Multi-Jurisdiction
Hazard Mitigation Plan 2020 Update
Volume 1: Planning-Area-Wide Elements

FINAL

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BRIDGEVIEW CONSULTING

2020 MULTI-JURISDICTION HAZARD MITIGATION PLAN UPDATE

VOLUME 1: BASE PLAN ELEMENTS

FINAL

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Island County
2020 Multi-Jurisdiction Hazard Mitigation Plan Update
Volume 1—Base Plan 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. Continued growth in information now leads to this 2020 update, which expands on the previous risk assessments and integration of planning efforts.

The 2020 Island County Plan Update—What has changed?

Island County is using the five-year update process to enhance the Island County Multi-Jurisdictional Mitigation Plan in scope and content based on the availability of new data. The update involved a comprehensive review and update of each section of the 2015 plan, and includes an assessment of the success of the participating communities in evaluating, monitoring and implementing the mitigation strategy outlined in the initial and 2015 plan update. Only the information and data still valid from the 2015 plan was carried forward as applicable into this update. Based on planning guidance and new available data, this 2020 plan has been significantly updated and rewritten.

The following highlight some of the changes which have been incorporated in the 2020 plan, which differ from the previous edition:

- The actual layout of the plan varies only slightly from the 2015 edition, with changes primarily associated with ease in reading of the plan. The plan again utilizes a two-volume approach with the base plan contained in Volume 1 and each jurisdiction's separate annex contained in Volume 2.
- Hazards of concern focused on natural hazards, leaving the man-made and technological hazards addressed in the County's Threat Hazard Identification and Risk Assessment to avoid redundancies.
- Incorporated new data or studies on hazards and risks; the risk assessment uses the same methodology to define risk and determine vulnerability; this edition again 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. One variation includes more accurate Tsunami modeling, as this edition utilizes FEMA's update Hazus program, which now includes Tsunami modeling as well.
- An update of the flood hazard analysis was also conducted and enhanced, recognizing the flooding problems affecting the planning area. This analysis included the use of new DFIRMs (2014), which were adopted by the County after the risk analysis of the previous plan was completed.
- Climate change has been addressed within the hazard profiles of each identified hazard to assist the County in considering climate change issues when identifying future mitigation actions for the Planning Area.
- 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.
- Incorporated growth and development-related changes to inventories; any new critical facilities identified since the completion of the last planning effort were included in this update.
- All Census and Census-related data has been updated with the most current data available.
- All charts, graphs and maps have been updated with the most current data as available.
- Goals and objectives were reviewed and updated appropriately to align with the County and its planning partners.
- Incorporate new action recommendations or changes in action prioritization; Strategies from the 2015 edition were updated, and new strategies identified. An updated method of prioritizing strategies was used as defined within the Strategy section of the plan.
- This plan also now documents success stories where mitigation efforts have proven effective, or where this plan has been utilized to support efforts for risk reduction, or strategy implementation;
- Incorporated new capabilities or changes in capabilities; more detail was provided on how the various planning efforts support (or hinder) mitigation efforts.

- Review of the County's previous plans identified a concern of how to address the 2,000+ water purveyors throughout the County. Many of the purveyors are small, some with only one or two houses per well. Specifics needed to conduct a risk assessment on those systems would be cost-prohibitive and excessive for this planning effort. The strategy identified to help meet the needs of many of those purveyors wanting risk information was the development of the County's website, which identifies the hazards of concern in a web-based mapping application. This will allow any of the County's water purveyors (as well as anyone else) to seek out information on their specific hazards of concern. The County launched the web application portal with that purpose in mind. In addition, the Planning Team elected to reach out and invite the larger water purveyors to become a partner in this planning effort. While such invitations were extended by the County's Emergency Management Director, participation did not occur during this update, but the County intends to continue this outreach during the life cycle of this plan.

THE PLANNING PARTNERSHIP

The planning partnership for this plan included Island County, its city and towns, and several special purpose districts defined as "local governments" under the Disaster Mitigation Act. Jurisdictional annexes for those partners completing the process are included in Volume 2 of the plan.

Due to COVID response and the expiration date of the County's plan, many of the planning partners were unable to complete the process during the update cycle due to furloughed employees, and the lack of ability to be part of the planning process. In order to assist those municipal jurisdictions who could not complete the process, maps were created, and critical facilities previously identified were included in the risk assessment for this 2020 update. The risk assessment was completed countywide, from border to border, allowing any new planning partner to complete a GIS application to identify exposure for those entities wishing to join in at a later date.

Jurisdictions not covered by this current process have the ability to link to this plan at a future date by following the linkage procedures identified in Volume 2 of this plan. The Director of Emergency Management will work with those entities to assist them in the process, although the burden of completing the annex will continue to fall upon the planning partner as defined as the 2020 plan update process. This will ensure consistency in the identify process, enabling the planning partnership to maintain the broad-based level of participation.

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; and
  - 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; and
  - 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. FEMA's "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; and
  - "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 begins, with each planning partner required to adopt the plan according to its own protocols.

MITIGATION GOALS AND OBJECTIVES

The goals and objectives which were developed for the 2015 mitigation plan were based on the work of the planning team, which consisted of the internal planning group, the planning partners, project stakeholders, and technical information. The original goals were again reviewed during the 2019 kick-off meeting. Based on that meeting, the planning team determined that the 2015 goals would be carried over for the current update of the mitigation plan with some minimal revision, the primary intent of the goals remaining consistent. The 2015 objectives were also reviewed, with some modifications to reduce their numbers and group the objectives to allow for greater ease and application of use, and to support the Community Rating System.

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 also identified initiatives benefiting the whole partnership that will be implemented by pooling resources based on capability. These initiatives are identified in Chapter 16.

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.

1.2 ACKNOWLEDGEMENTS

Many groups and individuals have contributed to the 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 2020 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, mitigation initiatives, and a plan maintenance strategy. Volume 1 serves as the County's Hazard Mitigation Plan.
- Volume 2 includes all federally required jurisdiction-specific elements, assimilated into specific annexes for each participating jurisdiction, as well as a description of the participation requirements for planning partners. Volume 2 also includes "linkage" procedures for eligible jurisdictions that could 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—Plan adoption resolutions from planning partners
- Appendix C—A template for progress reports to be completed as this plan is implemented.

CHAPTER 2.
PLANNING PROCESS

To develop the 2020 Island County Hazard Mitigation Plan (HMP), 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 Pre-Disaster Mitigation Grant (PDM) from FEMA. Island County was the applicant agent for the grant. The grant was applied for in 2018, and funding was appropriated in 2019. It covered 75 percent of the cost for development of this plan; the County and its planning partners covered 25 percent of the cost through in-kind contributions.

2.2 INTERNAL PLANNING GROUP FORMATION

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

Island County Hazard Mitigation Plan Development Team

Eric Brooks	Director and Project Manager Department of Emergency Management
Shelby Preston	Coordinator and Public Outreach Facilitator, Department of Emergency Management
Jessica Carpenter	Director, Planning & Community Development
Hiller West	Development Services Manager, Island County Planning & Community Development
Andy Griffith	Building Official / Floodplain Manager
Matt Nash	Ecologist – Island County Public Works

Ben Kort	Island County GIS Coordinator
Dugan McCloskey	Island County Public Works - Development Coordinator
Bill Poss	Island County Public Works - Development Coordinator
Beverly O’Dea	Bridgeview Consulting, LLC Project Manager Lead Planner
David O’Dea	Bridgeview Consulting, LLC Senior Strategic Analyst and Lead Public Outreach Facilitator

2.3 PLANNING PARTNERSHIP

A primary focus of this effort was to re-engage the original planning partnership from the previous planning process, and to open this process to eligible local governments throughout Island County. The internal planning group made a presentation at various meetings beginning June 2019, soliciting participation by stakeholders and planning partners. The initial kickoff meeting took place in October 28, 2019. These various 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; and
- Outline planning partner expectations.

Each jurisdiction wishing to join the planning partnership was asked to provide a point of contact for the jurisdiction and confirm 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. This process remained similar to that utilized for the 2015 plan edition. Table 2-1 summarizes participation by the planning partners.

**TABLE 2-1.
PLANNING PARTNER LEVEL OF PARTICIPATION**

Jurisdiction	Point of Contact	Title	Letter of Intent	Previous Plan Participation	Completed All Elements of Planning Process
MUNICIPALITIES					
Island County	Eric Brooks	DEM Director	NA	Yes	Yes
Island County	Shelby Preston	Emergency Coordinator	NA	No	
Island County	Ben Kort	GIS Administrator	NA	No	
Island County	Bill Poss	PW Development Coordinator	NA	Yes	
Island County	Matt Nash	Ecologist	NA	Yes	
Island County	Hiller West	Development Services Manager – Planning & Community Development	NA	Yes	

TABLE 2-1. PLANNING PARTNER LEVEL OF PARTICIPATION					
Jurisdiction	Point of Contact	Title	Letter of Intent	Previous Plan Participation	Completed All Elements of Planning Process
City of Oak Harbor	Ray Merrill	Fire Chief	Yes	Yes	Yes
Town of Coupeville	Molly Hughes Kelly Beech	Mayor Clerk-Treasurer	Yes	Yes	Yes
FIRE DISTRICTS					
Camano Island Fire & Rescue	Craig Helgeland	Assistant Chief	Yes	Yes	Yes
South Whidbey Island Fire/EMS	H.L. "Rusty Palmer	Chief	Yes	Yes	No
Central Whidbey Island Fire & Rescue	Ed Hartin	Fire Chief	Yes	Yes	Pending
WATER DISTRICTS					
Whidbey Island Water System Association	Jim Patton	President	No	No	No
HOSPITAL DISTRICT					
Whidbey General Public Hospital District	Chris Tumblin	Emergency Services	Yes	Yes	Yes

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 kickoff 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 Director of the Department of Emergency Management.

During the kickoff 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.

In advance of each meeting, an agenda and materials to be discussed (i.e. example mitigation strategies, risk ranking data, 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 either through personal communication, email invitation, or during meeting attendance. In some instances, data from entities were utilized to support the planning process:

- County stakeholders included county commissioners, emergency manager, the floodplain coordinator, the Planning and Community Development Department, the GIS division, the Public Health Department, Public Works Department, Public Works Ecologist, Island County Communications (ICOM 911 dispatch), the Roads Division, and the Sheriff's Office. Their participation included providing data, attending meetings, and reviewing the draft hazard mitigation plan, among other planning processes.
- Stakeholders from the communities of Coupeville, Langley, and Oak Harbor included mayors, city council members, planning offices, building departments, public works departments, fire chiefs, chiefs of police, and community development administration. Their participation included providing data, attending 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 and/or reviewing the draft hazard mitigation plan.
- Federal agency stakeholders included the U.S. Navy, 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, in some instances attended public meetings, and were notified of the plan's availability for review on its completion.
- Non-government stakeholders included the American Red Cross, the Whidbey Island Water System Association, 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. Information exchange occurred via emails, press releases, and the County's website. Some of the various stakeholders and their respective areas of participation are identified in Table 2-2. This list is not all-inclusive, but does demonstrate the various topics and agencies utilized/contacted.

TABLE 2-2 HAZARD MITIGATION STAKEHOLDERS AND AREAS OF PARTICIPATION			
Stakeholders			**Data and Information Provided**
Island County Water District	Jim Patton, President		Whidbey Island water systems information
Washington Surveying and Rating Bureau	Robert Ferrell, PE, Vice President, Public Protection		Building Code Effectiveness Data
FEMA Region X	John Schelling, Mitigation Program Manager		Risk Report, Tsunami data, Hazus data/reports
WA DNR	Daniel Eungard, PE		Tsunami Hazard
WA DOE	Jerry Franklin, Risk Map Coordinator		Flood data, SRL and CRS data and information; Coastal Zone Atlas (unstable slopes)
WA DOE	Diane Fowler, Community Right to Know Coordinator		Reporting Hazmat sites in county
WA DOE	Bobbak Talebi, Coastal Planner	George Kaminsky, PhD	Coastal Erosion data and information
USGS			Earthquake and Tsunami Data

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 17. The list of references at the end of this volume presents sources used to capture information necessary to complete this planning effort. As this is a second plan update, historic references remain listed, as those served as the initial data sources. In addition those sources and items referenced, additional plans, studies and reports used for this process include:

- Island County Comprehensive Emergency Management Plan (CEMP)
- Coupeville CEMP
- Regional Catastrophic Plan
- Oak Harbor CEMP (2018)
- Flood Insurance Study; Island County and Incorporated Areas (2007, 2014, 2017)
- Island County Pre-Disaster Mitigation Plan, 2015

- Washington State Enhanced Hazard Mitigation Plan (2010, 2013, 2018)
- Washington Department of Natural Resources (WDNR) Landslide Report, Tsunami Inundation data and walking maps
- Island County Transportation Plan
- Coastal erosion data (various)
- Climate change data (various)
- 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
- USGS updates – National Seismic Hazard studies (2018)
- FEMA Risk Map Report (2017)

Data obtained from the plan and regulation review was incorporated into various sections of the hazard mitigation plan. The hazard profiles in the various hazard chapters further refer to plans, ordinances and data that affect the management of each hazard. Section 18.2 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 with County data contained in Chapter 17. 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 on-going mitigation efforts, such as new tsunami sirens, the completion of new tsunami walking maps for part of the County, and the update of FEMA flood maps, etc.
- Include several safety fairs from the various planning partners.
- Include presentations to the various public officials conducted by all planning partners throughout the County.

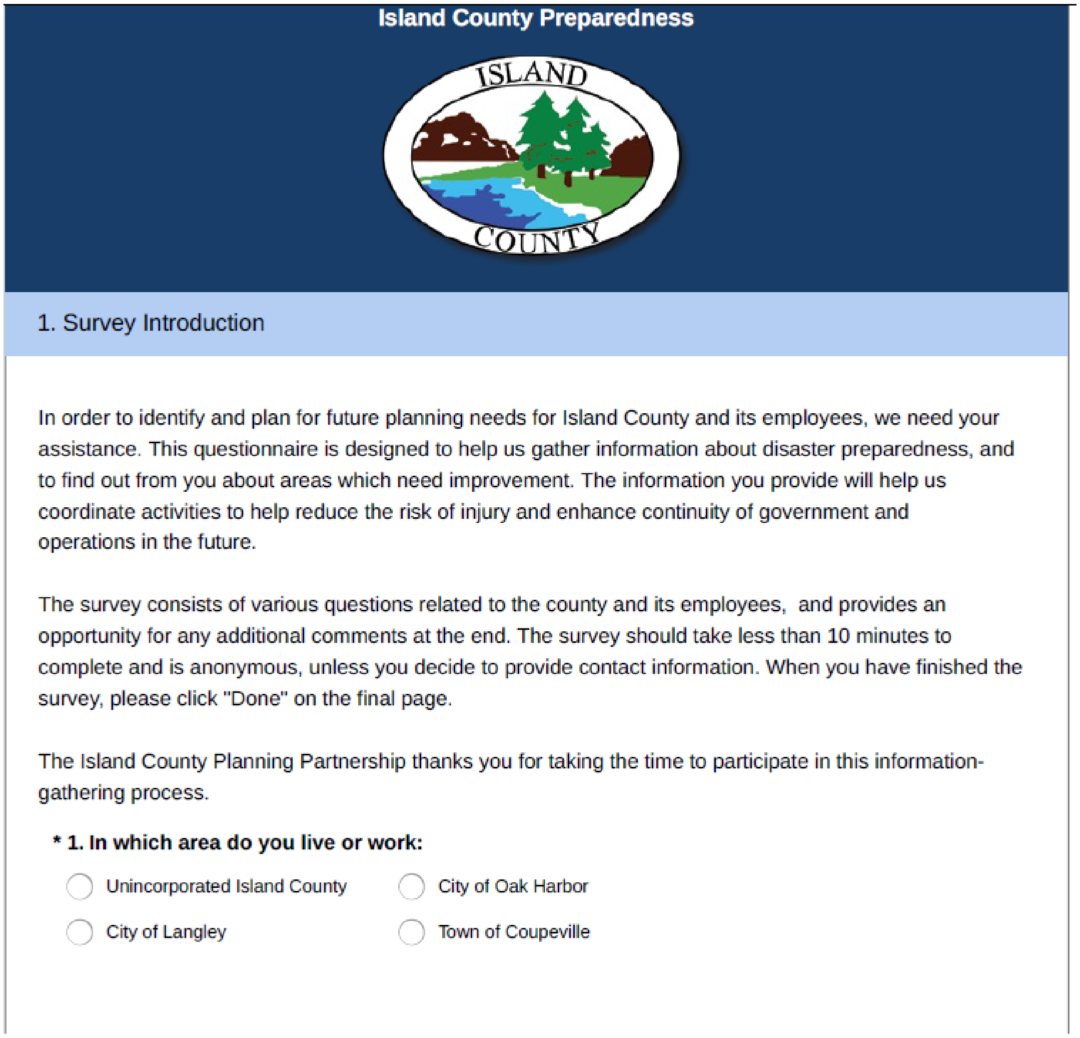
2.6.1 Planning Team Input

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 utilized its 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. Many of the Council / Commissioners' meetings are televised, for review by citizens at a later date.

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. Answers to the questions posed helped guide the planning partners in selecting goals, objectives and mitigation strategies. Hard copies were disseminated throughout the planning area, and a web-based version was made available on the hazard mitigation plan website. The questionnaire and responses in their entirety are available from the County's Emergency Management Office. The questionnaire will remain active during the life cycle of this plan to continue to capture citizen comments and information. A summary of its findings are provided below. Figure 2-1 shows a sample from the web-based questionnaire. Oak Harbor and the Town of Coupeville also posted information concerning the questionnaire's availability on their websites, as well as discussing the survey's availability during their outreach efforts, including council presentations. Review of the survey responses indicate a close match between respondents' hazards of greatest concern and hazards identified through the Planning Team's risk ranking.



Island County Preparedness

1. Survey Introduction

In order to identify and plan for future planning needs for Island County and its employees, we need your assistance. This questionnaire is designed to help us gather information about disaster preparedness, and to find out from you about areas which need improvement. The information you provide will help us coordinate activities to help reduce the risk of injury and enhance continuity of government and operations in the future.

The survey consists of various questions related to the county and its employees, 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 Oak Harbor
- City of Langley
- Town of Coupeville

Figure 2-1. Island County Survey Web Page

Summarized survey results include:

- 49 percent of respondents have experienced an earthquake over the last 20 years; 81 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 drought are also of concern to the citizens of the count.
- 60 percent of respondents have experienced one to three disaster events in their lifetime; over half of those occurred while the respondent resided or worked in Island County.
- 93 percent indicated that the impact of disasters did not restrict the use of their residence.
- 46 percent of respondents indicated some level of self-preparedness, although less than 8 percent have flood insurance through the NFIP. Approximately 20 percent of respondents have earthquake coverage.

- Over 70 percent 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.
- Over 80 percent of respondents felt that social media and the internet provide the most effective methods to distribute hazard and disaster information. Both methods were utilized by the Planning Team for this update to ensure adequate access and dissemination of information to residents and community members for review and input to the 2020 HMP update.

2.6.3 News Releases

A news release was published to draw attention to the County's update process and the survey at the beginning of the process. The County published a separate news release concerning the results of the risk assessment data and hazard maps once they became available for public review and comment. When the draft plan was available for public review, notice was again published in an effort to draw in as many comments as possible.

2.6.4 Internet and Social Media

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

The County's website address (https://www.islandcountywa.gov/DEM/Pages/Home.aspx) 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 data and maps were published on this site, and were available for download.

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 has over 2,100 followers, which it will continue to use in the future for updates of events in the county (Figure 2-2). In addition, there is also a Twitter account, and the local NextDoor accounts, all of which were utilized to announce events, draw attention to the process, and provide website addresses for review of the risk data and final draft plan.

2.6.5 Public Meetings

Several public meetings and events which were open to the public were held during this effort. Planning meetings were also open to the public. In addition, several events were 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 and story boards were set up for hazards of concern to which the planning area is 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, and citizens attending were asked to complete a questionnaire, and each was given an opportunity to provide written comments to Planning Team members.

Planning team members also staffed several public information booths, including senior luncheons, chamber meetings, and various safety fairs and expos. It is estimated that when combined, well over 1,000 people were in attendance at these various presentations and events.

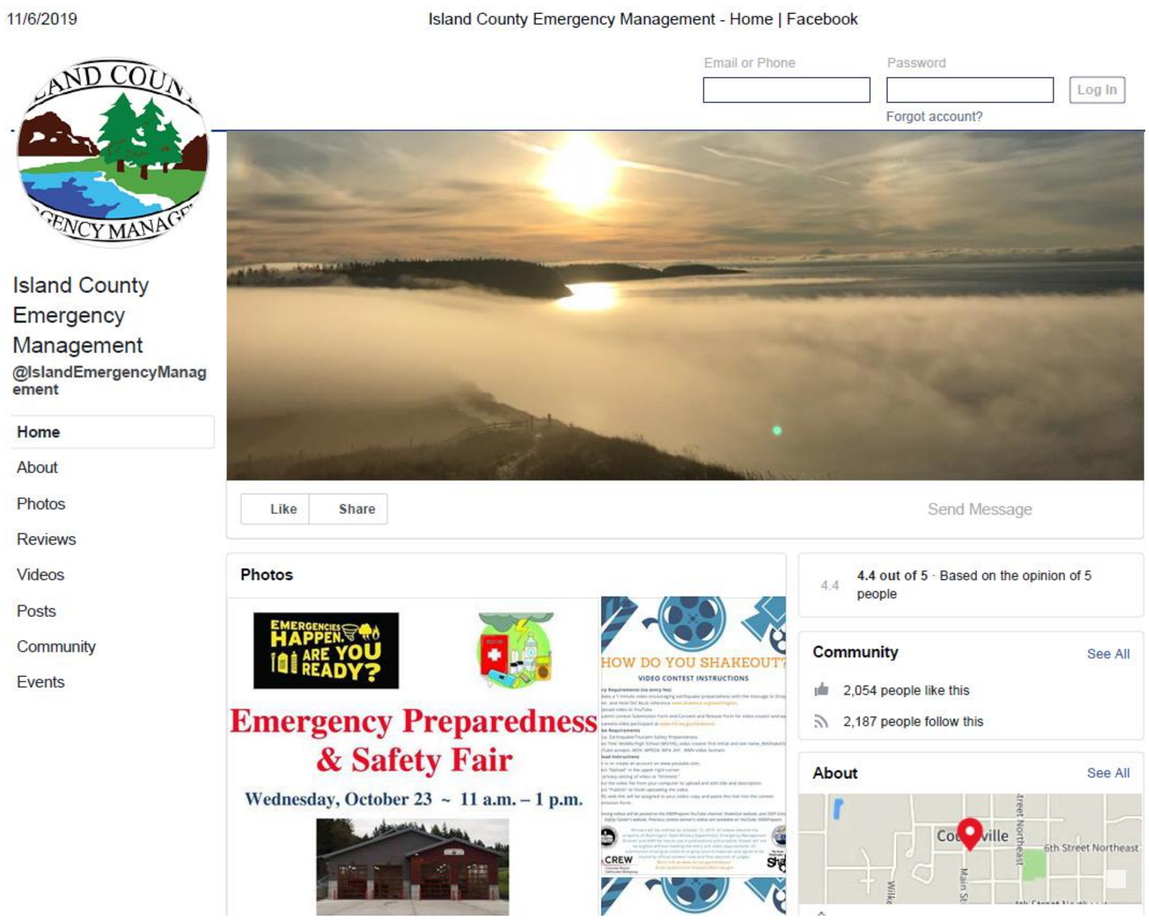


Figure 2-2 Island County Facebook

Kick-Off Meeting

During the kickoff meeting, which was open to the public and was publicized in the local paper (see Figure 2-3), the 2015 plan was reviewed in detail. Hazards were identified for the 2020 update. The planning team also reviewed the goals and objectives from the previous plan, and approved those with slight modifications. The risk assessment methodology was identified, discussed in detail, and approved. Strategies in general were discussed and examples identified, with FEMA's catalog provided to help develop ideas. The intent of providing the strategy information at the onset of the process (as well as on completion of the risk assessment portion of the plan development) was to encourage identification of potential strategies throughout the process when topics may be discussed, such as during budget development, strategic planning efforts, after an incident, disaster, or roundtable discussion with other department heads. During the kick-off meeting, planning team members also identified mitigation efforts completed since the last plan's adoption to further help identify potential strategies, and provide successful examples of actions completed. The capabilities assessment was also reviewed. Planning Team Members also discussed the significance of land use development as it has occurred since the last plan update, and whether that had increased or decreased their level of vulnerability since the last plan's completion. The 2015 Plan Maintenance Section was also discussed to determine whether the previous process identified was still a viable option. The Planning Team Members felt it was still a good process, and should remain the same for the 2020 update.

Figure 2-3 Open Public Kick-off Meeting

Figure 2-4. Public Information Booths at October Safety Fair

Additional Outreach

The Town of Coupeville discussed the mitigation planning process during their regularly scheduled meetings, providing updates during department roundtable discussions. The Mayor served as one of the Planning Team Members for the 2020 Update, and on completion of the HMP, provided information concerning the process and risk assessment. Once the draft plan was available for review, the Town also posted its availability on its website, and the Mayor provided information during the May council meeting, during which the Mayor identified the availability of the maps and the risk assessment in greater detail, inviting public input and comments. The Town hosted a link on its website, directing citizens to the County's website during the entire planning process.

The Fire Chief for the City of Oak Harbor discussed the hazard mitigation planning effort several times by providing Council updates of events occurring throughout the planning process, as well as on completion of the risk assessment, identifying the hazards of concern. Chief Merrill also sought direct input from department heads during the development of mitigation strategies during council meetings, and again made announcement of the draft plan's availability for review during council meetings.

Draft Plan Review

Once the draft plan was completed, the public was invited to provide comments on the hazard mitigation plan. The final public review period began June 4, 2020 lasting through June 22, 2020. The draft plan was posted on the project website and stakeholders were notified through press releases, social media, 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. Notice was also distributed through the County's Facebook, Twitter and NextDoor accounts.

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.

On completion of the review by State and FEMA, planning partners held their own public meetings, at which the plan was presented to their commissions, boards, or councils and the approving authority adopted the plan. Appendix B includes the adoption resolutions.

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 2-3 summarizes important milestones and public outreach efforts which occurred during the development of the Island County Multi-Jurisdiction Hazard Mitigation Plan. This list is not all-inclusive, as additional efforts of outreach and information sharing occurred by individual team members during routine meetings, as well as during community meetings, Chamber luncheons, and various briefings.

TABLE 2-3
PUBLIC OUTREACH AND PLAN DEVELOPMENT MILESTONES

Date	Event	Description	Attendance
2018			
2018	Submit grant application	Seek funding for plan development process.	
2019			
	Receive notice of grant award	Funding secured.	N/A
May	Countywide	Press release announcing the up-coming project.	N/A
May 1	Initiate consultant procurement	Seek a planning expert to facilitate the process.	N/A
May 22	Consultant selection	Facilitation of contract negotiations and execution.	
June 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.).	
July	County	Presentation to status of project to County Commissioners during regularly scheduled Commissioner's Meeting, which is open to the public.	~20
August	Countywide	Press release setting kickoff meeting dates.	N/A
August	Camano Kids Fest	Island County Department of Emergency Management focused on bringing the topic of emergency preparedness to children in a fun and interactive activity.	~350
August	Naval Air Station Whidbey Island	Used informational maps and handouts to educate the public on local hazards (Earthquakes and Tsunamis were popular topics to discuss).	~200
August	Countywide	National Night Out - Used informational maps that were used in the HMP and handouts to educate the public on local hazards (Earthquakes and Tsunamis were popular topics to discuss).	~400
September	Naval Air Station Whidbey Island	Navy Disaster Preparedness event - This event was focused on educating navy families about local hazards.	~75
September	Countywide	Third Annual Emergency Preparedness Expo	~300
September	Countywide	Senior Resources Fair – Information related to hazards as well as planning documents and handouts relating to planning as an older individual or an individual with special needs.	~250
October	Planning Meeting	Presentation on plan process, hazards, goals, objectives and public outreach strategy. Review of 2015 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 new plan would not include the technological or human-caused hazards. Discussed public presentation of hazard maps at various up-coming Safety Fairs. Goals and objectives were confirmed with slight modification to the objectives (intent remained consistent, but grouped together to reduce number).	11
October	Countywide	Survey deployed. Planning partners announced planning process underway and provide survey links on their respective webpages.	NA

TABLE 2-3
PUBLIC OUTREACH AND PLAN DEVELOPMENT MILESTONES

Date	Event	Description	Attendance
October	Countywide	Emergency Preparedness and Safety Fair; representatives from Island County Emergency Management, Red Cross, South Whidbey Fire and Rescue, Island County Amateur Radio Club, Whidbey Island Conservation District, and Puget Sound Energy were present to help answer questions on the various hazards of concern.	~150
October	Countywide Oak Harbor	Safety Fair—map presentation; laptops set up for citizen input through surveys; comment sheets requesting citizen input and follow-up	~150
October	Oak Harbor	Chamber of Commerce Luncheon - informed individuals about the upcoming HMP update and where they would be able to find more information.	~75
November	Camano Island	Camano Town Hall- Update for HMP.	17
December	Oak Harbor	Chief Ray Merrill provided an update during several regularly scheduled council session concerning the HMP update process, providing information on the hazards of concern, and the status of the on-going planning effort.	Televised
2020			
Jan & Feb	Planning Team Meetings	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
April 17	Countywide	Risk assessment results, profiles, hazard maps and poster boards were made available for public review and comment. A press release was issued, with notice of the availability of the risk assessment results publicized on Facebook, Twitter, NextDoor, and all planning team member's websites. Comments were accepted through an established email account, or via phone. Relevant comments were reviewed by the Planning Team and incorporated as appropriate.	NA
May 19	Draft Plan Internal Review	Draft provided by planning team to Planning Team (additional strategies added during review process).	All
June 4	Public Review	Draft plan provided on website with press releases inviting citizens to review and comment. The draft was available from June 4 – June 22, 2020.	NA
June 23	Submission	Plan submitted for State and FEMA review	NA
July	Adoption	Town of Coupeville Adopts Plan pending review due to outstanding grant award.	NA
Sept 3	FEMA Approval Pending Adoption	The 2020 Hazard Mitigation Plan was reviewed and approved by FEMA. Approval Pending Adoption issued.	NA
Sept	Plan Adoption	Planning Partners began adoption process.	NA

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 (see Figure 3-1), 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, 2019).

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)	46	48	51	54	58	62	65	66	63	57	51	45	
Average Min. Temperature (F)	35	35	37	40	45	49	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	2.1	2.0	1.4	0.6	0.6	0.9	2.0	2.7	1.8	-
Coupeville (11/1/1895 to 5/31/2016)													
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 November 7, 2019
Western Regional Climate Center DRI http://www.wrcc.dri.edu/summary/Climsmwa.html, Accessed November 7, 2019

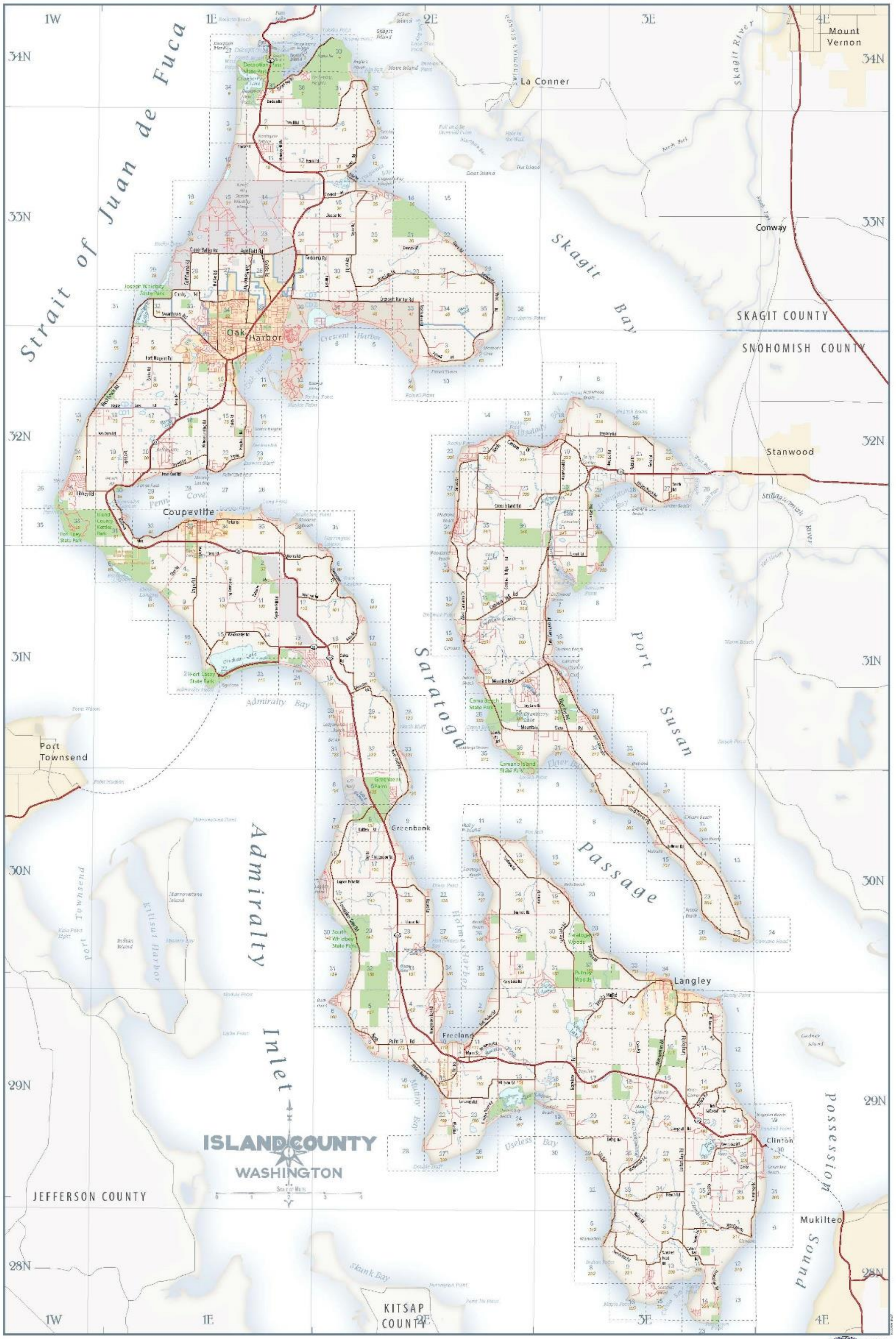


Figure 3-1 Island County

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, 14 federal disaster declarations have affected Island County, as listed in Table 3-2. That includes three events since completion of the last plan – all severe weather events, with winds, flooding and landslides categorized as the type of event most often impacting the County. 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. Those events rising to an Emergency Proclamation at the local level are also identified in Table 3-2.

**TABLE 3-2.
DISASTER DECLARATIONS IN ISLAND COUNTY**

Disaster Number[a]	Declaration Date	Incident Type/ Title
DR-623	5/21/1980	Volcanic Eruption – Mt. St. Helens
DR-883	11/26/1990	Severe Storms and Flooding
DR-896	3/8/1991	Severe Storms and High Tides
DR-1079	1/31/1996	Severe Storms, High Winds, and Flooding
DR-1159	1/17/1997	Severe Winter Storms, Land and Mudslides, and Flooding
DR-1361	3/1/2001	Earthquake

**TABLE 3-2.
DISASTER DECLARATIONS IN ISLAND COUNTY**

Disaster Number[a]	Declaration Date	Incident Type/ Title
DR-1499	11/17/2003	Severe Storms and Flooding
DR-3227	9/7/2005	Hurricane Katrina Evacuation
DR-1641	5/17/2006	Severe Storms, Flooding, Tidal Surge, Land and Mudslides
DR-1682	2/14/2007	Severe Winter Storm, Land and Mudslides
DR-1825	3/2/2009	Severe Winter Storm, and Record and Near Record Snowfall
DR-4242	11/15/2015	Severe Winter Storm
DR-4249	1/15/2016	Severe Winter Storms, Straight-Line Winds, Land and Mudslides
DR-4418	3/4/2019	Severe Winter Storms, Straight-Line Winds, Flooding, Landslides, Mudslides, and Tornado
Emergency Proclamations		
EM-C-24-99	3/10/1999	Beach Erosion/ Seawall Failure
Oak Harbor	12/2006	Severe Storms
EM-C01-11	1/4/2011	Flooding (Glendale Basin)
EM-C-33-11 and C-34-11 Langley Dec. (County not included)	3/22/2011	Landslide
EM-C-62-11	5/25/2011	Landslide (Camano Island)
EM-C-24-12	3/12/2012	Landslide/ Slope Instability (Camano Island)
EM-C-28-13	3/27/2013	Landslide (Whidbey)
EM-C-11-16	1/22/2016	Flooding (Severe Weather) – Island County

a. Declaration number codes as follows: DR = Major disaster declaration; EM = Emergency declaration; FM = Fire management assistance declaration.
b. Declarations prior to 1964 are Washington-statewide, not Island County specific; FEMA did not begin distinguishing declarations by county until 1964.

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 2015 definition of critical facilities and elected to continue its use for this 2020 update as defined in the following:

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.
- Major road systems including bridges, airports and marine terminal facilities.
- Hospitals 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.

Critical facilities throughout Island County are illustrated in Figure 3-2. 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.

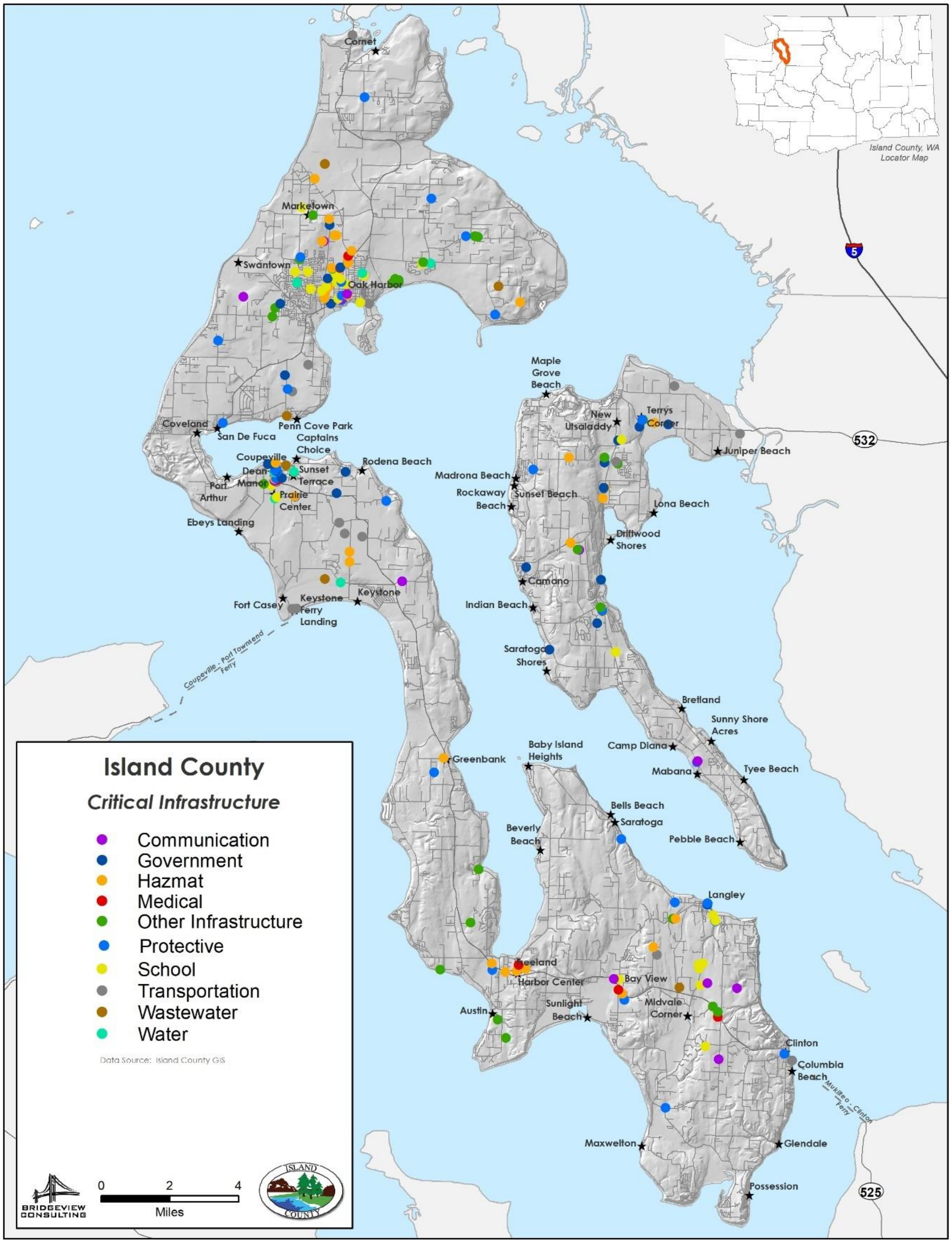


Figure 3-2 Island County Critical Facilities

TABLE 3-3.
ISLAND COUNTY CRITICAL FACILITIES

Jurisdiction	Medical and Health	Government Functions	Protective Functions	Schools	Hazmat	Total
Coupeville	2	6	5	3	3	19
Langley	0	1	2	2	0	5
Oak Harbor	2	5	4	14	8	33
Unincorporated	3	15	22	9	26	75
Total	**7**	**27**	**33**	**28**	**37**	**132**

*Other critical facilities are shelters, buses, and airports

TABLE 3-4.
ISLAND COUNTY CRITICAL INFRASTRUCTURE

Jurisdiction	Transportation	Water Supply	Wastewater	Communications	Other*	Total
Coupeville	1	3	1	1	0	6
Langley	0	0	0	0	0	0
Oak Harbor	1	3	0	2	7	13
Unincorporated	16	1	5	10	19	51
Total	**18**	**7**	**6**	**13**	**26**	**70**

* Other critical infrastructure types are dams and power

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 assist the County in extending focused public outreach and education to these most vulnerable citizens. Further discussion on vulnerable populations is contained in Chapter 15.

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 2019, Island County is the 15th most populous county in Washington, with 84,820 residents, and the 5th most densely populated, with 397.17 residents per square mile. The average number of persons per household in Island County was 1.9 according to the Washington State Office of Financial Management, compared to 2.38 in Washington state. Table 3-5 presents Island County 2019 populations by jurisdiction. While more limited in nature with respect to the type of demographic data available, US Census Quick Facts identifies population estimates for Island County in 2019 at 84,820, representing a 8.04 percent increase from the 2010 census.

**TABLE 3-5.
ISLAND COUNTY 2019 POPULATION BY JURISDICTION**

Place	Population
Coupeville	1,925
Langley	1,195
Oak Harbor	22,970
Unincorporated	58,730
Total	**84,820**

Source: U.S. Census Bureau, 2019 Accessed 12/2019.

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. 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 3.10.2). The most recent forecasts, which project out to 2040, were issued in December 2017 and are shown in Figure 3-3. 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 assumptions can be made in review of the population data:

- Island County's population has increased in every period since 1970.
- The median age of Island County (44.1) is higher than the state median (37.7) and is increasing faster. This increase will limit future population growth resulting from natural increase.
- The population of retirees (31% of households have a retirement income) which has historically been a significant component of Island County's population growth will likely continue.

**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
2019	84,820	8.04%	7,546,410	12.23%	328,653,775	6.4%
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%

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
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 and WA Office of Financial Management, 2019 Data

TABLE 3-7.
ISLAND COUNTY POPULATION TRENDS — CITIES

City	1970	1980	% Change Since Last Census	1990	% Change Since Last Census	2000	% Change Since Last Census	2010	% Change Since Last Census	2019	% Change Since Last Census
Coupeville, Town	678	1,006	48.4%	1,377	36.9%	1,723	25.1%	1,831	6.3%	1,925	5.0%
Langley, City	547	654	20%	845	15%	986	16%	1,035	5.0%	1,195	15.5%
Oak Harbor, City	9,167	12,271	33.9%	17,176	40.0%	19,795	15.2%	22,075	11.5%	22,970	4.05%

Source: WA Office of Financial Management, 2019 Data

Source: OFM, 2017c

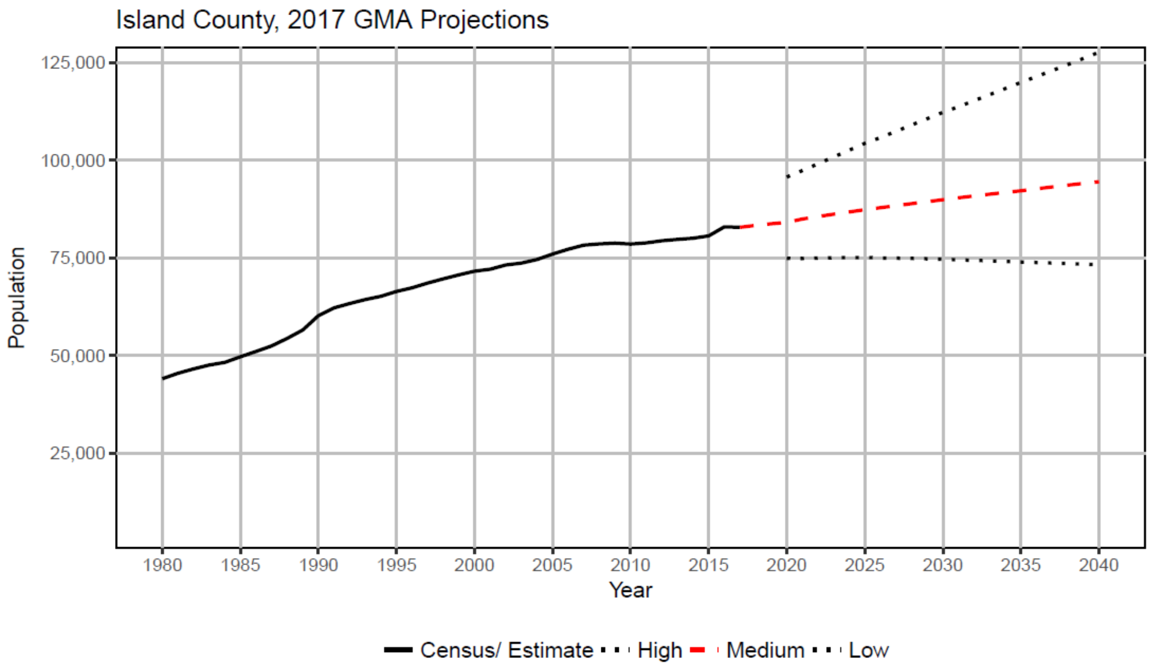


Figure 3-3. Island County Population Trends and Projections, 1970-2040

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, 23.6 percent of Island County’s population as of 2018 is 65 or older, compared to the state average of 15.4 percent. Both Island County and the State of Washington 65 or older population percentage have increased since the 2010 U. S. Census (18.4 percent for Island County and 12.3 percent for the State of Washington in 2010). Projections of the population conducted as part of the Office for Financial Management for Growth Management Act have Island County’s 65 and older population continuing to grow through 2035 (29.3 percentage) as a percentage of the entire population until it begins to decrease in 2040 (28 percent). (OFM)

Of the county’s over-65 population, 3.8 percent have incomes below the poverty line. It is also estimated that 5.7 percent of the county’s population is 5 or younger, compared to the state average of 6.1 percent and

18.1 percent of the county's population is 18 or younger, compared to the state average of 22.1 percent. Children under 18 account for 14.3 percent of individuals who are below the poverty line (U.S. Census 2019a).

In 2017, Island County's labor market was characterized by a higher proportion of more older and younger workers, with a smaller portion of mid-career workers when compared with the state. Statewide, 22.3 percent of the workforce was age 55 or older. Comparatively, Island County has 27.2 percent of the workforce age 55 or older, ~5 percent more than statewide averages. At the other end of the age spectrum for workers, Island County's share of workers age 14-24 was 13.5 percent, compared to a statewide average of 11.6 percent. (ESD)

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 2018 U.S. Census Bureau's QuickFacts, the racial composition of Island County is predominantly white, at about 85.4 percent, compared to 78.9 percent at the state level. The largest minority population is Hispanic or Latino, with 8.1 percent in Island County, compared to 12.9 percent statewide. The Asian (5.1 percent) and Native Hawaiian or other Pacific Islander population (0.5 percent) of the county is lower than the State of Washington populations of the same minorities; Asian (9.3 percent) and Native Hawaiian or other Pacific Islander (0.8 percent).

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 2013-2017 American Community Survey (ACS) data, 15.6 percent of the county's population has a disability. Those with Ambulatory Difficulties account for 8.1 percent followed by Hearing Difficulties (6.5 percent) and Independent Living Difficulties (5.9 percent). For those 65 or older in age, 32.2 percent have a disability. Table 3-8 summarizes the vulnerable populations within Island County.

**TABLE 3-8.
VULNERABLE POPULATIONS**

	Percent of Total Population			
Population Group	**County**	**Oak Harbor**	**Coupeville**	**Langley**
Households Children 5 and Under	5.7%	9.4%	4.1%	2.6%
Populations 65 and Older	24.6%	12.0%	27.5%	28.4%
Population Below Poverty Level	9.5%	*	*	*
Language Other Than English	8.1%	17.2%	*	*

TABLE 3-8.
VULNERABLE POPULATIONS

Population Group	County	Percent of Total Population: Oak Harbor	Coupeville	Langley
Total Population with any Reported Disability	15.6%	*	*	*
At Least One Disability Under 65	10.0%	9.1%	*	*
At Least One Disability 18 years and under	4.3%	*	*	*
At Least One Disability 18-64	12.1%	*	*	*
At Least One Disability 65 and over	31.8%	*	*	*

Sources: US Census[1]

*Data Not available at municipality level from Census Bureau or WA State Office of Financial Management

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 $33, 837 in 2018 compared with $34,869 for Washington State. The median household income was $61,516 in Island County and $66,174 in the state. It is estimated that 9.2 percent of the population in Island County lives below the poverty level. This is an increase from the 8.8 percent which existed at the time of the 2015 plan. This estimation is below Washington State's rate, which identifies approximately 10.3 percent of the population living below the poverty level.

3.7 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

[1] US Census Data Accessed 5 Fe 2020. Available online at: https://data.census.gov/cedsci/profile?g=0500000US53029&tid=ACSDP1Y2018.DP02&hidePreview=true&vintage=2018

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 2013-2017 ACS estimates that Island County has ~42,277 housing units, with a median value of $311,400.

