
Hazardous Materials	**43.24%** 80	**38.38%** 71	**11.35%** 21	**5.95%** 11	**1.08%** 2	185	1.83
Household Fire	**13.40%** 26	**43.81%** 85	**28.35%** 55	**9.79%** 19	**4.64%** 9	194	2.48
Landslide	**27.32%** 53	**29.90%** 58	**22.16%** 43	**12.37%** 24	**8.25%** 16	194	2.44
Severe Weather	**14.78%** 30	**22.17%** 45	**33.50%** 68	**22.17%** 45	**7.39%** 15	203	2.85
Thunderstorms	**45.55%** 87	**29.32%** 56	**18.32%** 35	**5.24%** 10	**1.57%** 3	191	1.88
Tornado	**80.42%** 152	**14.29%** 27	**2.65%** 5	**1.06%** 2	**1.59%** 3	189	1.29
Tsunami/Seiche	**32.62%** 61	**35.29%** 66	**20.86%** 39	**6.95%** 13	**4.28%** 8	187	2.15
Volcanic Eruption	**53.19%** 100	**28.72%** 54	**12.77%** 24	**4.26%** 8	**1.06%** 2	188	1.71
Wildland Fire	**50.54%** 94	**28.49%** 53	**12.90%** 24	**5.38%** 10	**2.69%** 5	186	1.81
Other	**80.95%** 34	**4.76%** 2	**9.52%** 4	**0.00%** 0	**4.76%** 2	42	1.43

Q15 Is your property located in or near a floodplain?

Answered: 203 Skipped: 23

Answer Choices	Responses	
Yes	**7.88%**	16
No	**76.35%**	155
Not Sure	**15.76%**	32
Total		**203**

Q16 Is your residence located in or near an area of known landslides?

Answered: 203 Skipped: 23

Answer Choices	Responses	
Yes	**20.20%**	41
No	**65.52%**	133
Not sure	**14.78%**	30
Total Respondents: 203		

Q17 Is your residence in or near a high fire danager area?

Answered: 202 Skipped: 24

Answer Choices	Responses	
Yes	**5.45%**	11
No	**71.29%**	144
Not sure	**23.27%**	47
Total		**202**

Q18 If the roadway to your residence is over 400 feet long, does it have turnouts that would allow two large trucks to pass each other?

Answered: 152 Skipped: 74

Answer Choices	Responses	
Yes	**56.58%**	86
No	**43.42%**	66
Total		**152**

Q19 If the primary access to your home

were cut off because of flood, landslide, wildfire or other hazard, would you have an alternate escape route?

Answered: 200 Skipped: 26

Answer Choices	Responses	
Yes	**67.50%**	135
No	**32.50%**	65
Total		**200**

Q20 When you moved into your home, did you consider the impact a natural disaster could have on your home?

Answered: 203 Skipped: 23

Answer Choices	Responses	
Yes	**48.28%**	98
No	**43.84%**	89
Not Sure	**7.88%**	16
Total		**203**

Q21 If you know you are in a hazard area, how much money would you be willing to spend to make modifications around your home which will reduce risks associated with natural disasters? (For example, elevating a home above the flood level, performing seismic upgrades, or replacing a combustible roof with non-combustible roofing.)

Answered: 182 Skipped: 44

Answer Choices	Responses	
$10,000 or above	**11.54%**	21
$5,000 to $9,999	**9.34%**	17
$1,000 to $4,999	**15.38%**	28
Less than $1,000	**8.24%**	15
Nothing - not willing to make changes	**11.54%**	21
Not Sure	**43.96%**	80

Total	182

Q22 Please indicate how you feel about the following statement:It is the responsibility of government (local, state and federal) to provide education and programs that promote citizen actions that will reduce exposure to the risks associated with natural hazards.

Answered: 200 Skipped: 26

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total	Weighted Average
Choose one:	**3.00%** 6	**6.50%** 13	**15.50%** 31	**41.00%** 82	**34.00%** 68	200	3.96

Q23 Please indicate how you feel about the following statement:It is my responsibility to educate myself and take actions that will reduce my exposure to the risks associated with natural hazards.

Answered: 201 Skipped: 25

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total	Weighted Average
Choose one:	**1.00%** 2	**0.00%** 0	**1.49%** 3	**22.39%** 45	**75.12%** 151	201	4.71

Q24 Please indicate how you feel about the following statement:Information about the risks associated with natural hazards is readily available and easy to locate.

Answered: 201 Skipped: 25

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total	Weighted Average
Choose one:	**4.48%** 9	**11.94%** 24	**26.37%** 53	**38.31%** 77	**18.91%** 38	201	3.55

Q25 Please indicate your age range:

Answered: 197 Skipped: 29

Answer Choices	Responses	
Under 18	**0.00%**	0
18 to 30	**7.61%**	15

31 to 40	**12.18%**	24
41 to 50	**12.69%**	25
51 to 60	**16.24%**	32
61 or older	**51.27%**	101
Total		**197**

Q26 How many people live with you in your home?

Answered: 197 Skipped: 29

Answer Choices	Responses	
1-2	**71.07%**	140
3-5	**27.92%**	55
6-8	**1.02%**	2
More than 8	**0.00%**	0
Total		**197**

Q27 Please indicate your gender:

Answered: 199 Skipped: 27

Answer Choices	Responses	
Male	**36.68%**	73
Female	**63.32%**	126
Total		**199**

Q28 Please indicate your highest level of education.