3.7.1 Age of Building Stock

The year of construction is significant in determining the potential impact from various hazards due to construction standards in place at the time. Structures built pre-1972 historically have maintained lower building standards than current codes in place. New construction is built to higher standards. A breakdown of the housing units by year of construction is presented in Table 3-9.

TABLE 3-9.
ISLAND COUNTY HOUSING STOCK AGE

	Island County	Coupeville	Langley	Oak Harbor
Year Structure Built				
1939 or earlier	1,855	87	39	163
1940 to 1949	1,102	15	53	184
1950 to 1959	2,533	80	54	684
1960 to 1969	3,481	42	69	863
1970 to 1979	7,489	226	134	2,117
1980 to 1989	5,663	187	159	1,517
1990 to 1999	9,900	180	109	2,112
2000 to 2009	7,786	112	105	2,027

Source: 2013-2017 American Community Survey 5-Year Estimates

3.8 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. The Naval Air Station has approximately 8,400 military personnel and 2,100 civilians / full-time contractors. In addition, there are approximately 14,000 retirees, 350 reservists, 14,000 family members, and 50 Canadian forces and their families. Annually, the installation generates around $630 million in total payroll, and local veterans receive around $77 million in veterans payment. Estimations for 2018 forward from Naval Air Station Whidbey Island indicate that they will have an additional 600 personnel over the next four to five years. Non-farm 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 non-farm employment averaged 16,660 in 2017. Just under 29 percent of all jobs in Island County were government jobs – with concentration in local government. Typically, the largest volume of local government jobs is related to K-12 education. Trade transportation and utilities, a sector that includes retail and wholesale trade in addition to logistics-related activities employed 2,640 (16 percent) of all jobs. Leisure and hospitality and private education and health services both made up about 14 percent of total nonfarm employment. Goods producing industries, which are predominantly represented by construction and manufacturing, made up nearly 11 percent of the non-military jobs in Island County. (ESD)

Island County's total civilian labor force increased almost every year from 2001 to 2010. From 2010 to 2014, the total labor force contracted, and has only begun to recover in the past couple of years. The average annual civilian labor force expanded by 1,522 or 4.4 percent from 2016 to 2017. (ESD)

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. 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.

3.9 LAND USE AND FUTURE DEVELOPMENT

44 CFR Section 201.6(d)(3) requires that plan updates be revised to reflect changes in development that occurred within the planning area during the past performance period of the plan. The plan must describe changes in development that have occurred in hazard prone areas and increased or decreased the vulnerability of each jurisdiction since the last plan was approved. If no changes in development impacted the jurisdiction's overall vulnerability, plan updates may validate the information in the previously approved plan. The intent of this requirement is to ensure that the mitigation strategy continues to address the risk and vulnerabilities to existing and potential new development, and takes into consideration possible future conditions that can impact the vulnerability of the community.

Over the course of time, changes to land use practices have decreased vulnerability throughout Island County, including within each of the municipalities. Land use practices have helped to limit exposure by minimizing development in areas where the likelihood of hazard impact is high. For example, structures constructed in flood prone areas were sited outside of the floodplain whenever possible. In situations where structures had to be sited within floodplains, property owners had to provide a certification by registered professional civil engineers, which state encroachments would not result in an increase in flood level during the occurrence of the base flood discharge.

Changes to building construction practices have also limited physical vulnerability by building structures whose resistance to hazard impacts is high. Structures built within various hazard zones are subject to design and construction standards to help reduce of impact.

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 updated its Comprehensive Land Use

Plan in 2016, with additional updates occurring in 2019 as it relates to its Floodplain Ordinance (Chapter 14 of the Island County Code). This hazard mitigation plan will provide information for future update efforts 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, 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.

Changes in Development – Impact on Hazards of Concern

During the time period of 2010-2018, population increased 7.6 percent Countywide. Based on U.S. Census data, 2018 saw a total of 319 permits of all types issued countywide, while 2017 saw a total of 408 building permits issued. Structure count (all types), based on Assessor's data, increased approximately 1,800 since completion of the 2015 plan, which maintained data through 2014.[2] The County and its municipalities have adopted comprehensive plans that govern land use decision and policy making within their jurisdictions, as well as building codes and specialty ordinances based on state and federal mandates, such as the National Flood Insurance Program (discussed separately). Such regulations also direct zoning, and identify those areas of growth, expansion, and where restrictions exist on development. Decisions on land use are also governed by various programs, and in many cases, continued enrollment in those programs validates compliance, which in most instances includes restrictions for development in hazard-prone areas.

It should be assumed that by this planning process, that new development triggered by the increase in population directly interfaced with hazards and hazard areas assessed by this plan. This would include: land mass assessed, which included any potential boundary revisions or annexations which may have occurred by municipal planning partners since completion of the last plan; increased structure count via Assessor's data (where available), including identification of structures currently in development; and, updated hazard information, such as updated NFIP Flood maps (among others), where available.

As such, results from the risk assessment itself includes changes in development since completion of the last plan, and are considered when determining the Calculated Priority Risk Index (CPRI) scoring, which is further discussed in Chapter 4. This is further reviewed during the risk ranking process contained in Chapter 15, which considers impact to people, property, the environment, and economy and the

[2] No additional permit data was readily available from the county to further enhance permitting information.

vulnerabilities thereto. Each hazard profile also identifies future development trends as well, during which Planning Team Members identify potential impact.

When specifically queried, Planning Team Members felt that while development itself has increased vulnerability based on the increased population at risk in general, development trends themselves have not increased risk, with the exception of additional structures in place. In some cases, Planning Team Members felt the opposite is true, such as in Oak Harbor with the construction of a new water retention pond, which helps reduce the flood risk. For the County itself, enhancements to the Floodplain Ordinance since completion of the last plan has further provided tools to help reduce the risk in flood prone areas. Throughout the plan, there are additional specific examples of issues of concern where they exist, or positive examples of reduction as it relates to land use development.

3.9.1 Land Use Planning

The Island County Planning and Community Development (ICPDC) 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. Most recent updates occurred in June 2019, with respect to the Special Flood Hazard Area (SFHA), and additional voluntary requirements associated with development in biologically sensitive areas (discussed further below). The department is also responsible for floodplain management in the County, and works with local jurisdictions as needed in this capacity. Island County provides building plan review services for the cities of Langley and Coupeville. However, ultimate responsibility for enforcement of their building codes and flood hazard regulations rests with those cities. For development within the County (unincorporated), Island County requires elevation certificates for construction within flood hazard areas and other compliance information. The Building Official within the Building Department is responsible for enforcement and ensuring compliance with flood hazard, seismic and building code requirements in unincorporated Island County. ICPDC consists of planners (long-range and current), development coordinators, building inspectors, permit managers, and code enforcement officers, among others. Collectively, they review development proposals by landowners to ensure they are consistent with federal, state, and county regulations. The department works with other governmental departments, 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.

ICPDC staff, in cooperation with staff from Island County's jurisdictions including Oak Harbor, Coupeville and Langley, have identified the current rural high density growth areas based on Planning and Community Development Department's estimated distribution of population growth. The County had previously completed a Buildable Lands Analysis based on the population projections, and during its 2016 periodic update, resized the Urban Growth Areas for Freeland and Langley, as they were larger than necessary to accommodate the projected growth. The projections made allocate an appropriate mix of zoning to accommodate growth over the next 20 year planning horizon. Those areas identified as rural areas of more intense growth are identified in Figure 3-4 through Figure 3-6 . The reduction in size for Freeland and Langley will result in more concentrated development, allowing for more efficient infrastructure service, and improve protection of rural lands (IC Comp Plan, 2016, p 14).[3]

With those exceptions, since completion of the last plan, the areas previously identified for growth have remained consistent in the projected growth as was expected. Therefore, while growth and expansion has occurred (approximately 1,800 new structures since completion of the last plan), the impact to the hazards has been minimal, with no increased vulnerability, except that associated increased risk due to exposure in

[3] Island County Comprehensive Land Use Plan (2016). Accessed 4 March 2020. Available online at: https://www.islandcountywa.gov/Planning/2016CompPlan/2016_01-LandUse.pdf

general. Again, it should be assumed that by this planning process, that new development triggered by the increase in population directly interfaced with hazards and hazard areas assessed by this plan, and validated by the planning team during this planning process.

Further, while the number of people have increased countywide, land use regulations, including the critical areas ordinance, has been effective, with no increase of hazard incidents associated with new development. While the number of properties potentially exposed has increased due to a factor of population growth in general, regulatory authority has proven effective.

Each planning partner has in place land use development regulations (discussed in each individual annex template), which identifies the authority to determine where development will occur, as well as the construction standards to which structures must be built. Such regulations help mitigate the impact of the hazards of concern on the respective municipalities. Zoning and land use trends in place as of February 2020 are shown in Figure 3-7. Island County's Future Land Use map is illustrated in Figure 3-8.

Low Impact Development

The County and its Planning Partners also utilize Low Impact Development opportunities as well to help reduce impact from the hazards of concern during land use development. Such activities not only have the potential to significantly reduce impact from various hazards, but also provide benefits to the natural ecosystems in the area. A few examples which have been incorporated into area development include:

- Oak Harbor – Fort Nugent ort Nugent Park: This location utilizes a 100% on-site stormwater retention area using bioswales, incorporating ponds with native plants. The project also maintains a pervious concrete pathway which leads to the football field and beneath bleachers, allowing precipitation to enter the ground, rather than being trapped above ground, potentially increasing flood potential.
- The Harbor Station, which is a mixed use commercial development located at the intersection of Northeast 7th and SR 20. In this project, runoff is directed into planted bioretention strips with under-drains, which filters through plants and topsoil. The water then flows into a perforated pipe leading to an underground retention area. The on-site subsoils infiltrate poorly, and as such, stormwater must be piped off site, but LID systems help clean the water while also helping to regulate runoff.
- Coupeville – At the Coupeville High School, water from paved areas flows through bioswales into a vegetated detention pond. The property is atop impermeable clay, and as such on-site infiltration to groundwater is not possible. The new pond provides irrigation, wildlife habitat, education and surge protection as stormwater runoff is slowed, filtered and cleaned by plants and soil. Excess runoff is then piped from pond into the storm drain system.
- South Whidbey - Bayview Corner Redevelopment, a project of Goosefoot which showcases multiple LID features, including: porous concrete parking areas and sidewalks; interlocking plastic grid (grass pave) parking area; walkways using interplanted recycled concrete pavers; a composting toilet in the public restroom with solar power and rainwater collection for flushing, and reused building materials.
- The Bayview High School maintains a rain garden with a native plant restoration project in the historic schoolyard, which captures roof runoff.

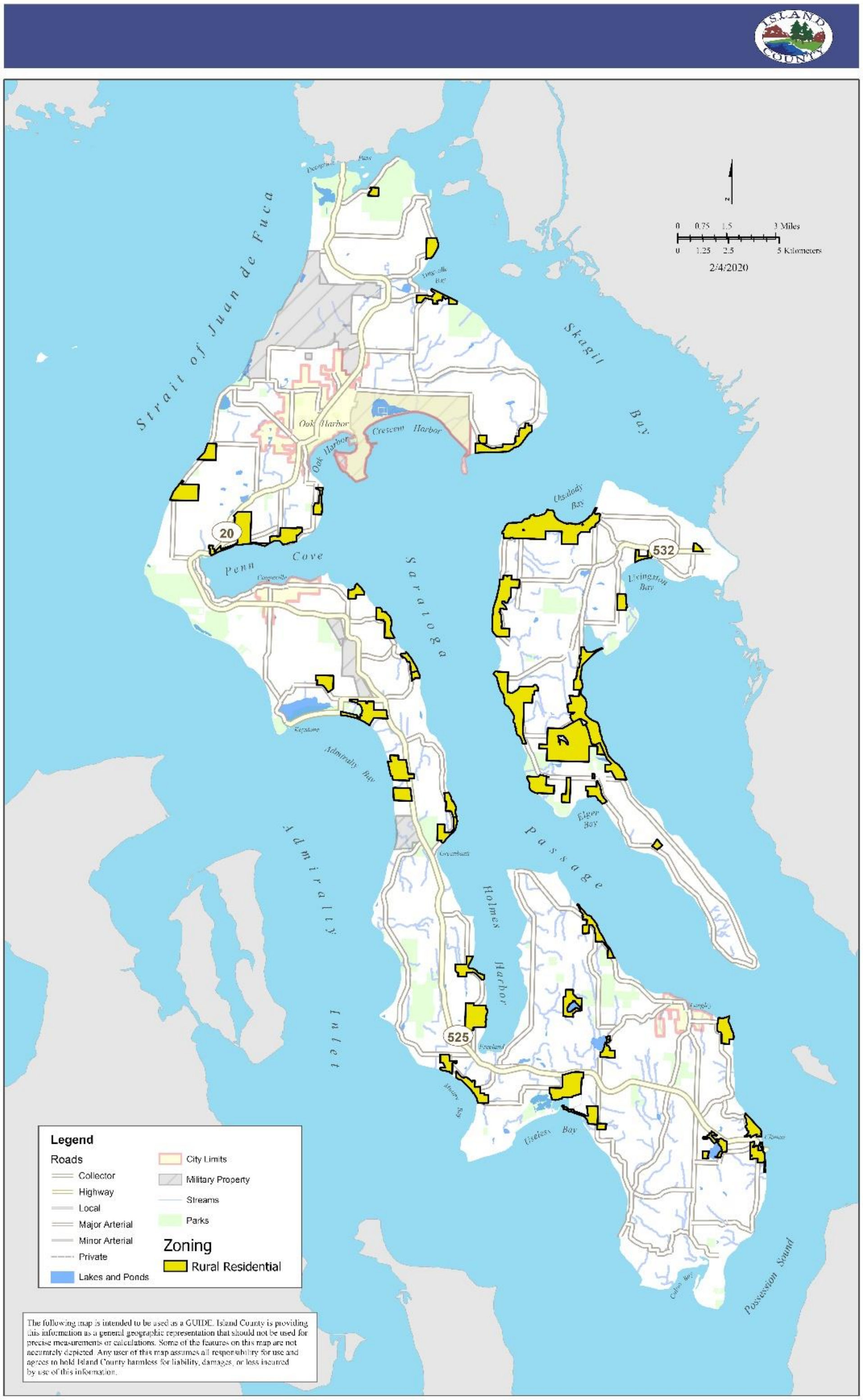


Figure 3-4 Island County Rural Areas of Intense Development (2020)

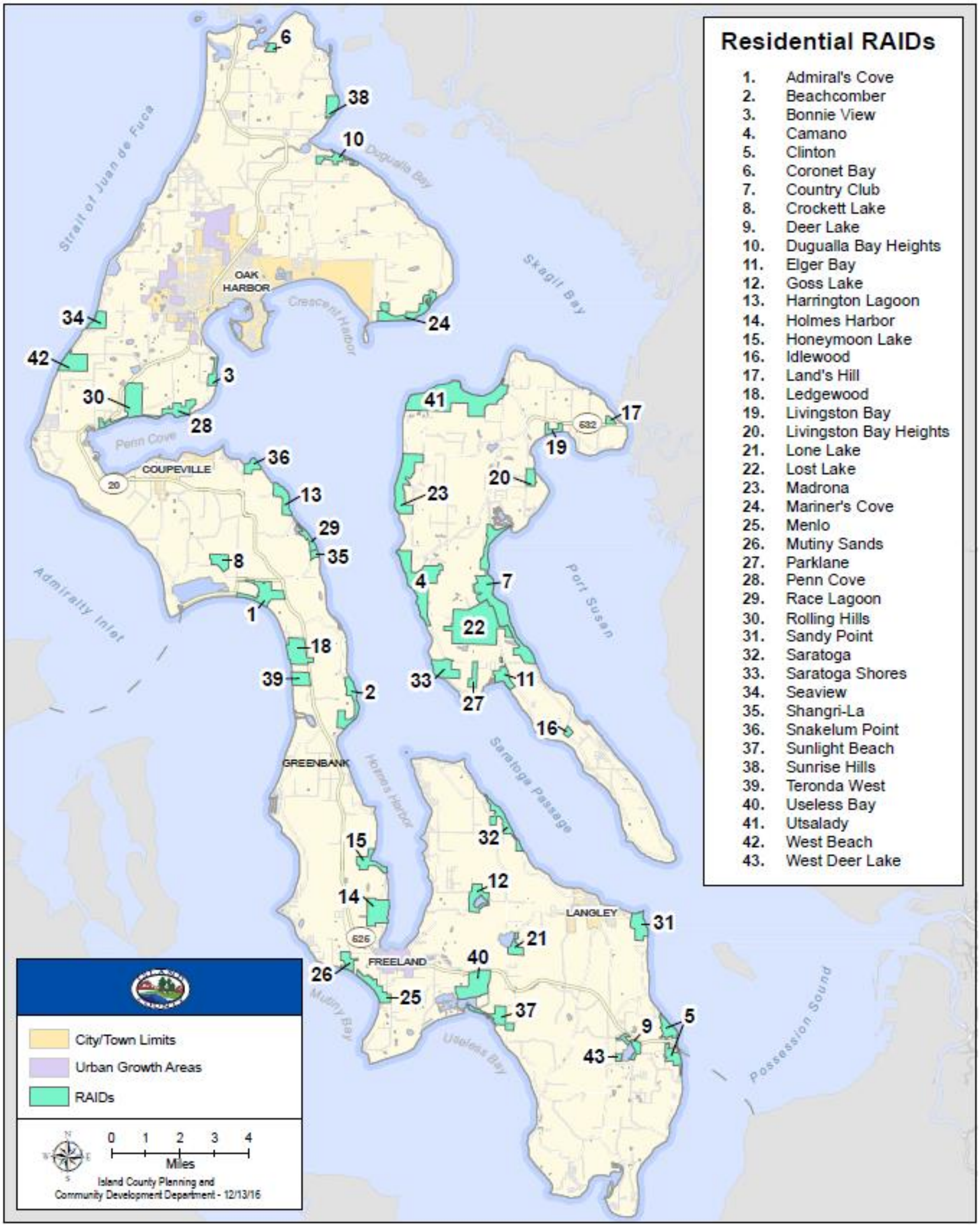


Figure 3-5 Rural Areas of Intense Development Identified (2016 Island County COMP)

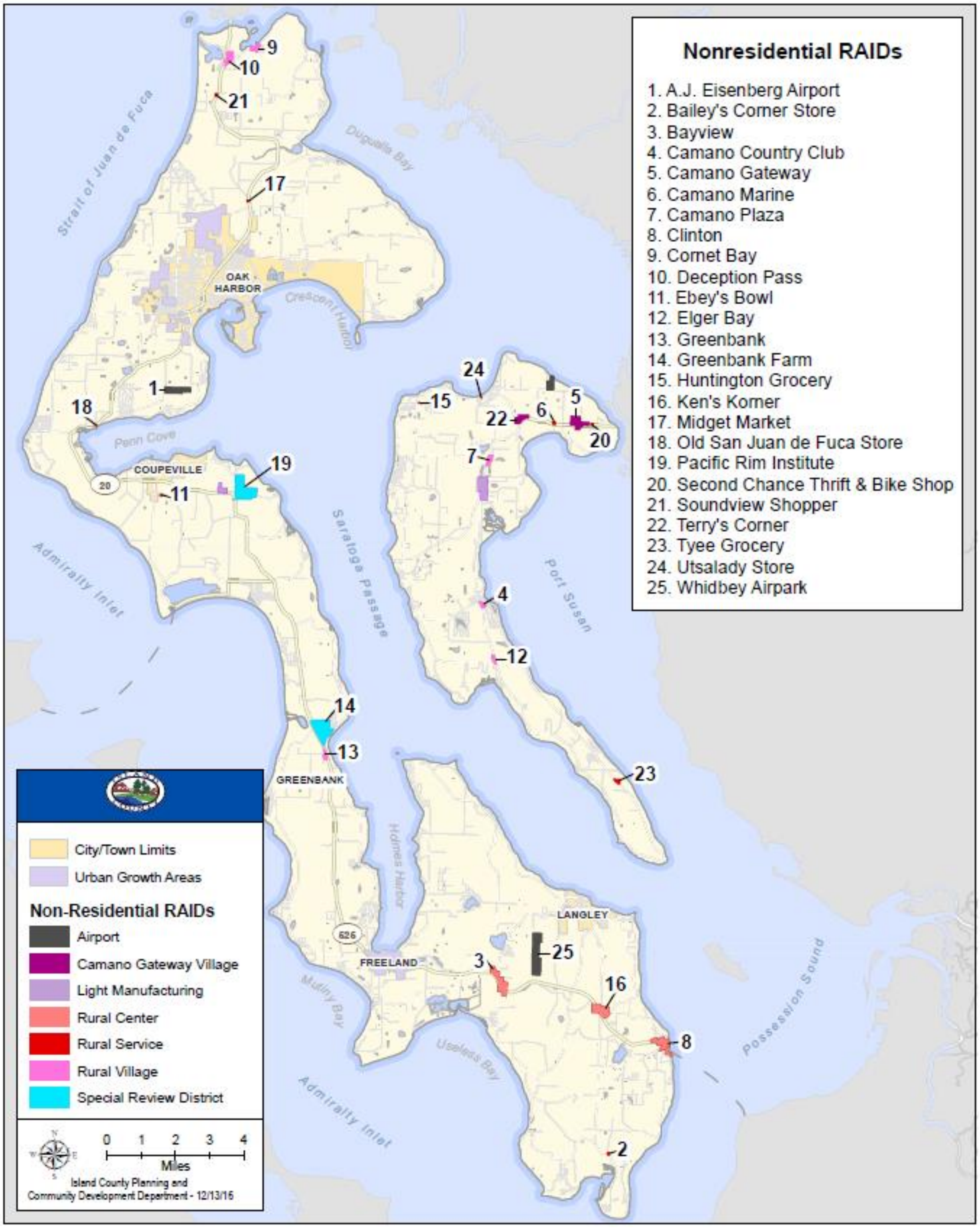


Figure 3-6 Nonresidential Rural Areas of Intense Development (2016 Island County COMP)

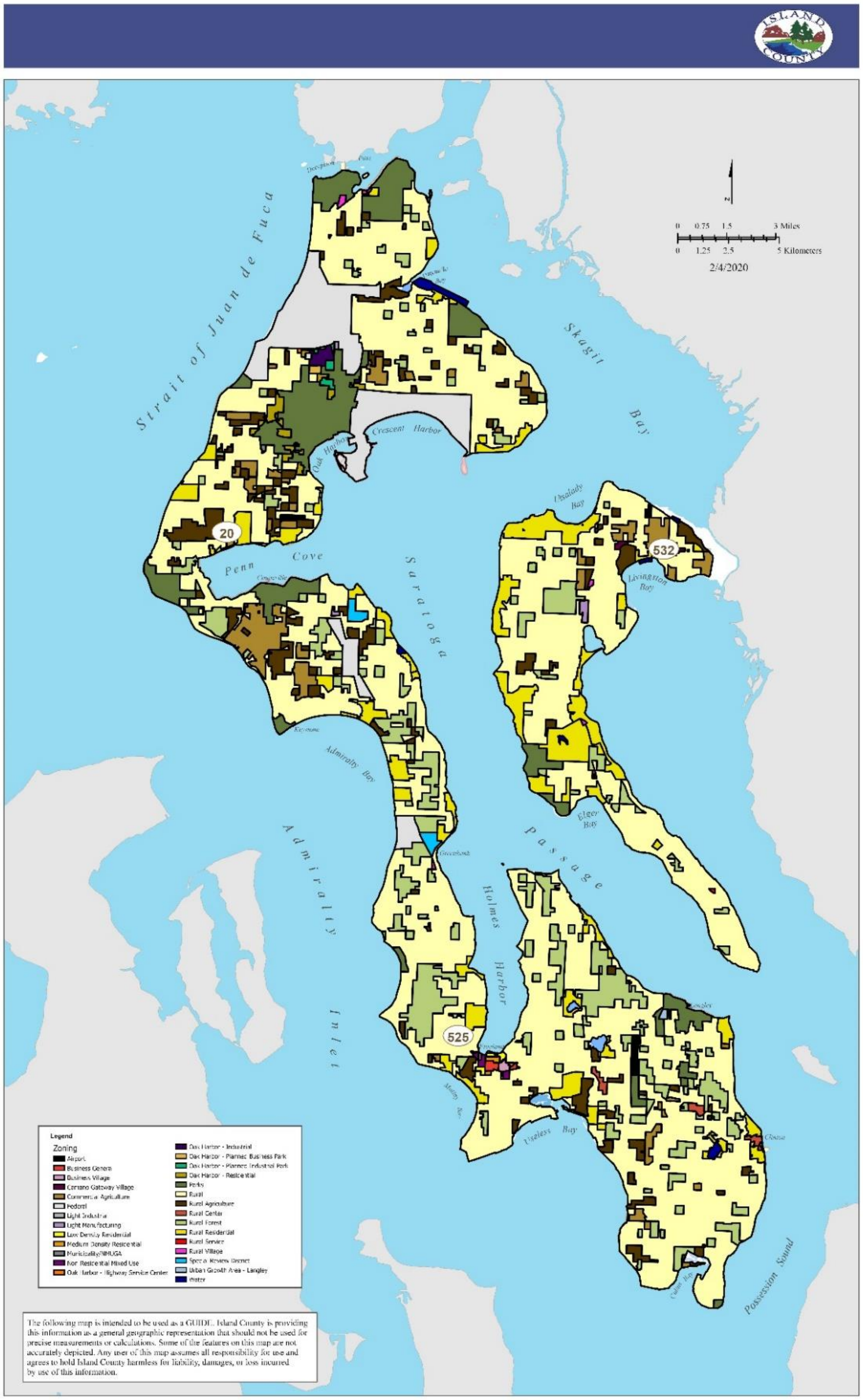


Figure 3-7. Zoning and Land Use in the Planning Area

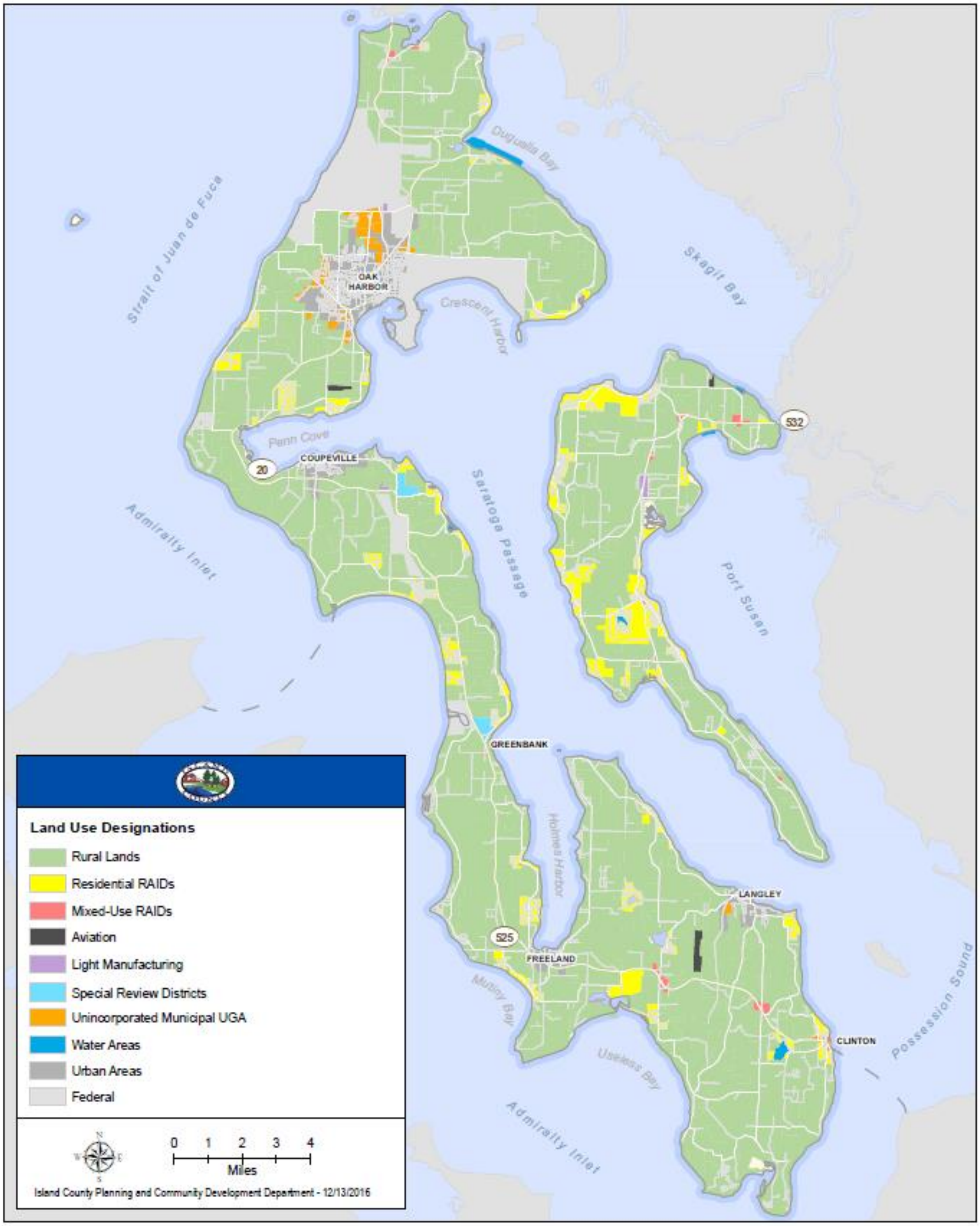


Figure 3-8 Future Land Use (2016 Island County COMP)

3.10 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.

3.10.1 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. Over the course of time, this Act has been amended several times, the last final rule becoming effective on December 23, 2019.

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 planning partners participate in the NFIP and have adopted regulations that meet the NFIP requirements. 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.

3.10.2 State-Level Planning Initiatives

Washington State Enhanced Mitigation Plan

The Washington State Enhanced Hazard Mitigation Plan approved by FEMA in 2018 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 2018 editions of national model codes, with some amendments and they are anticipated effective date is July 1, 2020. The Council also adopted changes to the Washington State Energy Code (effective 2015) 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.

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. Local jurisdictions must participate in the NFIP and be a member in good standing to qualify for an FCAAP grant.

In addition, 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.

3.10.3 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 section presents 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, including Island County and the City of Oak Harbor.

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 completed its review and revisions in June, 2016, and will again update the plan 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.

Island County Code Chapter 14.02A – Flood Damage Prevention Ordinance, provides the regulatory authority in place for construction within any area of the special flood hazard area, including permitting, enforcement, and provisions for flood hazard reduction. Portions of the ordinance were most recently updated in June 2019 with respect to property owners' increased voluntary standards established for development along shorelines that meet the criteria specified in the National Marine Fisheries Service 2008 Biological Opinion, which modifications were approved by FEMA prior to adoption by the County. As implemented, those actions – administered by the county's Floodplain Manager, will further help reduce the negative impacts of development within SFHA. Additional information on the 2019 modification is available on the County's website at: https://www.islandcountywa.gov/Planning/LandUseDocuments/C-48-19%20FEMA%20door%202.pdf

CHAPTER 4.
RISK ASSESSMENT 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 and supporting information is described below.

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 or potentially injured and damaged.
- 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.

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

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 October 28, 2019 meeting, identified the following natural hazards that this plan addresses as the hazards of concern:

- Drought
- Erosion
- Earthquake
- Flood
- Landslide
- Severe weather

- Tsunami
- Volcano
- Wildfire

This is a change from the previous plan edition. Human-caused and technological hazards have been removed as the plan addresses only natural hazards. The hazard profiles for the identified hazards of concern are contained in Chapters 5 through 14.

4.2.2 Risk Assessment Process

The hazard profiles and risk assessment describe the risks associated with each identified hazard of concern. Each chapter describes the hazard, the planning area's vulnerabilities, and 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 and assessing structures, facilities, and systems that are exposed to each hazard. Tools such as GIS and Hazus (discussed below) were used in this assessment.
- Where specific quantitative assessments could not be completed, vulnerability was measured in general, qualitative term, summarizing the potential impact based on past occurrences, spatial extent, and subjective damage and casualty potential. Those items were categorized utilizing the criteria established in the CPRI (discussed below).
- The final step in the process was to determine the cumulative results of vulnerability based on the risk assessment/CPRI schedule, assigning a final qualitative level of significance. It serves as a summary of the potential impact based on past occurrences, spatial extent, and damage and casualty potential based on the following levels of significance, with all of the results contained within Chapter 15:
    - □ Extremely Low—The occurrence and potential cost of damage to life and property is very minimal to nonexistent.
    - □ Low—Minimal potential impact. The occurrence and potential cost of damage to life and property is minimal.
    - □ Medium—Moderate potential impact. This ranking carries a moderate threat level to the general population and/or built environment. Here the potential damage is more isolated and less costly than a more widespread disaster.

- High—Widespread potential impact. This ranking carries a high threat to the general population and/or built environment. The potential for damage is widespread. Hazards in this category may have occurred in the past.

- Extremely High—Very widespread with catastrophic impact.

4.2.3 Calculated Priority Risk Index Scoring Criteria

For the 2020 update, the Planning Team utilized a Calculated Priority Risk Index Score for each hazard of concern, addressing impact both at the county level, and at the Planning Partner level. The same process was followed for both the County and by each Planning Partner. While the base plan defines the process followed, each jurisdictional annex provides only the outputs rather than re-describing the entire process.

Vulnerabilities are described in terms of critical facilities, structures, population, economic values, and functionality of government which can be affected by the hazard event as identified in the below tables. Hazard impact areas describe the geographic extent a hazard can impact a jurisdiction and are uniquely defined on a hazard-by-hazard basis. Mapping of the hazards, where spatial differences exist, allows for hazard analysis by geographic location. Some hazards can have varying levels of risk based on location. Other hazards cover larger geographic areas and affect the area uniformly. Therefore, a system must be established which addresses all elements (people, property, economy, continuity of government) in order to rate each hazard consistently, and in a manner which addresses the functionality of each Planning Partner involved (e.g., municipality, fire district, public utility district, etc.). The use of the Calculated Priority Risk Index illustrated in Figure 4-1 allows such application, based on established criteria of application to determine the risk factor. For identification purposes, the six criteria on which the CPRI is based are probability, magnitude, geographic extent and location, warning time/speed of onset, and duration of the event. This is a slight modification from the last plan's risk assessment, in that this edition included the category "geographic extent and location," which is a new ranking criteria within the CPRI scoring for this 2020 update. The elements of the CPRI are further defined below.

CPRI Category	Degree of Risk: Impact/ Level ID	Degree of Risk: Description	Degree of Risk: Impact Factor	Assigned Weighting Factor
Probability	Unlikely	• Rare with no documented history of occurrences or events. • Annual probability of less than 1% (~100 years or more).	1	40%
	Possible	• Infrequent occurrences; at least one documented or anecdotal historic event. • Annual probability that is between 1% and 10% (~10 years or more).	2	
	Likely	• Frequent occurrences with at least two or more documented historic events. • Annual probability that is between 10% and 90% (~10 years or less).	3	
	Highly Likely	• Common events with a well-documented history of occurrence. • Annual probability of occurring. (1% chance or 100% 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	25%
	Limited	• People – Injuries or illness predominantly minor in nature and do not result in permanent disability; 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. 25% to 49% 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. >50% of the population impacted. • Property – Severe property damage >50% of critical facilities and non-critical facilities and infrastructure impacted. • Economy – Significant impact - loss of buildings /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	
Geographic Extent and Location	Limited	Less than 10% of area impacted.	1	20%
	Moderate	10%-24% of area impacted.	2	
	Significant	25%-49% of area impacted.	3	
	Extensive	50% or more of area impacted.	4	
Warning Time / Speed of Onset	<6 hours	Self-explanatory.	4	10%
	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	5%
	< 24 hours	Self-explanatory.	2	
	<1 week	Self-explanatory.	3	
	>1 week	Self-explanatory.	4	

Figure 4-1 Calculated Priority Risk Index (CPRI)

Probability

Probability of a hazard event occurring in the future was assessed based on hazard frequency over a 100-year period (where available). Hazard frequency was based on the number of times the hazard event occurred divided by the period of record. If the hazard lacked a definitive historical record, the probability was assessed qualitatively based on regional history and other contributing factors. Probability of occurrence was assigned a 40% weighting factor, and was broken down as follows:

Rating	Likelihood	Frequency of Occurrence
1	Unlikely	Less than 1% probability in the next 100 years.
2	Possible	Between 1% and 10% probability in the next year, or at least one chance in the next 100 years.
3	Likely	Between 10% and 100% probability in next year, or at least one chance in the next 10 years.
4	Highly Likely	Greater than 1 event per year (frequency greater than 1).

Magnitude

The magnitude of potential hazard events was evaluated for each hazard. Magnitude is a measure of the strength of a hazard event and is usually determined using technical measures specific to the hazard. Magnitude was calculated for each hazard where property damage data was available, and was assigned a 25% weighting factor. Magnitude calculation was determined using the following: *Property Damage / Number of Incidents) / $ of Building Stock Exposure = Magnitude.* In some cases, the Hazus model provided specific people/dollar impact data. For other hazards, a GIS exposure analysis was conducted. Magnitude was broken down as follows:

Rating	Magnitude	Percentage of People and Property Affected
1	Negligible	Less than 5% Very minor impact to people, property, economy, and continuity of government at 90%.
2	Limited	6% to 24% Injuries or illnesses minor in nature, with only slight property damage and minimal loss associated with economic impact; continuity of government only slightly impacted, with 80% functionality.
3	Critical	25% to 49% Injuries result in some permanent disability; 25-49% of population impacted; moderate property damage ; moderate impact to economy, with loss of revenue and facility impact; government at 50% operational capacity with service disruption more than one week, but less than a month.
4	Catastrophic	More than 50% Injuries and illness resulting in permanent disability and death to more than 50% of the population; severe property damage greater than 50%; economy significantly impacted as a result of loss of buildings, content, inventory; government significantly impacted; limited services provided, with disruption anticipated to last beyond one month.

Extent and Location

The measure of the percentage of the people and property within the planning area impacted by the event, and the extent (degree) to which they are impacted. Extent and location were assigned a weighting factor of 20%, and broken down as follows:

Rating	Magnitude	Percentage of People and Property Affected
1	Negligible	Less than 10% Few if any injuries or illness. Minor quality of life lost with little or no property damage. Brief interruption of essential facilities and services for less than four hours.
2	Limited	10% to 24% Minor injuries and illness. Minor, short term property damage that does not threaten structural stability. Shutdown of essential facilities and services for 4 to 24 hours.
3	Critical	25% to 49% Serious injury and illness. Major or long term property damage, that threatens structural stability. Shutdown of essential facilities and services for 24 to 72 hours.
4	Catastrophic	More than 50% Multiple deaths Property destroyed or damaged beyond repair Complete shutdown of essential facilities and services for 3 days or more.

Warning Time/Speed of Onset

The rate at which a hazard occurs, or the time provided in advance of a situation occurring (e.g., notice of a cold front approaching or a potential hurricane, etc.) provides the time necessary to prepare for such an event. Sudden-impact hazards with no advanced warning are of greater concern. Warning Time/Speed of onset was assigned a 10% weighting factor, and broken down as follows:

Rating	Probable amount of warning time
1	More than 24 hours warning time.
2	12-24 hours warning time.
3	5-12 hours warning time.
4	Minimal or no warning time.

Duration

The time span associated with an event was also considered, the concept being the longer an event occurs, the greater the threat or potential for injuries and damages. Duration was assigned a weighting factor of 5%, and was broken down as follows:

Rating	Duration of Event
1	6-24 hours
2	More than 24 hours
3	Less than 1 week
4	More than 1 week

Outputs from the above assessment were then scored in an Excel spreadsheet, the Hazard Ranking Worksheet (see Figure 4-2), which contained the weighting factors.

Hazard	Probability				Magnitude/Severity				Geographic Extent and Location				Warning Time				Duration				CPRI Score
	Unlikely / Low (1)	Possible / Medium (2)	Likely / High (3)	Highly Likely / Very High (4)	Negligible (1)	Limited (2)	Critical (3)	Catastrophic (4)	Negligible (1)	Limited (2)	Significant (3)	Extensive (4)	< 6 hours (4)	6 - 12 hours (3)	12 - 24 hours (2)	> 24 hours (1)	< 6 hours (1)	< 24 hours (2)	< 1 week (3)	> 1 week (4)	
Climate Change																					0.00
Drought																					0.00
Earthquake																					0.00
Erosion																					0.00
Flood																					0.00
Landslides																					0.00
Severe Weather																					0.00
Tsunami																					0.00
Volcano																					0.00
Wildfire																					0.00
Other Hazards of Concern																					0.00
																					0.00
																					0.00

Rank	Hazard	CPRI Score	Level
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			

Figure 4-2 Hazard Ranking Worksheet

Chapter 15 summarizes all of the analysis conducted by way of completion of the Calculated Priority Risk Index (CPRI) process as incorporated into the hazard ranking worksheet.

It should again be emphasized that each planning partner utilized the outputs from the risk assessment to compute their CPRI for their own respective jurisdiction, following the process identified. Such outputs included specific structure-impact data by way of an Excel Spreadsheet which identified impact or exposure to each critical facility identified. Because of the sensitivity of that list, it is not included within this document, but rather only the outputs are illustrated. General building stock data is contained within the base plan for each planning partner as that data is available.

4.2.4 Risk Assessment Tools - Hazus and GIS Applications

Earthquake and Flood Modeling Overview

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, with new models for estimating potential losses from hurricanes and floods.

Hazus 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 tribal or local government and can be used to manage and update a hazard mitigation plan throughout its implementation.

Levels of Detail for Evaluation

HAZUS 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 was used in the vulnerability analysis for the earthquake and flood analysis. Based on modifications of the data contained within the Hazus program, the County and its planning partners conducted a modified Level 2 analysis for the 2020 update. The Hazus version used for this plan was Hazus 4.2.

Building Inventory

For this plan a General Building Stock (GBS) approach was developed using best available Assessor's data as well as building inventory data developed and used in previous Island County planning efforts. Building and content replacement values were estimated using the latest information from the Island County Assessor's database. With use of the Assessor's data, it should be assumed that future development permitted at the time of this update is included in the analysis. A User Defined Facility approach was used to model exposure and vulnerability to critical infrastructure identified during the planning process. The critical facilities list was reviewed and updated by the planning partners at the beginning of the 2020 update process.

Hazus Application for This Plan

The following methods were used to assess specific hazards for this plan:

Flood—A Hazus Level 2 analysis was performed. Analysis was based on current FEMA regulatory 100- and 500-year flood hazard data. The 2017 Island County FIRM was utilized for this analysis.

Earthquake—A Hazus Level 2 analysis was performed to assess earthquake risk and exposure. Earthquake shake map data prepared by the U.S. Geological Survey (USGS) were used for the analysis of this hazard. A modified version of the National Earthquake Hazard Reduction Program (NEHRP) soils inventory was used. Two scenario event were modeled:

– The scenario events used were the South Whidbey Fault (middle) M7.5 Earthquake Event and the Cascadia Subduction Zone M9.3 Earthquake Event.

Tsunami - The 2020 plan piggybacked the previous 2015 analysis which used a Level 2 Hazus flood protocol 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 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.

Drought, Landslide, Severe Weather, Volcano, and Wildfire

For drought, landslide, severe weather and wildfire, historical data is not adequate to model future losses as no specific damage functions have been developed. However, GIS is able to map hazard areas and calculate exposure if geographic information is available with respect to the location of the hazard and inventory data. Areas and inventory susceptible to some of the hazards of concern were mapped and exposure was evaluated. For other hazards, a qualitative analysis was conducted using the best available data and professional judgment. Locally relevant information was gathered from a variety of sources. Frequency and severity indicators include past events and the expert opinions of geologists, tribal staff, emergency management personnel and others. The primary data source was Tribal staff, including various GIS data sets, augmented with county, state, and federal datasets. Additional data sources for specific hazards were as follows:

Drought—The risk assessment methodologies used for this plan focus on damage to structures. Because drought does not impact structures, the risk assessment for drought was more limited and qualitative than the assessment for the other hazards of concern. The impact from drought also references fish loss associated with the negative impact of climate change on water levels, and sedimentation issues resulting from drought situations.

Landslide—Unstable slopes hazard data was used to assess exposure to landslides. This data depicts unstable slopes and included historic and recent slide locations. Steep slope hazards were also assessed utilizing 2014 Lidar elevation data identifying slope susceptibility at anything greater than 40 percent slope, a 100’ buffer was used to identify potential critical facilities falling within these potential landslide hazard areas. It should be noted that *this data is for mitigation planning purposes only, and should not be considered for life safety matters.* No landslide hazard analysis was conducted, but rather, only reprojection of existing data.

Severe Weather—Severe weather data was downloaded from various sources, including the Natural Resources Conservation Service and the National Climatic Data Center, PRISM, Tornado Project, and other sources as referenced. 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.

Volcano – 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 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.

Wildfire— 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 value of exposed structures identified utilizing the various LANDFIRE Fire Regime (1-5) datasets. Information on wildfire analysis was captured from various sources, including Washington State Department of Natural Resources, Wildfire Protection data,, US Forest Service data, LAND FIRE data, and Wildland Urban Interface Zone data, among other sources as available for the tribal planning area.

4.3 COMMUNITY VARIATIONS TO THE RISK ASSESSMENT

Each planning partner within their respective annex describes where or how their risk varies from what is described in the hazard profiles and risk ranking. Variations are documented in the risk assessment section in their annex to the plan, if appropriate. In some instances, planning partners elected to include additional hazards of concern which impact their planning area, or elected to not rate a hazard if they felt it was not applicable to their jurisdiction. In some instances, declared disaster events may not have impacted a specific jurisdiction or entity. Similarly, there may have been incidents of significance which did not rise to a level of a disaster declaration, but were nonetheless significant to the jurisdiction or entity. As such, those differences are noted where applicable.

4.4 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. The results from this risk assessment should not be utilized to determine life-safety measures, as such determination would need much more scientific, in-depth, and extensive details than required for the purposes of mitigation planning.

Concurrent with the 2015 planning process, FEMA was updating flood maps and Hazus data for the County. That project was completed in 2017 (see FEMA RiskMap Report). As a result of that project, FEMA updated the general building stock and User Defined Facility data based on the County's Assessor's data, which ultimately was loaded into Hazus. The exact method that FEMA used to collect the information and conduct its risk assessment is contained within the 2017 Risk Report and Flood Insurance Study, available directly from FEMA and the County Floodplain Manager. For the 2020 update, the previous data was enhanced with current values, as well as new buildings added.

Where data remained missing, 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 data captured during this risk assessment. For structures for which data was not provided, the missing information was determined using averages of similar types of structures, square footage, structure type, etc. at the general building stock aggregate level. This process 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

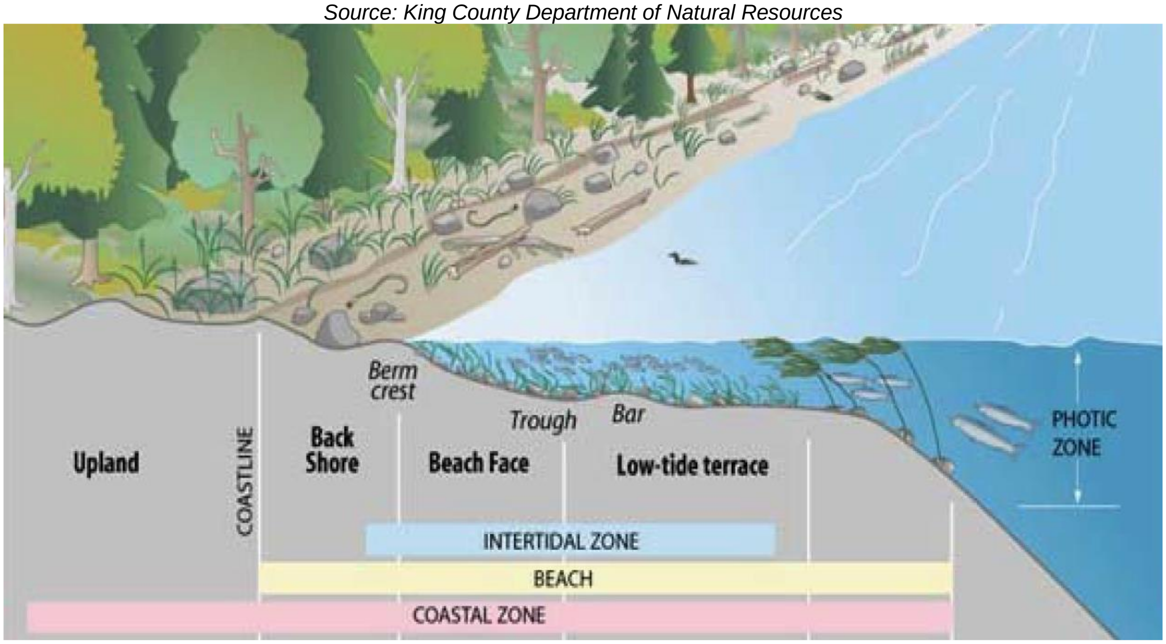


Figure 5-1. Accreting Beach Pre-Development

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. Island County Feeder Bluff designated areas are identified in Figure 5-2.

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.

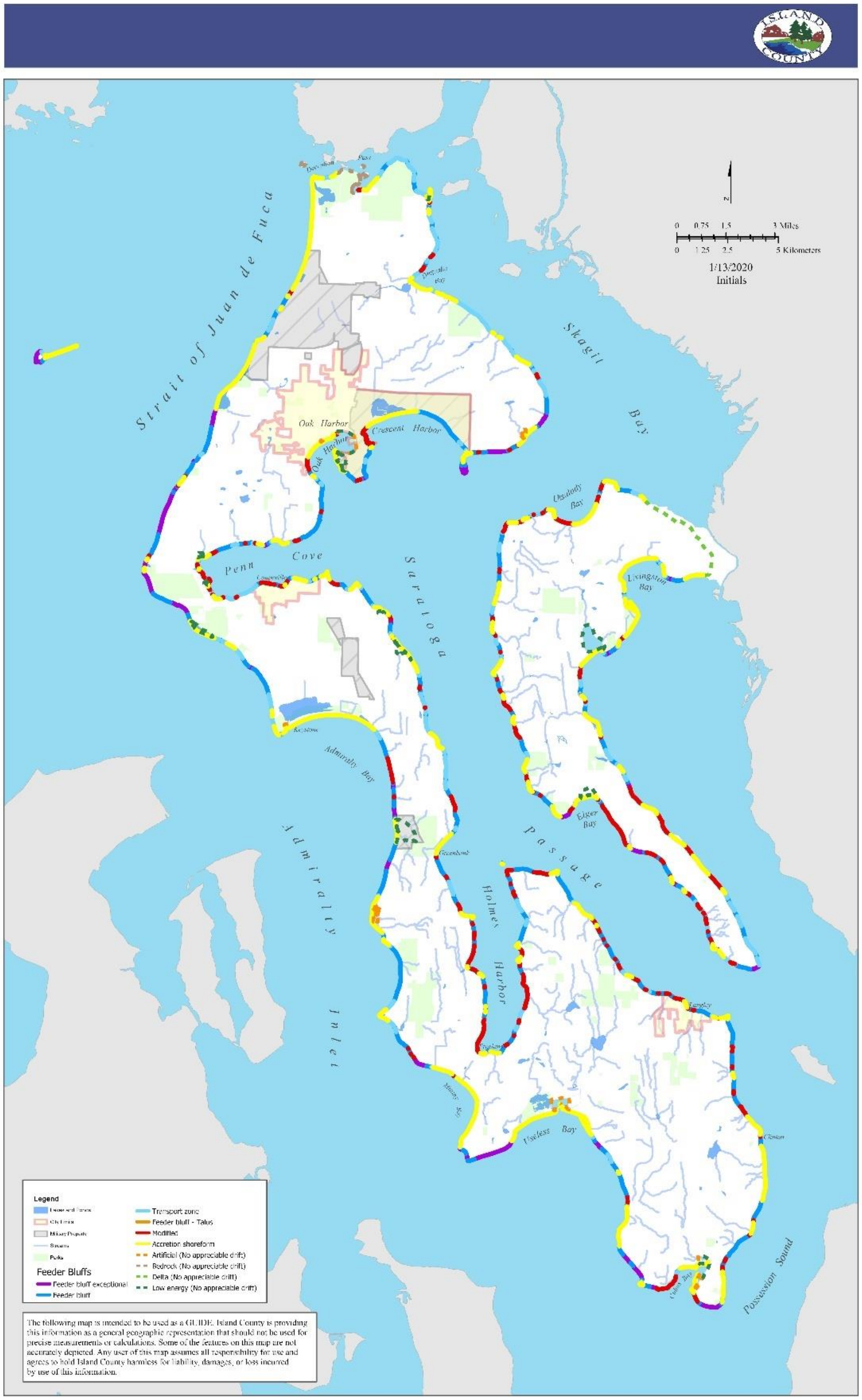


Figure 5-2 Island County Feeder Bluffs

5.2.1 Extent and Location

Areas identified for potential erosion may also coincide with the identification of landslide susceptibility areas based on the County's definition of potential landslide hazards areas within its Critical Areas Ordinance. As such, readers should also review the Landslide profile. At present, most of the county's coastlines are designated Residential. Figure 5-3 identifies the shoreline designations for all of Island County. Figure 5-4 further identifies slopes with degradation of nearshore reaches of coastline as identified by Schlenger, et al. (2010).

Areas of 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).

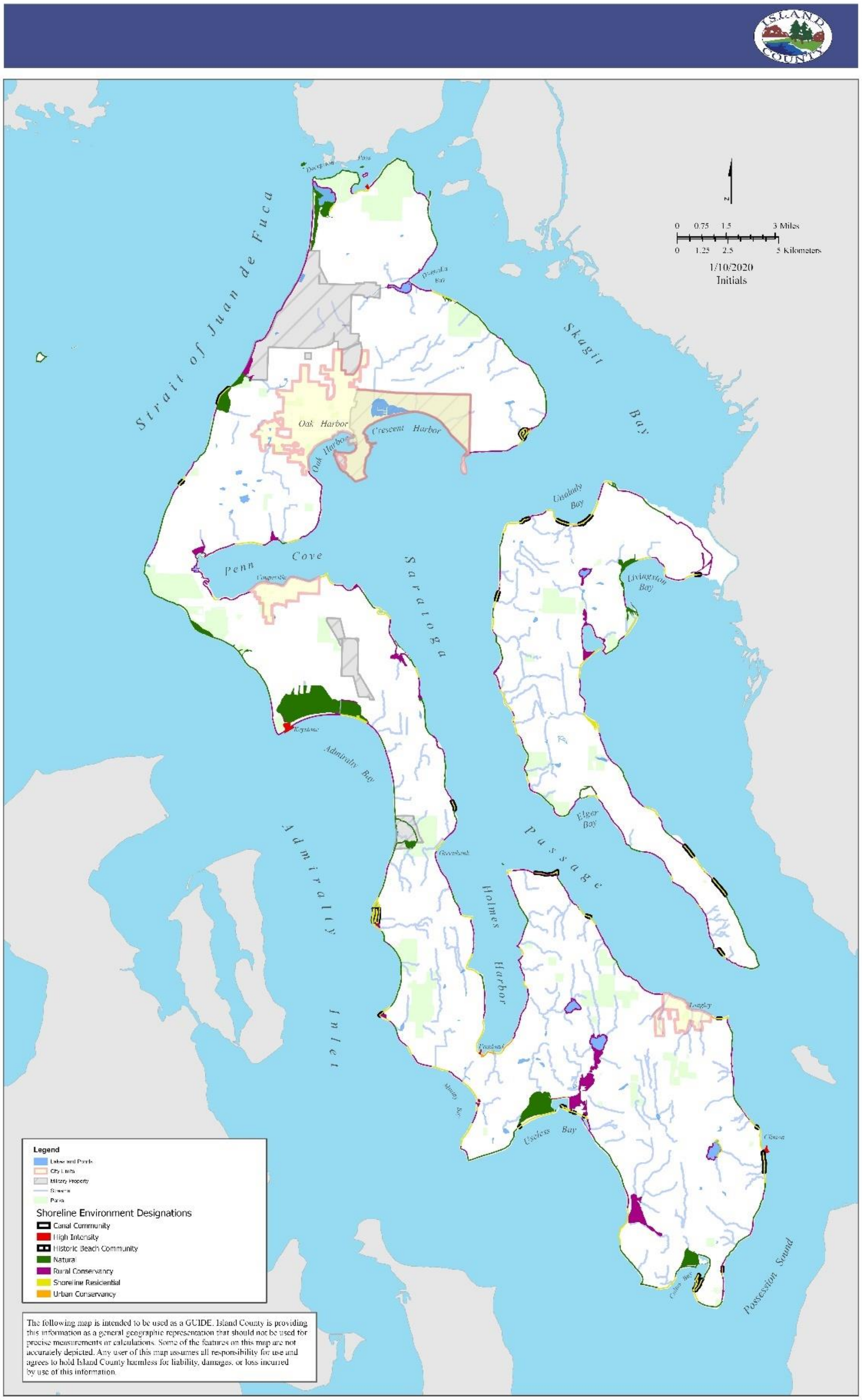


Figure 5-3. Island County Shoreline Designations

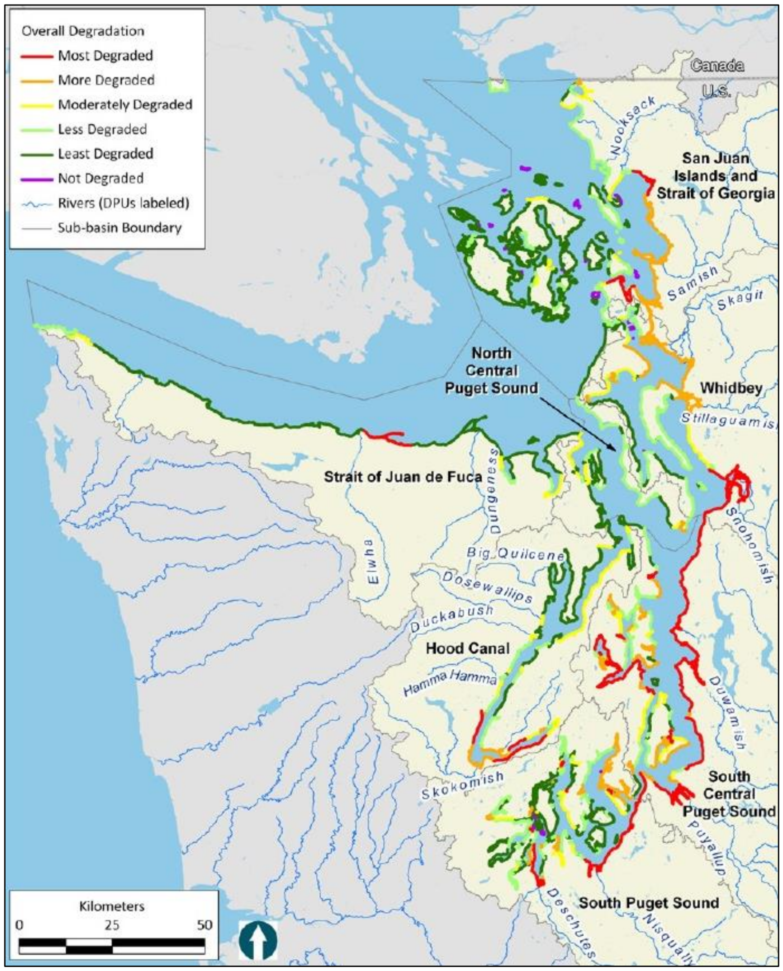


Figure 5-4. Relative Degradation of Strait of Juan de Fuca Nearshore Reach

Source: Island County, 2015b

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. In 2015, during the update of the previous plan, one house was washed away as a result of a storm surge and the cumulative impacts of previous coastal erosion. In January 2016, Coupeville experienced a fissure which opened as a result continued erosion. That fissure prompted Coupeville officials to shut down sidewalks and limit truck traffic in the area. According to a KOMO News broadcast (2016), geotechnical experts estimated that the bluff on which the fissure developed is "losing about two inches a year, which adds up to about eight feet over the next 50 years" (see Figure 5-5). To mitigate the issue, the Town installed pylons to help reduce impact.

Additional previous impacts include the coastline near residential structures where erosion has caused much of the landscape to be washed away and mitigation efforts have been implemented in an attempt to protect residences (see Figure 5-6).

Figure 5-5 Coupeville Erosion (2016)
Source: H. Shipman, WA Dept. of Ecology

Figure 5-6. 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.

Island County is home to over 200 miles of shoreline around Whidbey and Camano Island along with seven other small islands. Increases in sea level can make coastlines more vulnerable to the impacts of flooding, storm surges, tsunamis, and extreme astronomic tide. While tsunamis are rare in Washington, flooding from storm surges and extreme tides are issues that many residents are already experiencing. (Climate Central, 2016)

For Island County, measurable near-term sea level rise is possible, with a 5% chance of sea level change more than 0.5 feet by 2030. By 2100 there is a strong likelihood (50% probability) of sea level rise greater than 2 feet, and extreme projections far exceed that (e.g. a 1% chance of sea level rise of about 5 feet by 2100, and a 0.1% change of sea level rise of ~8 feet by 2100). (Miller, 2016).

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, 2019), Island County can expect water levels to rise from 2 to 9 inches (depending on modeling methodology). As part of the 2017 Flood Insurance Study and associated Risk Report, FEMA identified potential areas of impact from sea level rise at varying degrees based on the 100-year flood zone, with incremental increases to illustrate potential areas of increased inundation. Figure 5-7 identifies FEMA's data, illustrating the +1, 2 and 3 feet potential increased sea level rise. As sea levels continue to rise, more area is susceptible to potential erosion, or in some cases, accretion. Sea level rise is also discussed within the flood hazard profile of this document.

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.

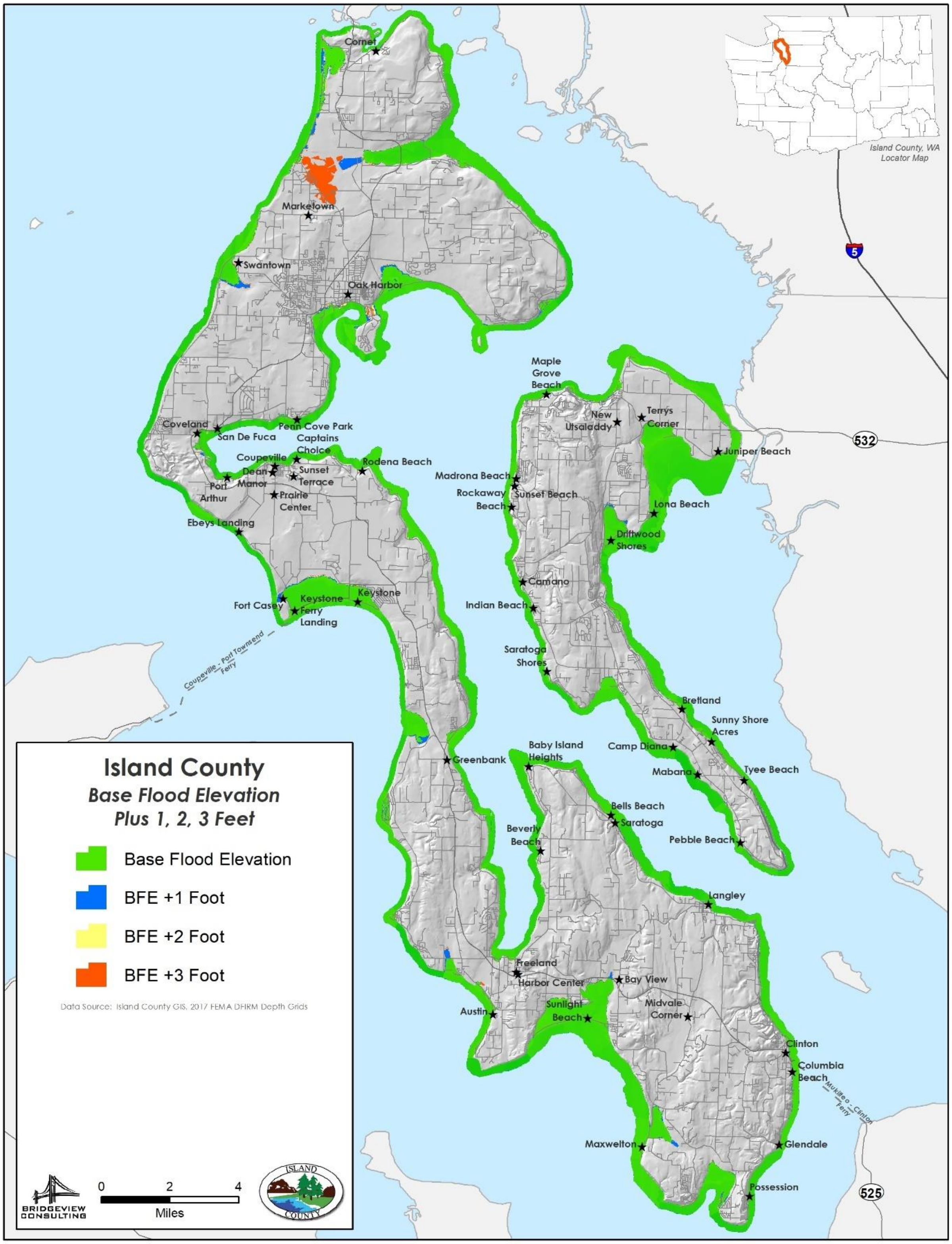


Figure 5-7 FEMA Defined Base Flood Evelevation and Increased Potential Sea Level Risk

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.

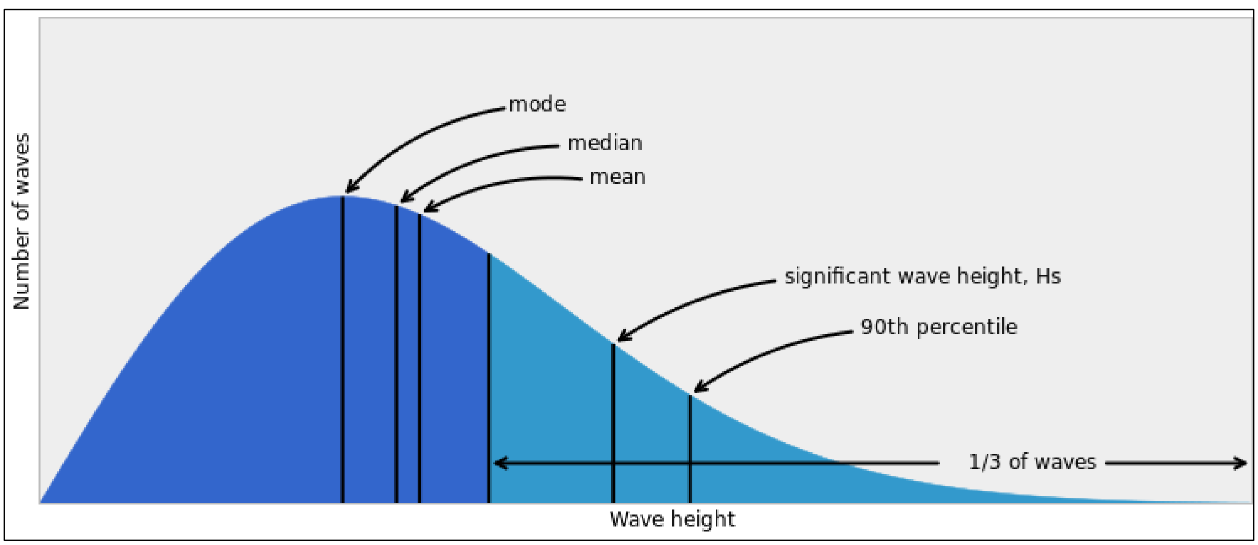


Figure 5-8. Statistical Wave Distribution

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.

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 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 5-7 (above) identifies potential seal level rise in the Puget Sound region as identified by FEMA's 2017 Risk Report, which was completed in conjunction with the updated flood insurance maps.

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 or high wave action. 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.

The erosion rates on Whidbey Island, the most populated island of Island County, is estimated to be 1.2 inches per year, which suggests the loss of one meter of bluff or bank every 33 years (Zelo et al 2000). High waves have been a major cause of increased erosion on Whidbey Island, particularly on the southeastern parts of the island and on large spits on Cultus Bay (Johannessen and MacLennan, 2007). Risk analysis conducted by Barton and Frink (2007) using Zillow suggests that along West Beach Road on northwest Whidbey Island approximately $32 million worth of property could be at risk due to increased bluff erosion and landslides with increasing sea level rise (Washington State Hazard Mitigation Plan, 2018).

5.3.4 Impact on Critical Facilities and Infrastructure

The County and its planning partners have limited critical facilities in the area subject to coastal erosion. Incapacity and loss of roads are the primary transportation failures resulting from coastal erosion that has previously been experienced. 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. As in the case of Coupeville, erosion has impacted areas of its downtown historic area as well. The City has taken proactive measures to help reduce the impact, including installing pylons to reduce wave action. The flood and landslide profiles presented in later chapters of this hazard mitigation plan should also be reviewed for additional 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. For example, the loss or impact to Coupeville's economic hub in the historic district, which has a higher-than average number of tourists annually, would significantly impact not only the Town of Coupeville, but surrounding communities as well.

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.

Washington State Ferry (WSF) terminal assets are also located in areas that are vulnerable to erosion, as well as abrupt seismic events and emerging risks related to sea-level rise and increasing intensity of storms.

Current closures due to low tides may not occur with higher sea levels as climate change continues to expand its impacts; however, erosion in those terminal areas will also increase as sea levels encroach further inland, impacting supporting structures. Currently, when terminals close now due to severe weather, vessels and users are rerouted to other terminals. Should long-term impact occur as a result of erosion, such re-routing would have an economic impact in the County. In addition, the Eagle Harbor ferry maintenance facility is located near sea level. If this facility is impacted or inundated permanently, other options would need to be explored. The WSF 2040 Long-Range plan currently prioritizes terminal maintenance needs with the most seismic risk and vulnerability to sea level rise, among other factors. (DOT, 2019)

As shorelines erode, the potential exists for wave action, tides, storm surges, and rivers to carry more debris and sediment into Puget Sound as a whole. This would have the potential to also increase operational expenses in order to remove debris that could damage ferries, docks, or boats, among other things. Large waves that come over decks can move cars, and ferry elevators do not work if vessels are rocked by large waves. With larger waves and more extreme storms, this risk for erosion to occur increases. With 4-foot and 6-foot sea levels, power lines to docks may also be impacted.

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 coastal areas have 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 have the potential to increase in number as sea level rise and costal erosion continues; however, regulatory is currently in place to reduce new construction in these high hazard areas to help ensure limited impact.

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.

5.7 IMPACT AND RESULTS

Based on historical evidence and events, the planning team determined that the probability for future issues associated with coastal erosion is high. The continued influence from climate change will only increase the vulnerability to this hazard. While limited critical infrastructure is at risk, residential dwellings and roadways do exist in areas highly susceptible to erosion. As such, the planning team determined the overall CPRI Score to be 2.15 with an overall ranking of medium.

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.
- 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.

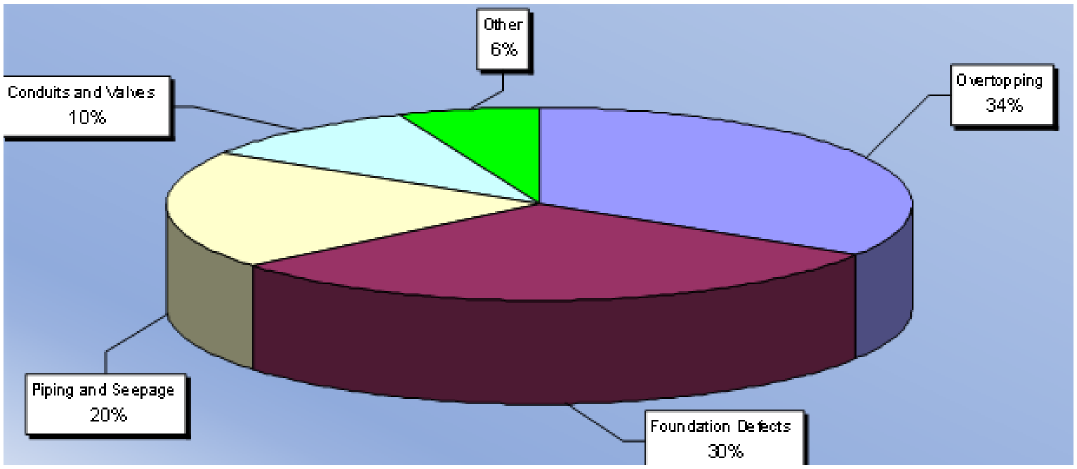


Figure 6-1. Historical Causes of Dam Failure

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 (USACE).

Federal Energy Regulatory Commission Dam Safety Program

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. (FERC)

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 the majority of all 1233 identified dams across the state (2019). High hazard dam inspections occur, on average, on a 6-year cycle and significant hazard dam inspections will occur on a 12-year cycle.

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 approximately eight dams constructed pre-1900, to more than 28 dams completed since 2010. 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 Table 6-1 (2019).[4] 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).

[4] https://fortress.wa.gov/ecy/publications/documents/94016.pdf

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 the Holmes Harbor Reclaimed Water Ponds all 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.

TABLE 6-1.
DAMS IN ISLAND COUNTY

Name	National ID #	Water Course	Owner	Year Built	Dam Type[a]	Crest Length (feet)	Height (feet)	Surface Area (acres)	Drainage area (sq. mi.)	Hazard Class[b]
Dahlman Dam	WA01158	Mutiny Bay	Tinyblue Foundation	1971	RE	265	12	8.0	.02	3
Holmes Harbor Reclaimed Water Ponds	WA01952	Offstream	Holmes Harbor Reclaimed Water Ponds	1994	RE	2200	50	3.8	.01	1C
Honeymoon Lake Dame	WA00203	Honeymoon Bay	Honeymoon Lake Community Club	1969	RE	380	22	7.0	1.84	2D
Kristofferson Lake Dam	WA00138	Triangle Cove	Kristofferson Farm, LLC	1961	RE	150	7	53.0	1.12	3
Loers Dam	WA00157	Puget Sound	Whidbey Golf & Country Club	1958	RE	1500	9	10.0	2.5	3
Minckler Dam A	WA01884	Crescent Harbor	Sherwood Minckler	1975	RE	200	9	1.6	.04	1C
Minckler Dam B	WA00691	Crescent Harbor	Sherwood Minckler	1975	RE	500	18	3.0	.01	1C
Oak Harbor Wastewater Lagoon – NE Cell	WA00596	Crescent Harbor – Offstream	Oak Harbor City	1990	RE	1550	8	5.9	.01	3
Oak Harbor Wastewater Lagoon – NW Cell	WA00595	Crescent Harbor – Offstream	Oak Harbor City	1990	RE	2700	8	8.2	.01	3
Oak Harbor Wastewater Lagoon – SE Cell	WA01673	Crescent Harbor – Offstream	Oak Harbor City	1990	RE	1490	8	3.0	.01	3
Oak Harbor Wastewater Lagoon – SE Cell	WA00597	Crescent Harbor – Offstream	Oak Harbor City	1990	RE	2550	8	8.2	.01	3
Raden Dam	WA01138	Mutiny Bay	Paul Raden Trust	1968	RE	365	14	15.0	.61	3
Smith Lake Dam Island Co	WA01575	Triangle Cove	Cominco American Inc	1970	RE	180	9	17.0	0.0	3

a. RE = Earth Fill

6.2.2 Previous Occurrences

According to the Washington State Enhanced Hazard Mitigation Plan (2018), Washington State Department of Ecology has reported 19 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. Washington State’s 2018 Hazard Mitigation Plan states that since 1970, “there has been, on average, a dam failure about every three years” (p. 97).

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, 2019

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.

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, 2019).

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 24 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 (2018 Census data). 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 may be used to conduct analysis during future updates of the plan. As the 2020 edition of the plan update does again 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. 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.

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 municipalities. The buildable lands analysis assumes that these regulations will discourage development from these areas, helping to reduce potential increased vulnerability resulting from land use development trends. Information contained in this HMP development will continue to be utilized during the Comprehensive Plan updates 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.

6.7 IMPACT AND RESULTS

There have been no previous occurrences of dam failure within the County. While the County has 13 dams within its boundaries, there is limited critical infrastructure at risk should a dam be impacted. Inundation maps are not available for use in this analysis, and as such, the County and its planning partners will continue to work with the dam owners to ensure public safety. Due to the lack of inundation maps, the flood profile was also utilized to help in determining vulnerability to the hazard. Based on review of the existing data in place, the planning team determined that the probability of a dam breach occurring is low, with limited impact expected. As such, the CPRI score was 1.7, with an overall low ranking.

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.

> **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.

There are five generally accepted operational definitions of drought: (Drought, 2019)

- **Meteorological drought** is an expression of precipitation's departure from normal over some period of time. Meteorological measurements are the first indicators of drought. Definitions are usually region-specific, and based on an understanding of regional climatology. A definition of drought developed in one part of the world may not apply to another, given the wide range of meteorological definitions.
- **Agricultural drought** occurs when there is not enough soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought happens after meteorological drought but before hydrological drought. Agriculture is usually the first economic sector to be affected by drought.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow and as lake, reservoir, and groundwater levels. There is a time lag between lack of rain and less water in streams, rivers, lakes and reservoirs, so hydrological measurements are not the earliest indicators of drought. After precipitation has been reduced or deficient over an extended period of time, this shortage is reflected in declining surface and subsurface water levels. Water supply is controlled not only by precipitation, but also by other factors, including evaporation (which is increased by higher than normal heat and winds), transpiration (the use of water by plants), and human use.
- **Socioeconomic drought** occurs when a physical water shortage starts to affect people, individually and collectively. Most socioeconomic definitions of drought associate it with the supply and demand of an economic good.
- **Ecological drought** is a recent concept defined as a "prolonged and widespread deficit in naturally available water supplies including changes in natural and managed hydrology that create multiple stresses across ecosystems." Ecological drought's impacts are then transferred to human communities via ecosystem services.

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:

- 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.

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. Reduced water levels in wells also means that the wells are subject to saltwater intrusion.

The area's drinking water comes from the local watersheds provided to homeowners by public utility districts and water from privately-owned wells. Drought conditions within the planning area may increase pressure on local aquifers, with increased pumping potentially resulting in saltwater intrusion into freshwater aquifers. This, in turn, could cause restrictions on economic growth and development, impacting the economy of 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 7-12 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.

TABLE 7-1 DROUGHT OCCURRENCES	
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. The 1977 drought led to widespread water shortages and severe water conservation measures throughout Washington. More than 70 public and private drinking-water operations reported water-supply problems. Wheat and cattle were the most seriously affected agricultural products in the state. The Federal Power Commission ordered public utilities on the Columbia River to release water to help fish survive. Agriculture experienced drought-related losses of more than $400 million.
2001	Governor declared statewide Stage 2 drought in response to severe dry spell.
June – September 2003	Federal disaster number 1499 assigned to 15 counties. The original disaster was for flooding, but several jurisdictions were included because of previous drought conditions. The 2001 drought came on fairly rapidly. Between November 2000 and March 2001, most of the state's rainfall and snowpack totals were only about 60 percent of normal. The 2001 event was a result of warm weather melting snowpack into streams a month earlier than normal. Nine large utility companies statewide advised the Washington State Department of Health that they were highly vulnerable to the drought. Washington declared a statewide drought emergency on March 14, 2001. As a result of the 2001 drought, 90,000 acres of agricultural land were taken out of production; thousands of acres of orchards were unused, and the sugar beet industry was out of production.
March 10, 2005 Governor Declared Drought	Precipitation levels was below or much below the average from November through February, with extremely warm fall and winter months, adversely affecting the state's mountain snowpack. A warm mid-January removed much of the remaining snowpack, with March projections at 66 percent of normal, indicating that Washington might be facing a drought as bad as, or worse, than the 1977 drought. Late March rains filled reservoirs to about 95 percent. State legislature approved $12 million supplemental budget that provided funds to buy water, improve wells, and implement other emergency water supply projects. Wildfires numbers was about 75 percent of previous five years, but acreage burned was three times greater.
2015	2015 was the year of the "snowpack drought." Washington State had normal or near-normal precipitation over the 2014-2015 winter season. However, October through March the average statewide temperature was 40.5 degrees Fahrenheit, 4.7 degrees above the 20th century long-term average and ranking as the warmest October through March on record. Washington experienced record low snowpack because mountain precipitation that normally fell as snow instead fell as rain. The snowpack deficit then was compounded as precipitation began to lag behind normal levels in early spring and into the summer. With record spring and summer temperatures, and little to no precipitation over many parts of the state, the snowpack drought morphed into a traditional precipitation drought, causing injury to crops and aquatic species. Many rivers and streams experienced record low flows. (See Figure 7-1.)

TABLE 7-1 DROUGHT OCCURRENCES	
2019	As of May 20, 2019, Governor Jay Inslee issued an emergency drought declaration in 24 watersheds statewide (see Figure 7-2). According to the Washington State Department of Ecology, very dry conditions over the past several months and a diminished snowpack impacted streamflow, which were identified to be well below normal conditions across most of the state (see Figure 7-3).[5] Watersheds west of the Cascades crest, which are more rain dependent than rivers on the east side, flowed at much below normal levels. Some rivers set record daily lows for historic May flows. Statewide, at the time the declaration was ordered, only four (4) percent of rivers were flowing at levels above normal. Streamflows were strong in the southeast corner of the state. Twenty-seven out of 62 watersheds were declared for drought as of May 20, 2019. Skagit County and several of its watersheds were among the Counties identified as having a drought emergency. On August 29, 2019, the USDA designated Skagit County as one of the four areas identified as sustaining a natural disaster due to the drought.

[5] Source: https://waterwatch.usgs.gov/?m=real&r=wa

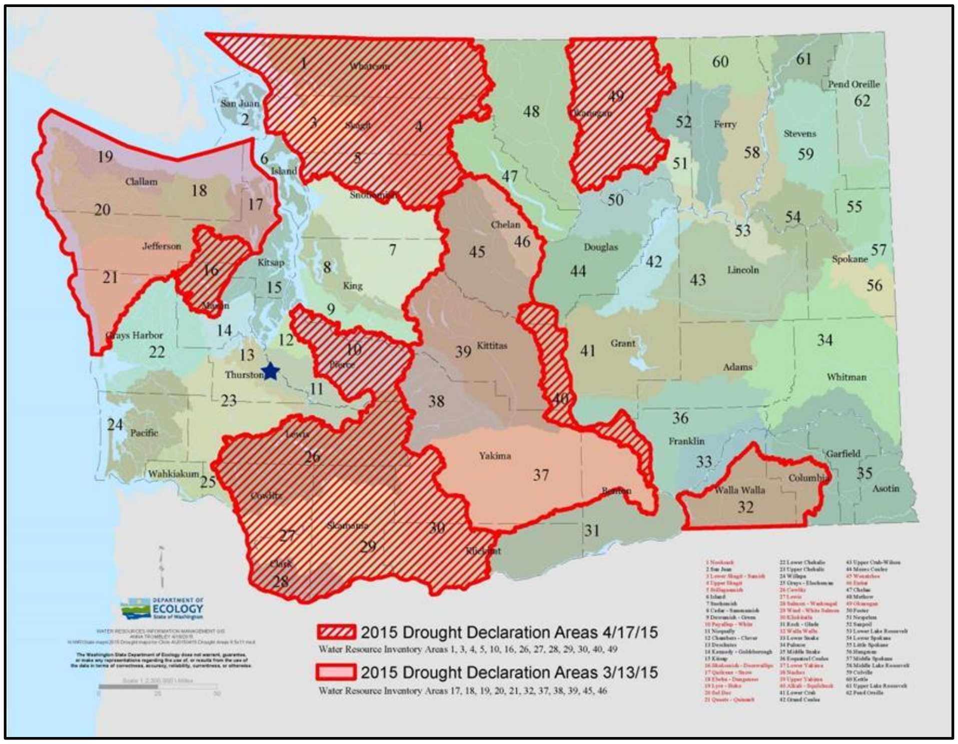


Figure 7-1 Washington State Department of Ecology 2015 Drought Map

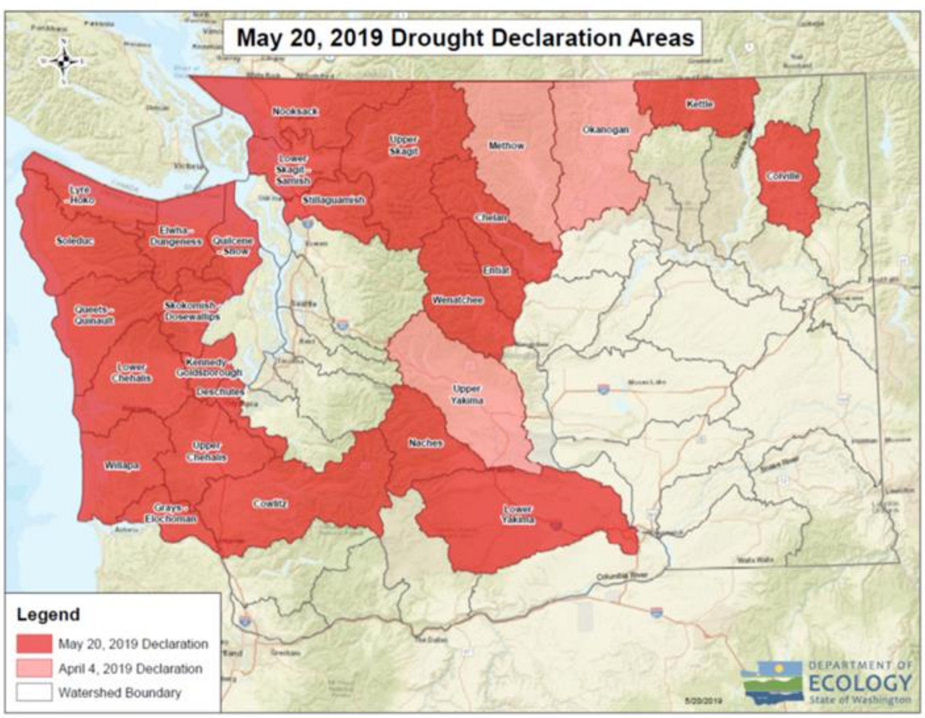


Figure 7-2 Washington State Department of Ecology May 2019 Drought Declaration Areas

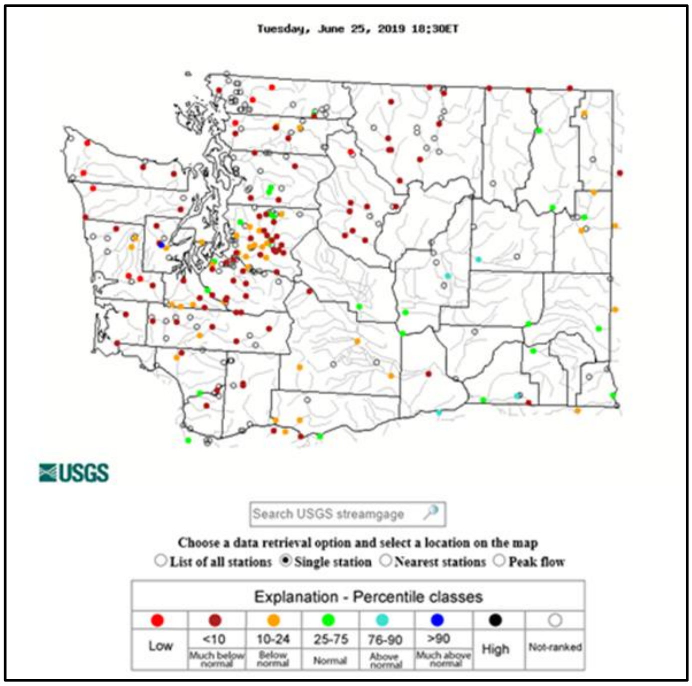


Figure 7-3. USGS Streamflow Comparison for Day of Year

TABLE 7-1. 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.

**TABLE 7-1.
COMPARISON OF IMPACTS OF 1977 DROUGHT TO 2001 DROUGHT**

Impact	1977 Drought	2001 Drought
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.

- In March 2015, the Governor declared a statewide drought which originally started in March 2015 for three regions of the State – the Olympic Peninsula, the east slopes of the central Cascades, and the Walla Walla Basin. The drought was characterized by extended precipitation defects, and was identified as the "snowpack drought", when the October through March statewide average temperature was higher than long-term averages, ranking the warmest October through March on record. As a result, mountain precipitation normally falling as snow fell as rain instead. With lower levels of precipitation in the early spring and summer months, with record-breaking temperatures, what was originally dubbed the "snowpack drought" morphed into a traditional drought, impact crops, aquatic species and low water levels in the watersheds.
- Unlike classic droughts, characterized by extended precipitation deficits, 2015 was the year of the "snowpack drought." Washington State had normal or near-normal precipitation over the 2014-2015 winter season. However, October through March the average statewide temperature was 40.5 degrees Fahrenheit, 4.7 degrees above the 20th century long-term average and ranking as the warmest October through March on record. Washington experienced record low snowpack because mountain precipitation that normally fell as snow instead fell as rain. The snowpack deficit then was compounded as precipitation began to lag behind normal levels in early spring and into the summer. With record spring and summer temperatures, and little to no precipitation over many parts of the state, the snowpack drought morphed into a traditional precipitation drought, causing injury to crops and aquatic species. Many rivers and streams experienced record low flows. The Governor declared drought on March 13, 2015, for three regions of the state—the Olympic Peninsula, the east slopes of the central Cascades and the Walla Walla Basin. The state-level drought declaration was extended on April 17, 2015, to include more watersheds, and then was extended statewide on May 15, 2015. In May, the Water Supply Availability and Emergency Water Executive committees determined that 48 of the 62 watersheds had water supply conditions below 75 percent of normal, an area representing 85 percent of the state's geographic area (see Figure 7-1 above).
- Snowpack in Washington tends to peak around early April. In April 2019, statewide snowpack measured about 80 percent of normal on April 1 — lower than in 2016, 2017 and 2018 — but significantly higher than in 2015, when April snowpack averaged less than 25 percent of normal statewide. As a result, in April 4, 2019, Washington State declared a drought in which 23 counties, or part of them, are designated as having a drought emergency with the drought declaration expiring on April 4, 2020. The declaration also included 27 Water Resource Inventory Areas (WRIAs) as having a drought emergency. Island County and its WRIAs were not listed but federal water supply forecasters predicted lower available water supplies this summer in all areas except the southern part of the state. (see Figure 7-2 above).

Approximately 80% of Washington water withdrawals are for agricultural purposes. Water for Washington agriculture comes from two main sources: surface water and groundwater. Surface water is the largest source, accounting for approximately 75% of agricultural water needs on average (WSU, 2015).

Irrigation use for agriculture varies across the island and seasonally, depending on soil water holding capacity and rainfall rates during the growing season. Based on crop surveys conducted every two years for the Washington Department of Agriculture (WSDA), approximately 1,300 acres of crop, hay, and pasture lands are irrigated for some part of the growing season. (Drought Conservation Planning).

Climate change will bring both positive and negative impacts to agriculture in the Puget Sound region. Puget Sound's agricultural systems are expected to adapt to these changes.

Positive impacts may include:

- Lengthening of the growing season due to increased temperatures, allowing opportunities to diversify into crops requiring more heat units for optimum growth.
- Where adequate irrigation water is available, increasing temperatures may result in higher yields of many crops.

Negative impacts may include:

- Declines in production where summer precipitation decreases and supplemental irrigation water is not available.
- Decreased availability of irrigation water for land that has been historically been irrigated, resulting in reduced crop yields.
- Increased flooding on low lying agricultural ground delaying and, in some cases, preventing planting.
- Changing risks from pests and plant diseases.
- Damage to agricultural infrastructure due to flooding affecting crops and livestock.
- Heat stress to meat and milk producing livestock.

The impact of climate change to agriculture will vary, leaving some locations, crops and livestock more influenced than others.

The use of irrigation for agriculture production is varied and sporadic across Whidbey Island. The usually wet springs often supply soils with water sufficient for plant production for the spring and, depending on soil types, into the first half of the summer. Many crops, hayfields, and pastures are managed without supplemental irrigation, although approximately 1,300 acres are known to be irrigated at some point of the year (USDA).

Livestock production is also quite varied on Whidbey Island. In general, livestock operations are relatively small, with few farms running more than 50 large animals.

Water for irrigation and livestock is primarily sourced from groundwater, although there is some use of water captured in constructed ponds. Managing soil health and irrigation efficiencies are two of many important tools for agriculture producers to mitigate drought conditions and minimize impacts to groundwater aquifers.

Agriculture is a constantly developing industry, with changes in cropping systems and commodities grown driven by external pressures like increasing temperatures, water uncertainty, market prices, new technology, and available growing space. This changing landscape also makes it more difficult to quantify the impacts of drought. (Drought and Agriculture).

For alfalfa and field corn, two specific field crops impacted by the drought, the estimate of impacts was calculated by assessing the drop in acreage planted/harvested in 2015 as compared to the 5-year average. This was an important distinction from other commodities. Washington has very consistent acreage for these two crops to support livestock agriculture, and harvested acres were significantly reduced in 2015 (Prest, 2016).

The impacts from the 2015 drought were not limited to certain crops, or certain regions, or even certain times of the year. Negatively affected farmers felt a variety of effects, including yield or quality reduction. Many of these impacts were not quantifiable in the scope of this report.

Drought effects were widespread and will be ongoing. Drought damaged permanent crops will take time to recover fully, if they ever do recover fully. Changes that growers made to crop rotations and plantings choices will take time to normalize. We will not truly know the impact of this drought for 2 - 4 years, and that is only if another drought does not occur during this time. If climate and weather changes like those seen in 2015 become more regular some farming operations will struggle to stay solvent despite technological innovation and new practices.

7.2.3 Severity

In 1989, the Washington State Legislature gave permanent drought relief authority to the Department of Ecology and enabled them to issue orders declaring drought emergencies. (RCW 43.83B.400-430 and Chapter 173-166 WAC). In Washington State, the statutory criteria for drought is a water supply below 75% of normal and a shortage expected to create undue hardship for some water users.

Droughts impact individuals (farm owners, tenants, and farm laborers), the agricultural industry, and other agriculture-related sectors. Lack of snowpack 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 health of forests is also a concern with respect to infestation associated with weakened trees due to drought.

Nearly all areas of Washington are vulnerable to drought. The coastal areas of Washington, the Olympic Peninsula, and areas in Central Washington just east of the Cascades are particularly vulnerable. High quality agricultural soils exist in Skagit County. These areas of the county sustain crops that are dependent upon moisture through the winter and spring and dryer conditions in the summer.

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 Palmer Drought Severity Index (PDSI) and Crop Moisture Index (CMI) are indices of the relative dryness or wetness effecting water sensitive economies. The PDSI indicates the prolonged and abnormal moisture deficiency or excess. The CMI gives the short-term or current status of purely agricultural drought or moisture surplus and can change rapidly from week to week. Both indices indicate general conditions and not local variations caused by isolated rain. Input to the calculations include the weekly precipitation total and average temperature, division constants (water capacity of the soil, etc.) and previous history of the indices.

The PDSI is an important climatological tool for evaluating the scope, severity, and frequency of prolonged periods of abnormally dry or wet weather. It can be used to help delineate disaster areas and indicate the availability of irrigation water supplies, reservoir levels, range conditions, amount of stock water, and potential intensity of forest fires. The CMI can be used to measure the status of dryness or wetness affecting warm season crops and field activities.

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 7-4 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 7-4 shows this index for October 2019.

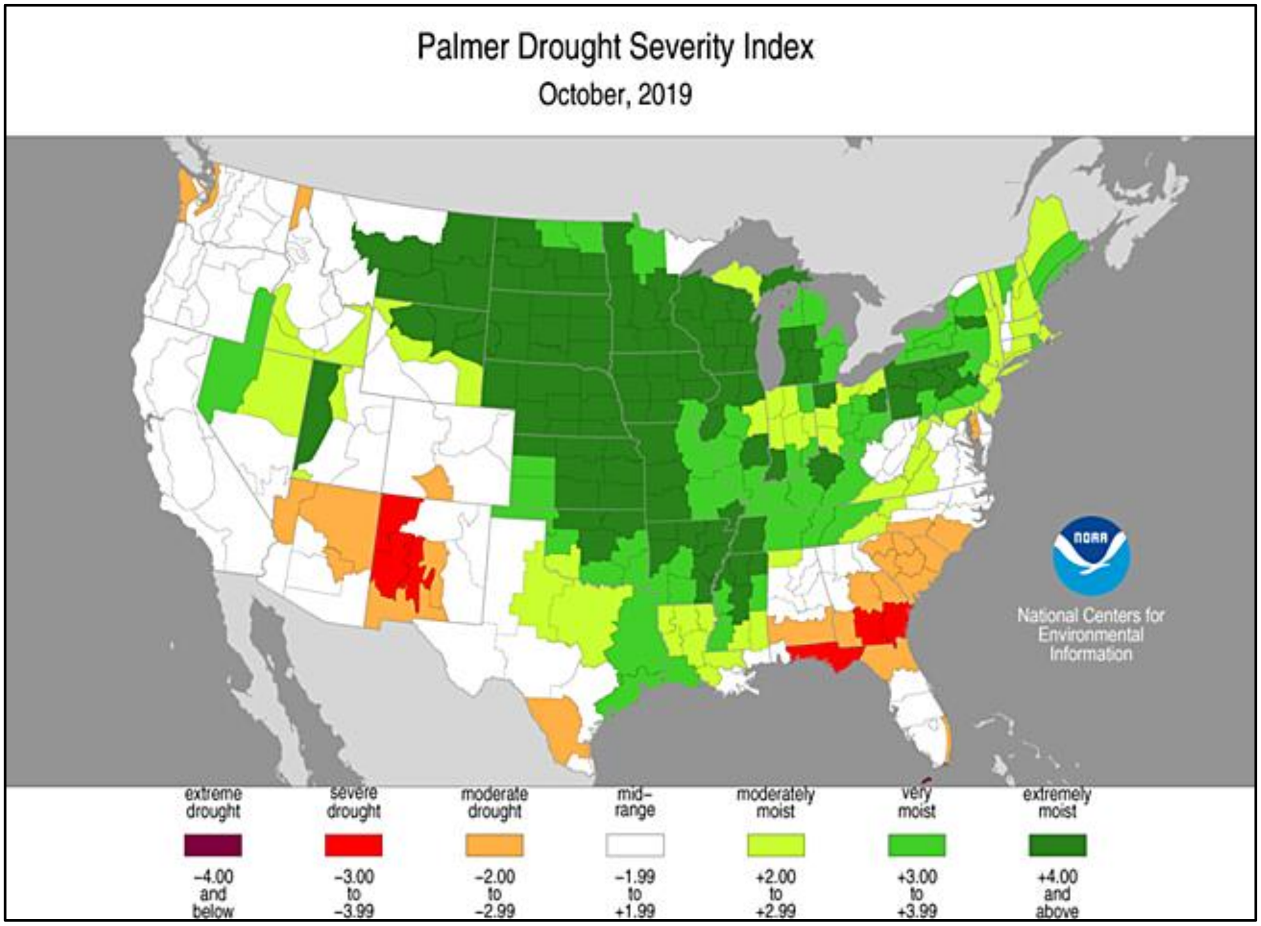


Figure 7-4. Palmer Z Index Short-Term Drought Conditions (October, 2019)

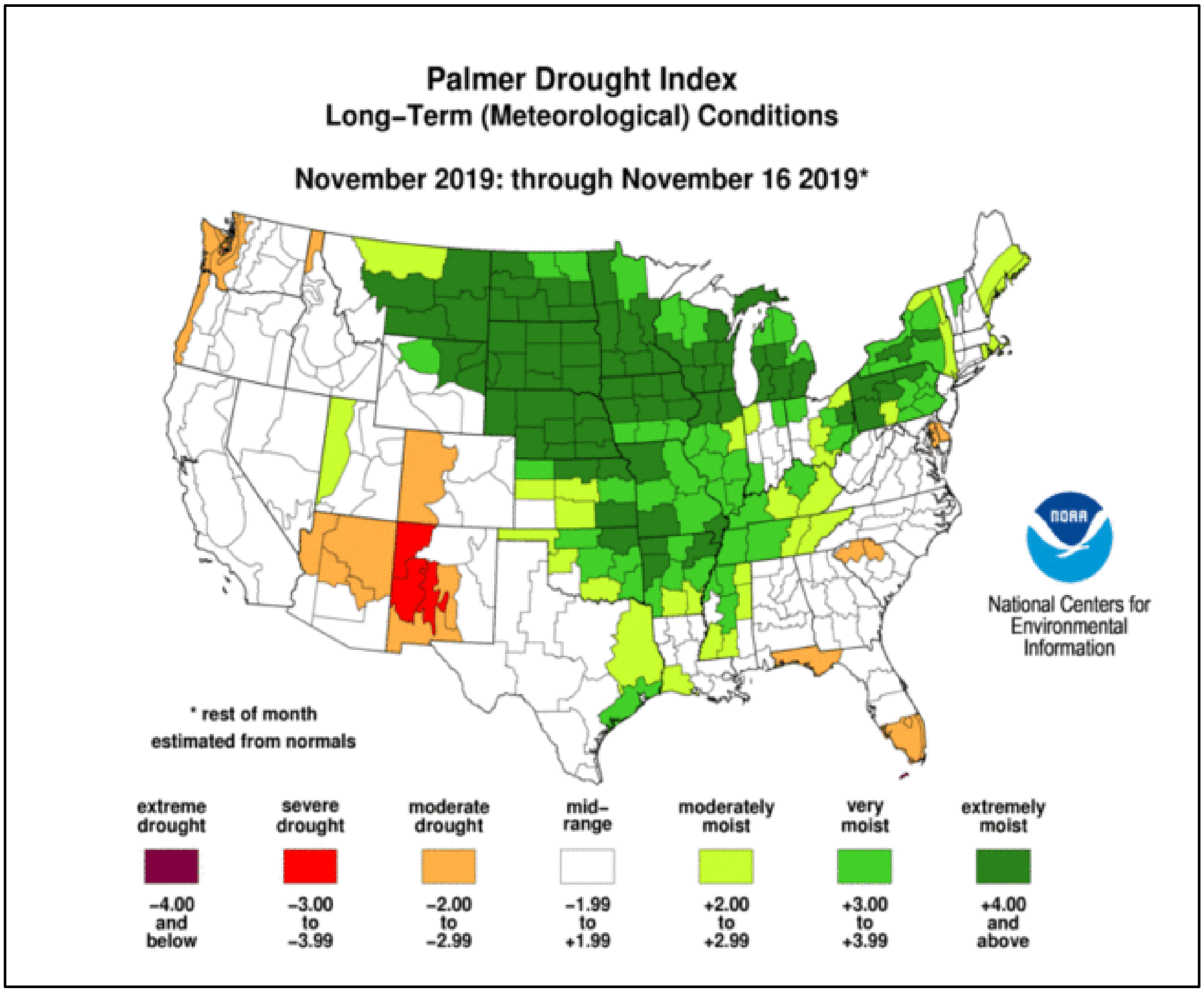


Figure 7-5. Palmer Drought Index Long-Term Drought Conditions (November, 2019)

- 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)

Washington is projected to have more frequent droughts as the climate warms. To proactively meet the needs of the state's rural communities, farmers and fish during droughts, Ecology has asked the Legislature to modernize the state's decades-old drought laws.

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 7-4) for October 2019, the planning area experienced a "moderate drought" situation within the area. Figure 7-5 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.

The Washington State Enhanced Hazard Mitigation plan has established criteria on which it defines jurisdictions as being vulnerable to drought, changing the 2018 methodology from that in previous plan editions. To that degree, the State's plan identifies Island County is among the counties referenced as being in a "low" status with respect to vulnerability to drought in the Washington State Enhanced Hazard Mitigation Plan.

Washington State is one of the few states to have a statutory definition of drought (Revised Code of Washington Chapter 43.83B.400). Drought is defined as (1) the water supply for the area is below 75 percent of normal and (2) water uses and users in the area will likely incur undue hardships because of the water shortage.

Like other western states, Washington relies on surface water for about three-quarters of total freshwater withdrawals—the majority of which is sustained in warm seasons by melting snowpack. Ground water accounts for the remaining one-quarter of Washington's water supply.

Climate change is and will continue to increase the likelihood of drought conditions. Two of the three distinct types of favorable drought conditions within Washington State are being changed - Low winter precipitation rate will vary normally, but winters will be warmer and summers drier. Periods of low winter precipitation are not expected to decrease. Similarly, projected annual precipitation rates will experience little change in seasonal variations. However, winters are, and will continue bring, more frequent intense periods of rain fall. Less snow will be available to feed rivers during summer month due to warmer winter temperatures. Accordingly, most rivers will be drier.

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

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, a significant level of the established economy of the county. 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, impacting income. 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 Washington State as a whole previously, when a lack of snowpack has decreased hydroelectric generating capacity, and raised the electric prices, impacting residents.

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. Island County has 390 farms totaling 15,850 acres with the vast majority of those farms being under 49 acres with a Total Value of Production (TVP) of $12 million according to the most recent census of agriculture (2017 Census of Agriculture). Crops accounted for 72% of the production and livestock for the remainder while livestock accounted for 75% of the TVP.

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 2012 to 2017, while the statewide value of agricultural products sold has increased to $9.6 billion from $9.1 billion from 2012 to 2017 (USDA, 2017). 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

Impact from Climate Change

The impact from climate change on drought will be significant. With historic records demonstrating increased temperature rise, the results will only further exacerbate drought stations. Drought plays a significant role in the wildfire system, fire behavior, ignitions, 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. Climate change will further change the use of water agricultural growers need for their crops; with decreased precipitation in the form of snow, water levels will fall, creating water shortages for use by consumers as drinking water, farmers for irrigation and watering of livestock, and firefighters to control and fight fires.

The Pacific Northwest is projected to warm rapidly during the 21st century, relative to 20th century average climate, as a result of greenhouse gases emitted from human activities. The actual amount of warming that occurs in the Pacific Northwest after about 2050 depends on the amount of greenhouse gases emitted globally in coming decades (Mote). 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.

7.7 IMPACT AND RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from Drought throughout the area is likely. The area has experienced drought conditions, with drought incidents occurring in 2015 and 2019. As of this 2020 update, the State experienced one of its driest summers on record for the last 30 years occurring in 2017, with several counties in the state issuing declarations in April and June 2019. Parts of Island County (Oak Harbor) receive their water supply from

Anacortes, whose watersheds were noted as being below normal during the 2019 drought occurrence. With anticipated increase in temperatures as a result of climate change, drought situations will only intensify. In addition, higher temperatures anticipated with climate change would increase vulnerability of the population due to excessive heat, while also potentially impacting power supplies at the hydro-dam in the area. Climate change could also impact sea level risk, which could increase the likelihood of salinization of wells in the area, something on which much of the county is reliant upon as its primary source of water.

Current water supplies are relatively resistant to short-term drought episodes. Should a severe, long-term drought occur, it will be vital that local elected officials, governmental agencies, private industry and residents all work cooperatively to help ensure efforts are made to protect public water supplies, aid agriculture and local industry, and safeguard fish and stream flows.

Based on the potential impact, the Planning Team determined the CPRI score to be 2.15, with overall vulnerability determined to be a medium level.

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.

DEFINITIONS

Earthquake—The shaking of the ground caused by an abrupt shift of rock along a fracture in the earth or a contact zone between tectonic plates.

Epicenter—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.

Fault—A fracture in the earth's crust along which two blocks of the crust have slipped with respect to each other.

Focal Depth—The depth from the earth's surface to the hypocenter.

Hypocenter—The region underground where an earthquake's energy originates

Liquefaction— Loosely packed, water-logged sediments losing their strength in response to strong shaking, causing major damage during earthquakes.

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.

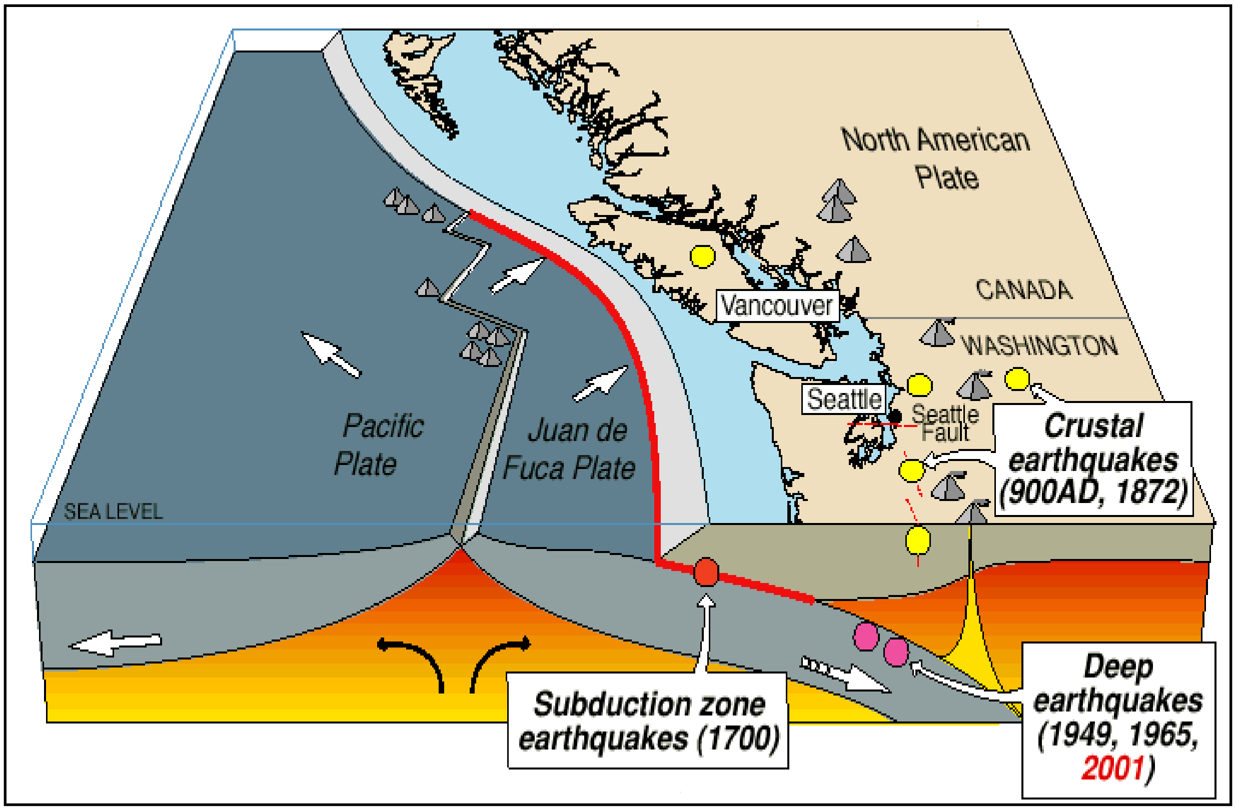


Figure 8-1. Earthquake Types in the Pacific Northwest

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. Table 8-1 presents a classification of earthquakes according to their magnitude. Table 8-2 compares the moment magnitude scale to the modified Mercalli intensity scale.

**TABLE 8-1.
EARTHQUAKE MAGNITUDE CLASSES**

Magnitude Class	Magnitude Range (M = magnitude)
Great	M > 8
Major	7 <= M < 7.9
Strong	6 <= M < 6.9
Moderate	5 <= M < 5.9
Light	4 <= M < 4.9
Minor	3 <= M < 3.9
Micro	M < 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, 2019):

**TABLE 8-2.
EARTHQUAKE MAGNITUDE AND INTENSITY**

Magnitude (Mw)	Intensity (Modified Mercalli)	Description
1.0—3.0	I	I. Not felt except by a very few under especially favorable conditions
3.0—3.9	II—III	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.
4.0—4.9	IV—V	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.

**TABLE 8-2.
EARTHQUAKE MAGNITUDE AND INTENSITY**

Magnitude (Mw)	Intensity (Modified Mercalli)	Description
5.0—5.9	VI—VII	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.
6.0—6.9	VII—IX	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.
7.0 and higher	VIII and higher	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.

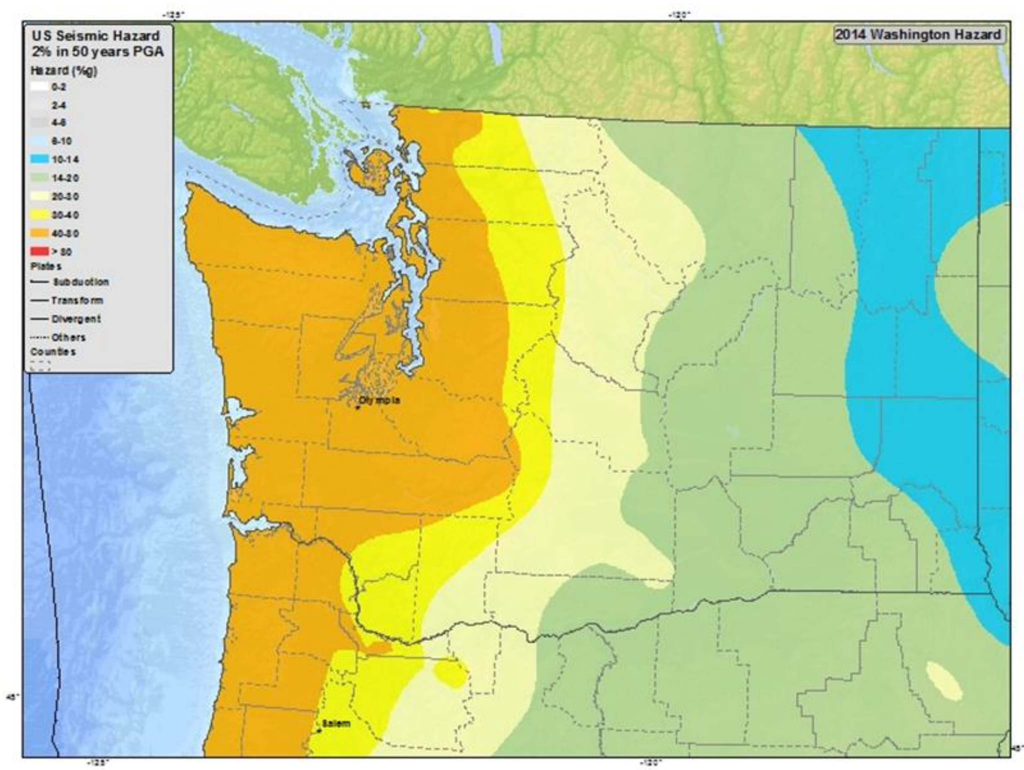


Figure 8-2 USGS PGA for Washington State (2014)

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 8-3 lists damage potential and perceived shaking by PGA factors, compared to the Mercalli scale.

TABLE 8-3.
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 8-4 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 8-4.
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 8-3 depicts the faults and seismogenic folds known or suspected to be active.

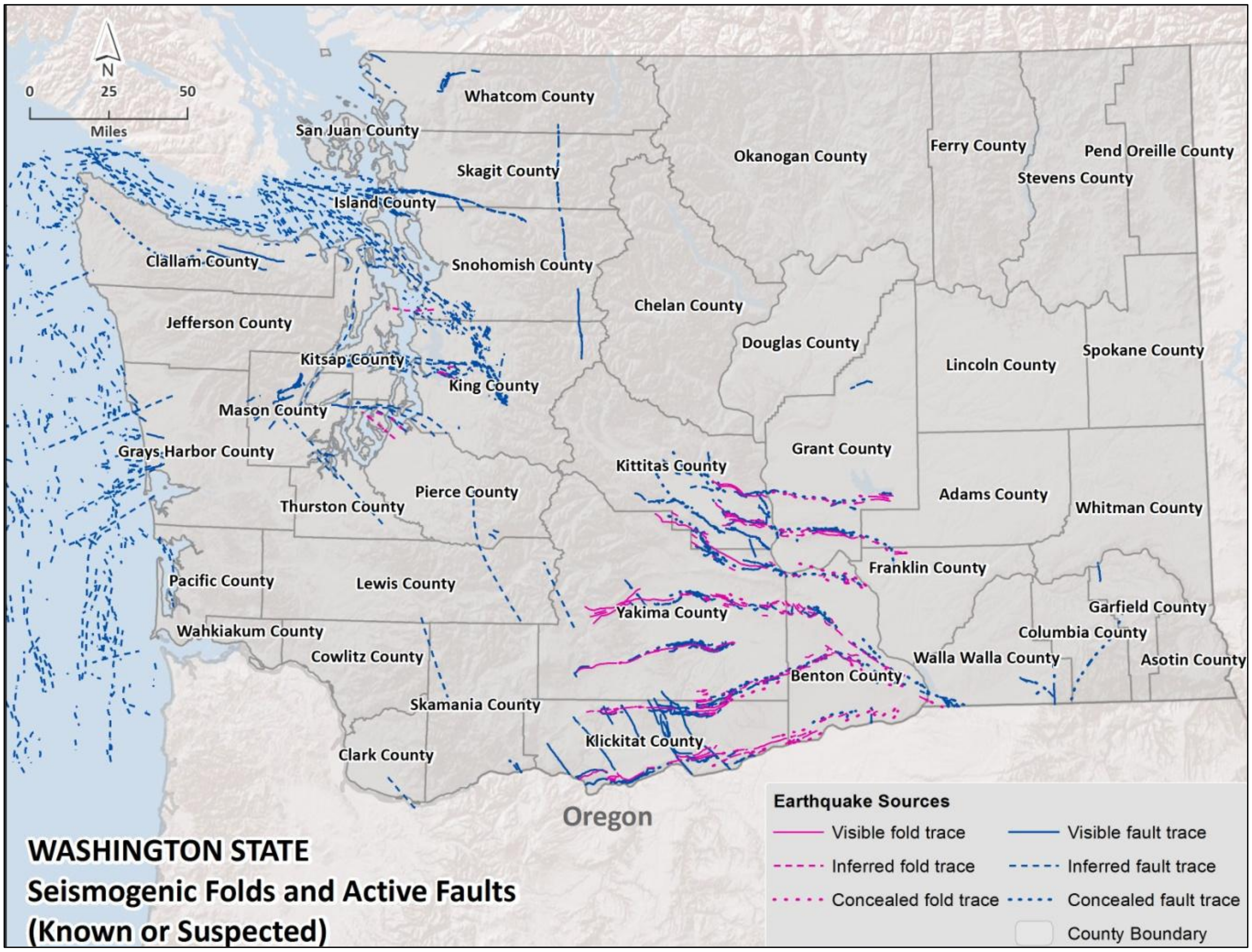


Figure 8-3. Washington State Seismogenic Folds and Active Faults

Local Faults

There are a number of faults running near or through Island County (see Figure 8-4 and Figure 8-5). 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.

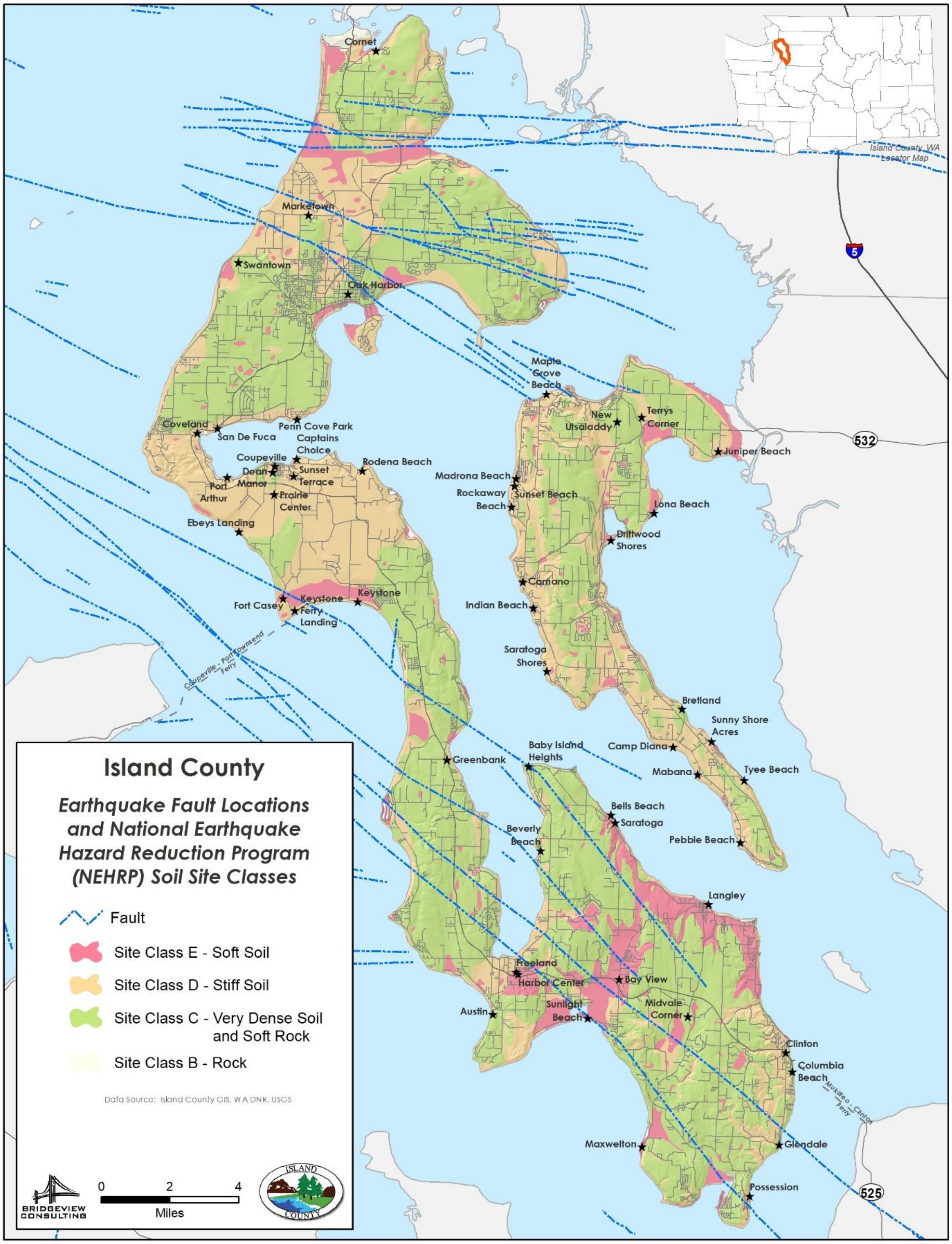


Figure 8-4. Regional Faults with NEHRP Soils Classifications

Source: USGS, 2019

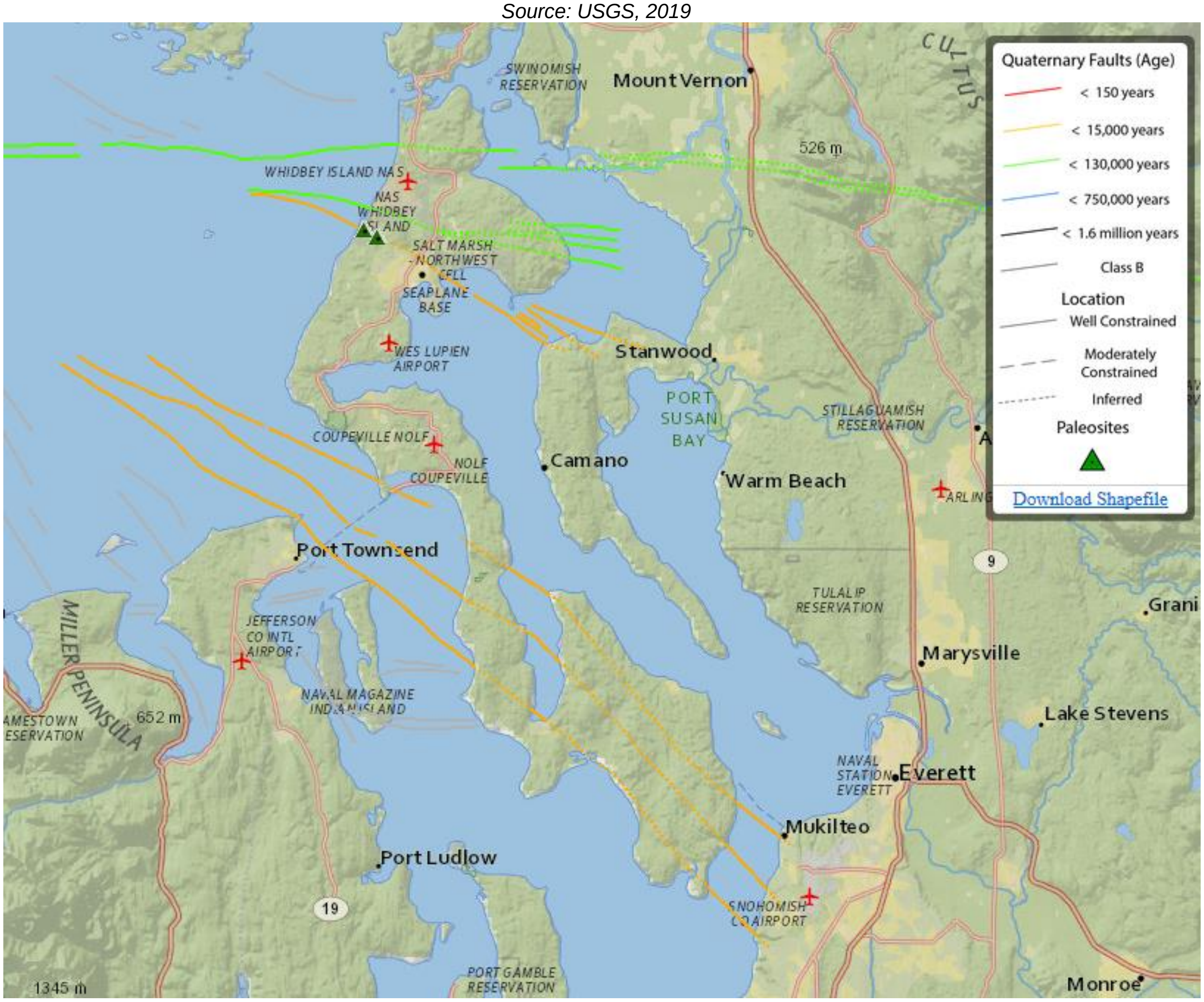


Figure 8-5. USGS Known Faults in Vicinity of Island County

The sections below provide descriptions of the planning area's main faults 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, 2006).

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.
- 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 2014 is based on a Magnitude 7.5 earthquake on the South Whidbey Fault, with an epicenter in the Everett area. (see Figure 8-6)
  - Cascadia Subduction Zone Earthquake—This scenario was based on a USGS publication (2014) that estimates previous Magnitude-9.3 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 8-7).

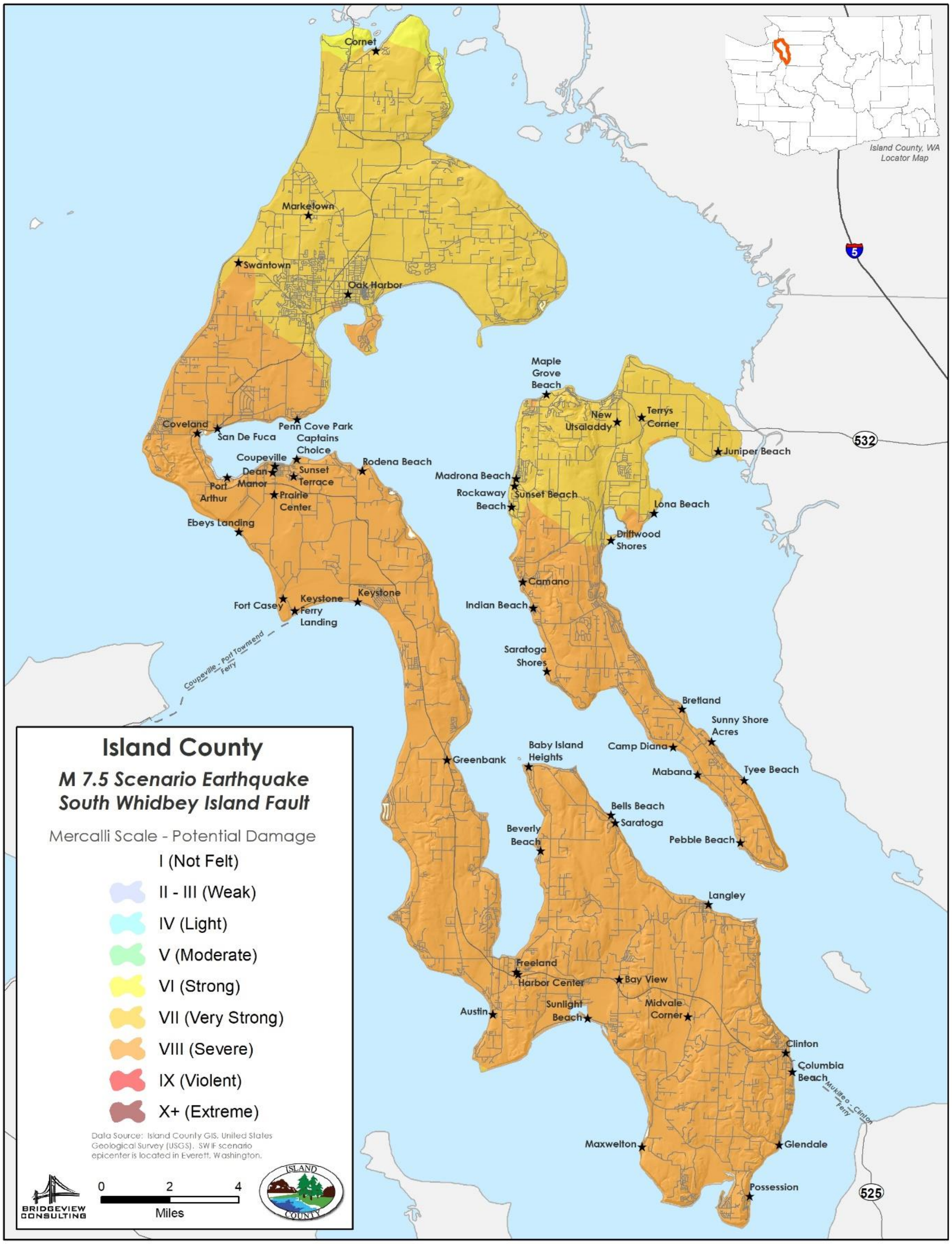


Figure 8-6. South Whidbey Fault Scenario

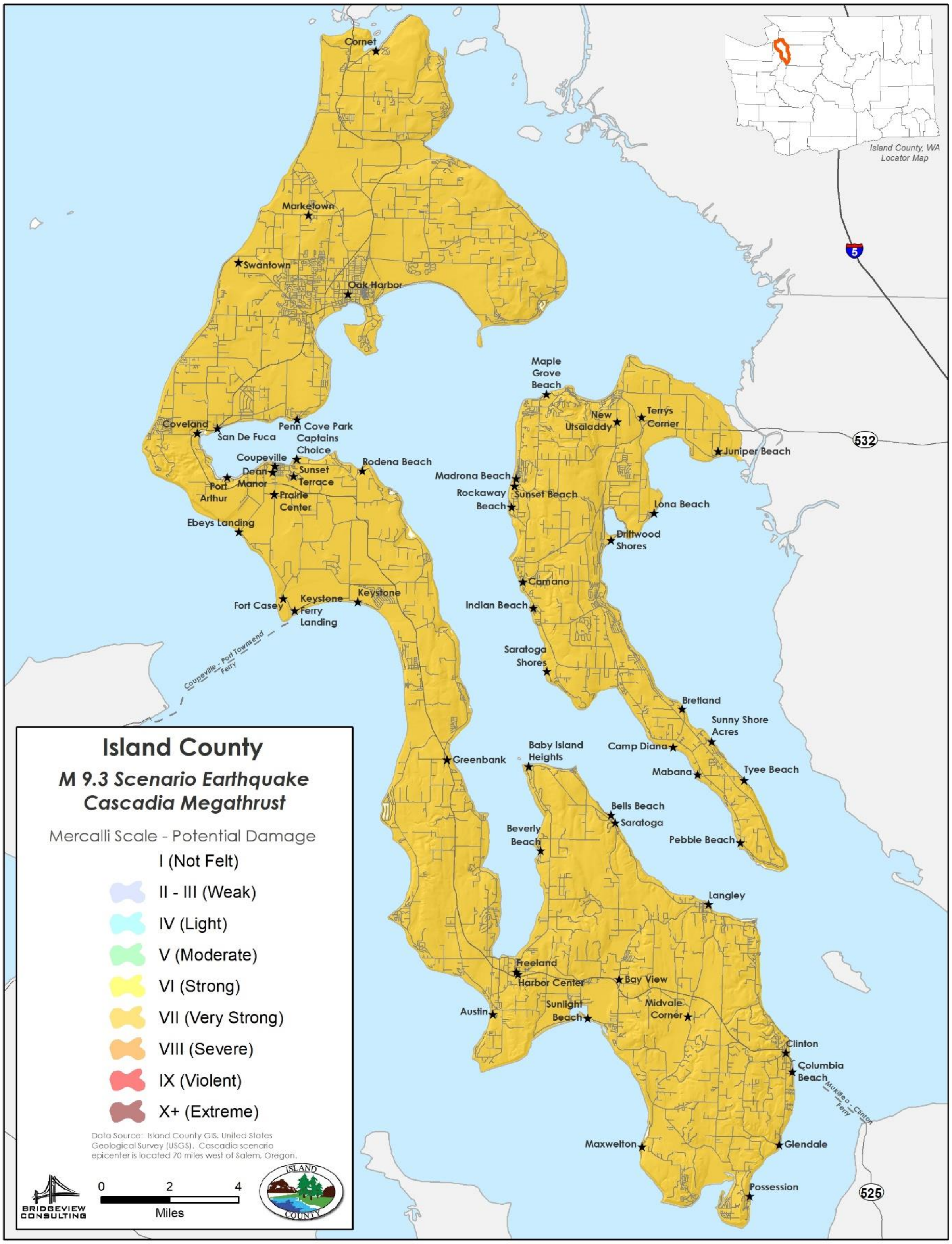


Figure 8-7. Cascadia Megathrust M9.3 Fault Scenario

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 8-8 illustrates 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.

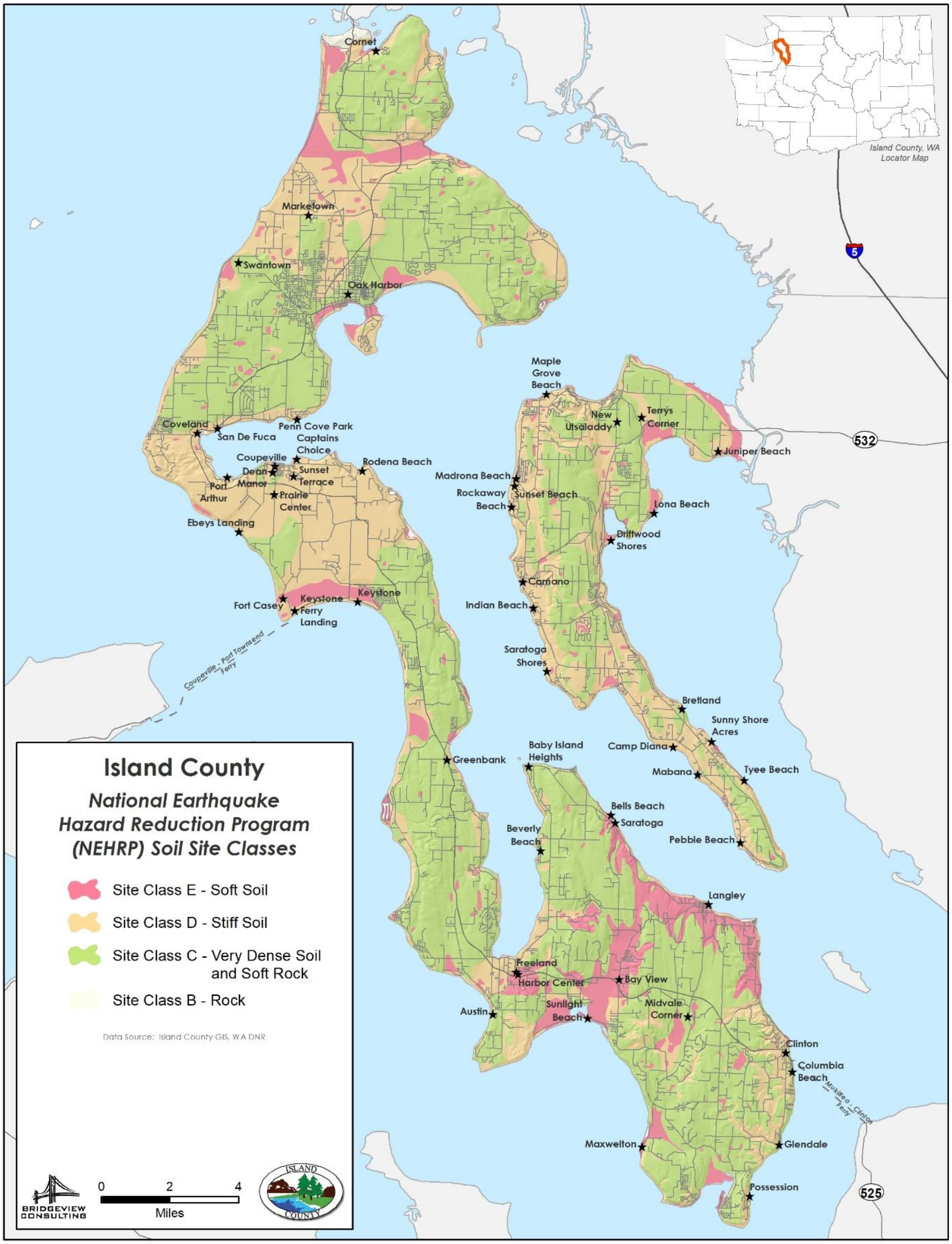


Figure 8-8 NEHRP Soils Classifications

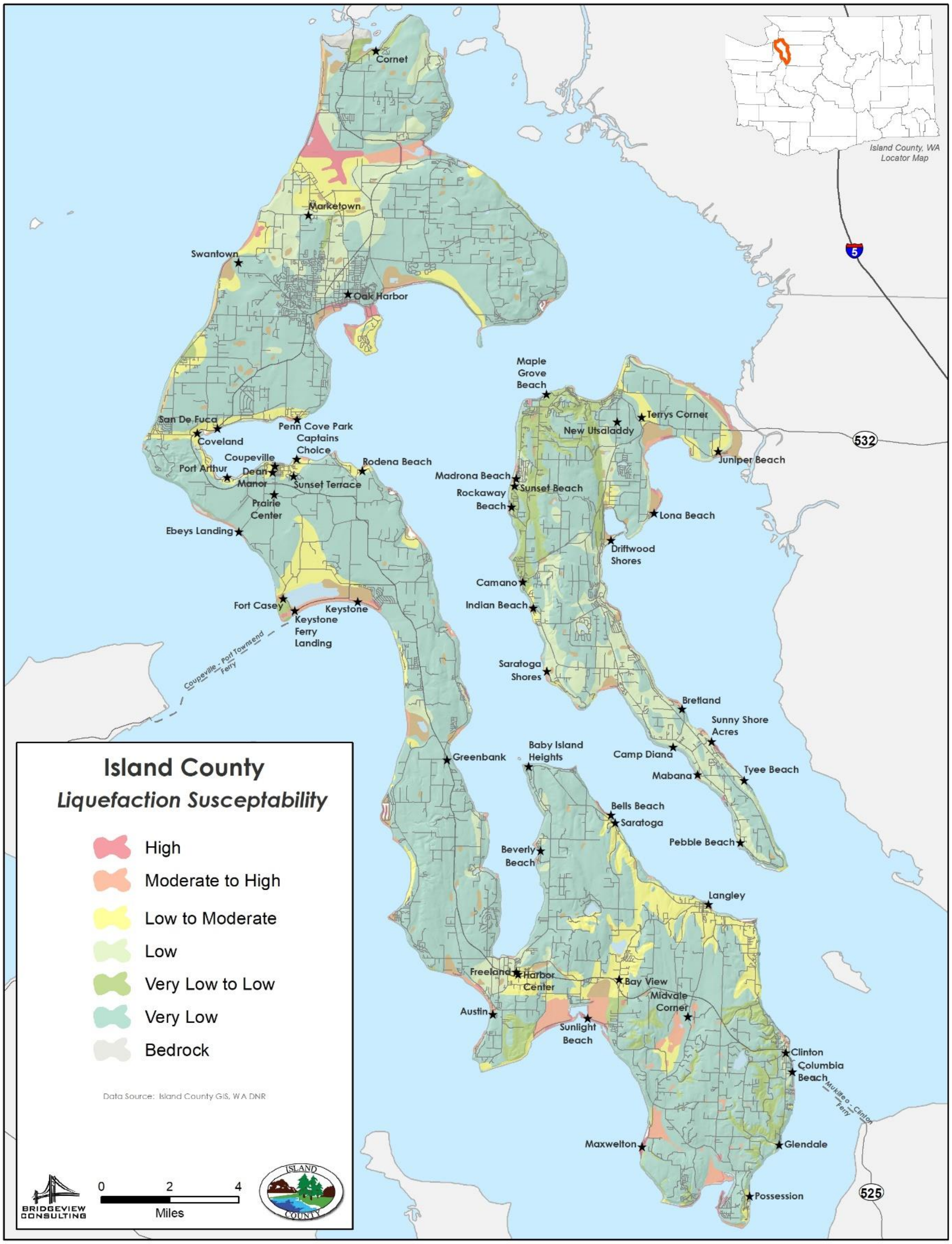


Figure 8-9 Liquefaction Susceptibility

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 8-5 lists past seismic events that have affected the areas in and around Island County.

TABLE 8-5.
HISTORICAL EARTHQUAKES IMPACTING THE PLANNING AREA

Year	Magnitude	Epicenter	Type
07/12/2019	4.6	Monroe	Crustal
01/20/2009	4.9	Poulsbo	Crustal
02/28/2001	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, 2019

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.

The severity of an earthquake can be expressed in terms of intensity or magnitude. Intensity represents the observed effects of ground shaking on people, buildings and natural features. The USGS has created ground motion maps based on current information about several fault zones. These maps show the PGA that has a certain probability (2 percent or 10 percent) of being exceeded in a 50-year period. The PGA is measured in numbers of g's (the acceleration associated with gravity). Figure 8-10 shows the PGAs with a 2-percent exceedance chance in 50 years in Washington.

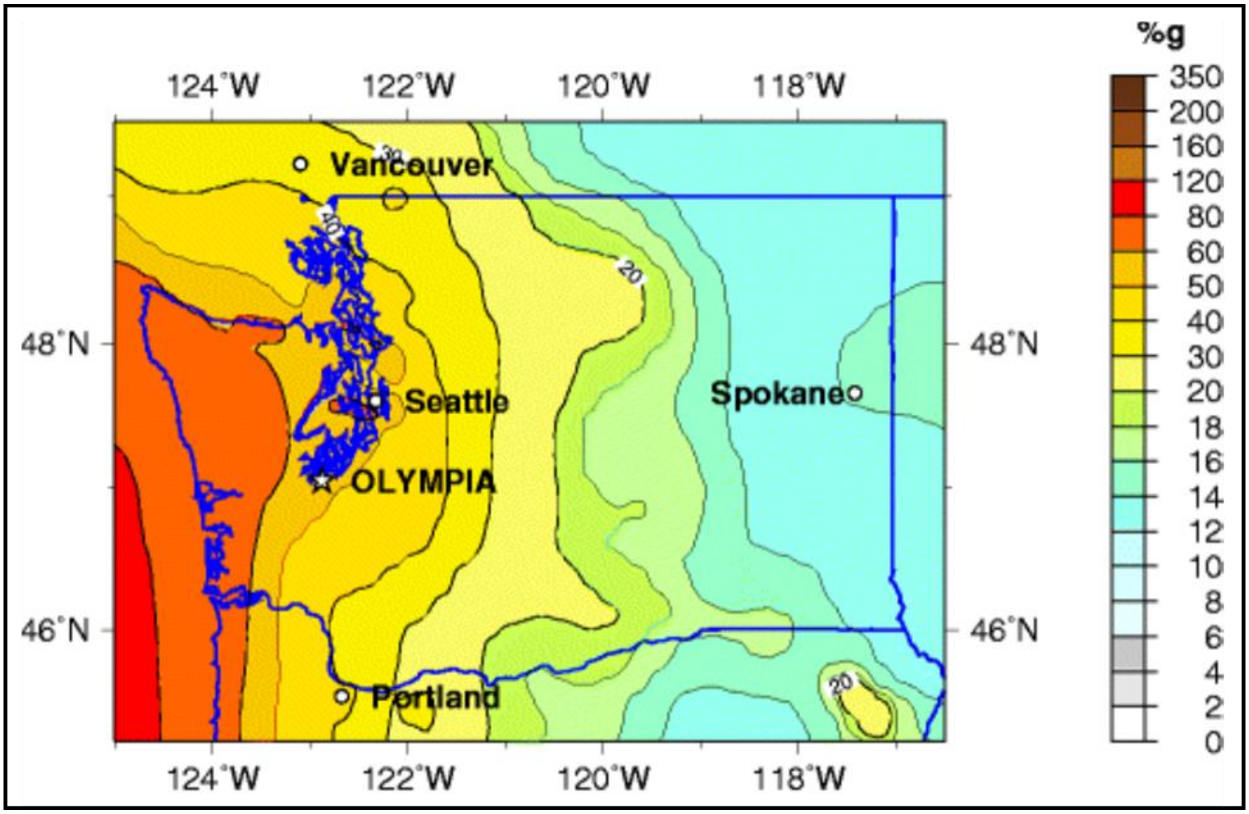


Figure 8-10 PGA with 2-Percent Probability of Exceedance in 50 Years, Northwest Region

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.

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, 2015).

– Current estimates are 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.

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. The U.S. Geological Survey (USGS) along with a coalition of State and university partners is developing and testing the ShakeAlert System for the West Coast of the United States. Before general public alerting can begin long-term, operational funding must be secured and the speed and reach of mass alerting technologies must be tested and improved. The seconds to tens of seconds of advance warning can allow people and systems to take actions to protect life and property from destructive shaking. In the fall of 2018, the West Coast ShakeAlert® Earthquake Early Warning System became sufficiently functional and tested to begin Phase 1 of alerting in California, Oregon, and Washington. Several commercial and institutional users are alerting personnel and taking automated actions; an important step in a strategy of phased rollout leading to full public operation. (ShakeAlert, 2019)

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 8-3 identifies the number of individuals and households impacted by the various earthquake events as identified by Hazus.

TABLE 8-3.
ESTIMATED EARTHQUAKE IMPACT ON PERSON AND HOUSEHOLDS

	Displaced Households	Persons Requiring Short-Term Shelter
South Whidbey Fault Earthquake		
	695	**357**
Cascadia Subduction Zone Earthquake		
	251	**140**

8.3.3 Impact on Property

There are 40,043 buildings in the planning area, with an estimated total replacement and content value of ~$13.4 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 analysis for two scenario events. A summary of the total building-related loss, which includes structure and content loss, is as follows:

- For the South Whidbey Island earthquake, the estimated potential is $456 million, or 3.4 percent of the total value for the planning area.
- For the Cascadia earthquake, the estimated potential is $1.1 billion, or 8.5 percent of the total value for the planning area.

Property losses were estimated through the Level 2 Hazus analysis for the Cascadia Subduction Zone and South Whidbey Fault earthquake scenario events, utilizing the USGS/Washington State Department of Natural Resources scenario catalog data, FEMA 2017 GIS datasets, and 2020 updated Assessor's general building stock and the 2020 updated critical facilities lists. A summary of the building-related loss impact are illustrated in Table 8-4. Damage categories by occupancy type for both events are illustrated in Figure 8-11 and Figure 8-12.

TABLE 8-4.
HAZUS ESTIMATED EARTHQUAKE DAMAGES

	Number of Buildings Sustaining Moderate Damaged	Percent of Buildings in Region	Number of Buildings Sustaining Damaged Beyond Repair
Cascadia Subduction Zone Earthquake			
	5,740	>14%	421
South Whidbey Fault Earthquake			
	14,853	>37%	1,402

TABLE 8-5.
EARTHQUAKE EXPOSURE FOR CASCADIA M9.3 SUBDUCTION ZONE SCENARIO EVENT

Jurisdiction	Estimated 2019 Population (1)	Estimated Building Count (2)	Total Building Value (Structure and Contents) (2)	Potential Exposed Structure Impact (3)			
				Building Structure Damaged by a 9.3M Cascadia Event	Building Contents Damaged by a 9.3M Cascadia Event	Sum of Structure and Contents Damaged by a 9.3M Cascadia Event	% of Total Value
Coupeville	1,925	843	$440,648,701	$26,708,673	$7,691,475	$34,400,149	7.81%
Langley	1,195	714	$231,125,633	$20,505,049	$5,726,476	$26,231,525	11.35%
Oak Harbor	22,970	8,060	$4,016,992,564	$145,182,213	$41,640,490	$186,822,703	4.65%
County – Unincorporated	58,730	30,426	$8,681,024,425	$166,149,196	$42,620,929	$208,770,125	2.40%
Total	**84,820**	**40,043**	**$13,369,791,322**	**$358,545,132**	**$97,679,370**	**$456,224,502**	**3.41%**

Sources (1) 2019 State of Washington Department of Finance Estimated Populations
(2) Exposure numbers were estimated using Island County Parcel and Assessor data.
(3) Earthquake Scenarios describe the expected ground motions and effects of specific hypothetical large earthquakes.
(4) Results by jurisdiction are estimated using Census Tract data and do not match actual jurisdictional boundaries

TABLE 8-6.
EARTHQUAKE EXPOSURE FOR SOUTH WHIDBEY ISLAND FAULT SCENARIO EVENT

Jurisdiction	Estimated 2019 Population (1)	Estimated Building Count (2)	Total Building Value (Structure and Contents) (2)	Potential Exposed Structure Impact (3)			
				Building Structure Damaged by a 7.5M SWIF Event	Building Contents Damaged by a 7.5M SWIF Event	Sum of Structure and Contents Damaged by a 7.5M SWIF Event	% of Total Value
Coupeville	1,925	843	$440,648,701	$87,109,787	$24,842,657	$111,952,444	25.41%
Langley	1,195	714	$231,125,633	$96,444,296	$25,633,006	$122,077,302	52.82%
Oak Harbor	22,970	8,060	$4,016,992,564	$195,031,865	$57,642,834	$252,674,699	6.29%
County – Unincorporated	58,730	30,426	$8,681,024,425	$525,753,983	$130,180,143	$655,934,126	7.56%
Total	**84,820**	**40,043**	**$13,369,791,322**	**$904,339,931**	**$238,298,639**	**$1,142,638,570**	**8.55%**

Sources (1) 2019 State of Washington Department of Finance Estimated Populations
(2) Exposure numbers were estimated using Island County Parcel and Assessor data.
(3) Earthquake Scenarios describe the expected ground motions and effects of specific hypothetical large earthquakes.
(4) Results by jurisdiction are estimated using Census Tract data and do not match actual jurisdictional boundaries

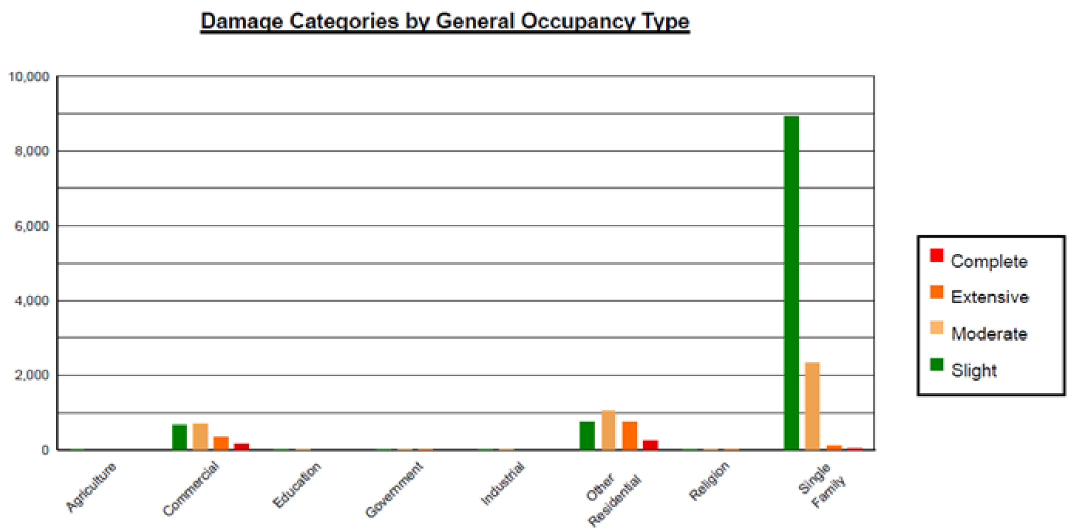


Figure 8-11 Expected Building Damage By Occupancy Type - Cascadia Event (Hazus)

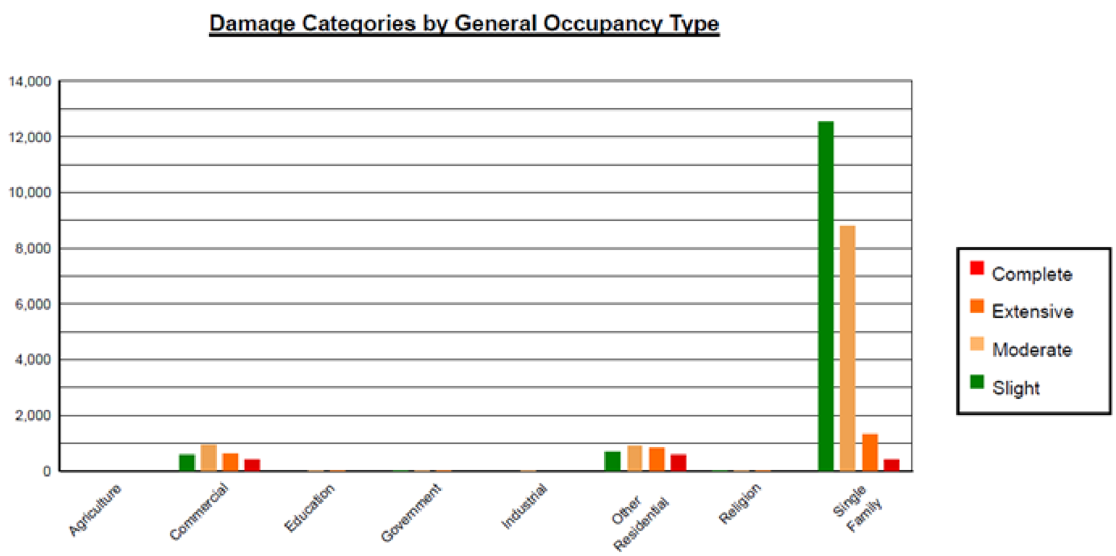


Figure 8-12 Expected Building Damage by Occupancy Type - South Whidebey Event (Hazus)

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 2019 the state again upgraded the building code to follow International Building Code Standards.

Based on Census data (2017 data was the most current available to provide all necessary information as of this 2020 update), the median date of construction for the planning area is approximately 1979. It is estimated that 18.1 percent of the building stock in the planning area was constructed between 1970 and 1979, and 21.7 percent was constructed pre-1969 (U.S. Census, 2017). It should be noted that census data identified 41,287 structures; however, Island County Assessor's data identified 40,043 as of December 2019. Figure 8-13 and Table 8-7 identify additional results of structure age analysis.

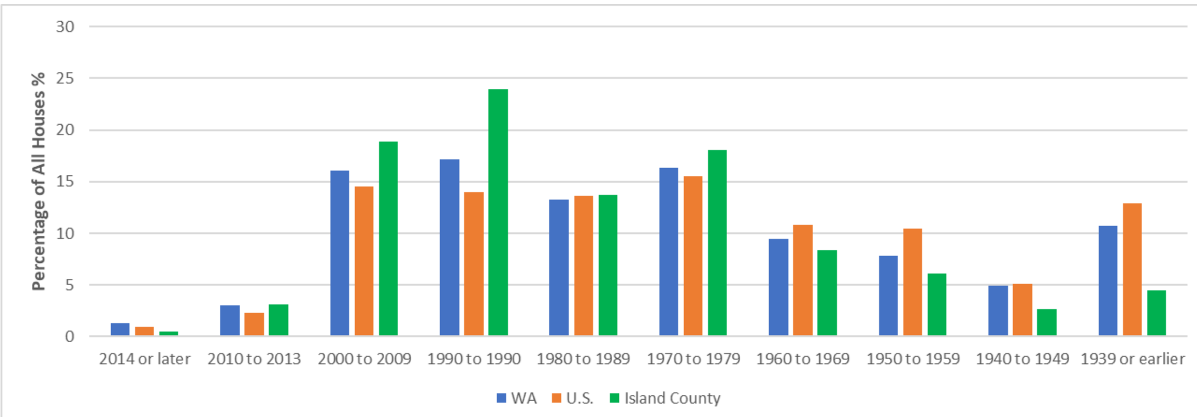


Figure 8-13. Distribution of Planning Area Residential Structures by Year Constructed

TABLE 8-7.
AGE OF STRUCTURES WITHIN PLANNING AREA

Time Period	Number of Current Structures Building within Identified Period	Code Significance for Identified Time Period
Pre-1972	11,495	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	14,144	UBC seismic construction standards were adopted in Washington.
1994-2003	8,299	Seismic Risk Zone 3 was established within the Uniform Building Code in 1994, requiring higher standards
2004-Present	6,105	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	**40,043**	

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.

Time to Return to Functionality

Hazus 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 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 Cascadia Subduction Zone and South Whidbey Island Fault scenario earthquake events. The results are summarized in Table 8-8 and Table 8-9.

TABLE 8-8.
FUNCTIONALITY OF CRITICAL FACILITIES CASCADIA SUBDUCTION ZONE EARTHQUAKE

	# 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	7	36	37	68	69	95	97
Bridges	5	95	97	97	98	98	98
Protective Functions	33	66	66	92	92	99	99
Schools	28	57	58	86	87	99	99
Other Critical Facilities*	39	83	92	95	95	96	98
Water & Wastewater	13	41	75	92	94	95	99
Total/Average	**125**	**63**	**71**	**88**	**89**	**97**	**98**

**Other Critical Facilities include Transportation, Communication, Power.*

TABLE 8-9.
FUNCTIONALITY OF CRITICAL FACILITIES FOR SOUTH WHIDBEY ISLAND FAULT SCENARIO

	# 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	7	12	13	42	43	85	91
Bridges	5	68	74	78	78	79	86
Protective Functions	33	28	29	66	67	95	97
Schools	28	20	20	50	51	86	92
Other Critical Facilities*	39	55	70	75	77	80	89
Water & Wastewater	13	23	49	70	74	76	93
Total	**125**	**34**	**43**	**64**	**65**	**84**	**91**

Debris

The Hazus analysis also estimated the amount of earthquake-caused debris in the planning area for the scenario events as summarized in Table 8-10.

**TABLE 8-10.
ESTIMATED EARTHQUAKE CAUSED DEBRIS**

Event	Amount of Debris to be Removed
M 7.4 South Whidbey Island Fault Scenario	581,000 tons
M 9.3 Cascadia Subduction Zone Scenario	253,000 tons

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

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. 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.

Additional economic losses identified in the Hazus global summary report should also be considered when determining cost, such as sheltering needs and debris removal costs. (e.g., life-line losses, sheltering costs, debris removal costs). Hazus output also includes life-line losses and estimated damage potential, although the information does contain a high-level of variables which can skew the data. For planning purposes, such information is considered an acceptable level, but reviewers should realize the high level of inaccuracy which may be involved. A summary of additional economic loss including these types of losses are as follows:

- For a M9.3 Cascadia Fault event, the estimated damage potential is $456.22 (millions of dollars), which includes building related losses based on the region’s available inventory.
- For a M7.4 South Whidbey Fault event, the estimated damage potential is $1.14 (billions of dollars) which includes building related losses based on the region’s available inventory.

8.3.6 Impact on Environment

Secondary hazards associated with earthquakes will likely have some of the most damaging effects on the environment. Earthquake-induced landslides can significantly impact surrounding habitat. It is also possible for streams to be rerouted after an earthquake. This can change the 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. Such standards will also help reduce potential impact from earthquakes where new development occurs.

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, 2019).

Glacial melt may also be re-awakening dormant earthquakes and volcanoes. Large glaciers suppressed earthquakes, but as the Earth rebounds, the downward pressure on the plates is released and shaky pre-existing faults could reactivate. In Southeast Alaska, where uplift is most prevalent, the Pacific plate slides under the North American plate, causing a lot of strain. Glaciers had previously quelled that strain, but the rebound is allowing those plates to grind up against each other again. (Chen).

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 such as ShakeAlert can provide notification 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. In some instances, 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. The area also has a relatively high number of older buildings, which are more susceptible to impact.

- A high number of facilities and structures in the planning area are expected to be damaged 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.

8.1 IMPACT AND RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from an Earthquake throughout the area is highly likely. Both the Cascadia Subduction Zone and South Whidbey Island Fault scenarios type events, such as those utilized as the scenario modeled for this update, have a high probability of occurring within the region, as well as a high level of impact.

Also a factor is the large number of buildings being constructed pre-1979 (~40 percent). Due to the age of these buildings and the absence of building codes at time of construction, they may not perform as well during an earthquake compared to structures built after code implementation, or after more stringent codes were in place. Also of concern are the number of developments on hillsides, or high-bluff areas, which would be prone to landslides after a significant earthquake event.

Based on the potential impact, the Planning Team determined the CPRI score to be 3.65, with overall vulnerability determined to be a high level.

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.

During FEMA’s 2017 RiskMap Study, FEMA included updated flood modeling for the coastline of Langley, Oak Harbor, Coupeville, and the unincorporated areas of Island County utilizing the 1 percent annual-chance flood (100-year flood), combined with depth grids ranging from 3-10 feet. Figure 9-1 below illustrates the results of that analysis (in feet) for Oak Harbor and Coupeville. Reviewers wishing more information on the outputs and methodology utilized by FEMA in completing this analysis should review FEMA’s Risk Report, which contains additional data. That report is available directly from FEMA, or from Island County Community Development Department’s Floodplain Manager, or the County’s Emergency Management Director.

Figure 9-1 FEMA 2017 Flood Depth Grid

Sea Level Rise and Ocean Acidification Will Affect the Coastal Environment

In a study conducted by the Stillaguamish Tribe of Indian's Natural Resource Department and the University of Washington Climate Impact Group (May 2017), the findings of that study state:

> Sea level is projected to rise in most coastal areas of Washington State due to the combined effects of global sea level rise, land subsidence related to plate tectonics, and other factors. A recent assessment of changes in coastal flooding in Island County due to sea level rise concluded there was a 50% probability of at least nine inches of sea level rise by 2050 and at least 2.2 feet of sea level rise by 2100 for a high (RCP 8.5) greenhouse gas scenario (Miller et al. 2016). At the 1% probability level, Miller et al. projected 1.4 feet and 4.9 feet of sea level rise by 2050 and 2100, respectively. A 2012 study by the National Research Council, which pre-dated the probabilistic framework applied in Island County, reached similar conclusions (NRC 2012). That study projected a rise of seven inches (range: -1 inch to +1.6 feet) by 2050 and two feet (range: +4 inches to +4.7 feet) by 2100.
>
> The nearshore and marine environment will also be affected by rising ocean temperatures and ocean acidification. Worldwide the oceans have absorbed about 25% of the carbon dioxide associated with human activities (Feely et al 2009). The added carbon dioxide has changed the ocean's chemistry by increasing its acidity (+30% relative to pre-industrial levels) and reducing the availability of carbonate ions (NOAA 2012). This latter impact is particularly threatening to shellfish that require calcium carbonate as the molecular building block for shell formation.

> The impacts of a rising sea level are diverse. Rising seas will lead to permanent inundation of low-lying areas; increased tidal reach, coastal flooding, and exposure to storm surge events; increased coastal erosion; and shifts in or loss of coastal habitat (NWF 2007; NRC 2012; Thorne et al. 2015; Hamman et al. 2016; Miller et al. 2016).

FEMA analysis for the 2017 Risk Map Study also included potential sea level rise at the 100-year flood level, increasing the level of water by 1, 2, and 3 feet. Figure 9-2 illustrates the results of that impact countywide (this is the same illustration contained in the Coastal Erosion chapter).

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.

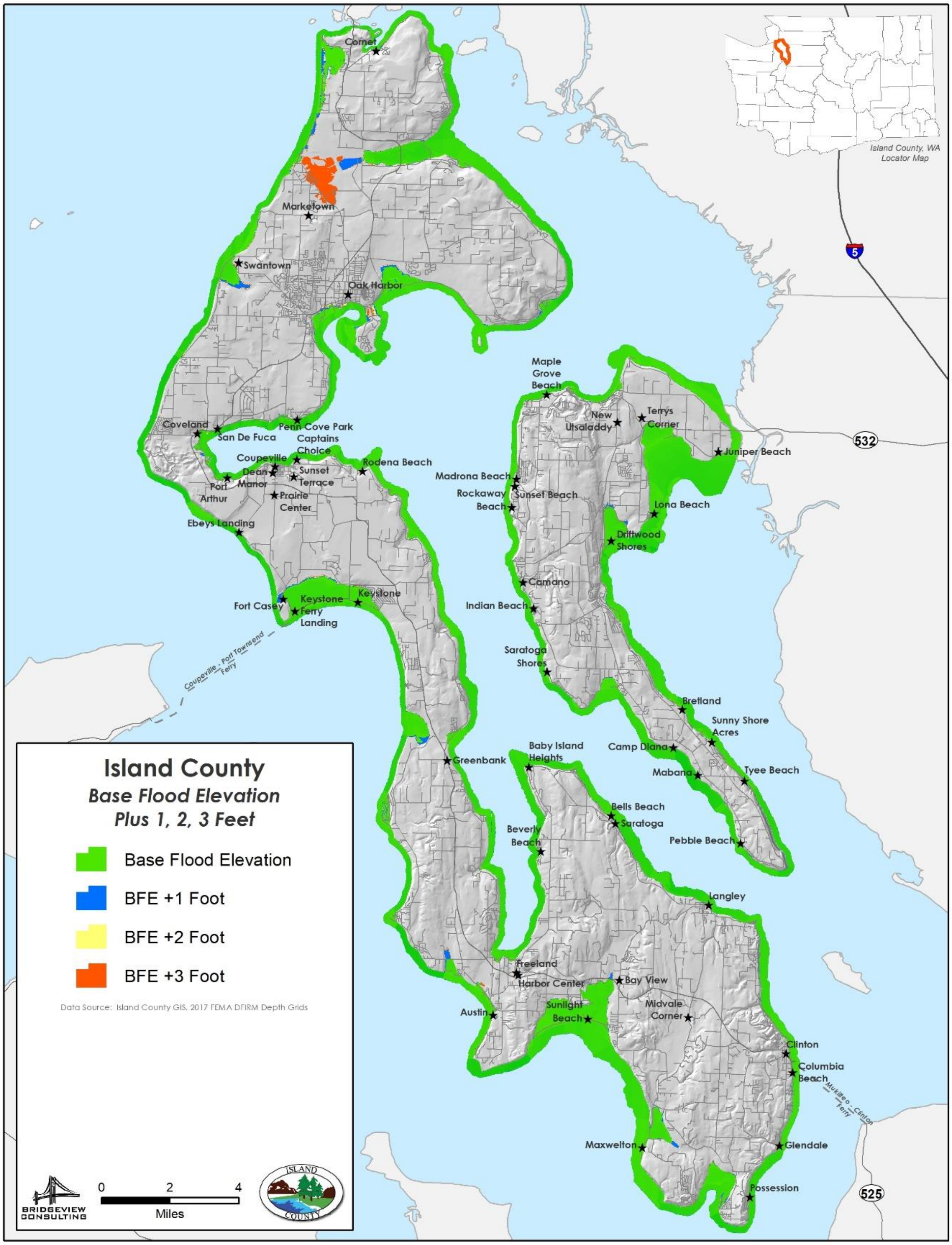


Figure 9-2 Potential Impacts from Sea Level Risk (FEMA 2017)

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 9-3). 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.

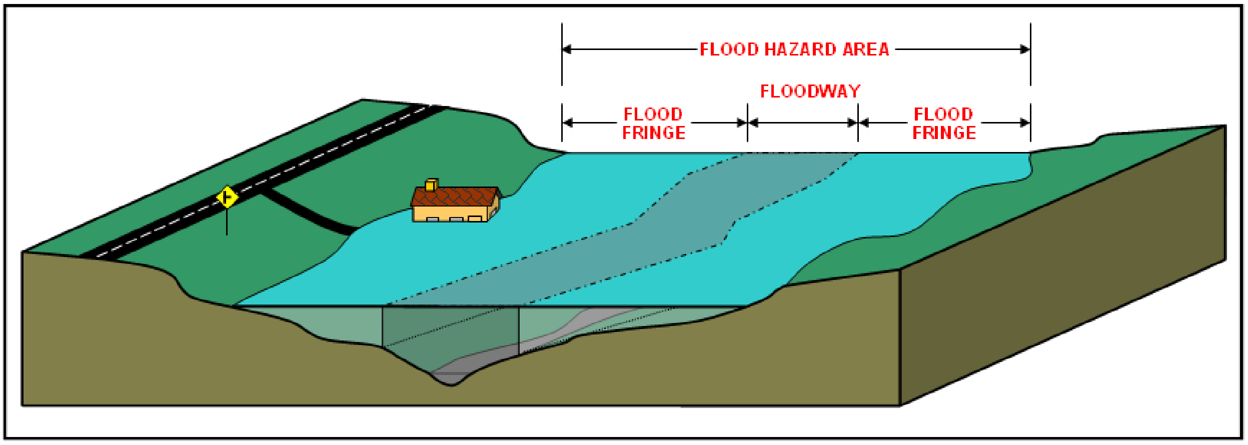


Figure 9-3. Flood Hazard Area Referred to as Floodplain

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).

Following the release of FEMA flood-risk maps in 2015, Island County and local property owners voiced concern that FEMA's 2015 maps identified areas not previously falling within a flood hazard area. The County conducted its own analysis, and presented that information to FEMA. FEMA, agreed to reconsider its preliminary mapping of some Island County areas as subject to flooding. The resulting 2017 release of the adopted NFIP flood maps are a result of that effort, with FEMA revising the floodplain to more appropriate levels. [*It should be noted that as of this update, there are pending discussions on-going between the County and FEMA concerning remaining discrepancies which are being addressed, so readers should check the County's website for updated maps developed after December 2019.*]

Figure 9-4 illustrates the areas studied by FEMA, and the resulting map panels. Additional information on the 2017 Flood Insurance Study is available for download from FEMA's website at: https://msc.fema.gov/portal/advanceSearch#searchresultsanchor

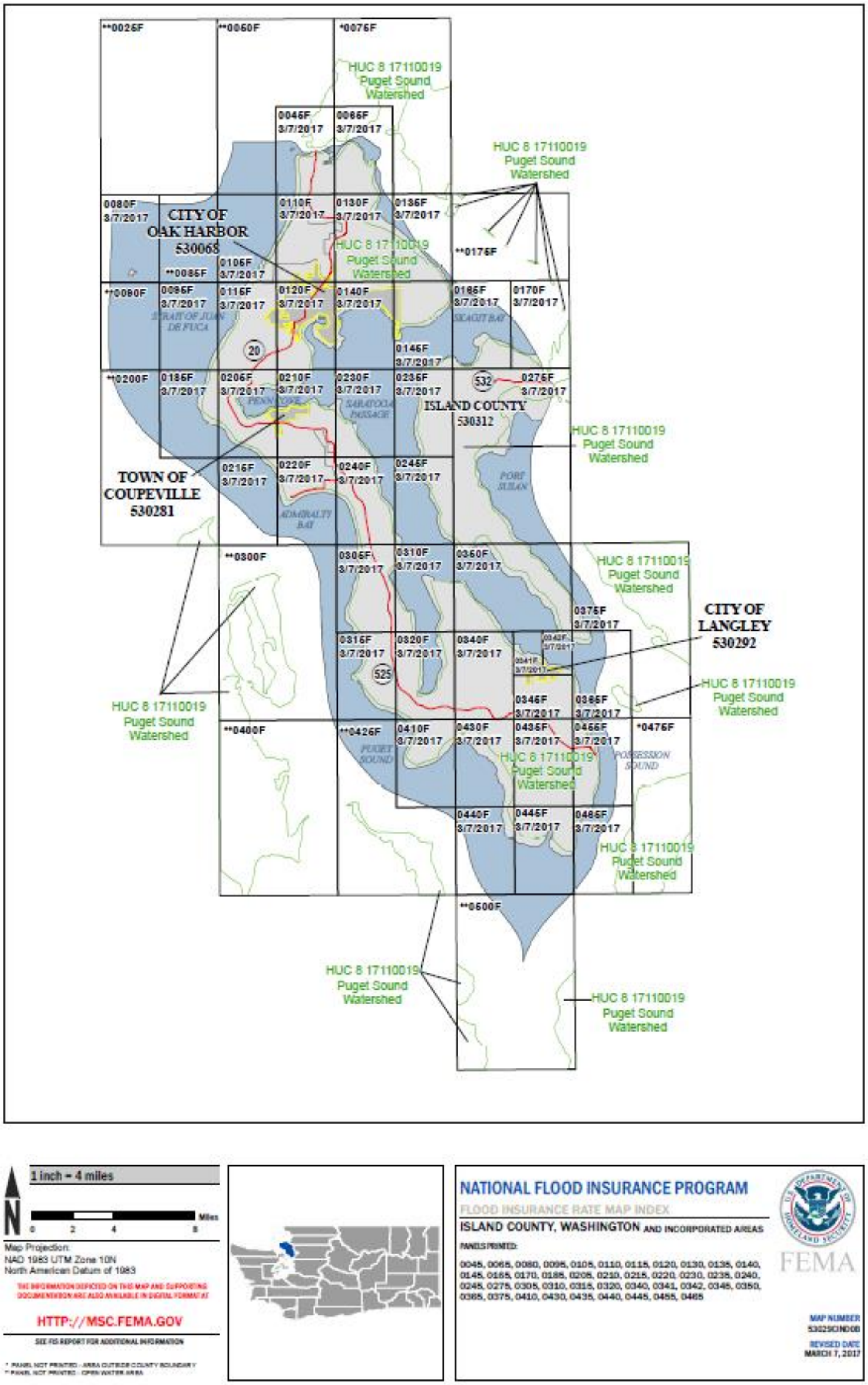


Figure 9-4 NFIP Firm Panel - Island County (2017)

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 9-5 shows the existing 100-year and 500-year floodplains within Island County, based on FEMA's existing flood insurance rate maps.

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 (referenced above). 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. These maps identify the geographic areas or zones that FEMA has defined according to varying levels of flood risk, and include: 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 (FEMA, 2003; FEMA, 2005; FEMA, 2008). Table 9-1 identifies the various rate map zones.[6] Figure 9-5 identifies Island County Flood Hazard Areas associated with applicable zones.

NFIP Participants, including Island County, 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.

TABLE 9-1.
FLOOD INSURANCE RATE MAP ZONES

Moderate to Low Risk Areas: Areas of moderate or minimal hazard are studied based upon the principal source of flood in the area. However, buildings in these zones could be flooded by severe, concentrated rainfall coupled with inadequate local drainage systems. Local stormwater drainage systems are not normally considered in a community's flood insurance study. The failure of a local drainage system can create areas of high flood risk within these zones. Flood insurance is available in participating communities, but is not required by regulation in these zones. Nearly 25-percent of all flood claims filed are for structures located within these zones.	
Zone	**Description**
B and X (shaded)	Area of moderate flood hazard, usually the area between the limits of the 100-year and 500-year floodplain area with a 0.2% (or 1 in 500 chance) annual chance of flooding. B Zones are also used to designate base floodplains of lesser hazards, such as areas protected by levees from 100-year flood, or shallow flooding areas with average depths of less than one foot or drainage areas less than one (1) square mile.
C and X (unshaded)	Area of minimal flood hazard, usually depicted on FIRMs as above the 500-year flood level. Zone C may have ponding and local drainage problems that do not warrant a detailed study or designation as base floodplain. Zone X is the area determined to be outside the 500-year flood and protected by levee from 100-year flood.
High Risk Areas: Special Flood Hazard Areas represent the area subject to inundation by 1-percent-annual chance flood. Structures located within the SFHA have a 26-percent chance of flooding during the life of a standard 30-year mortgage. Federal floodplain management regulations and mandatory flood insurance purchase requirements apply to participating communities in these zones.	
Zone	**Description**
A	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these zones.
AE	The base floodplain where base flood elevations are provided. AE Zones are now used on new format FIRMs instead of A1-A30 Zones.
A1-30	These are known as numbered A Zones (e.g., A7 or A14). This is the base floodplain where the FIRM shows a BFE (old format). Older maps still utilize this numbered system, but

[6] http://msc.fema.gov/webapp/wcs/stores/servlet/info?storeId=10001&catalogId=10001&langId=-1&content=floodZones&title=FEMA%20Flood%20Zone%20Designations

TABLE 9-1. FLOOD INSURANCE RATE MAP ZONES	
(old map format)	newer FEMA products no longer use the "numbered" A Zones. (Zone AE is used on new and revised maps in place of Zones A1–A30.)
AH	Areas with a 1% annual chance of shallow flooding, usually in the form of a pond, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
AO	River or stream flood hazard areas, and areas with a 1% or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Average flood depths derived from detailed analyses are shown within these zones.
AR	Areas with a temporarily increased flood risk due to the building or restoration of a flood control system (such as a levee or a dam). Mandatory flood insurance purchase requirements will apply, but rates will not exceed the rates for unnumbered A zones if the structure is built or restored in compliance with Zone AR floodplain management regulations.
A99	Areas with a 1% annual chance of flooding that will be protected by a Federal flood control system where construction has reached specified legal requirements. No depths or base flood elevations are shown within these zones.
High Risk - Coastal High Hazard Areas (CHHA): These represent the area subject to inundation by 1-percent-annual chance flood, extending from offshore to the inland limit of a primary front al dune along an open coast and any other area subject to high velocity wave action from storms or seismic sources. Structures located within the CHHA have a 26-percent chance of flooding during the life of a standard 30-year mortgage. Federal floodplain management regulations and mandatory purchase requirements apply in the following zones.	
Zone	**Description**
V	Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26% chance of flooding over the life of a 30-year mortgage. No base flood elevations are shown within these zones.
VE, V1-30	Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
Undetermined Risk Areas	
Zone	**Description**
D	Areas with possible but undetermined flood hazard. No flood hazard analysis has been conducted. Flood insurance rates are commensurate with the uncertainty of the flood risk.

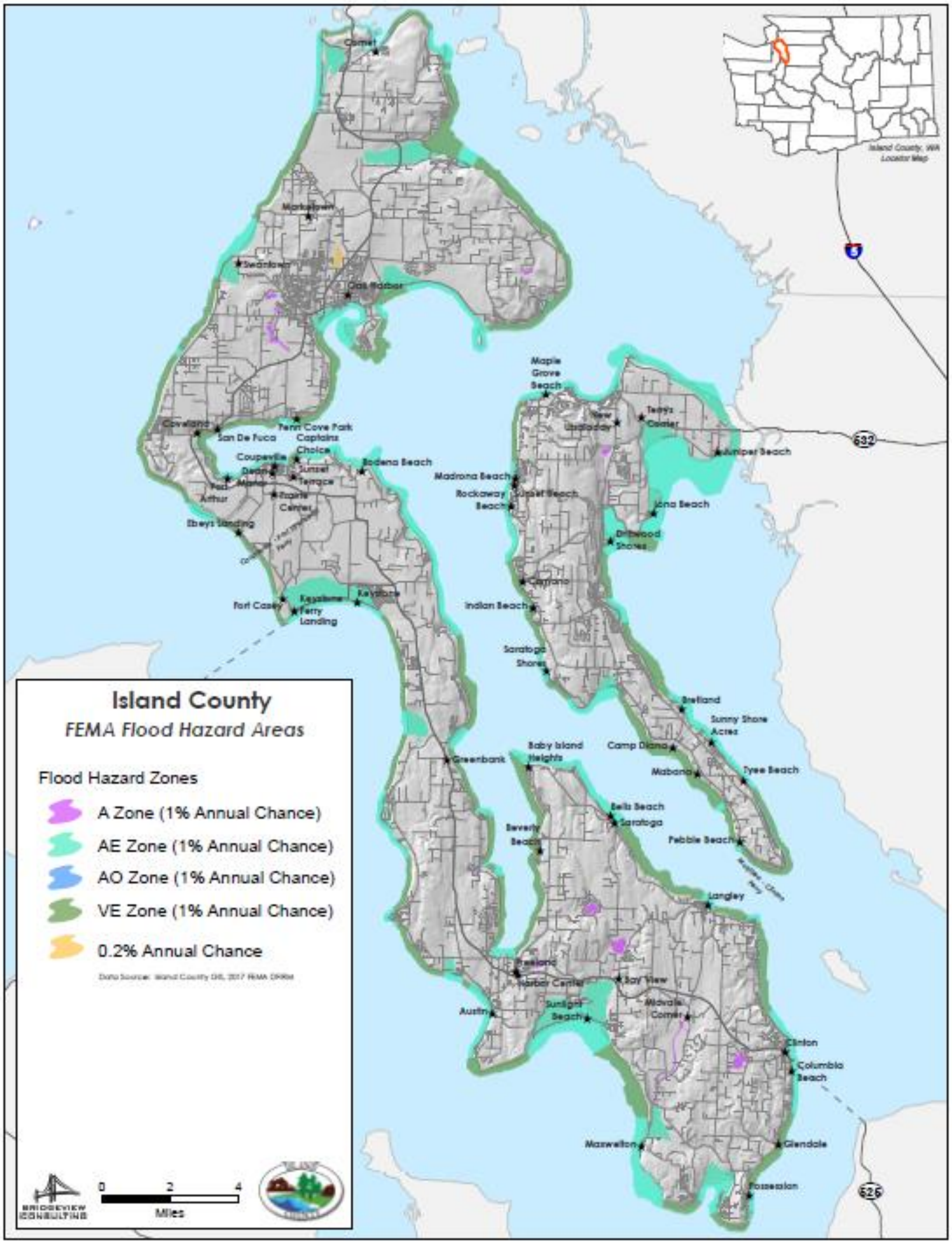


Figure 9-5 Island County Flood Hazard Areas

NFIP Status and Severe Loss/Repetitive Loss Properties

As of this writing, Island County is a member of the NFIP, and does incorporate regulatory authority within several elements of its land use planning for enforcement and inspection. The County does have a designated Floodplain Manager within its planning department. New construction is required to comply with Island County flood development, seismic risk, and other building code and geotechnical requirements so that there is no increased risk as a result of new development. "Critical area" standards address frequently flooded areas, geohazard areas and other concerns.

Island County provides building plan review services for the cities of Langley and Coupeville. However, ultimate responsibility for enforcement of their respective building codes and flood hazard regulations rests with those cities.

For development within the County (unincorporated), Island County requires elevation certificates for construction within flood hazard areas and other compliance information. The Building Department (via its Building Official) is responsible for ensuring compliance with flood hazard, seismic and building code requirements in unincorporated Island County.

Table 9-2 presents NFIP policy status as of August 2014. Table 9-3 presents the NFIP policy status as of September 30, 2019. Statistically, the County itself has reduced the number of policies in force since 2014, while Coupeville and Oak Harbor have increased its policies in force, with Langley reducing its policies by one (1). While the County and Langley have reduced the numbers of policies in-force, the overall amount of insurance has increased for all planning partners. Table 9-4 identifies the numbers of claims filed throughout the County, as well as the total amount of payouts under those policies.

TABLE 9-2.
2014 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
Total	1,028	258,727,100	1,208,481

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

TABLE 9-3.
2018 NFIP POLICY STATISTICS

Community Name	Policies In-Force	Insurance In-Force	Premiums In-Force
Island County	946	262,710,900	1,078,829
Coupeville	8	2,297,000	8,047
Langley	5	2,062,000	2,192
Oak Harbor	78	19,320,100	48,144
Total	1,037	286,390,000	1,137,212

Source: http://bsa.nfipstat.fema.gov/reports/1011.htm#WAT
Most recent available for 2020 Update

TABLE 9-4.
2019 NFIP CLAIMS STATISTICS

Community Name	Total Number of Losses	Closed Losses	Total Payments Issued
Island County	218	157	2,468,768.7
Coupeville	1	1	1,950.63
Langley	2	0	-
Oak Harbor	2	2	9,393.37
Total	223	160	2,480,112.70

Source: FEMA and WA DOE. Values are as of 9/30/18, the most recent available as of Jan. 7. 2020.

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 2018 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 September 2019 (most recent data available for update), 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.

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 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. 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 also 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 9-5 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 9-5.
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.			
November 2015 (Disaster 4242)	Severe winter storm, record and near record snow, heavy rains, landslides, winds, tidal surge	Unknown	Unknown
Description: Severe winter storm, including heavy rains, landslides, and winds.			

TABLE 9-5.
FLOOD EVENTS IMPACTING PLANNING AREA SINCE 1956

Date	Type	Deaths or Injuries	Property Damage
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 2019, 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.

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 FEMA 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 2.5 persons per household. Table 9-6 lists the estimated population located within these flood zones by municipality. There is currently one residential structure (mobile home) exposed to the adopted FEMA 0.2 percent annual chance flood hazard located in the unincorporated area of the county.

TABLE 9-6
EXPOSED 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	10,180	2
Coupeville	35	0
Langley	16	0
Oak Harbor	262	0
Total	**4,168**	**2**

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 9-7 summarizes the total area and number of structures in the 100-year flood boundary. Table 9-8 summarizes the estimated value of exposed buildings in the 100- year flood boundaries.

Two structures (one a residential mobile home and one an agricultural structure) are identified within the 500-year flood boundary; building and content value for both structures totals $149,984. Total land area within the 500-year flood boundary encompasses 68.9 acres; 14.3 acres within Oak Harbor and 54.6 acres within the unincorporated area of the county.

In order to provide a general estimate of the number of properties and structural/content exposed to the flood hazard area, the current FEMA DFIRM flood boundaries and Island County parcel GIS data containing assessed values 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 content) located in the flood zone.

TABLE 9-7
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	7,458	2,439	164	0	3	1	1	2	**2,610**
Coupeville	36	3	10	0	0	0	1	0	**14**
Langley	20	7	6	0	0	0	0	0	**13**
Oak Harbor	646	71	19	1	0	0	3	0	**94**
Total	**8,160**	**2,520**	**199**	**1**	**3**	**1**	**5**	**2**	**2,731**

TABLE 9-8.
VALUE OF STRUCTURES EXPOSED IN 100-YEAR FLOODPLAIN

	Value Exposed			**% of Total Assessed Value**
	Structure	**Contents**	**Total**	
Unincorporated	$485,624,731	$262,567,000	$748,191,731	8.62%
Coupeville	$5,234,628	$5,123,897	$10,358,525	2.35%
Langley	$3,068,246	$2,197,368	$5,265,614	2.28%
Oak Harbor	$42,632,210	$36,347,300	$78,979,510	1.97%
Total	**$536,559,815**	**$306,235,564**	**$842,795,379**	**6.30%**

Notes: Structure assessed value (AV) was calculated by subtracting the land AV from the total AV.
Sources (1) 2019 State of Washington, Department of Finance Estimated Populations
(2) Exposure numbers were estimated using Island County Parcel and Assessor data.
(3) FEMA Flood analysis based on the current County-wide Effective DFIRM GIS dataset.

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 was used to estimate critical facilities exposed to the flood risk. Table 9-9 and Table

9-10 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. 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.

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

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

TABLE 9-10.
CRITICAL INFRASTRUCTURE IN THE 100-YEAR FLOODPLAIN

Jurisdiction	Transportation	Water Supply	Wastewater	Power	Communications	Other	Total
Unincorporated	6	0	1	0	0	2	**9**
Coupeville	0	0	0	0	0	0	**0**
Langley	0	0	0	0	0	0	**0**
Oak Harbor	0	0	0	0	0	4*	**4**
Total	**8**	**0**	**0**	**0**	**0**	**3**	**13**

*The four "Other" structures in Oak Harbor are various cells of the City's Crescent Harbor Wastewater Lagoons identified as a dam on the dam inventory list maintained by WA DOE.

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. Business interruption losses associated with a flood event include not only the inability to operate a business because of damages sustained because of the flood (including inventory, equipment, structure, wages, relocation costs, etc.), but also include temporary living expenses for those individuals displaced from their homes because of the flood. In many cases, such individuals may relocate out of the area, impacting the economy which customarily would benefit from their proximity to local businesses.

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.

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 2016 as part of its Comprehensive Plan Update, which included land use map changes illustrated in Chapter 3 - Profile. It excludes areas designated as "critical areas" from consideration as buildable lands due to the scope of regulations affecting them, this includes floodplains. 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. Those codes are inspected and enforced through the County's planning department, among others. The buildable lands analysis assumes that these regulations will discourage development from these areas. As development expands, coordination with this mitigation plan will also occur to help define areas of potential risk and determining where development should take place, 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. Such actions should help ensure that limited impact is sustained as a result of new development within potentially flooded areas.

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.

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 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). While one roadway (SR 532) was enhanced on Camano Island since completion of the 2015 plan in coordination with WA DOT, additional transportation corridors should also be considered.
- 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.

9.7 IMPACT AND RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from flood throughout the area is likely. The area experiences some level of flood annually, albeit not necessarily to the level of a disaster declaration.

While structural damage may vary due to flood depths and existing floodplain management regulations, the county as a whole has been fortunate in that limited structures have been impacted; however, flooding does increase the probability of landslides, which can close down roadways. Such activity has occurred. Based on the potential impact, the Planning Team determined the CPRI score to be 2.2 with overall vulnerability determined to be a medium level.

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.

DEFINITIONS

Landslide—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, such as weight or saturation, acting upon them.

Mass Movement—A collective term for landslides, debris flows, falls and sinkholes.

Mudslide (or Mudflow or Debris Flow)—A river of rock, earth, organic matter and other materials saturated with water.

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 within a vertical elevation change of at least ten (10) feet.
- 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.

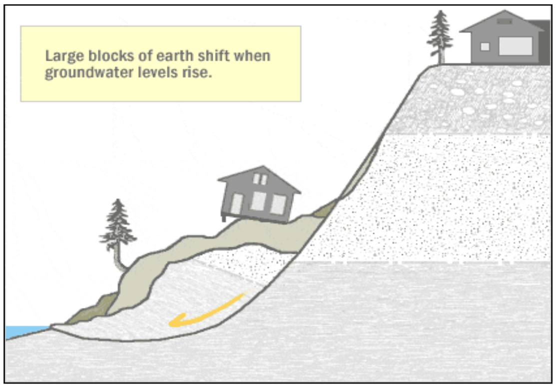


Figure 10-1. Deep Seated Slide

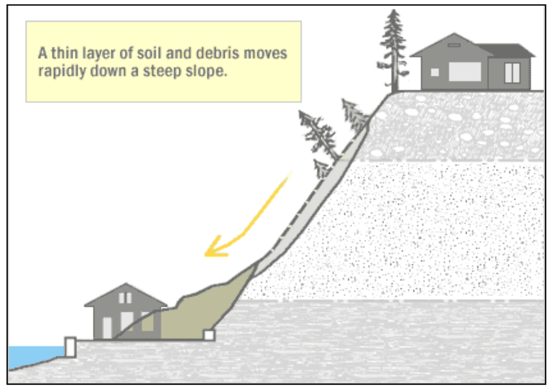


Figure 10-2. Shallow Colluvial Slide

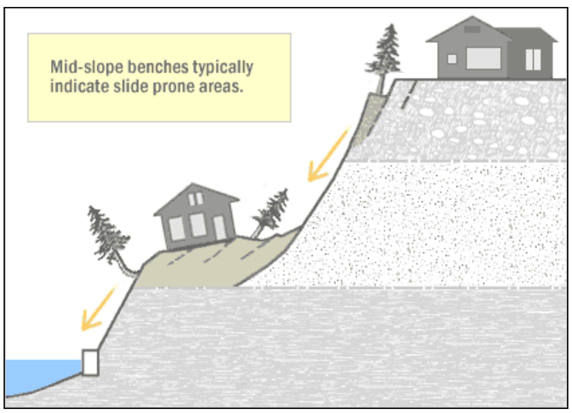


Figure 10-3. Bench Slide

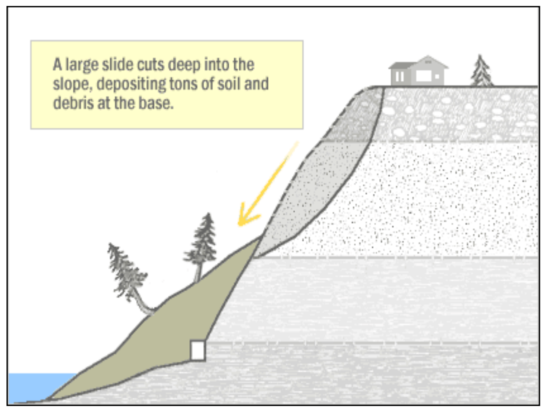


Figure 10-4. Large Slide

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. Figure 10-5 illustrates the Blowers Bluff slope. Erosion hazards in the County have also been mapped, and are contained in the Erosion profile. 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 which intersect those with FEMA's identified flood hazard areas. Figure 10-6 identifies those areas; however, it should be noted that while these areas are identified, the information is based on FEMA's previous flood maps, not the current 2017 maps in place. The illustration is the most currently available as of this 2020 update.

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

Source: WSDOT, 2010

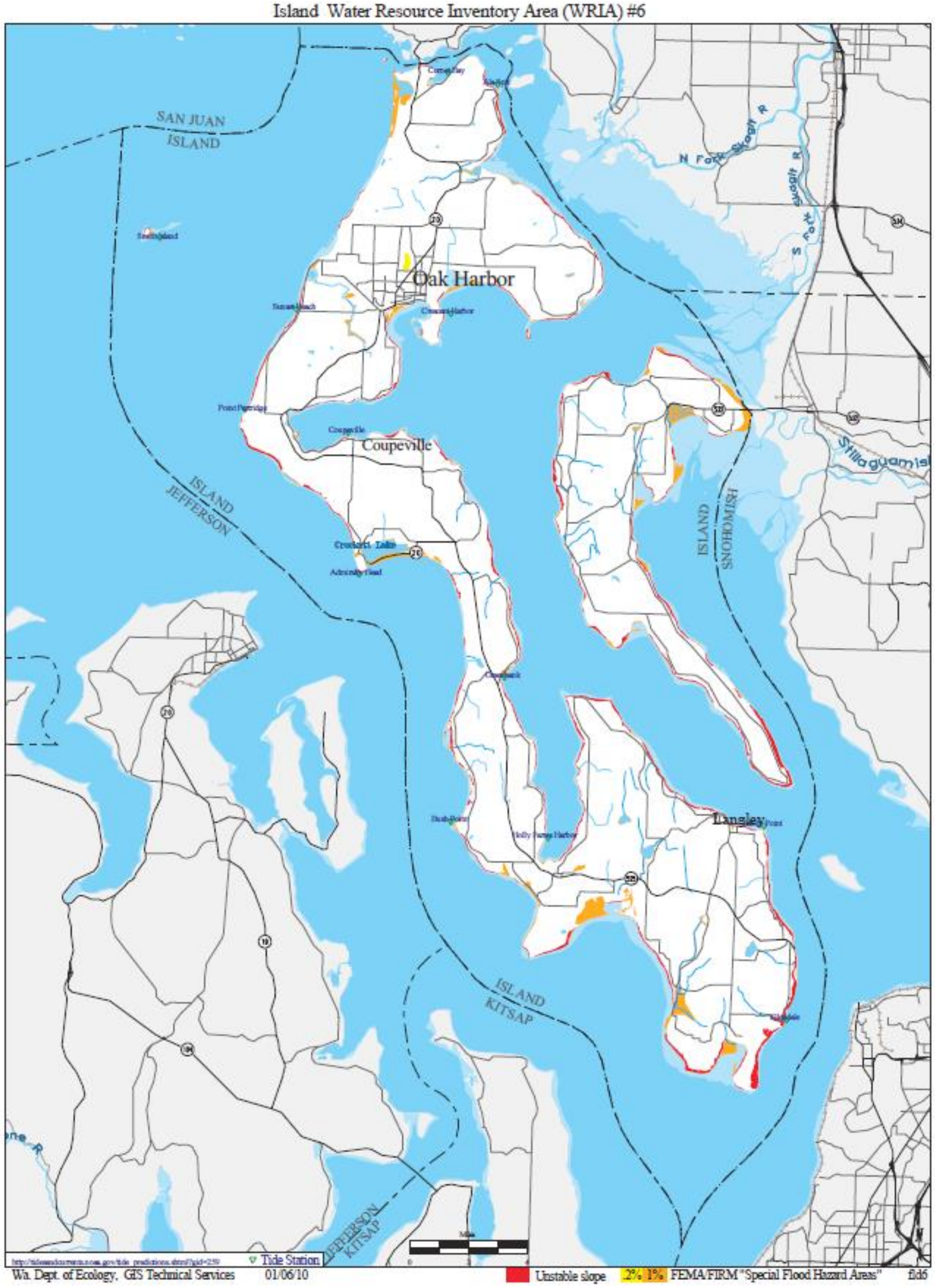


Figure 10-6. WRIA 6 Unstable Slopes

10.2.2 Previous Occurrences

Landslides of some degree within the planning area are fairly common. While the County has not sustained a FEMA declared event typed as a Landslide by itself, landslides have been included within the Flood and

Severe Weather declared events Readers should review those profiles for additional information. There are no records of fatalities or physical injuries due to landslide in the County.

One of the most significant landslides in the County is the Ledgewood-Bonair Landslide, which occurred on Whidbey Island 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). In 1991, a smaller landslide occurred in the same general area, which destroyed at least one home (Whidbey News-Times, 2013).[7] Photos of the slide are shown on Figure 10-7 through Figure 10-9.

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 10-10.
- 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.

[7] https://www.whidbeynewstimes.com/news/ledgewood-slide-declaration-dissolved/

Figure 10-7. Ledgewood-Bonair Landslide March 2013

Photo by: WDNR/Stephen Slaughter March 27, 2013

Figure 10-8. Ledgewood-Bonair Landslide

Source: Isabelle Sarikhan/WDNR.

Figure 10-9. Newly Exposed Hillside at Site of Ledgewood-Bonair Landslide

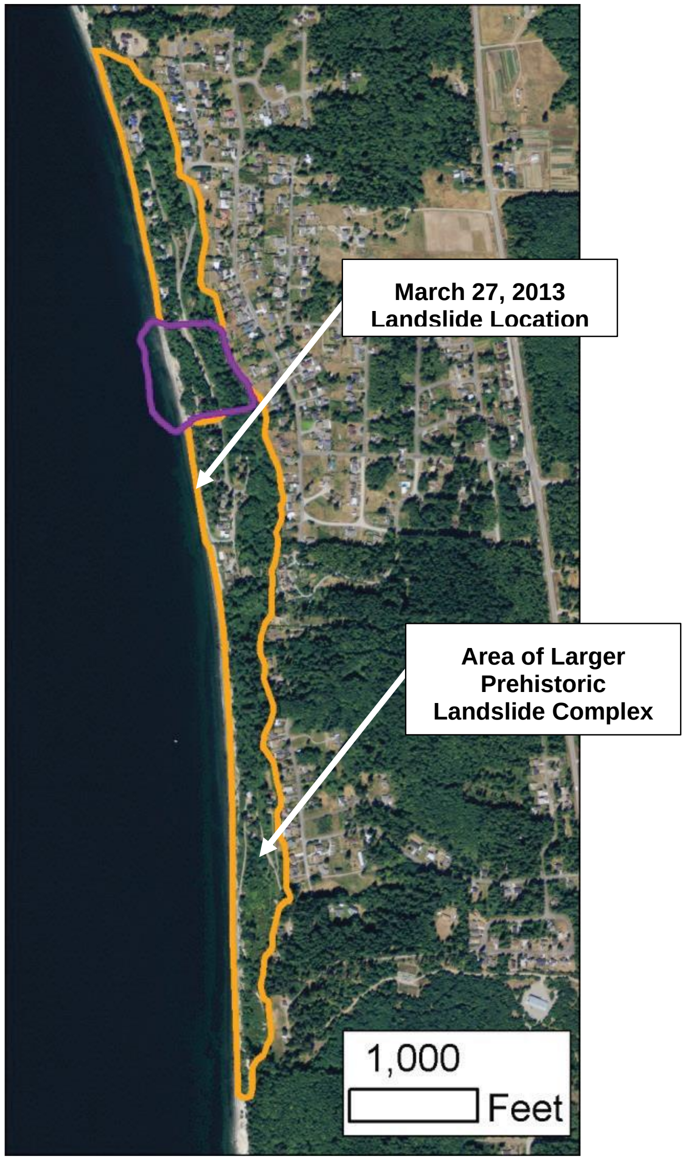


Figure 10-10. WDNR Reconnaissance Map of Ledgewood-Bonair Landslide

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. Figure 10-11 illustrates the loss of property and proximity to a residential structure associated with the Brentwood Slide, which occurred in 2016.

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.

Figure 10-11 Brentwood Slide (2016)

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). Snohomish County recovered 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. Five declared landslides have occurred in conjunction with severe storm events; however, some type of landslide event occurs almost 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.

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.

Warning Time

Unlike flood hazards which often are predictable, mass movements or landslides may be slow-moving, with limited warning, or have a sudden-onset; therefore, most are generally unpredictable. 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

Landslides can be fast moving, or slow creeping, with the fast moving obviously increasing the potential for injury or death from such an event. While landslide and erosion hazard areas are identified in the various maps contained in this hazard profile, it should be noted that areas identified within this document were based on existing data; no geotechnical or scientific analyses were conducted for development of this hazard mitigation plan as such analyses far exceed the intent of this document; therefore, no data should not be relied upon for life safety measures, or anything other than informing emergency managers of potential risk for planning purposes.

No damage function currently exists on which to establish population impact potential due to the unknown factors associated with the size of the slide, traffic patterns, area impacted, etc. Therefore, at a minimum, those residents living on bluffs or steep slopes would be more at risk, although landslides can, and have, occurred on relatively minor slopes. 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. Island County as a whole has a high transient population of tourists, especially during summertime months, increasing population count potentially impacted. Landslides can also damage water treatment facilities and wells, potentially harming water quality. 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.

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 number of structures exposed to the landslide hazards in the planning area are summarized in Table 10-1 and 10-2. Structures by building type are identified in Table 10-3. Table 10-4 identifies critical facilities potentially impacted. [It should be noted that identification of such structures within this document are for hazard mitigation planning purposes, and no life-safety measures (or other determinations) should be made based on this analysis as identification for such purposes far exceeds the intent of this plan. Reviewers of this document should contact appropriate subject matter experts should specific site information be required/desired.]

TABLE 10-1.
SLOPE HAZARD BUILDINGS EXPOSED TO COUNTY STEEP SLOPES (3)

Jurisdiction	Estimated Buildings Exposed (2)	Building Structure Value Exposed to Landslide (2)	Building Content Value Exposed to Landslide (2)	Sum of Structure and Contents Exposed to Landslide (2)	% of Total Value
Coupeville	10	$1,707,223	$1,045,616	$2,752,839	0.6%
Langley	20	$3,016,975	$1,865,716	$4,882,691	2.1%
Oak Harbor	7	$1,004,192	$528,576	$1,532,768	0.0%
Unincorporated County	1,010	$193,176,301	$101,534,670	$294,710,971	3.4%
Island County	**1,047**	**$198,904,691**	**$104,974,577**	**$303,879,268**	**2.27%**

Sources:
(2) Exposure numbers estimated using Island County Parcel and Assessor data.
(3) Steep slope data derived from 2014 Island County lidar data to identify locations of slope of 40% or greater for regulatory purposes. Polygons spanning elevation difference <10' were deleted.

TABLE 10-2.
SLOPE HAZARD BUILDINGS EXPOSED TO COUNTY UNSTABLE SLOPES (4)

Jurisdiction	Estimated Buildings Exposed (2)	Building Structure Value Exposed to Landslide (2)	Building Content Value Exposed to Landslide (2)	Sum of Structure and Contents Exposed to Landslide (2)	% of Total Value
Coupeville	12	$2,565,603	$1,282,802	$3,848,405	0.9%
Langley	17	$2,703,317	$1,641,848	$4,345,165	1.9%
Oak Harbor	2	$433,895	$216,948	$650,843	0.0%
Unincorporated County	1,027	$200,483,631	$103,291,694	$303,775,325	3.5%
Island County	1,058	$206,186,446	$106,433,291	$312,619,737	2.34%

Sources:
(2) Exposure numbers estimated using Island County Parcel and Assessor data.
(4) Unstable slope data intended to educate the public about Washington's shoreline and to guide regional land use decisions. These maps should not be used as a substitute for site-specific studies carried out by qualified geologists and engineers.

TABLE 10-3.
STRUCTURES BY BUILDING TYPE EXPOSED TO STEEP SLOPES

Jurisdiction	Government	Industrial	Residential	Commercial	Agricultural
Unincorporated County	1	0	941	67	0
Coupeville	0	0	8	2	0
Langley	0	0	13	7	0
Oak Harbor	0	0	6	1	0
Total	**1**	**0**	**968**	**77**	**0**

10.3.4 Impact on Critical Facilities and Infrastructure

Table 10-4 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 10-4.
CRITICAL FACILITIES EXPOSED TO LANDSLIDE HAZARDS

Jurisdiction	Steep Slopes	Unstable Slopes
Unincorporated County	4	1
Coupeville	1	0
Langley	0	0
Oak Harbor	0	0
Total	**5**	**1**

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.

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.

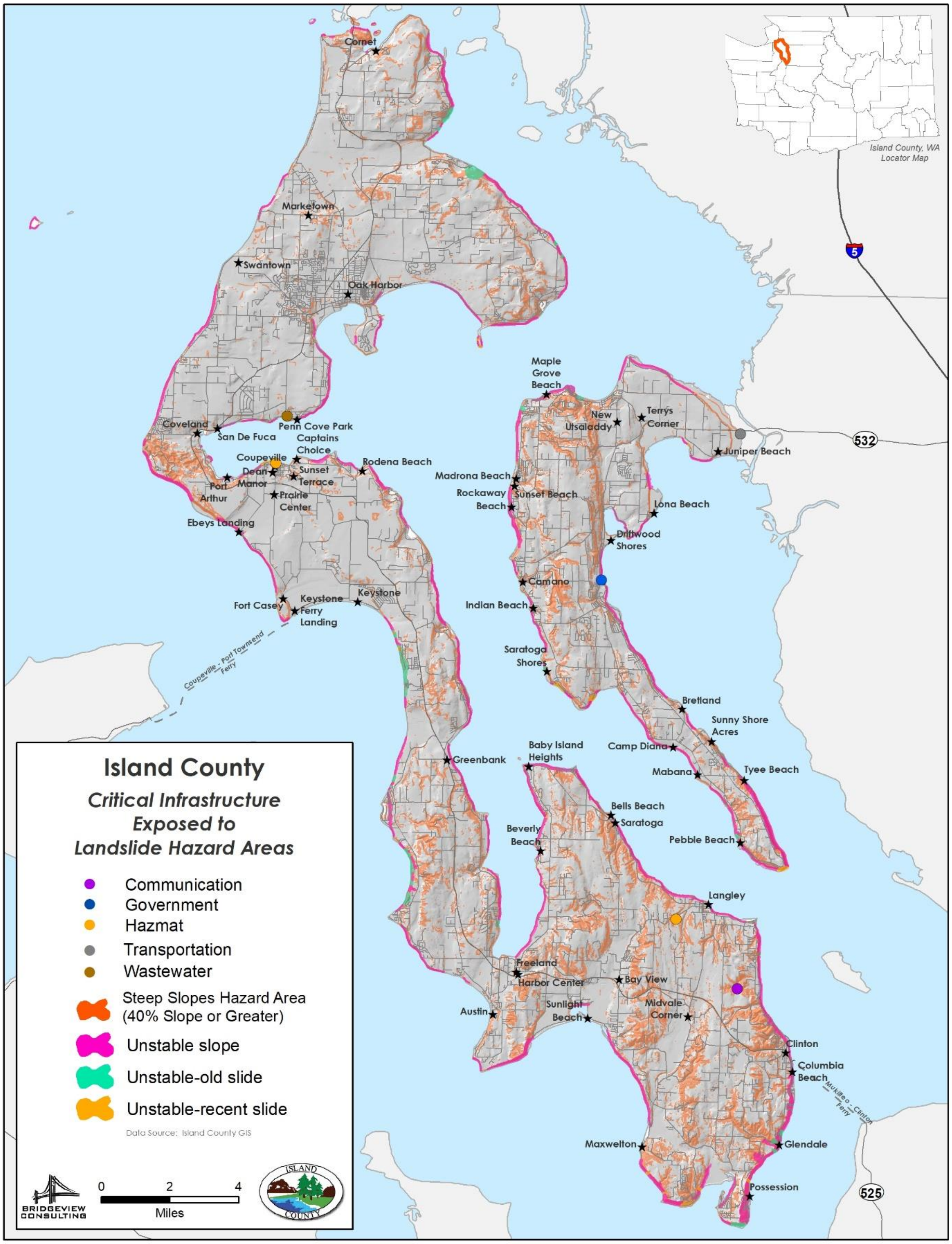


Figure 10-12. Landslide Risk to Critical Facilities

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.

In research on landslides and climate change conducted by Jeffrey Coe, Mr. Coe indicated that within the United States, the impacts of climate change on landslide activity will be greatest in Alaska, followed by Pacific Northwest States of Washington and Oregon as a result of glacial retreat in the Cascade Mountains. The projected increase in sea level will impact all coastal states, but States along the West Coast (Alaska, Washington, Oregon, California, Hawai'i) appear to be most susceptible to increased landslide activity.

In the western United States, research indicates that the number of wildfires has increased and may continue to do so in the future. This trend suggests that there will be increased possibilities for post-wildfire debris flows, although their frequency and magnitude is dependent on future precipitation, which is highly uncertain. For the rest of the United States, the impact of climate change on landslide hazards is unclear because of the high uncertainty in projections of future precipitation and evapotranspiration. In particular, there is large uncertainty in changes in the magnitude and frequency of extreme storms and regional climate phenomena such as the El Niño Southern Oscillation, tropical cyclones, and the North American Monsoon. These phenomena can have a profound influence on the frequency and magnitude of shallow landslides and debris flows. Given this summary, it seems appropriate that the West Coast States have been the most aggressive in developing adaptation strategies that include landslide hazards. (Coe)

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.

10.7 IMPACT AND RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from a landslide throughout the area is highly likely. The area experiences some level of landslides and erosion almost annually. The coastal bluff areas and areas along waterways have issues with both landslides and erosion. Areas throughout the County have identifiable landslide risk. While there are areas where no landslide risk areas are identified, landslides can nonetheless occur on fairly low slopes, and areas with no slopes can be impacted by slides at a distance.

No injuries or deaths have been reported as a result of landslides, but property damage has occurred, albeit the number of structures exposed are limited in nature when viewed from the respect of the landslide hazard area and identified exposure. Also of concern is the impact to roadways, which have the potential for increased impact, including isolation of areas.

Based on the potential impact, the Planning Team determined the CPRI score to be 2.65 with overall vulnerability determined to be a high level.

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

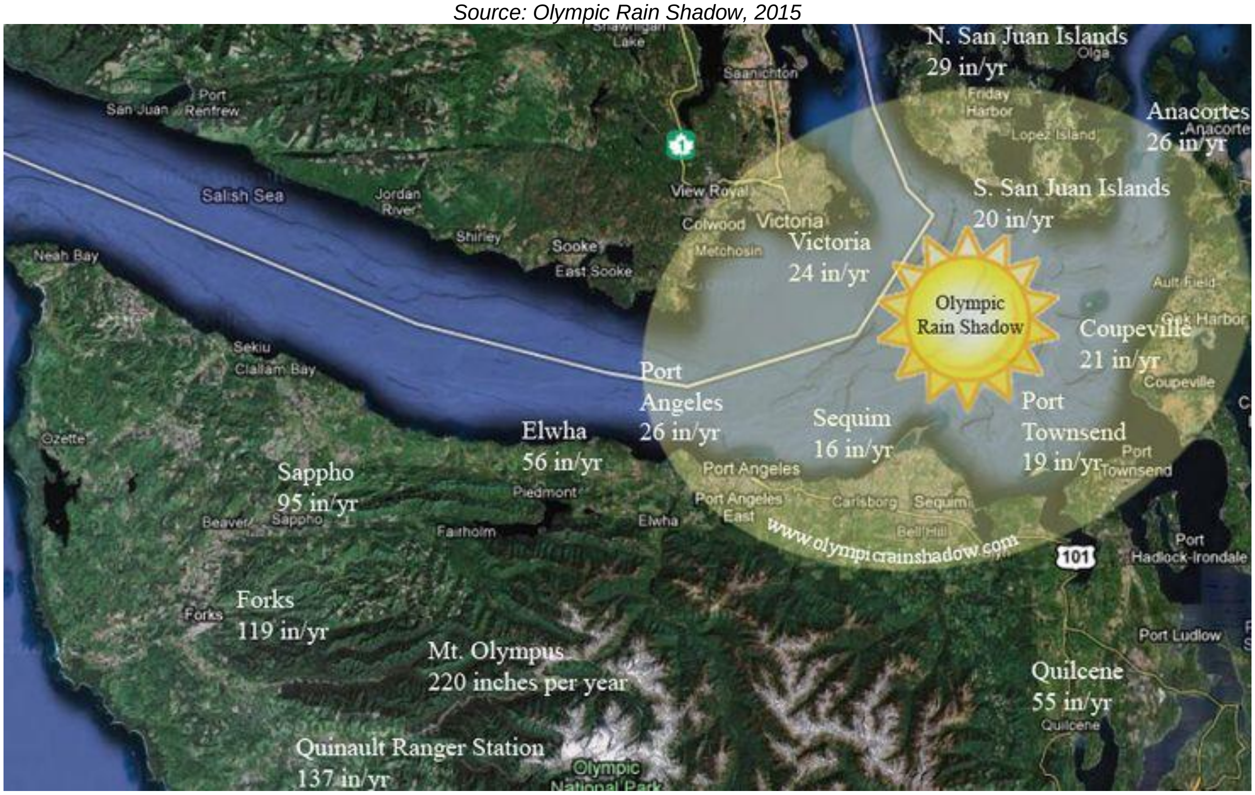


Figure 11-1. Washington's Rain Shadow

Source: Wikimedia.org, 2015

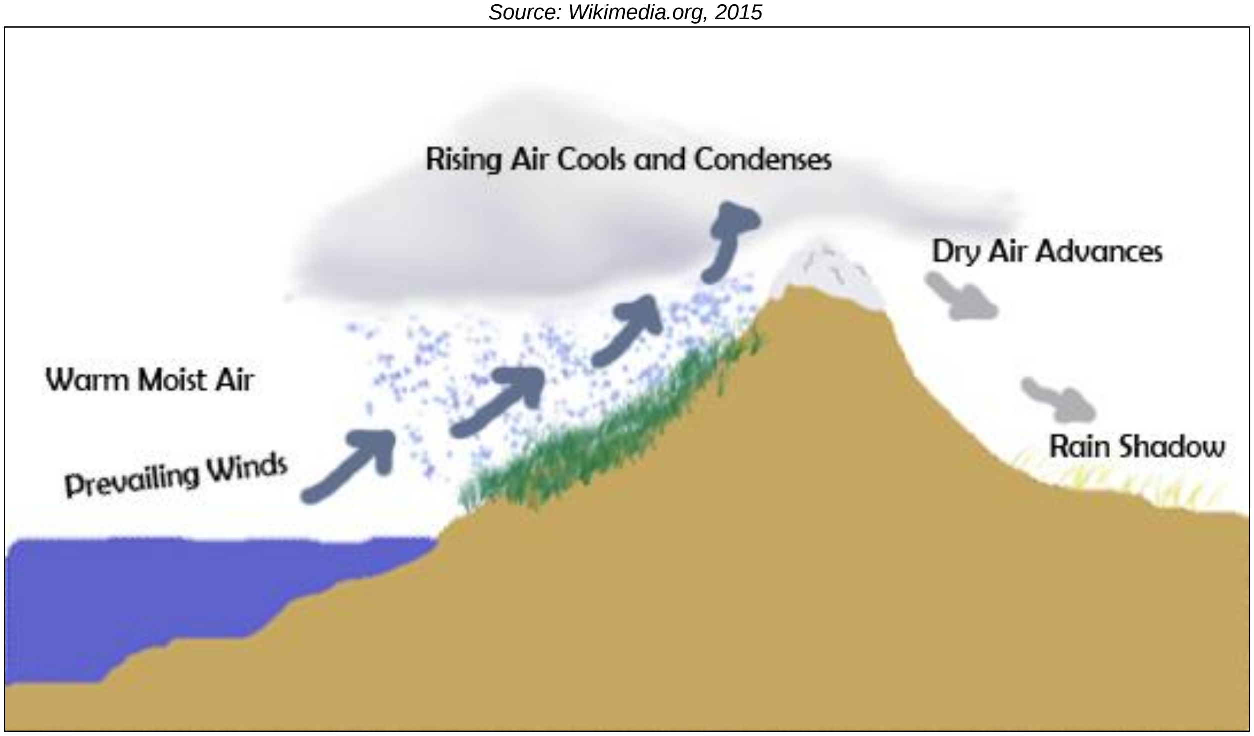


Figure 11-2. Rain Shadow Effect

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):

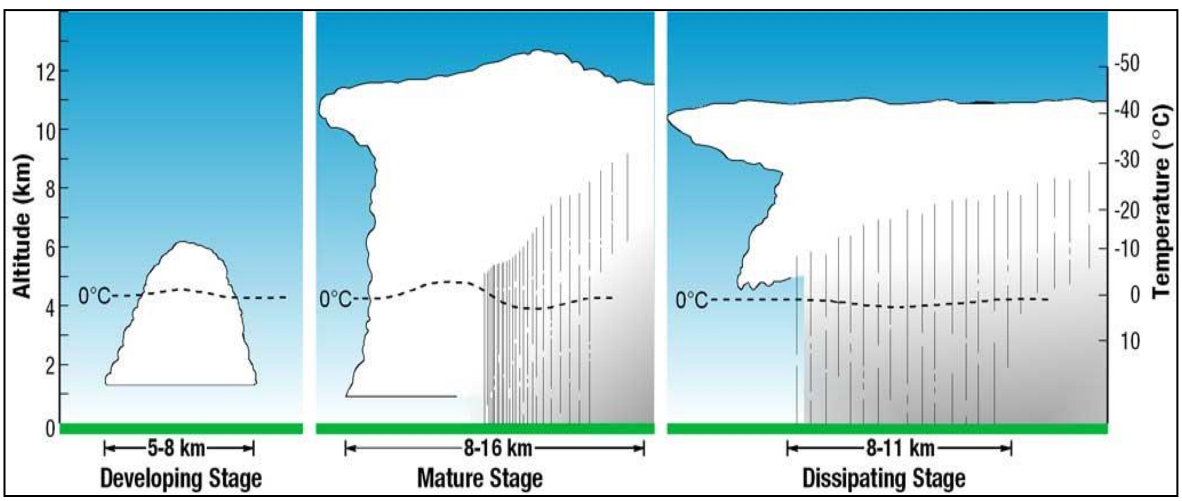


Figure 11-3. The Thunderstorm Life Cycle

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 49th nationwide in deaths associated with lightning strikes, having five deaths during the time period 1959-2018 (most recent data available). The most recorded deaths nationwide on an annual basis was 40 in 2016, with 2017 having the fewest deaths since 2008, at 16. Figure 11-4 identifies the average number of thunderstorms days annually across the United States.

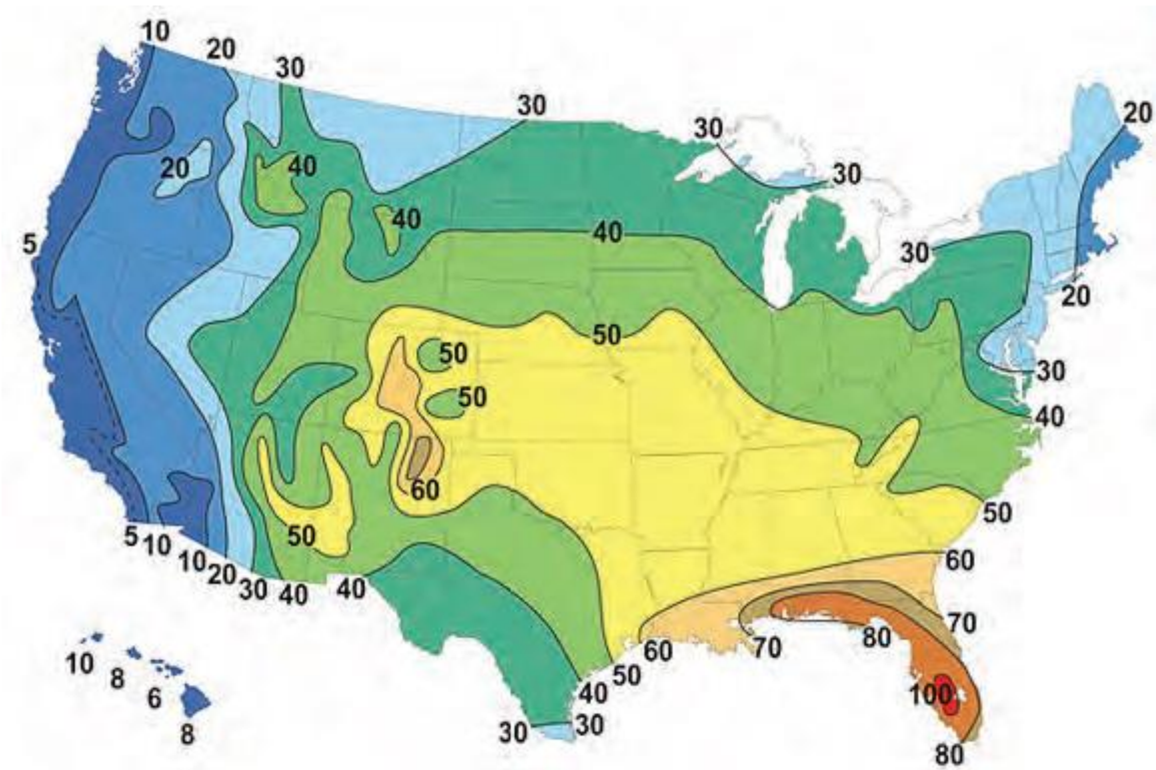


Figure 11-4. Average Number of Thunderstorms Days Annually

Source: NOAA

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.

Based on an analysis completed in 2019 by John Jensenius, Jr., of the National Lightning Safety Council victims of lightning fatalities are most often engaged in leisure activities; of those, 80 percent of victims involved were male (see Figure 11-5). Based on NOAA data, of the deaths reported nationwide during the time period 2008-2018, 237 were male, and 65 were female.[8]

[8] NOAA. US Lightning Deaths. Accessed 13 Jan 2020. Available online at: https://www.weather.gov/safety/lightning-fatalities18

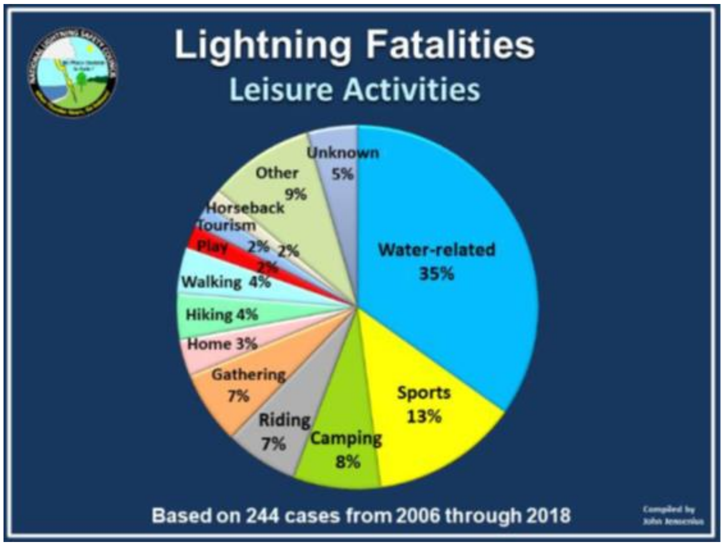


Figure 11-5. Lightning Fatalities by Leisure Activities

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.
- **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 11-6. 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

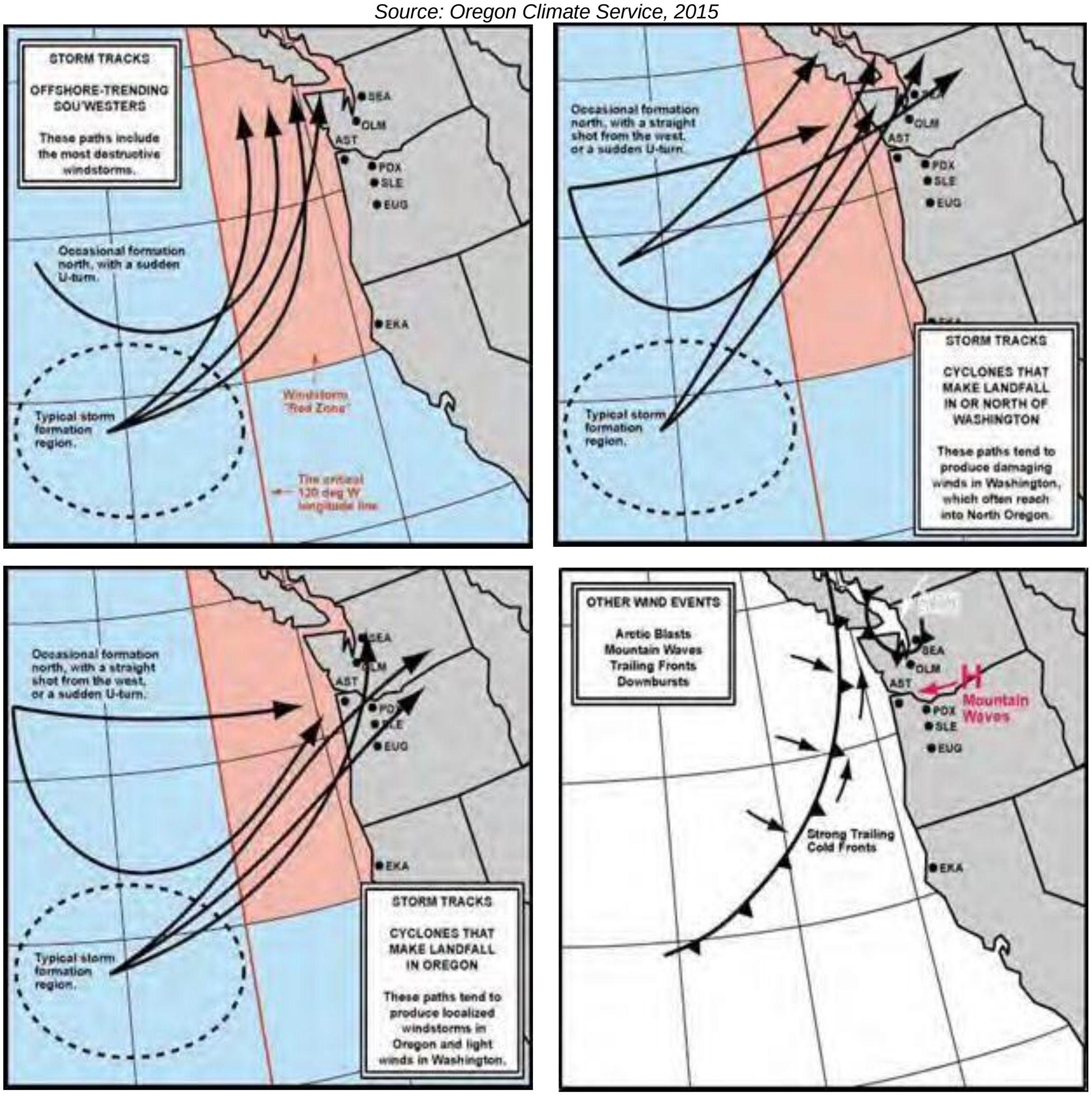


Figure 11-6. Windstorm Tracks Impacting the Pacific Northwest

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 11-7), 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

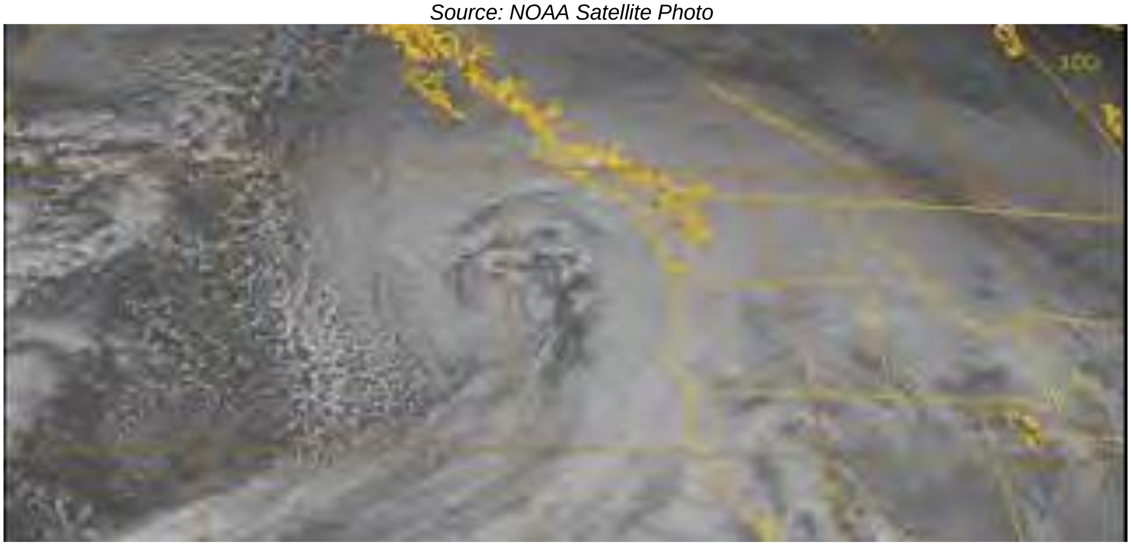


Figure 11-7. Hanukkah Eve Windstorm of December 13, 2006

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 and Snow 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 11-8).

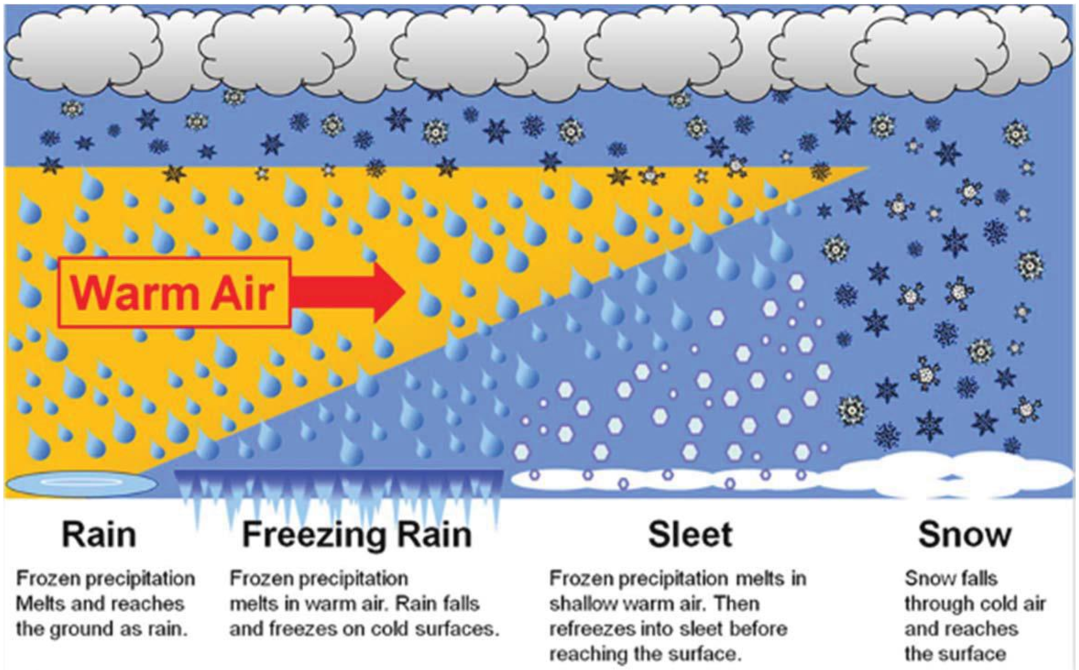


Figure 11-8. Types of Precipitation

Precipitation falls as snow when air temperature remains below freezing throughout the atmosphere. In many climates, precipitation that forms in wintertime clouds starts out as snow because the top layer of the storm is usually cold enough to create snowflakes. Snowflakes are just collections of ice crystals that cling to each other as they fall toward the ground. Precipitation continues to fall as snow when the temperature remains at or below 0 degrees Celsius from the cloud base to the ground. The following are used to define snow events:

- Snow Flurries. Light snow falling for short durations. No accumulation or light dusting is all that is expected.
- Snow Showers. Snow falling at varying intensities for brief periods of time. Some accumulation is possible.
- Snow Squalls. Brief, intense snow showers accompanied by strong, gusty winds. Accumulation may be significant. Snow squalls are best known in the Great Lakes Region.
- Blowing Snow. Wind-driven snow that reduces visibility and causes significant drifting. Blowing snow may be snow that is falling and/or loose snow on the ground picked up by the wind.
- Blizzards. Winds over 35mph with snow and blowing snow, reducing visibility to 1/4 mile or less for at least 3 hours.

While the County does occasionally experience snowfall, in most instances, the accumulations are not significant. Figure 11-9 illustrates the amount of snowfall within the Seattle area since 2004 as recorded at Sea-Tac Airport, the official weather station for the area.[9]

[9] Seattle Weather Blog. Accessed 28 Jan 2020. Available at http://www.seattleweatherblog.com/snow-stats/

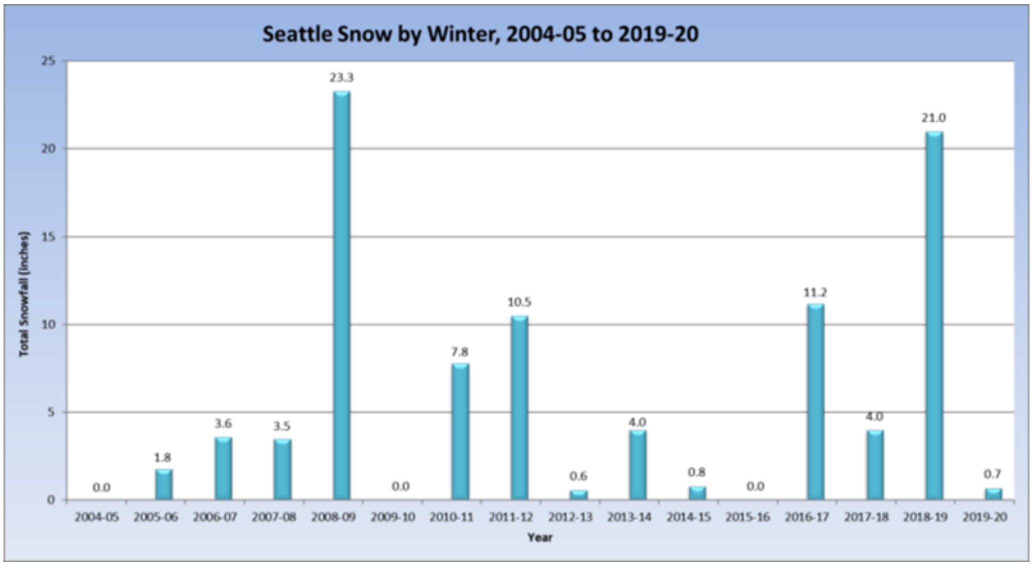


Figure 11-9 Snowfall Accumulations (Sea-Tac Weather Station) 2004-2020

11.1.7 Extreme Temperatures

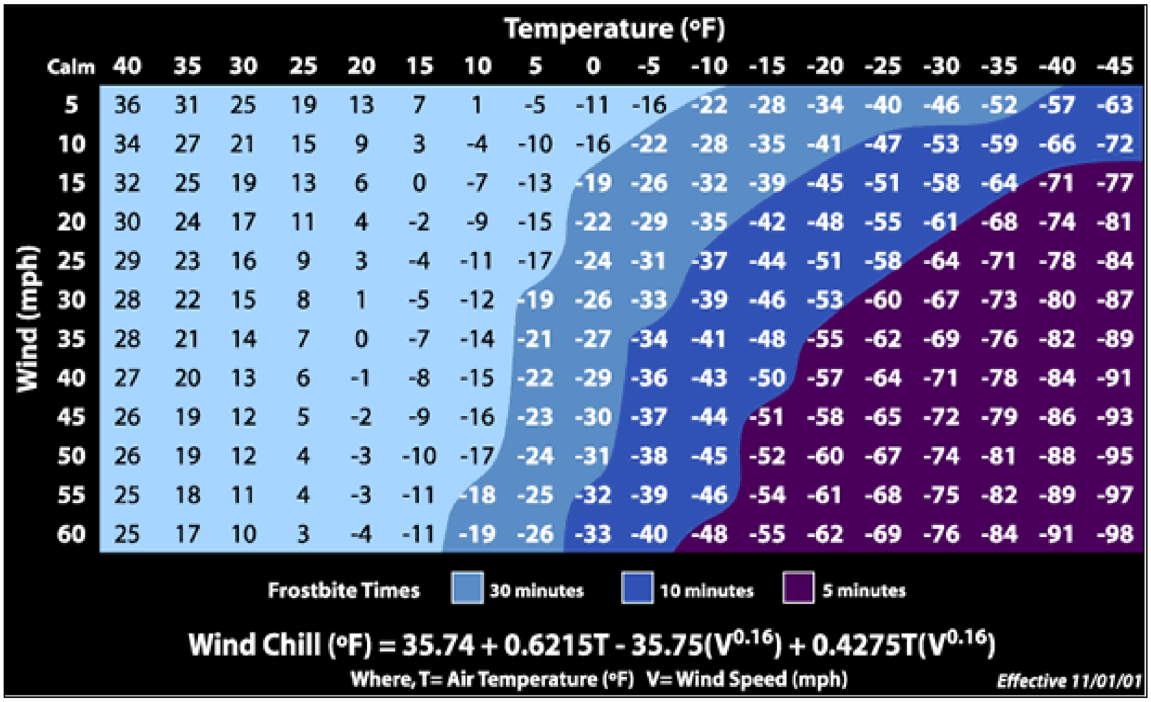
Extreme temperature includes both heat and cold events, which can have a significant impact on human health, commercial/agricultural businesses and primary and secondary effects on infrastructure (e.g., burst pipes and power failure). What constitutes "extreme cold" or "extreme heat" can vary across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

Extreme Cold

Extreme cold events exist when temperatures drop below normal. 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 quickly carrying away body heat, making it feel colder than is indicated by the actual temperature (known as wind chill). Figure 11-10 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.

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.



Wind (mph) \ Temperature (°F) 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

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

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

Effective 11/01/01

Figure 11-10. NWS Wind Chill Index

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, CDC). 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. 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. Figure 11-11 shows the number of weather fatalities based on a 10-year average and 30-year average[10]. Heat has the highest average of weather related fatalities between 2009 and 2018.

[10] NOAA, 201https://www.weather.gov/hazstat/ (Most recently available at time of update.)

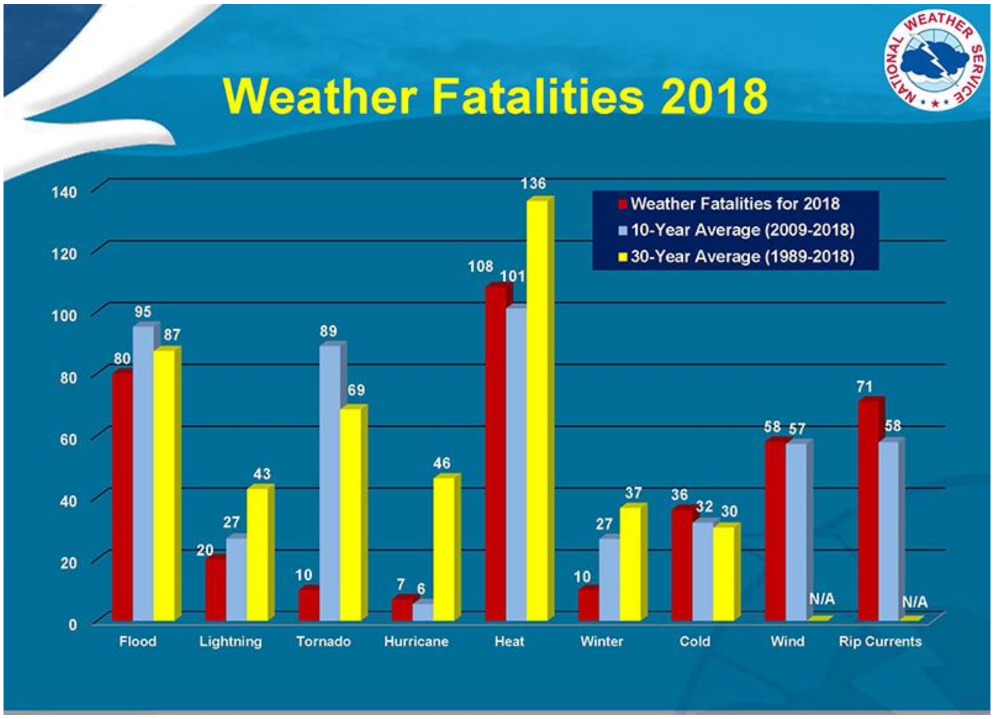


Figure 11-11. Average Number of Weather Related Fatalities in the U.S.

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, and people with disabilities and chronic diseases.

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 September to May, although they have occurred year round. January and March are the months which have historically experienced the highest number of severe weather events, three and two, respectively, with February, May, October and November each experiencing one event. The County has been impacted by strong winds, tornadoes, rain, snow, or other precipitation, and often are accompanied by thunder or lightening. 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 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 11-12 through Figure 11-15.

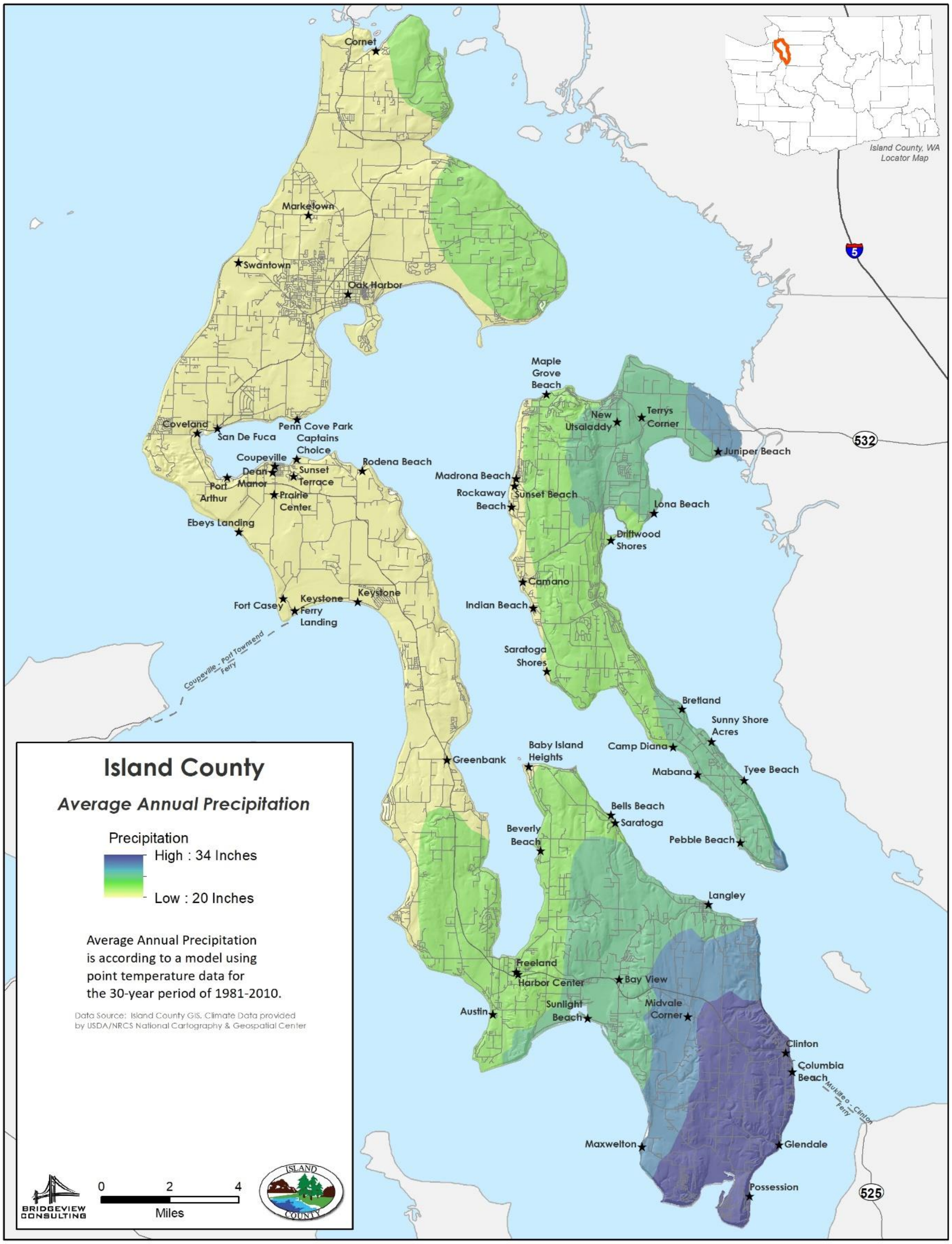


Figure 11-12. Island County Average Annual Precipitation

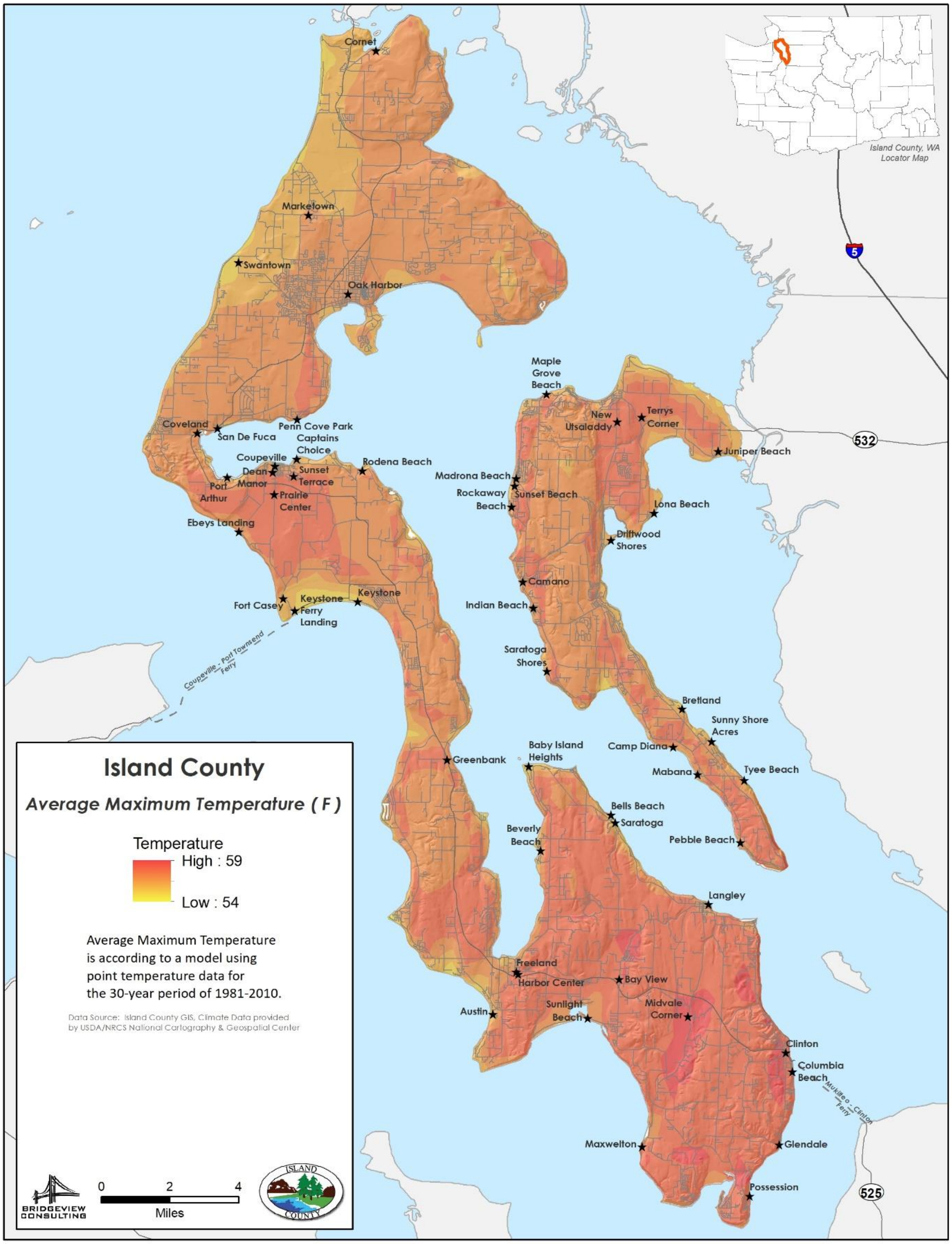


Figure 11-13. Island County Average Maximum Temperature

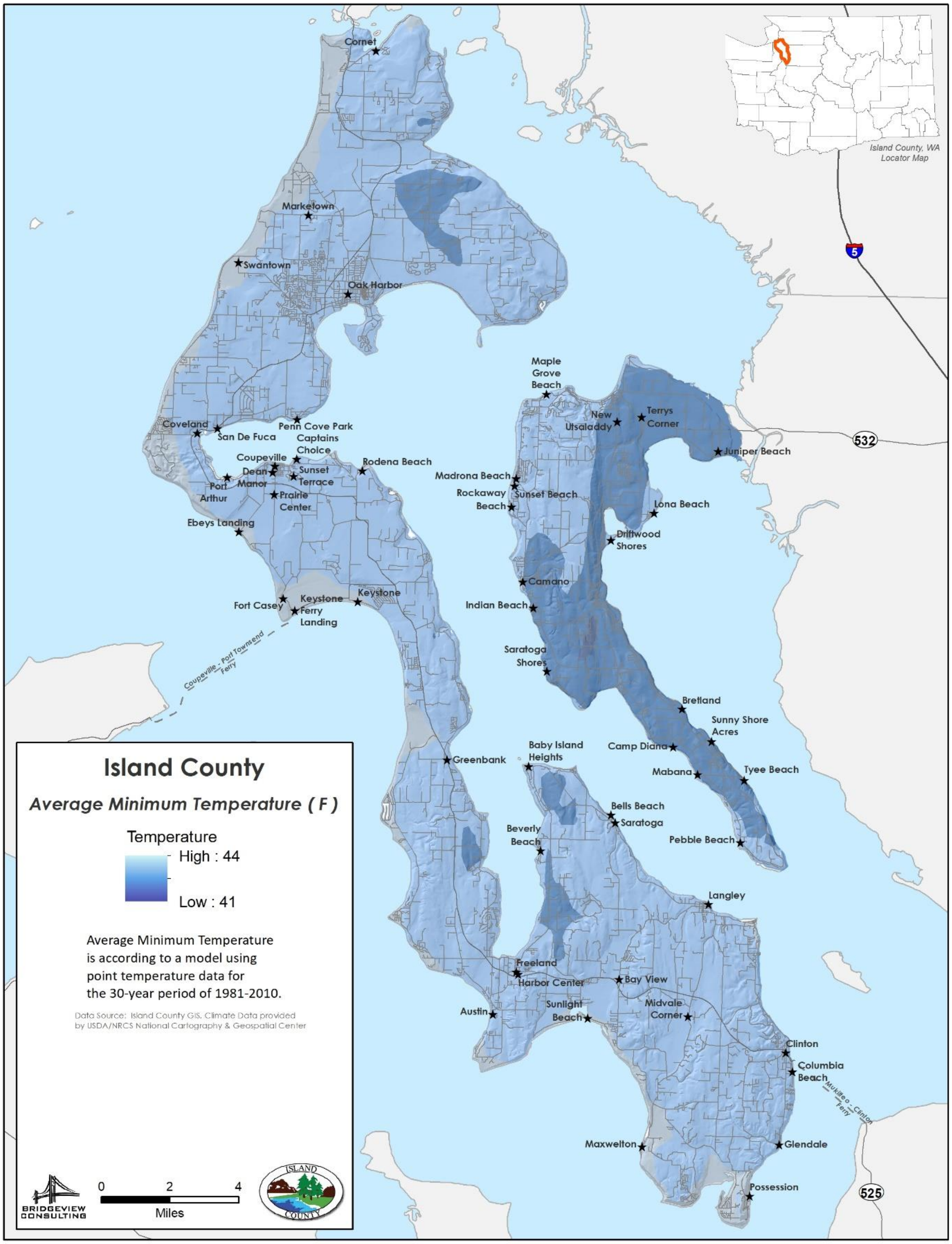


Figure 11-14. Island County Average Minimum Temperature

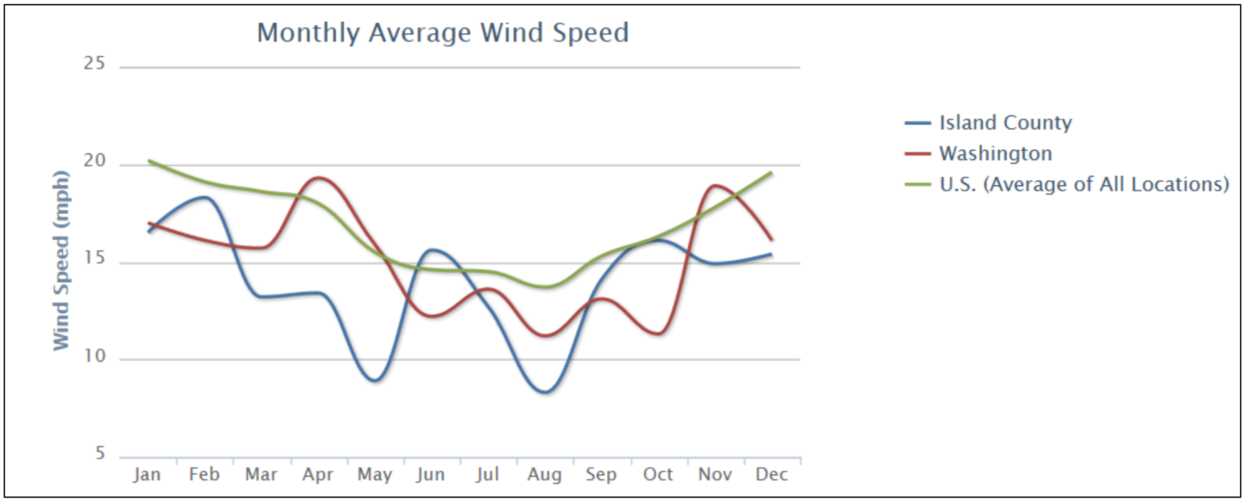


Figure 11-15. Island County Monthly Average Wind Speed

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 11-16 compares the 1962 Columbus Day Storm to the 2007 event[11].
- 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 11-18).[12] Citizens reported waves as high as

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

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

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.
- In late December 2018, Whidbey Island, as much of western Washington, experienced a severe winter storm. The windstorm associated with the storm resulted in over 322,000 homes and businesses losing power during the peak of the storm's outages. Rainfall was 1-2 inches, adding to the 3-10 inches that had fallen over the are in the preceding week. The Deception Pass Bridge closed due to downed trees and power lines; winds at Coupeville hit 44 MPH. Power outages left schools closed including all schools in Coupeville. Much of Whidbey Island was without power and remained that way for one-two days.

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)			
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

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

Date	Type	Deaths or Injuries	Property Damage
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.			
August 2015 (Disaster 4242)	Severe wind storm	Unknown	Public Assistance to all declared counties was over $6.3 million
Description: Severe wind storm impacted much of the state with wind and rain, knocking down utility poles and trees across western Washington. A 36-year old man was struck and killed by a falling tree in Gig Harbor while driving down a local road; his three year old daughter was also in the car at the time, but was uninjured. In Federal Way, a falling tree branch killed a 10-year-old girl. NWS issued high wind warnings for much of the region, with sustained winds of 20-35 mph, and gusts up to 50+ in some areas. Highest gust recorded were on the coast. (See Figure 11-17 for peak gust speeds.)			
November 2015 (Disaster 4249)	Severe winter storm, straight line winds, land and mudslides	Unknown	PA $25M statewide
Description: Severe winter storm, including winds, land and mudslides (See Figure 11-17)			
December 2018 (Disaster 4418)	Severe winter storm, straight line winds, land and mudslides	Unknown	Unknown
Description: Severe winter storm, including winds, land and mudslides, tornado			

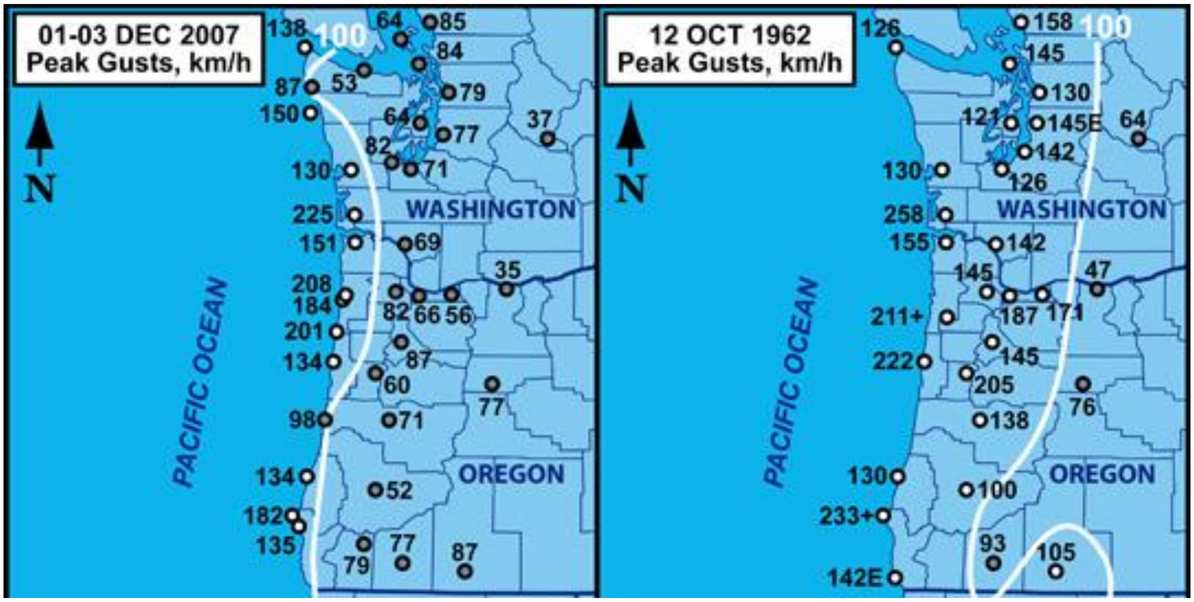


Figure 11-16. Peak Gust Comparison- 2007 Great Coastal Gale and 1962 Columbus Day Storm

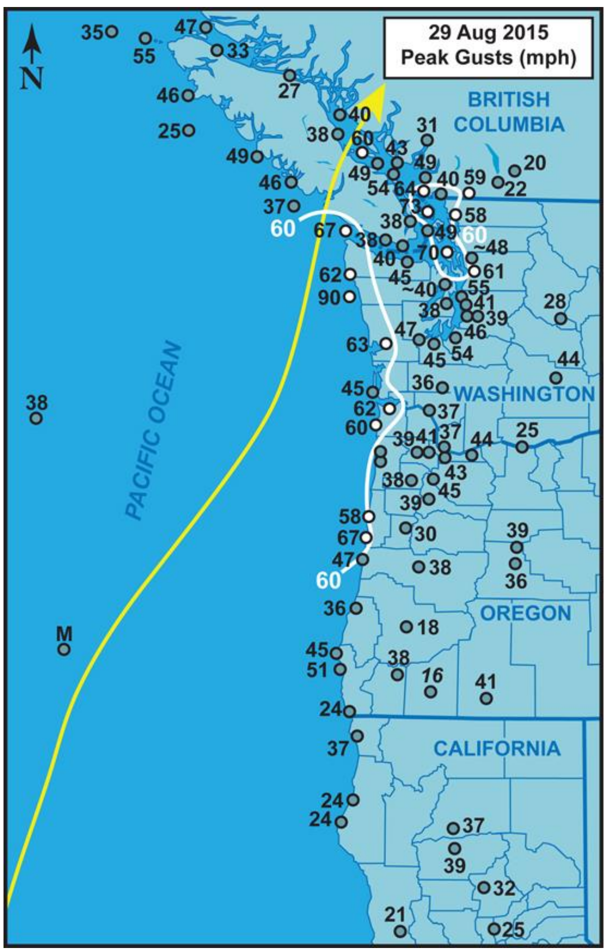


Figure 11-17. August 29, 2015 Peak Gusts (Disaster # 4242)

Figure 11-18. West Beach Road Storm Debris - December 2012 Severe Storm Event

Figure 11-19. August 2015 Windstorm 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. Island County average snowfall is 3-5 inches. Historic records in Western Washington are:

- 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, 2019).

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 11-10 shows the new wind chill temperature index[13]. 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, 2019).

The extent of extreme temperatures is generally measured through the heat index shown in Figure 11-20[14]. 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

[13] NWS, 2008

[14] NCDC, 2000

temperature and humidity can have on the population (NCDC, 2000). Figure 11-21 describes the adverse effects that prolonged exposure to heat and humidity can have on an individual[15].

		Temperature (°F)															
Relative Humidity (%)		**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 11-20. 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 11-21. Adverse Effects of Prolonged Exposures to Heat on Individuals

[15] NYSDEC, 2008

11.2.4 Frequency

The severe weather events for Island County identified 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. Winds are the most common event causing damage. The planning area can expect to experience exposure to some type of severe weather event at least annually.

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.

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 expand the Community Paramedic Program, which works 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 continuing 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 approximately 40,000 structures in the planning area totaling ~$13.4 billion dollars of building and content value. 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
Coupeville	843	$440,648,701	$44,064,870.10	$132,194,610.30	$220,324,350.50
Langley	714	$231,125,633	$23,112,563.30	$69,337,689.90	$115,562,816.50
Oak Harbor	8,060	$4,016,992,564	$401,699,256.35	$1,205,097,769.05	$2,008,496,281.75
Unincorporated County	30,426	$8,681,024,425	$868,102,442.45	$2,604,307,327.35	$4,340,512,212.25
Total	**40,043**	**$13,369,791,322**	**$1,336,979,132**	**$4,010,937,397**	**$6,684,895,661**

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. For Island County, this would also include ferry services. 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 11-22). The changing hydrograph caused by climate change could have a significant impact on the intensity, duration and frequency of storm events. In addition, sea level rise will also impact the county and its planning partners. As water levels rise, the amount of erosion may also increase, causing more damage in certain areas. All of these impacts could have significant economic consequences.

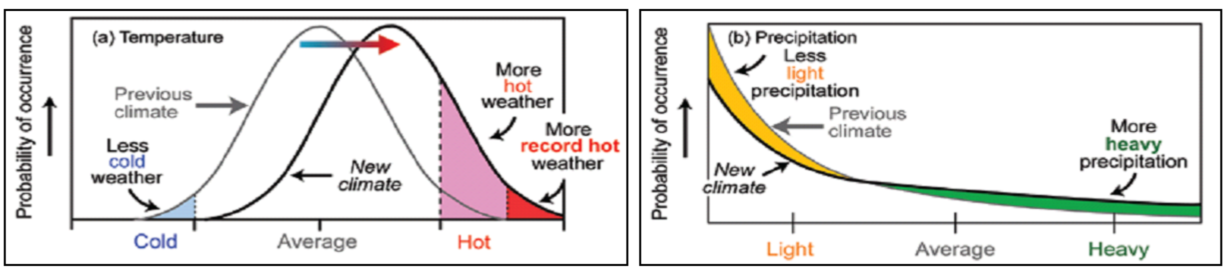


Figure 11-22. Severe Weather Probabilities in Warmer Climates

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.
- Snow removal measures are required.
- Debris management (downed trees, etc.) must be addressed.

11.7 IMPACT AND RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from a severe weather event throughout the area is likely, but the impact is more limited with respect to geographic extent, particularly when removing resulting flood and landslide events from the severe weather category (those hazards are analyzed separately).

The entire area experiences some severe storm or weather event annually, be it wind, rain, snow, fog, extreme heat, hail, or thunderstorms. When severe weather events occur, the storms do have the ability to impact the area, posing a danger to life and property, as well as possibly causing economic losses. While snow and ice do occur, impact and duration are somewhat limited, reducing life safety dangers as advanced warning many times allow residents to take precautionary measures (extra food, not driving, etc.). The more significant issue would be a severe storm which causes a landslide or flood event, isolating areas or blocking ingress and egress.

Wind is a very significant factor, which can cause power outages, as well as impacting transportation of both citizens and goods. While the local PUD/utilities maintain excellent records for low incidents of long-term power outages, the possibility does exist. This is also of concern with respect to the very large number of both public and private wells which provide water to a large portion of the county. The majority of the private wells in the County do not have generators to pump the water. Fortunately, historic severe weather events that have occurred are of a relatively short duration, with more localized impacts.

Based on the potential impact, the Planning Team determined the CPRI score to be 3.25, with overall vulnerability determined to be a high level.

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. Based on FEMA's 2017 Risk Map Report, studies indicate that for a Cascadia subduction zone tsunami, the first wave crest is "generally predicted to arrive around 90 minutes after the earthquake, whereas a Seattle fault-generated tsunami would arrive in Island County within 20 minutes" (FEMA, 2017). [16]

> **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.

[16] As of this 2020 update, studies are underway to help identify the tsunami risk within the County, but none have been completed to the point of providing data for this update. The 2005 USGS study referenced in this plan has undergone several reviews and updates, including FEMA's 2017 Risk Report, the initial report by Pacific Marine Environmental Laboratory (PMEL), and USGS' 2018-Draft 2 release by LeVeque, et al.. That study and additional data is available in their entirety at https://www.usgs.gov/centers/pcmsc/science/could-it-happen-here?qt-science_center_objects=0#qt-science_center_objects

- **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.

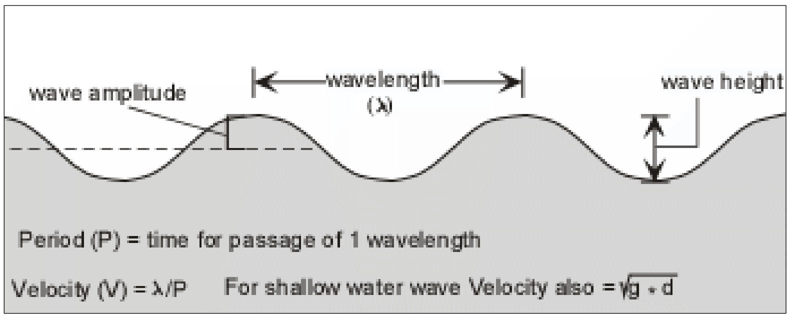


Figure 12-1. Physical Characteristics of Waves

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.

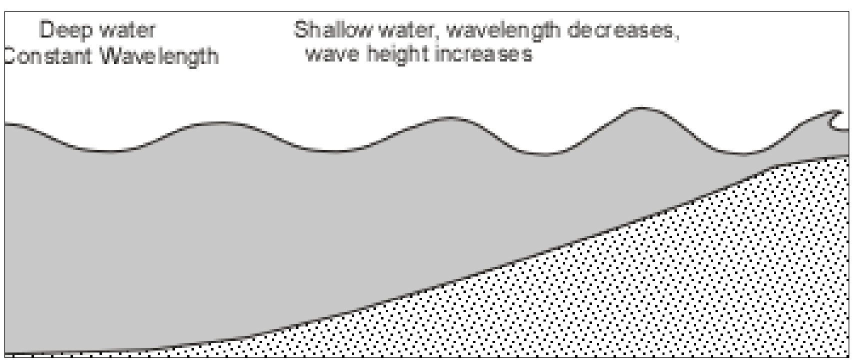


Figure 12-2. Change in Wave Behavior with Reduced Water Depth

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. Approximately 28 tsunamis with runup > 1 meter have occurred along the U.S. West Coast since 1812. 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.

For hazard mitigation planning purposes, the earthquake scenario utilized for this study is based on the Cascadia Subduction Zone event, which has a 10-14 percent probability of occurrence within the next 50 years (Petersen, et al., 2002). This scenario has been adopted by Washington State as the "worst considered case" for many inundation modeling studies and subsequent evacuation map development; it is used because the standard engineering planning horizon is 2500 years and Witter, et al. (2013) estimated that such event has a mean recurrence period of approximately 3333 years, with the highest probability of occurrence of all events considered with magnitude greater than Mw9. Based on this event, 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. Review of the existing report indicates that these areas are currently protected by dikes which were not resolved in the grid used for the modeling. The analysis indicates that the height of the dikes suggests that they would be overtopped by the modeled tsunami. As such, inundation shown there is felt to be appropriate, as the dikes would have no major impact on the wave (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 are shown on Figure 12-5. This map is based on best available data as of this update; however, reviewers should continue to monitor Washington State Department of Natural Resource websites for updated data based on new modeling and scientific data (LeVeque, 2018).

12.2.2 Previous Occurrences

In addition to the historic events referenced above, 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. As a result of that event, 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.

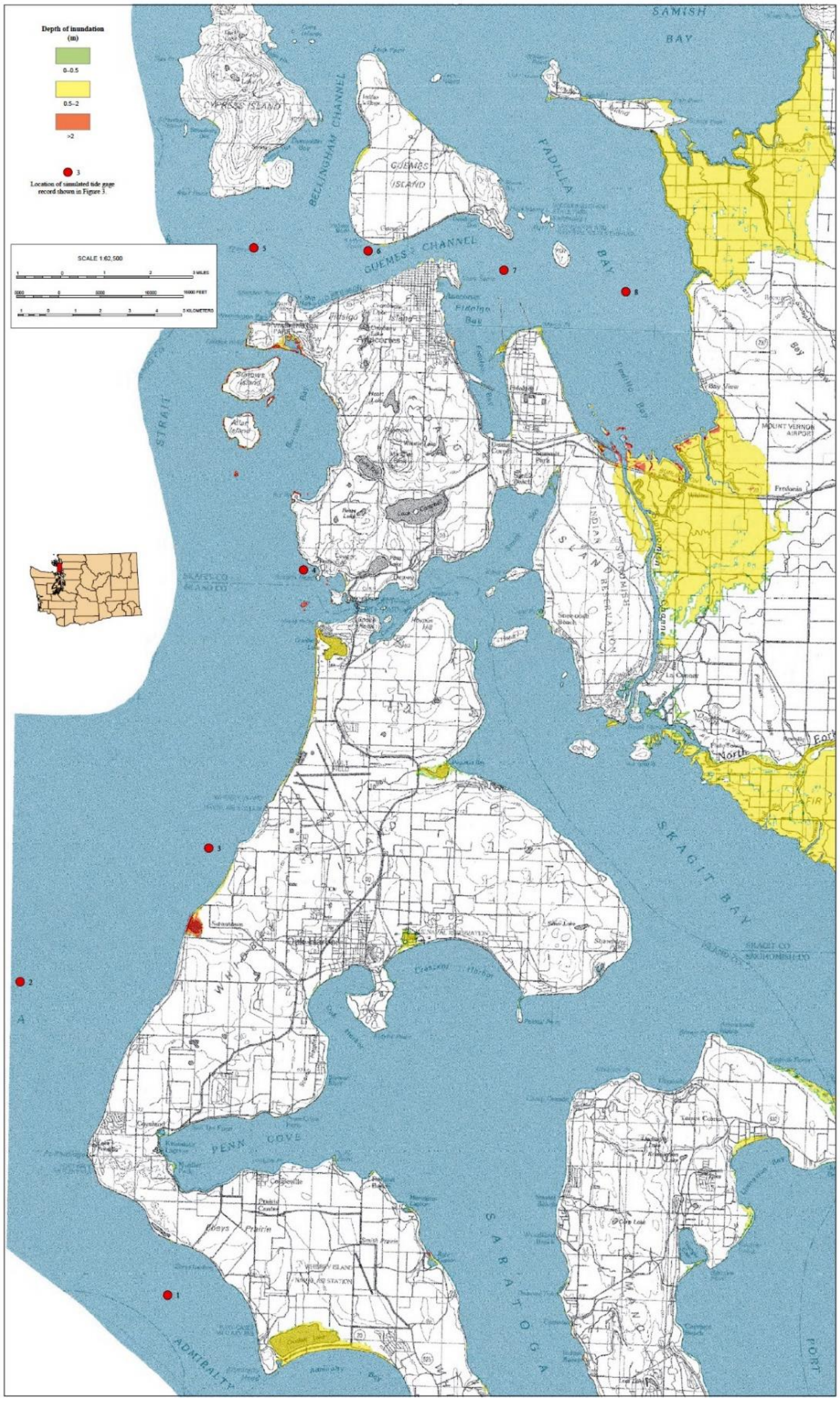


Figure 12-3. Inundation Depth Determined by Washington State Department of Natural Resources

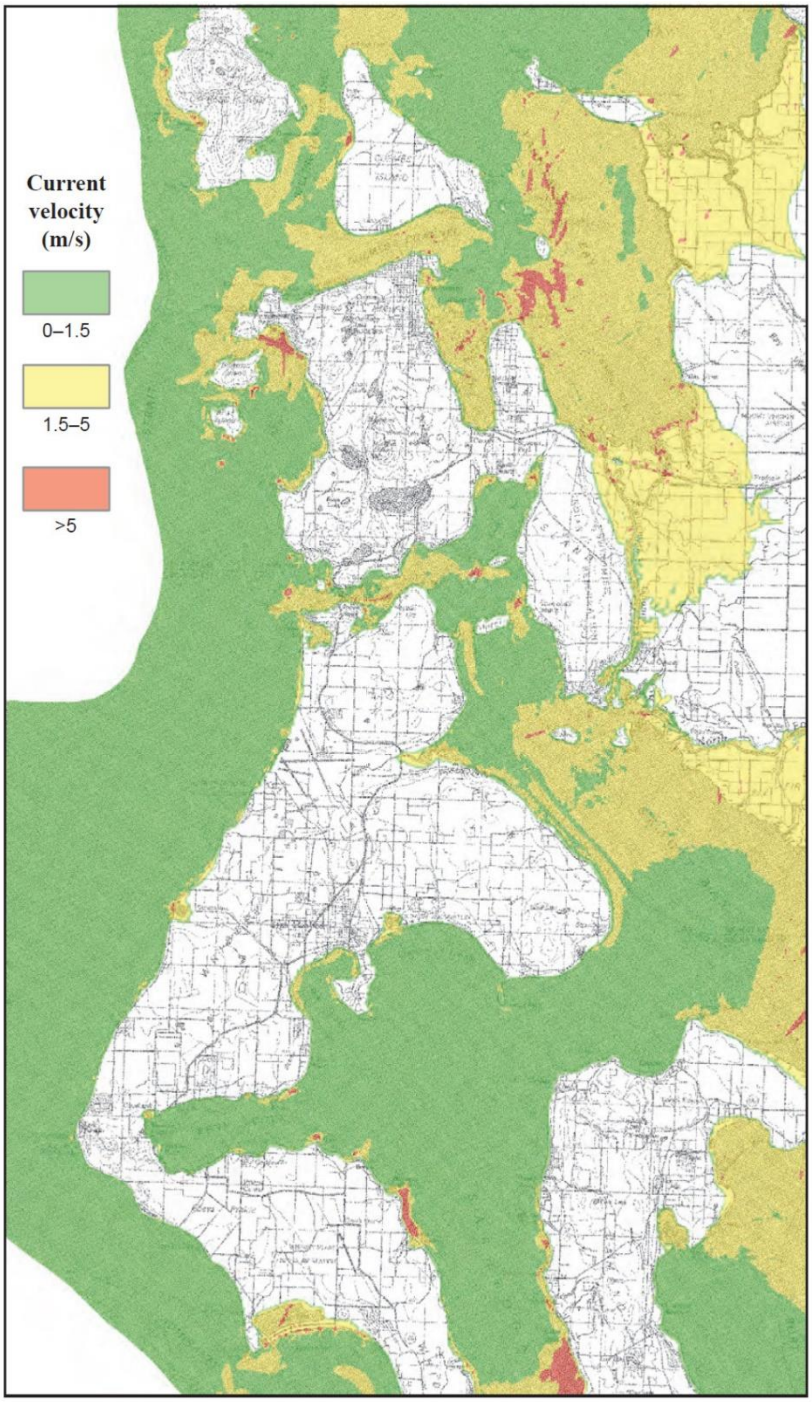


Figure 12-4. Velocity Zones as Defined by Washington State Department of Natural Resources

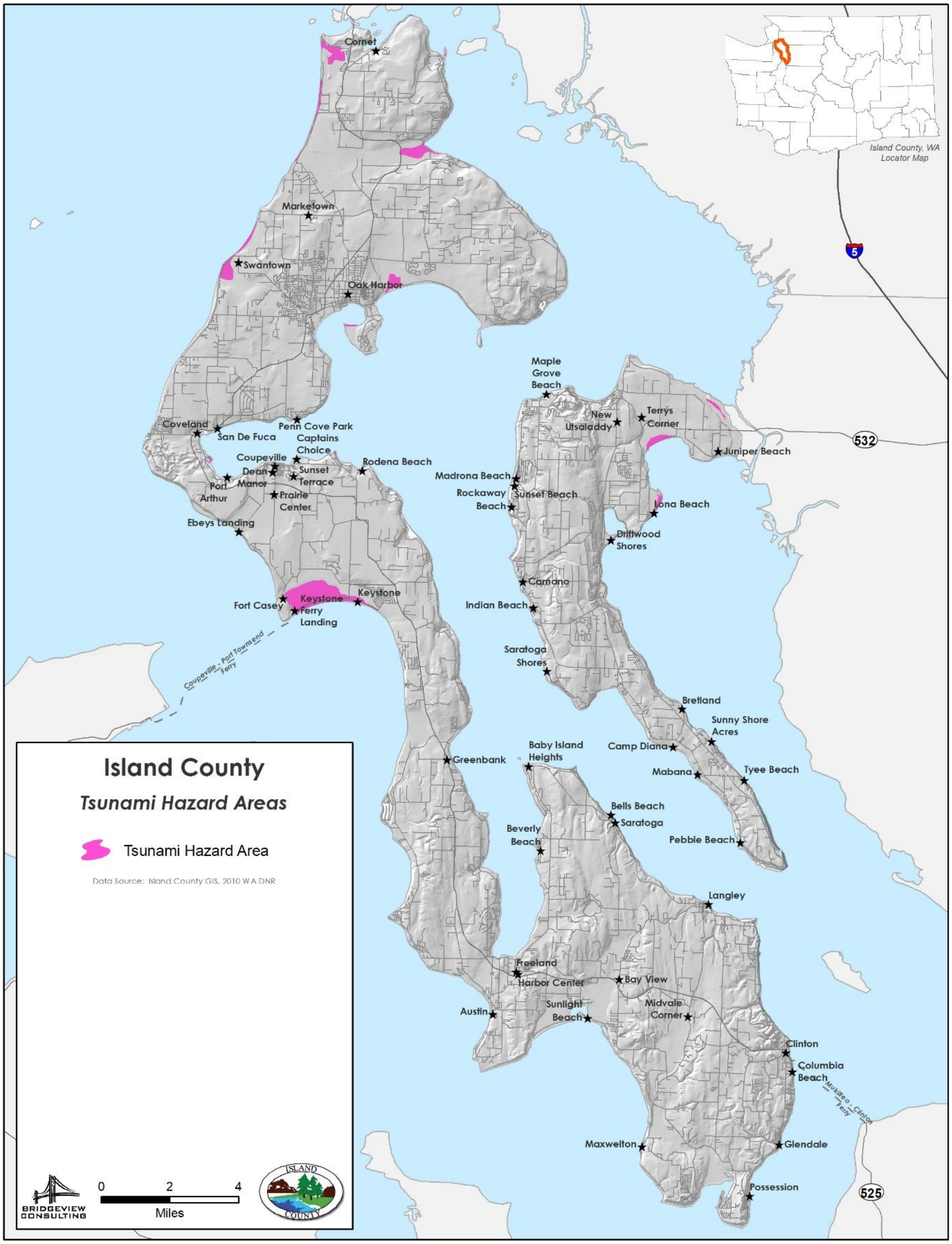


Figure 12-5. Island County Tsunami Inundation Areas

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.

Results of a (draft) 2018 Tsunami Hazard Assessment of Snohomish County, Washington[17] completed by the Pacific Marine Environmental Laboratory and the University of Washington illustrate that based on a Cascadia Subduction Zone earthquake and resulting tsunami event, portions of Cultus Bay are inundated, again confirming the 2005 study completed by WA DNR.

As of this 2020 update, a Tsunami Study for the entire Island County region has not been completed, but is anticipated to be completed prior to the end of the life cycle of this update. Therefore, detailed and updated analysis is not available beyond the data discussed above, with the exception of updated walking/evacuation maps detailed in the *Warning Time* section below. Once a tsunami study for the Island County area has been completed, this profile should be updated to include new, relevant data.

12.2.3 Severity

Tsunamis are a threat to life and property to anyone living near the ocean. According to the National Centers for Environmental Information (NCEI), tsunamis took the lives of more than 290,000 million people in the past 100 years.[18] From the time period 1950 to 2007 alone, 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, and is expected to lower the ground surface along the coast of Washington, with flooding occurring in areas less than six (6) feet above tide stages in certain areas. Maximum flooding depth, velocity, and extent will depend greatly on the tide height at the time of the tsunami arrival.

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.

[17] Available at: http://depts.washington.edu/ptha/WA_EMD_Snohomish/

[18] https://www.ncei.noaa.gov/news/november-5-world-tsunami-awareness-day

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). The frequency of tsunamis is related to the frequency of the events that cause them, which would include seismic, volcanic, or landslide events.

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.

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.

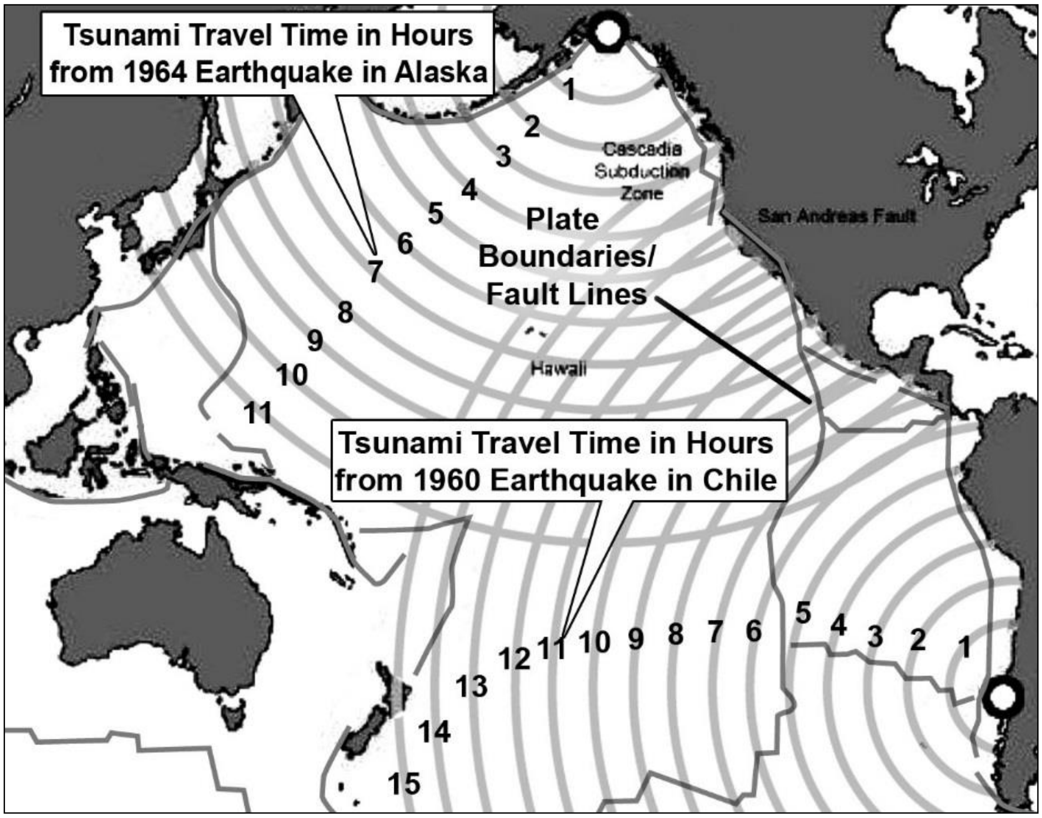


Figure 12-6. Tsunami Travel Times in the Pacific Ocean

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.

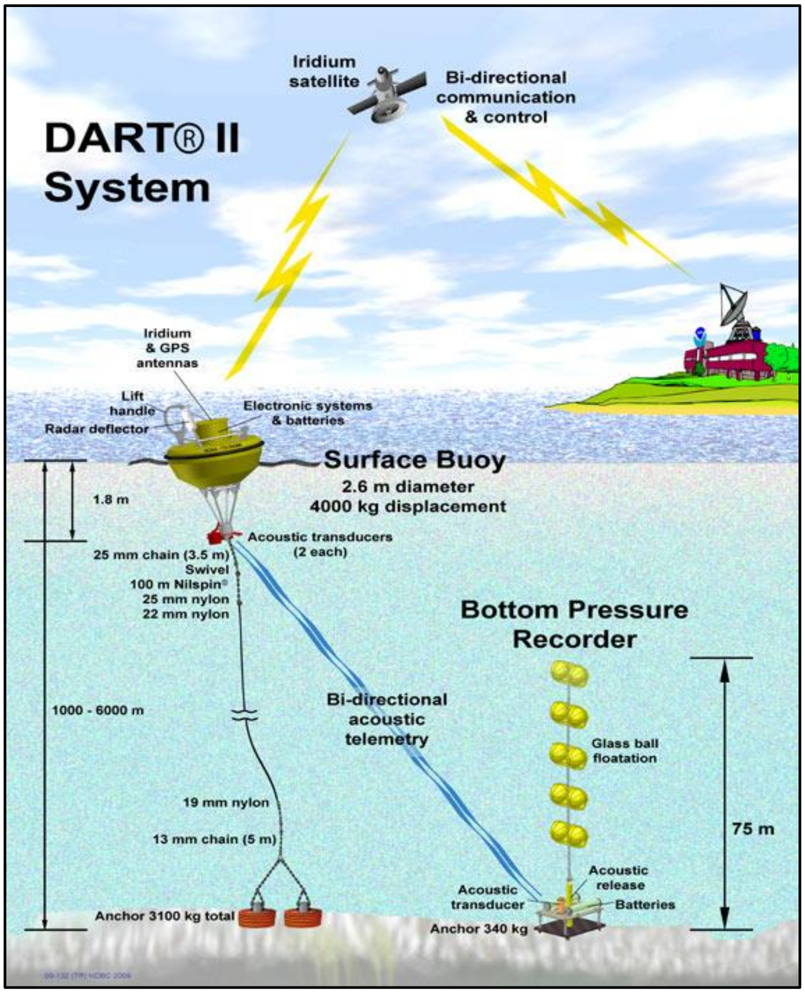


Figure 12-7. Deep-Ocean Assessment and Reporting of Tsunamis System

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. The system provides rapid alert to citizens and visitors who are in the hazard zone, giving advanced warning for evacuation. Currently, there is one siren is situated in Island County, located in Oak Harbor.

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, including but not limited to:

- 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 by the number of exposed residential buildings. Using this approach, it was estimated that 642 people, or 279 households, are exposed to the tsunami hazard zone (0.75 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 2.3 per person/household	Percent of Total Population in Planning Area
Unincorporated	279	642	1%
Coupeville	0	0	0%
Langley	0	0	0%
Oak Harbor	0	0	0%
Total	**279**	**642**	**0.75%**

Based on the 2005 WDNR report (confirmed by other recent studies as identified herein), 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. The value of exposed buildings in the tsunami hazard zone within the planning area was generated using Hazus at the user-defined level and is summarized in Table 12-3.

**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	1,377	1.08
Coupeville	816	0	0
Langley	668	0	0
Oak Harbor	6,180	99	1.6
Total	**134,384**	**1,476**	**1.09**

**TABLE 12-3
ESTIMATED DOLLAR VALUE OF STRUCTURES EXPOSED TO TSUNAMI**

	Structures Impacted[a]	Assessed Value			% of AV
		Structure	Contents	Total	
Unincorporated Island County	294	$44,930,154	$23,542,465	$68,472,619	0.79%
Coupeville	0	$0	$0	$0	0
Langley	0	$0	$0	$0	0
Oak Harbor	1	$275,000	$412,500	$687,500	0.02
Total	**295**	**$45,205,154**	**$23,954,965**	**$69,160,119**	**0.52**

a. Impacted structures are those structures expected to receive measurable damage from the Cascadia Scenario Tsunami Event because they have lowest floor elevations below the projected tsunami inundation height.

Hazus 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. The results are summarized in Table 12-4.

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	0.01%
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, bridges or ferries 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	2
Water	0
Waste Water	0
Communications	0
Other Critical Function	4*
Total	**6**

* “Other” Critical Facilities Exposed include the City of Oak Harbor’s Crescent Harbor Wastewater Lagoons identified as a dam on the dam inventory list maintained by WA DOE.

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. The County also has the docks associated with the Washington State Ferry systems at Clinton and Coupeville.

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.

12.3.5 Impact on Economy

Daily life for individuals in a nation affected by a tsunami changes because of the damage the disaster causes to the economy. Locations that were previously popular destinations for visitors suffer depression as a result of lost tourism, with people staying away out of , as well as during the recovery and reconstruction phase. Rebuilding after a tsunami puts a significant financial strain on governments as well, resulting in an economic downturn that can affect entire regions.

Businesses impacted by a tsunami will take time to recover their activity to pre-disaster levels. This time period will vary from business to business depending on a range of factors including level of preparedness, supply of raw materials, availability of distribution/transport networks and requirements of the market place/product user and variations in price. In extreme cases, the business recovery phase may last considerable periods of time. For example, reestablishment of crab fishing beds in Prince William Sound following total destruction by the 1964 Alaska tsunami took between 8 and 12 years. Such a recovery period would have had significant consequences for the crab fishing industry and its employees.

Port facilities, naval facilities, fishing vessels 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.

While the inundation zone for the planning region is limited in nature, it would nonetheless have a devastating impact on the planning region's economy due also to the potential for isolation. Loss of tax base, destruction of 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 various boundaries within ~2-2.5 hours of a Cascadia Subduction Zone earthquake. This analysis was again confirmed in the Tsunami

Hazard Assessment of Snohomish County (2018 Draft, Version 2, p.3 confirming consistency in previous results), which included portions of Island County in that analysis (see Figure 12-8 for study region).

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.

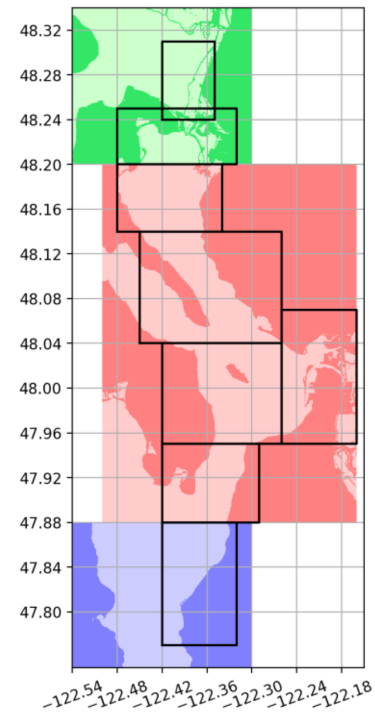


Figure 12-8 Snohomish County 2018 Study Region

12.7 IMPACT AND RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from a tsunami event throughout the area is possible given previous history. This is particularly true given the seismic activity to which our region is susceptible, although there have not been any recent events.. The impact is more limited with respect to geographic extent, with approximately 290 structures (out of over 40,000 countywide) impacted; however, there are many variables which would take into account the potential impact, including the magnitude and epicenter of the earthquake causing the tsunami event, which could increase waive height, direction, and velocity. Likewise, maximum flooding depth will also be impacted based on the tide height at the time of the tsunami arrival.

For an event such as a Cascadia Subduction Zone, it is anticipated by WA DNR and others that the first waves will start to appear approximately 2+ hours after an incident, while waves from earthquakes occurring on other faults, such as the Seattle fault, may arrive in less than 20 minutes. Educational outreach with respect to evacuation to higher grounds when the earth shakes will help reduce death and injuries to some degree. Coastal and adjacent lower-lying areas of the county would be more impacted than other areas; however, the entire region would be impacted due to the economic factor, as well as impact to the various types of transportation to the area, and the potential impact to major thoroughfares and transportation corridors.

Based on the potential impact, the Planning Team determined the CPRI score to be 1.9, with overall vulnerability determined to be a low level.

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.

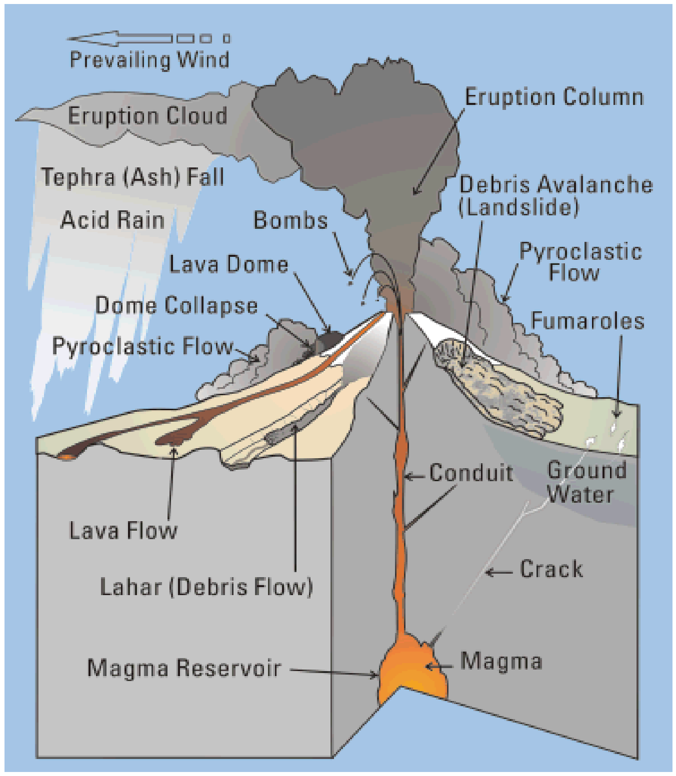


Figure 13-1. Volcano Hazard

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

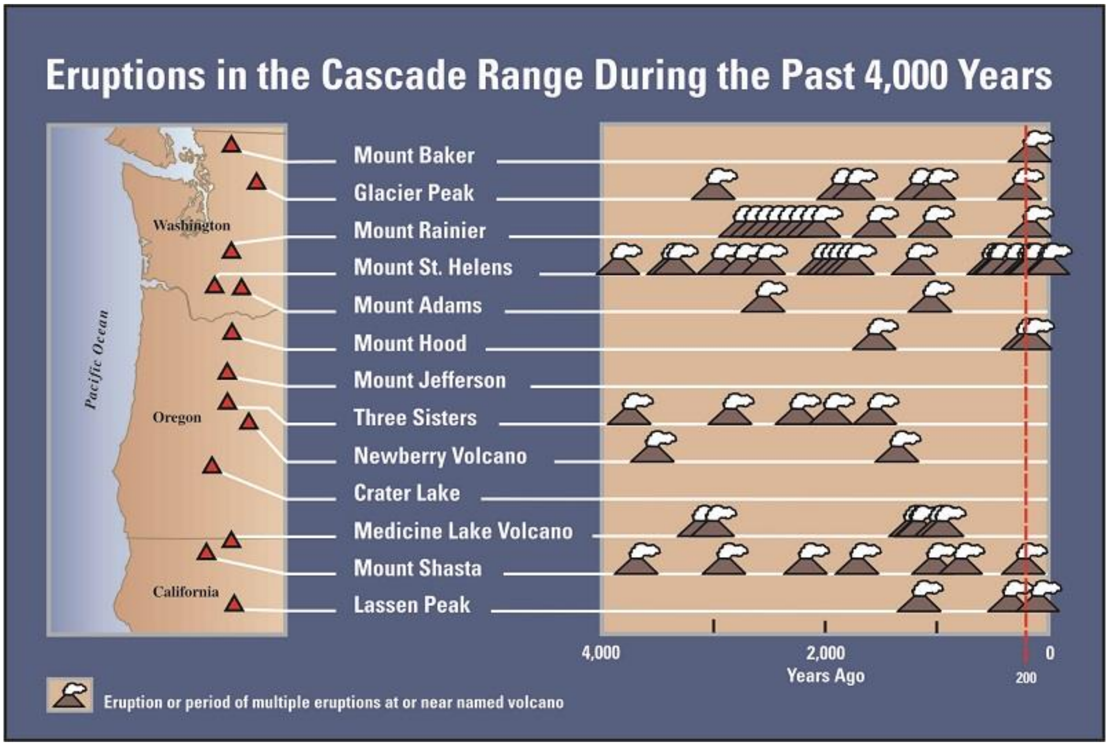


Figure 13-2. Past Eruptions of Cascade Volcanoes

Based on review, the volcanoes most likely to impact the planning area are Mount Baker and Glacier Peak. Mount Baker is considered in this analysis due to the transient population of the County with respect to employment in the areas outside of Island County which would be impacted by a Mt. Baker event. The County is not within the Mount Baker lahar zone. The County (Camano Island) could be impacted with respect to the lahar zone from Glacier Peak. Both Mount Baker and Glacier Peak could impact the county with respect to ash, depending on the prevailing winds.

Mount 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 illustrates Glacier Peak from the west. Its eruption history is shown in Figure 13-4. Mount Baker eruption history is shown in Figure 13-5. Table 13-1 summarizes past eruptions in the Cascades.

The most recent volcanic event to occur within Washington State is the 1980 Mount St. Helens eruption, during which 23 square miles of volcanic material buried the North Fork of the Toutle River, and 57 people lost their lives.

Source: USGS files[19]

Figure 13-3. Glacier Peak, Seen from the West.

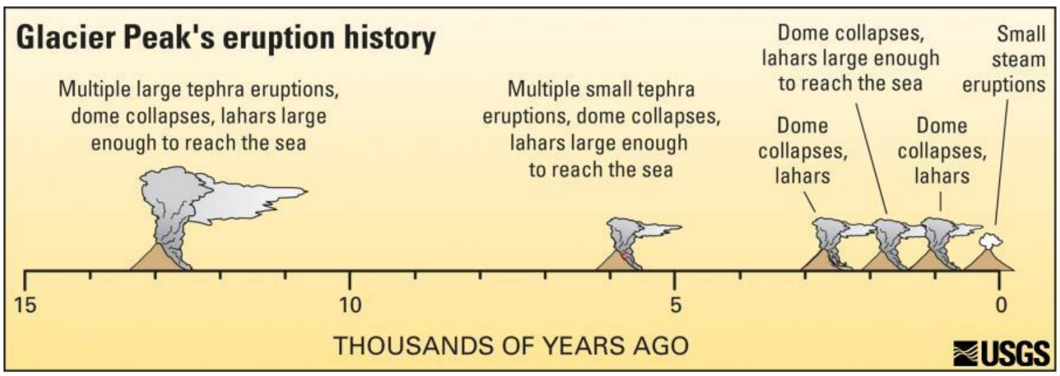


Figure 13-4. Glacier Peak Eruption History

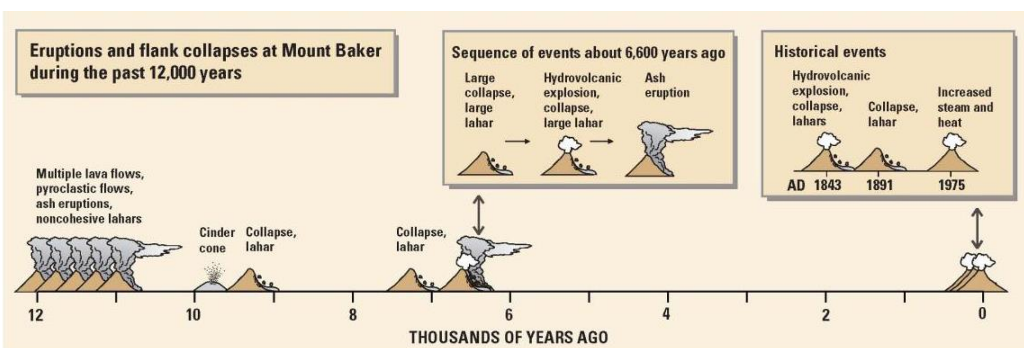


Figure 13-5. Mt. Baker Eruption History

19 http://volcanoes.usgs.gov/volcanoes/glacier_peak/glacier_peak_gallery_39.html

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 13-6 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 are far more likely on the east side of the volcano. Yet 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 13-7 shows areas of the U.S. that have been covered by volcanic ash. Figure 13-8 identifies the volcano hazard zones from Glacier Peak as identified by the USGS. As previously indicated, the USGS-identified lahar zone from Mount Baker does not impact Island County.

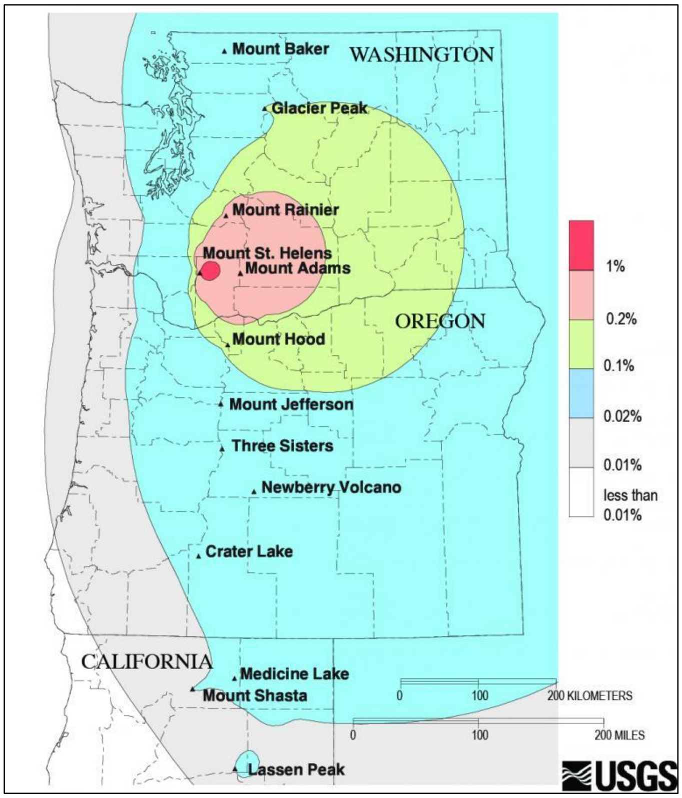


Figure 13-6. Probability of Tephra Accumulation in Pacific Northwest

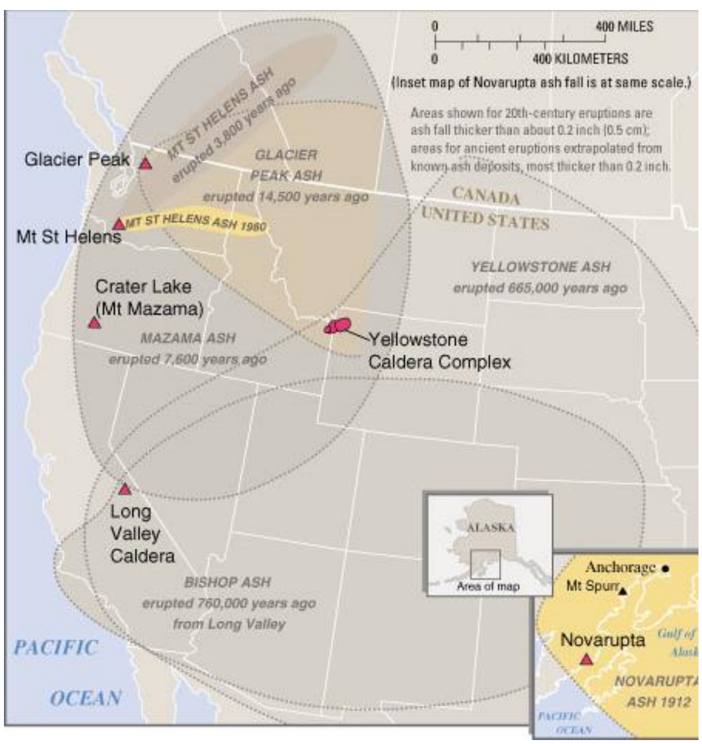


Figure 13-7. Defined Tephra Layers Associated with Historical Eruptions

Source: USGS. http://volcanoes.usgs.gov/vsc/multimedia/cvo_hazards_maps_gallery.html

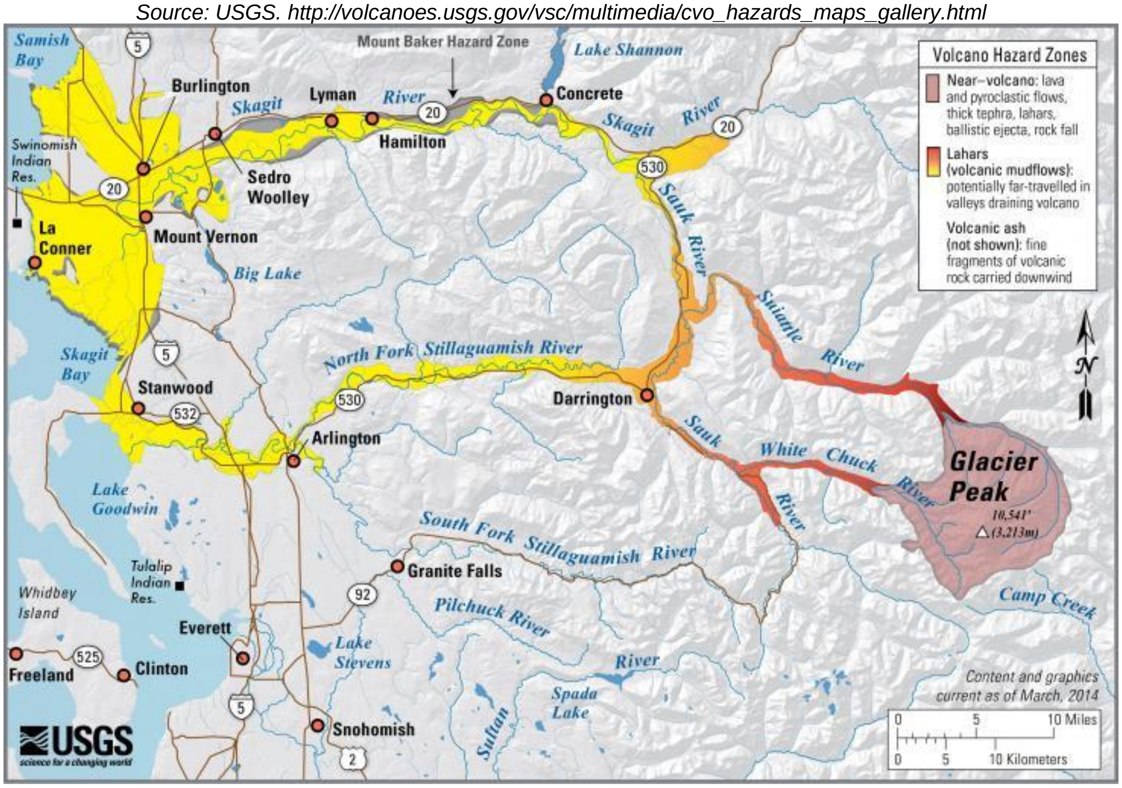


Figure 13-8. Volcano Hazard Zones from Glacier Peak

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.

Future eruptions from Glacier Peak will very likely be preceded by earthquakes, and possibly by measurable swelling of the volcano and emission of volcanic gases. All of these signals could be detected by monitoring equipment operated by the USGS and the Pacific Northwest Seismic Network (PNSN) as long adequate sensor networks are in place ahead of time. (USGS, 2019a).

Mount Baker is presently not showing signs of renewed magmatic activity, but it will surely become restless again. Future magmatic eruptions at Mount Baker are likely to be preceded by changes at the volcano that could be detected by modern volcano-monitoring techniques. As of 2013, only a minimal number of seismometers are installed near Mount Baker and gas measurements are made on an annual or biannual basis. Deformation monitoring occurs infrequently. The USGS places a high priority on improving the volcano monitoring systems at Mount Baker as part of the National Volcano Early Warning System (NVEWS) initiative. (USGS, 2019b).

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.

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[20]. The USGS Cascade Volcano Observatory works in conjunction with PNSN to provide constant monitoring and

[20] Mt. Baker and Glacier Peak Coordination Plan (2012). Accessed October 29, 2014. Available on-line at: https://volcanoes.usgs.gov/vsc/file_mngr/file-129/mount%20baker%20glacier%20peak%20coordination%20plan.pdf

notification when activities increase. Figure 13-9 depicts one of the sensors used by USGS and PNSN for monitoring purposes. Figure 13-10 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.

Figure 13-9. Glacier Peak Monitoring Equipment

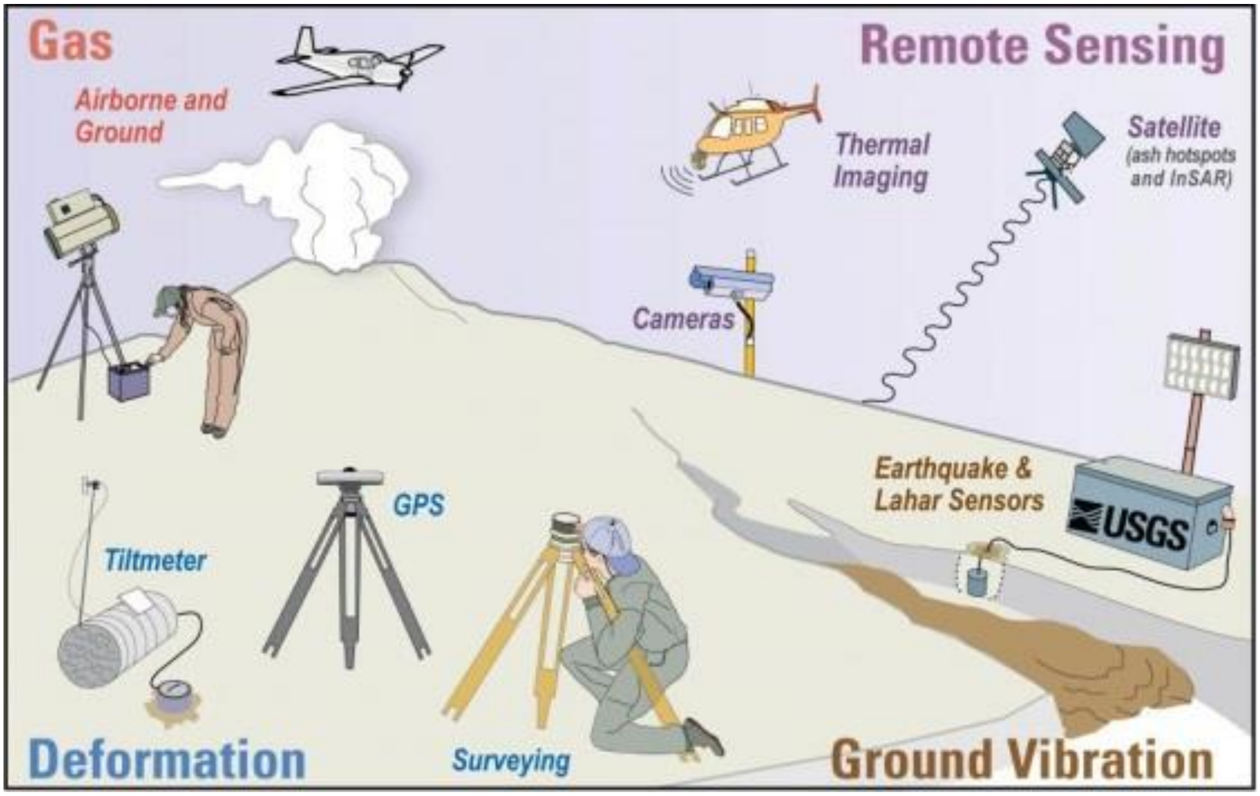


Figure 13-10. Remote Sensing Devices

13.3.2 Impact on Life, Health and Safety

The entire population of the planning area, as well as any tourists traveling through the area 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.

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 older 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.

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 aqua- and agri-cultural losses, the loss of tourism, 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 due to impacts from ash and those economies related to the natural environment.

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.

13.7 IMPACT AND RESULTS

Although the probability of a volcanic eruption is low, if an eruption were to occur, the greatest threat to life, property, infrastructure, and the environment would be from lahars or debris avalanches. Fortunately, the County is not in a lahar zone; however, primary transportation corridors are vulnerable (I-5 and SR532 in Skagit/Snohomish Counties could be impacted).

The greatest threat to the county from structural impact would be ash accumulations; however, the prevailing wind would carry the ash away from the County. Load capacities in place with respect to building codes do establish a relative barrier from impact as a result of ash accumulations. Planning Team members do not recall a significant impact with respect to structures as a result of Mount Saint Helens; however, should prevailing winds shift and carry ash into the area, equipment and machinery could be impacted.

Rivers providing potable water in the Skagit watershed areas would be contaminated by ash, with much of the Skagit County in lahar zones. Lahar activities could divert water sources, causing groundwater issues with respect to contamination from ash, as well as a change in the actual watershed due to debris redirecting tributaries as river valleys and associated floodplains are particularly vulnerable to the effects of large-scale lahars and associated flooding that will no doubt result from a large lahar.

Problems related to lahar debris would not directly impact Island County with the exception of a potential small area of impact to Camano Island; however, debris would impact Skagit and Snohomish Counties. Such accumulations could last for years and even decades because of the tremendous volume of loose rock and ash that has could potentially have been added to the ground surface. Such actions, again, could impact the I-5 corridor, potentially impacting evacuation (for other hazards), and commodity flow region-wide.

Based on review and analysis of the data, the Planning Team has determined that the probability for a future event is low; however, there could be impact at some level based on the lahar inundation zone in the surrounding counties, particularly when viewing the topography of the area, the impact to the river drainage basins, and ashfall. Dependent on the force of the lahar, transportation onto Camano Island may be impacted.

Based on the potential impact, the Planning Team determined the CPRI score to be 1.7 with overall vulnerability determined to be a low level.

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.

DEFINITIONS

Brush fire—A fast-moving fire that ignites grass, shrubs, bushes, scrub oak, chaparral, marsh grass (cattails), and grain fields. This is the type of wildfire most likely to affect Whitman County.

Conflagration—A fire that grows beyond its original source area to engulf adjoining regions. Wind, extremely dry or hazardous weather conditions, excessive fuel buildup and explosions are usually the elements behind a wildfire conflagration.

Firestorm—A fire that expands to cover a large area, often more than a square mile, when many individual fires grow together. Temperatures may exceed 1000°C. Superheated air and hot gases of combustion rise over the fire zone, drawing surface winds in from all sides, often at velocities approaching 50 miles per hour. Although firestorms seldom spread because of the inward direction of the winds, once started there is no known way of stopping them. Lethal concentrations of carbon monoxide, combined with the intense heat, poses a serious life threat to responding fire forces. In very large events, the rising column of heated air carries enough particulate matter into the upper atmosphere to cause cloud nucleation, creating a thunderstorm and the hazard of lightning strikes.

Interface Area—An area where vegetation susceptible to wildfires and urban or suburban development occur together.

Wildfire—Fires that result in uncontrolled destruction of forests, brush, field crops, grasslands, and real and personal property in non-urban areas. Because of their distance from firefighting resources, they can be difficult to contain and can cause a great deal of destruction.

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.

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*.

Review of the 2018 Washington State Enhanced Hazard Mitigation Plan does designate Island County as a WUI Community (see Figure 14-1). Currently, 86 percent of the WUI land in Island County is extensively developed, equating to 22.87 square miles, leaving 3.73 square miles of WUI defined land as undeveloped (Headwaters, 2019).[21] Based on these criteria, Island County is considered to be at high to moderate risk (see Figure 14-2).[22] Camano Island is specifically referenced and indicated as a high-risk community in the State's 2018 Hazard Mitigation Plan. Figure 14-3 identifies the extreme/high/low/moderate level of wildfire hazard rating countywide based on Washington State DNR data.

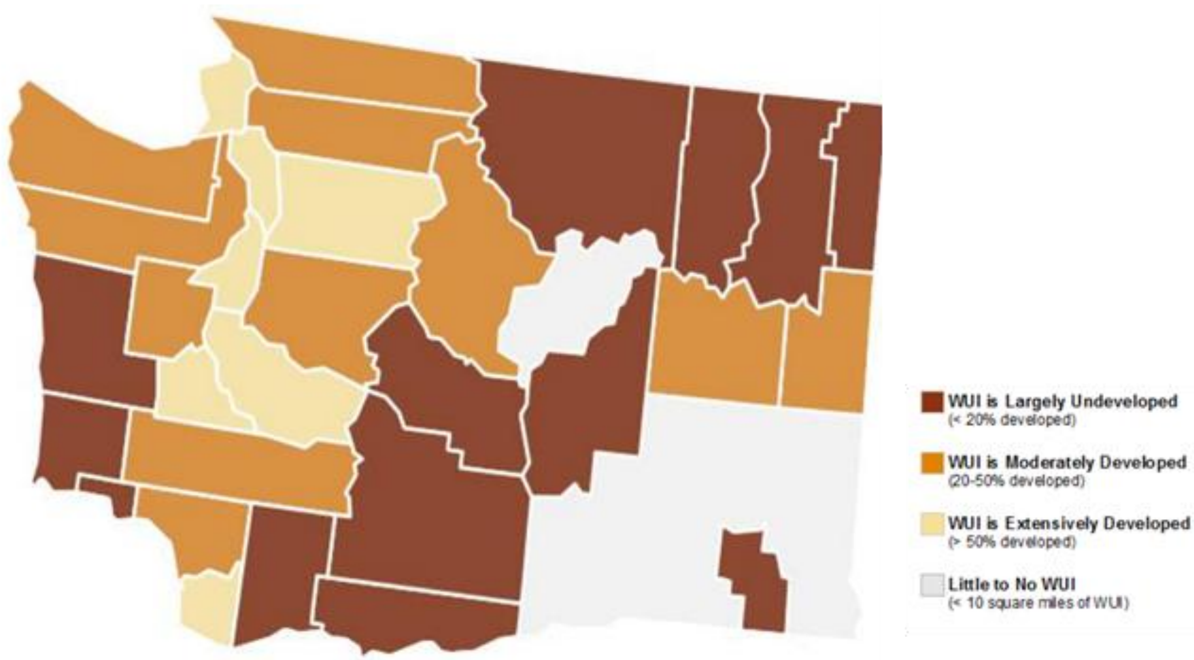


Figure 14-1. Wildland Urban Interface (WUI) Development
Source: Headwaters Economics, 2016

[21] Wildland Urban Interface Development. Headwaters Economics. Accessed 10 Feb 2020. Available online at: https://headwaterseconomics.org/dataviz/wui-development-and-wildfire-costs/
[22] http://mil.wa.gov/uploads/pdf/HAZ%20MIT%20PLAN/Wildland_Fire_Hazard_Profile.pdf

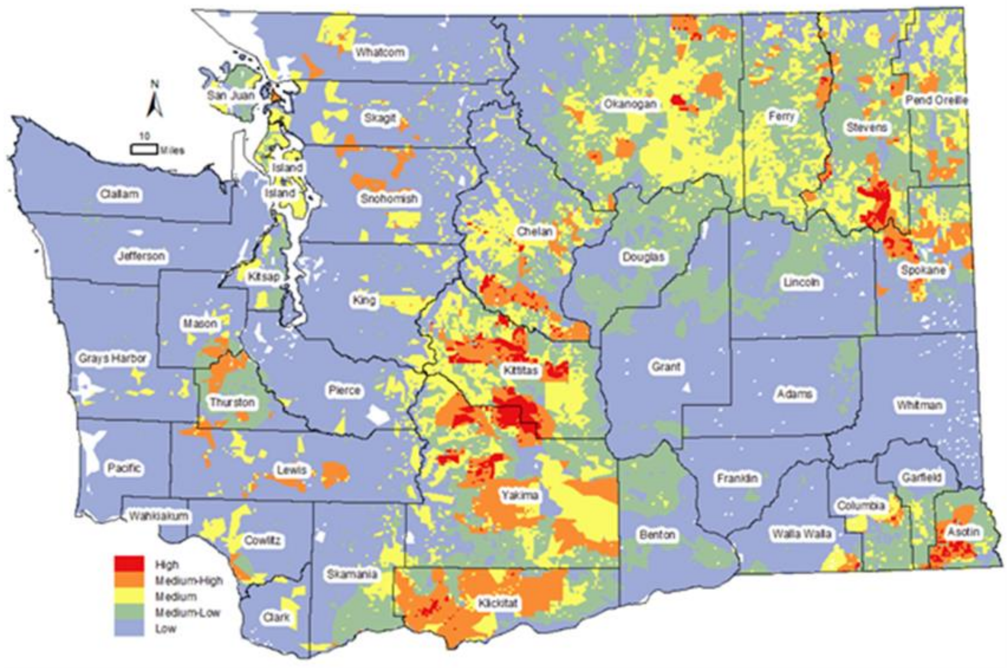


Figure 14-2. Level of Risk for Wildland Urban Interface Communities
(Source: Headwaters, 2018)

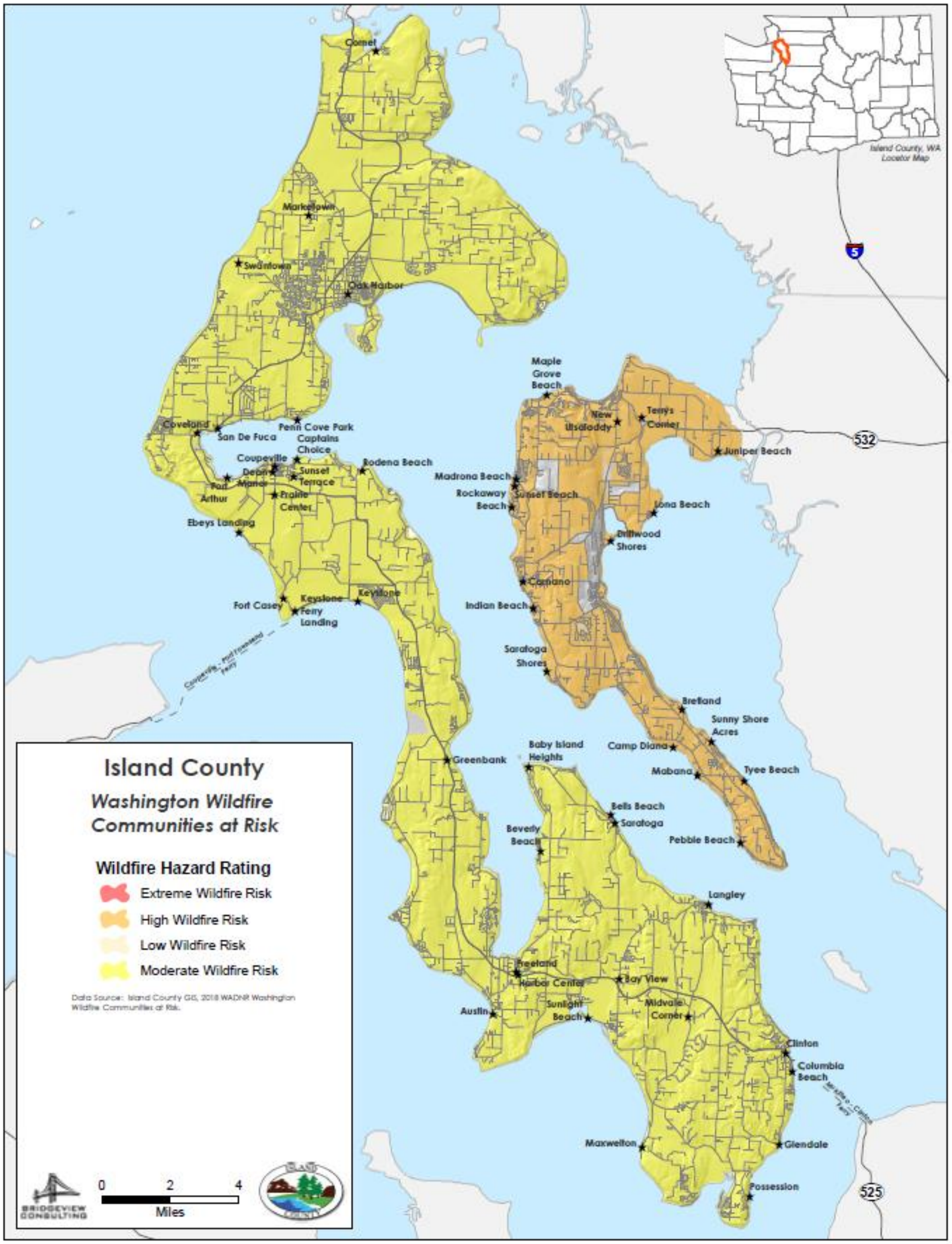


Figure 14-3 Wildfire Communities at Risk

14.1.1 Wildfire Behavior

The wildfire triangle (see Figure 14-4) 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.

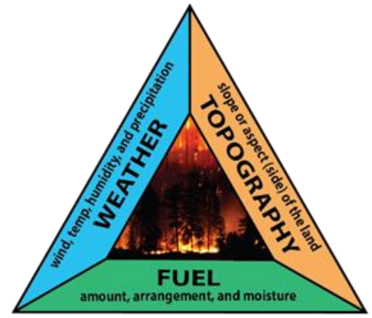


Figure 14-4 Wildfire Behavior Triangle

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). As indicated, in the case of Island County, 86 percent of the area's WUI areas are heavily developed.

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 Historic Fire Regime and Condition Classifications

Many ecosystems are adapted to historical patterns of fire. These patterns, called "fire regimes," include attributes such as frequency and seasonality, spatial attributes such as size and spatial complexity, and magnitude attributes, defined as 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 simulates aspects of a fire as a function of vegetation changes, 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 this data is categorize by the mean fire return interval and fire severities, which are grouped into five regimes defined in the Interagency Fire Regime Condition Class (FRCC) Guidebook, which identify the frequency and severity of the anticipated fire, as follows:

- 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

Land managers need to understand historical fire regimes (that is, fire frequency and fire severity) to be able to define appropriate goals and objectives for an area, including management plans and treatment strategies to help reduce impact from wildfires.

Understanding ecosystem departures (how ecosystems have changed over time) provides a context for managing sustainable ecosystems, that is, what measures must be taken to help reduce risk, but also by how such changes have increased or decreased the probability and severity of a fire occurring.

Broad-scale alterations of historical fire regimes and vegetation conditions have occurred in many landscapes in the U.S. through the combined influence of land management practices, fire prevention, livestock grazing, insect and disease outbreaks, climate change, and invasion of non-native plant species. These departures result in changes to one or more of the following ecological components which can increase fire danger:

- Vegetation characteristics (species composition, structural stages, stand age, canopy closure and mosaic pattern)
- Fuel composition
- Fire frequency, severity, and pattern
- Associated disturbances (e.g. insect and disease mortality, grazing, and drought).

Through a series of processes, LANDFIRE has determined various Fire Regime Condition Classes that represent a classification of a given area's amount of departure from the historical fire regime. The classifications categorize wildland vegetation and fuel conditions into one of the three condition classes, based on the degree of departure, helping to identify how frequently an area may experience a wildfire, and the degree of damage it may cause.

The three classes indicate low (FRCC 1), moderate (FRCC 2) and high (FRCC 3) departure from the historical fire regime. Low departure is considered to be within the historical range of variability, while moderate and high departures are outside. Determination of the amount of departure is based on comparison of a composite measure of fire regime attributes to the central tendency of the historical fire regime. The amount of departure is then classified to determine the fire regime condition class. Table 14-1 presents a simplified description of the fire regime condition classes and associated potential risks. Figure 14-5 identifies the fire regimes in Island County.

TABLE 14-1.
FIRE REGIME CONDITION CLASS DEFINITIONS

Description	Potential Risks
Fire Regime Condition Class 1	
Within the historical range of variability.	• Fire behavior, effects and other associated disturbances are similar to those that occurred prior to fire exclusion (suppression) and other types of management that do not mimic the natural fire regime and associated vegetation and fuel characteristics. • Composition and structure of vegetation and fuels are similar to the natural (historical) regime. • Risk of loss of key ecosystem components (e.g. native species, large trees and soil) is low.
Fire Regime Condition Class 2	
Moderate departure from the historical regime of variability.	• Fire behavior, effects, and other associated disturbances are moderately departed (more or less severe). • Composition and structure of vegetation and fuel are moderately altered. • Uncharacteristic conditions range from low to moderate. • Risk of loss of key ecosystem components is moderate.
Fire Regime Condition Class 3	
High departure from the historical regime of variability.	• Fire behavior, effects, and other associated disturbances are highly departed (more or less severe). • Composition and structure of vegetation and fuel are highly altered. • Uncharacteristic conditions range from moderate to high. • Risk of loss of key ecosystem components is high.

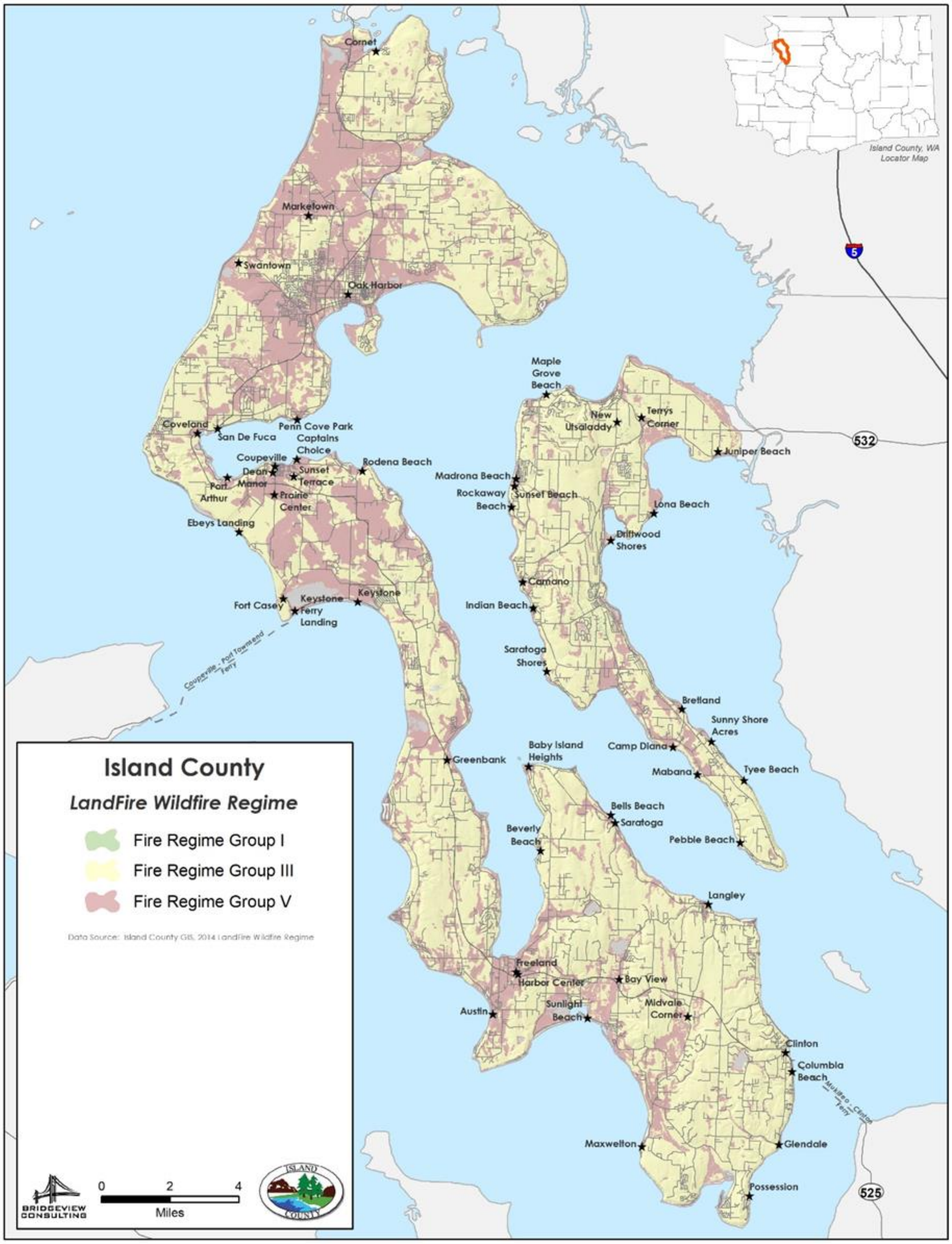


Figure 14-5 LANDFIRE Fire Regimes in Island County

14.2 HAZARD PROFILE

14.2.1 Extent and Location

Based on review of existing DNR and FEMA data, Island County has never received a state or federal disaster declaration for a wildfire event. Historic impact has been relatively minor, with one exception; a fire in July 1920, which destroyed Oak Harbor. That fire left the town to struggle through the Great Depression, until 1941, when Naval Air Station Whidbey Island was constructed.

14.2.2 Previous Occurrences

During the five-year-period of 2007-2011, the National Fire Protection Administration (NFPA) estimates that U.S. local fire departments responded to an estimated average of 22,600 fires started by lightning per year. These fires caused an estimated average of nine civilian deaths, 53 civilian injuries and $451 million in direct property damage per year. These estimates are based on data from the U.S. Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS) and the NFPA's annual fire department experience survey. Only 19% of reported lightning fires occurred in homes, but these fires caused a majority of the associated losses. Lightning is also a major factor in wildland fires, and the average number of acres burned per fire is much higher in lightning fires than in fires caused by humans. (Ahrens)

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. On average, Washington State experiences 10 or fewer days per year of lightning storms.

Since completion of the last plan in 2015:

- South Whidbey Fire/EMS has had a total of 61 vegetation fires, burning less than 20 acres total. The largest fire encompassed 15 of the ~20 acres. None of the fires were a significant threat, and were managed by fire suppression tactics.
- Oak Harbor sustained less than two (2) acres of wildfire impact, with a total of 25 fires, all small in nature and all managed by fire suppression tactics.
- Camano Island Fire & Rescue experienced 33 events; eight (8) events in 2017; nine (9) events in 2018, and 16 events in 2019. Each fire involved less than one acre in size.

- During the time period 2003 to 2015, the County had sustained ~48 wildfires, burning a total of 32.41 acres. Most of those fires occurred in 2003, during which season 13 fires burned; six (6) fires occurred in 2012, and eight (8) fires occurred in 2009.

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). Such fires are also significantly more difficult to combat and suppress, increasing the threat to homes and communities.

The statistical analysis of the wildfire exposure assessments conducted by the State of Washington revealed that six counties are at the highest risk from wildfires, including Island County. Klickitat, Okanogan, Pend Oreille, San Juan and Stevens are the remaining counties. Island County is estimated to have a medium wildfire hazard exposure. Island County has a high proportion of residents located in areas exposed to medium or higher wildfire hazard. While the proportion of built environment at risk from wildfires is consistently high among in Island County, exposure of vulnerable population varies greatly. Island County ranked at a medium level for vulnerable population exposure to wildfires. (Washington State Enhanced Hazard Mitigation Plan Risk and Vulnerability Assessment, 2018).

14.2.4 Frequency

None of Washington State’s most significant wildfires have occurred in Island County, although smaller fires have occurred in the area regularly. 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; however, the built environment has greatly changed historic norms. From review of the number of previous occurrences since the last plan’s completion, it appears as though the area is experiencing an increase in wildfire activities. Such is not to be unexpected due to the dryer than normal conditions experienced over the course of the last several years, including 2019 when we were again in a drought situation. This type of situation does correlate to the increased number of wildfires in 2019 that were experienced by Camano Island, among others. Review of data illustrates that large quantities of land fall within Regime I and Regime V, meaning that frequency for burns in the area range from 35-200 years based on LANDFIRE data.

14.3 VULNERABILITY ASSESSMENT

14.3.1 Overview

Structures, above-ground infrastructure, critical facilities and natural environments are all vulnerable to the wildfire hazard. Currently as there are no validated damage functions available to support wildfire mitigation planning due to the fact that no such damage functions exist, for these planning purposes, 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 2.3 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 increase 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.

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 2.3 persons per household for Island County. These estimates are shown in Table 14-2. Table 14-3 illustrates the population potentially impacted within the various fire regimes during the last plan cycle in 2014. Not calculated into the potential impact is the number of tourists who may be visiting the area at any given time.

In viewing the data between the last plan to the current plan, population growth in the area has increased the risk factor of population exposed in each municipality. Fire Regime 3 saw the highest increase of almost 10,000 citizens since the last plan was completed. This increase in number could be due to multiple factors, including better Assessor's data during this planning cycle, more accurate census data, and updated hazard maps. The other factor relates to the built environment, and the actual increased number of structures built within the various areas identified since completion of the last plan. All of the fire agencies remain confident, however, that such increase in growth will not jeopardize their ability to manage fires in the same effective manner.

TABLE 14-2.
2020 POPULATION WITHIN FIRE REGIME AREAS

	Fire Regime 1		Fire Regime 3		Fire Regime 5	
	Population	% of Total	Population	% of Total	Population	% of Total
Unincorporated	334	0.57%	44,881	76.42%	17,441	29.70%
Coupeville	9	0.47%	610	31.69%	886	46.03%
Langley	0	0.00%	998	83.51%	324	27.11%
Oak Harbor	44	0.19%	6,587	28.68%	8,846	38.51%
Total (2020)	**387**	**0.46%**	**53,076**	**62.57%**	**27,497**	**32.42%**

TABLE 14-3.
2014 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 (2014)	**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. Details on the number and value of structures exposed to LANDFIRE Wildfire Regime areas are provided in Table 14-4 through Table 14-6. 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 14-7 through Table 14-9.

In addition, review of Headwaters Economics data indicates that in excess of 14,000 residential structures (~13 percent) fall within the WUI area (2013).[23] WDNR further identifies Island County as being of medium to medium-high risk for impact to state owned or leased facilities (see Figure 14-6). State assets exposed to wildfire in Island County include 72 owned and leased facilities. It is unclear whether the state indicates these assets to be of critical in nature, or merely structures owned.

TABLE 14-4.
PLANNING AREA STRUCTURES EXPOSED TO LANDFIRE FIRE REGIME 1

	Buildings Exposed	Estimated Value			% of Total Value
		Structure	Contents	Total	
Unincorporated	151	$25,236,156	$12,993,446	$38,229,602	0.44%
Coupeville	6	$1,258,272	$777,999	$2,036,271	0.46%
Langley	0	$0	$0	$0	0.00%
Oak Harbor	24	$4,461,949	$2,869,359	$7,331,308	0.18%
Total	**181**	**$30,956,377**	**$16,640,804**	**$47,597,181**	**0.36%**

[23] In reviewing this data, it is unclear what type of data Headwaters utilized to reach its determination (e.g., Assessor's data identifying residential structure; general building stock available from Hazus). Variations could be an aggregate or average at the block or census track levels. The data is also dated (2013). As such, this should be an informative figure only, as methodology for determining such data is unclear. Data accessed 11 Feb 2020. Available at: https://headwaterseconomics.org/dataviz/wui-development-and-wildfire-costs/

**TABLE 14-5.
PLANNING AREA STRUCTURES EXPOSED TO LANDFIRE FIRE REGIME 3**

	Buildings Exposed	Estimated Value			% of Total Value
		Structure	Contents	Total	
Unincorporated	20,353	$3,884,700,089	$2,053,598,013	$5,938,298,102	68.4%
Coupeville	335	$65,037,553	$41,099,050	$106,136,603	24.1%
Langley	512	$101,279,352	$63,580,741	$164,860,093	71.3%
Oak Harbor	3,487	$1,166,382,816	$904,067,438	$2,070,450,254	51.5%
Total	**24,687**	**$5,217,399,810**	**$3,062,345,240**	**$8,279,745,050**	**61.93%**

**TABLE 14-6.
PLANNING AREA STRUCTURES EXPOSED TO LANDFIRE FIRE REGIME 5**

	Buildings Exposed	Estimated Value			% of Total Value
		Structure	Contents	Total	
Unincorporated	8,149	$1,410,554,556	$777,915,498	$2,188,470,054	25.2%
Coupeville	484	$167,371,353	$160,779,085	$328,150,438	74.5%
Langley	187	$36,187,393	$24,610,825	$60,798,218	26.3%
Oak Harbor	4,526	$1,143,256,964	$779,793,453	$1,923,050,417	47.9%
Total	**13,346**	**2,757,370,266**	**1,743,098,861**	**4,500,469,127**	**33.66%**

**TABLE 14-7.
ESTIMATED LOSS POTENTIAL FOR LANDFIRE FIRE REGIME 1**

	Exposed Value	10% Damage	30% Damage	50% Damage
Unincorporated	$38,229,602	$3,822,960	$11,468,881	$19,114,801
Coupeville	$2,036,271	$203,627	$610,881	$1,018,136
Langley	$0	$0	$0	$0
Oak Harbor	$7,331,308	$733,131	$2,199,392	$3,665,654
Total	**$47,597,181**	**$4,759,718**	**$14,279,154**	**$23,798,590**

**TABLE 14-8.
ESTIMATED LOSS POTENTIAL FOR LANDFIRE FIRE REGIME 3**

	Exposed Value	10% Damage	30% Damage	50% Damage
Unincorporated	$5,938,298,102	$593,829,810	$1,781,489,430	$2,969,149,051
Coupeville	$106,136,603	$10,613,660	$31,840,981	$53,068,301
Langley	$164,860,093	$16,486,009	$49,458,028	$82,430,046
Oak Harbor	$2,070,450,254	$207,045,025	$621,135,076	$1,035,225,127
Total	**$2,341,446,949**	**$234,144,695**	**$702,434,085**	**$1,170,723,474**

TABLE 14-9.
ESTIMATED LOSS POTENTIAL FOR LANDFIRE FIRE REGIME 5

	Exposed Value	10% Damage	30% Damage	50% Damage
Unincorporated	$2,188,470,054	$218,847,005	$656,541,016	$1,094,235,027
Coupeville	$328,150,438	$32,815,044	$98,445,131	$164,075,219
Langley	$60,798,218	$6,079,822	$18,239,465	$30,399,109
Oak Harbor	$1,923,050,417	$192,305,042	$576,915,125	$961,525,209
Total	$2,311,999,073	$231,199,907	$693,599,722	$1,155,999,536

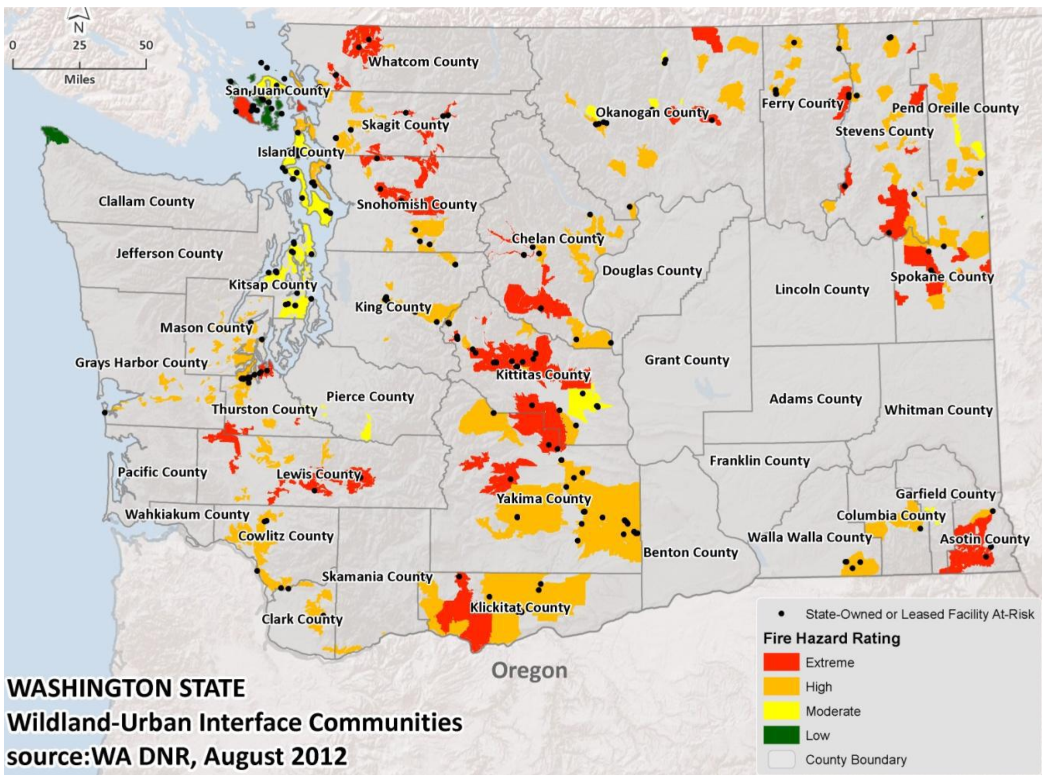


Figure 14-6. Wildland-Urban Interface Communities and State Facilities at Risk

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 14-10 identifies critical facilities exposed to the wildfire hazard.

TABLE 14-10. CRITICAL FACILITIES AND INFRASTRUCTURE EXPOSED TO FIRE REGIME AREAS			
	Regime 1	**Regime 3**	**Regime 5**
Medical and Health Services	0	1	6
Government Function	0	16	10
Protective Function	0	22	11
Schools	0	16	11
Hazmat	0	19	18
Other Critical Function	0	9	12
Transportation	0	7	7
Water	0	5	2
Wastewater	0	2	4
Communications	0	6	7
Total	**0**	**103**	**88**

Hazardous Material Involved Fire Impact on Critical Facilities and Infrastructure

Currently there are 38 registered Tier II hazardous material containment sites throughout Island County (based on 2018 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.

Climate change is influencing the frequency, intensity, and duration of wildfires and will likely exacerbate wildfire costs in the future. In the aftermath of a wildfire, local communities shoulder the responsibilities and costs of ongoing recovery. Homeowners, businesses, local organizations, and agencies can take years to financially rebound, and perhaps longer to heal emotionally and psychologically. Yet as more people continue to build in harm's way and as wildfire trends rise, wildfire costs will increase. By realizing that local communities bear the brunt of wildfire costs, elected officials and decisionmakers can take steps now in the planning and design of their communities to prevent devastating wildfire impacts in the future. Almost half of all wildfire costs are paid for at the local level, including homeowners, businesses, and government agencies. Many local wildfire costs are due to long-term damages to community and environmental services, such as landscape rehabilitation, lost business and tax revenues, and property and infrastructure repairs.

Some of the most prevalent and enduring long-term damages are related to restoring local landscapes. The restoration of forests, viewsheds, and critical natural resources such as watersheds is a slow and painstaking task. In the years and decades it takes to recover from a catastrophic wildfire, communities may experience decreasing property values, degraded ecosystem services, declining business and tax revenues, and other persistent adverse impacts. A wildfire can severely damage local utilities and infrastructure. The replacement and repair of transmission lines, gas lines, electric utility poles, and transportation routes can take years and quickly add to the overall costs of a wildfire.

Wildfires can have an enduring effect on the local economy by impacting tax and business revenue and other forms of income. Less visible than other wildfire impacts, long-term damages resulting from a depreciated tax and business base can add up to millions of dollars over succeeding years. Wildfire impacts on tax and business revenues can be particularly acute in places dependent on tourism and recreation. Fewer tourists and recreational users result in less business for local retailers, outfitters, hotels, and restaurants, as well as reduced income from user fees in national parks and recreational areas. (Headwaters Economics)

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 and its planning partners are 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 and its planning partners feel that this expansion of the wildland-urban interface can be managed with strong land use and building codes, and to date, while the number of fires has increased, it is unclear because such increase has occurred as a result of increased population, or the various drought situations that have occurred since the last plan's completion. Regardless, all feel that growth can be managed effectively through fire suppression tactics and land use regulations without increasing the vulnerability to the citizens as a result of wildfires. **Error! Reference source not found.** identifies some land use options which will help reduce the risk of the wildfire hazard in the planning area. The County and its planning partners will continue to consider such regulations as they update their respective municipal codes and comprehensive plans.

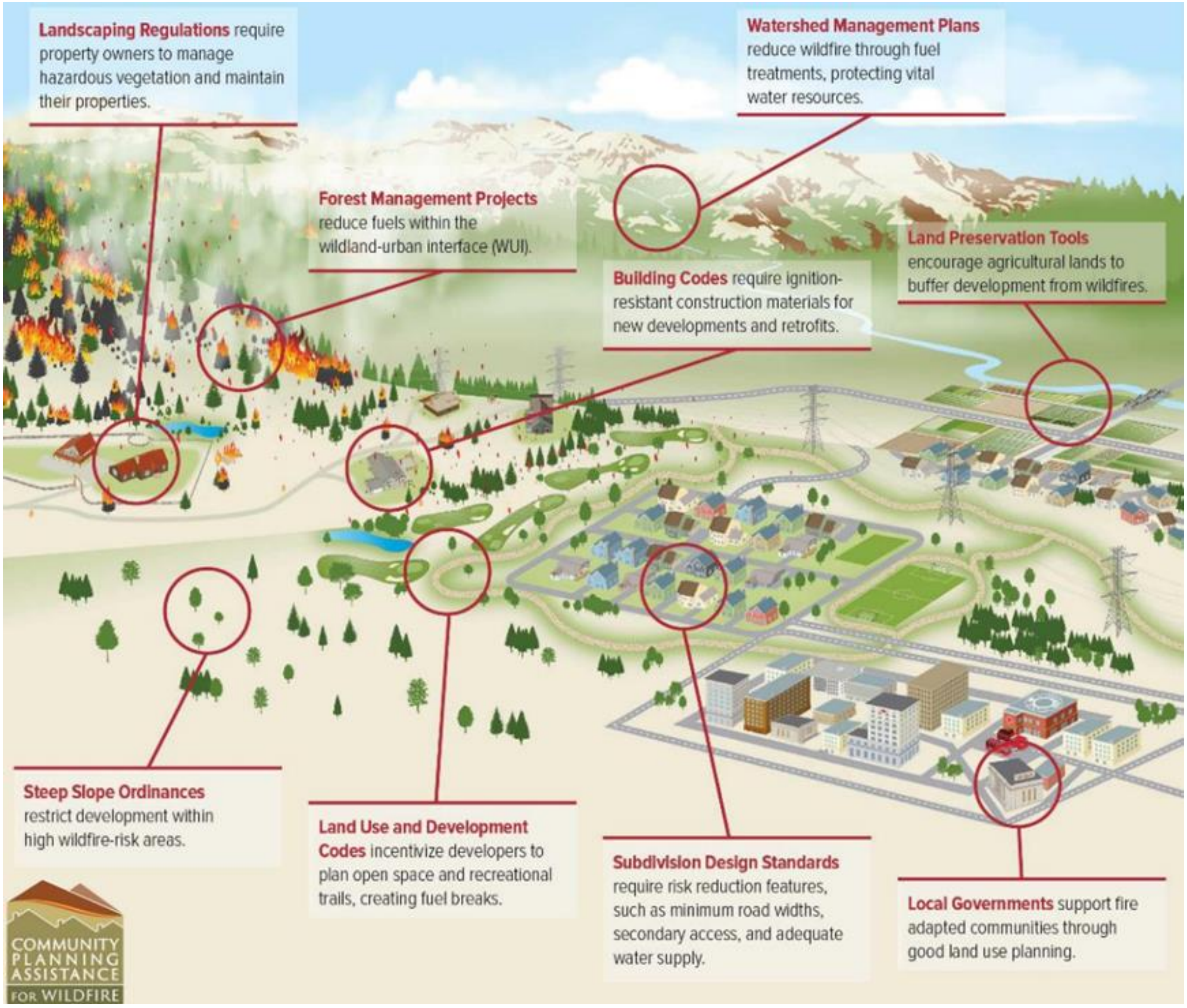


Figure 14-7 Potential Land Use Mitigation Activities to Reduce Wildfire Impact

In addition to the public element of land use development, a growing body of research suggests that "the only effective home protection treatment is treatment in, on, and around the house (see Figure 14-8); 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 14-9 illustrates additional ember and home ignition zones.