Answered: 199 Skipped: 27

Answer Choices	Responses	
Grade school/No schooling	**0.00%**	0
Some high school	**0.50%**	1
High school graduate/GED	**3.52%**	7
Some college/Trade school	**24.62%**	49
College degree	**33.67%**	67
Graduate degree	**36.68%**	73
Other (please specify)	**1.01%**	2
Total		**199**

Q29 How long have you lived or worked in Island County?

Answered: 200 Skipped: 26

Answer Choices	Responses	
Do not live or work in the County	**0.50%**	1
Less than 1 year	**9.00%**	18
1 to 5 years	**19.00%**	38
6 to 10 years	**19.00%**	38
11 to 20 years	**28.00%**	56
More than 20 years	**24.50%**	49
Total		**200**

Q30 Comments

Answered: 37 Skipped: 189

APPENDIX C
PLAN ADOPTION RESOLUTIONS FROM PLANNING PARTNERS

APPENDIX C
PLAN ADOPTION RESOLUTIONS FROM PLANNING PARTNERS

To Be Provided With Final Release

APPENDIX D
EXAMPLE TEMPLATE FOR FUTURE PROGRESS REPORTS

APPENDIX D
EXAMPLE TEMPLATE FOR FUTURE PROGRESS REPORTS

Island County
Hazard Mitigation Plan
Annual Progress Report

Reporting Period: (Insert reporting period)

Background: Island County and participating cities and special purpose districts in the county developed a hazard mitigation plan to reduce risk from all hazards by identifying resources, information, and strategies for risk reduction. The federal Disaster Mitigation Act requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. To prepare the plan, the participating partners organized resources, assessed risks from natural hazards within the county, developed planning goals and objectives, reviewed mitigation alternatives, and developed an action plan to address probable impacts from natural hazards. By completing this process, these jurisdictions maintained compliance with the Disaster Mitigation Act, achieving eligibility for mitigation grant funding opportunities afforded under the Robert T. Stafford Act. The plan can be viewed on-line at:

Insert web address

Summary Overview of the Plan's Progress: The performance period for the hazard mitigation plan became effective on ____, 2015, with the final approval of the plan by FEMA. The initial performance period for this plan will be 5 years, with an anticipated update to the plan to occur before _______, 2020. As of this reporting period, the performance period for this plan is considered to be __ percent complete. The hazard mitigation plan has targeted __ hazard mitigation initiatives to be pursued during the 5-year performance period. As of the reporting period, the following overall progress can be reported:

- __ out of __ initiatives (__%) reported ongoing action toward completion.
- __ out of __ initiatives (__%) were reported as being complete.
- __ out of __ initiatives (___%) reported no action taken.

Purpose: The purpose of this report is to provide an annual update on the implementation of the action plan identified in the Island County hazard mitigation plan. The objective is to ensure that there is a continuing and responsive planning process that will keep the hazard mitigation plan dynamic and responsive to the needs and capabilities of the partner jurisdictions. This report discusses the following:

- Natural hazard events that have occurred within the last year
- Changes in risk exposure within the planning area (all of Island County)
- Mitigation success stories
- Review of the action plan
- Changes in capabilities that could impact plan implementation
- Recommendations for changes/enhancement.

The Hazard Mitigation Plan Planning Team: The Hazard Mitigation Plan Planning Team, made up of planning partners and stakeholders within the planning area, reviewed and approved this progress report at its annual meeting held on _____, 201_. It was determined through the plan's development process that a planning team would remain in service to oversee maintenance of the plan. At a minimum, the planning team will provide technical review and oversight on the development of the annual progress report. It is anticipated that there will be turnover in the membership annually, which will be documented in the progress reports. For this reporting period, the planning team membership is as indicated in Table 1.

TABLE 1
PLANNING TEAM MEMBERS

Name	Title	Jurisdiction/Agency

Natural Hazard Events within the Planning Area: During the reporting period, there were __ natural hazard events in the planning area that had a measurable impact on people or property. A summary of these events is as follows:

- ____________________________
- ____________________________

Changes in Risk Exposure in the Planning Area: *(Insert brief overview of any natural hazard event in the planning area that changed the probability of occurrence or ranking of risk for the hazards addressed in the hazard mitigation plan)*

Mitigation Success Stories: *(Insert brief overview of mitigation accomplishments during the reporting period)*

Review of the Action Plan: Table 2 reviews the action plan, reporting the status of each initiative. Reviewers of this report should refer to the hazard mitigation plan for more detailed descriptions of each initiative and the prioritization process.

Address the following in the "status" column of the following table:

- *Was any element of the initiative carried out during the reporting period?*
- *If no action was completed, why?*
- *Is the timeline for implementation for the initiative still appropriate?*
- *If the initiative was completed, does it need to be changed or removed from the action plan?*

TABLE 2
ACTION PLAN MATRIX

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O,✓)
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
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Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				

TABLE 2 ACTION PLAN MATRIX				
Action Taken? (Yes or No)	**Time Line**	**Priority**	**Status**	**Status (X, O,✓)**
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Completion status legend: ✓= Project Completed O = Action ongoing toward completion X = No progress at this time				

Changes That May Impact Implementation of the Plan: *(Insert brief overview of any significant changes in the planning area that would have a profound impact on the implementation of the plan. Specify any changes in technical, regulatory and financial capabilities identified during the plan's development)*

Recommendations for Changes or Enhancements: Based on the review of this report by the Hazard Mitigation Plan Planning Team, the following recommendations will be noted for future updates or revisions to the plan:

- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________

Public review notice: The contents of this report are considered to be public knowledge and have been prepared for total public disclosure. Copies of the report have been provided to the governing boards of all planning partners and to local media outlets and the report is posted on the Island County hazard mitigation plan website. Any questions or comments regarding the contents of this report should be directed to: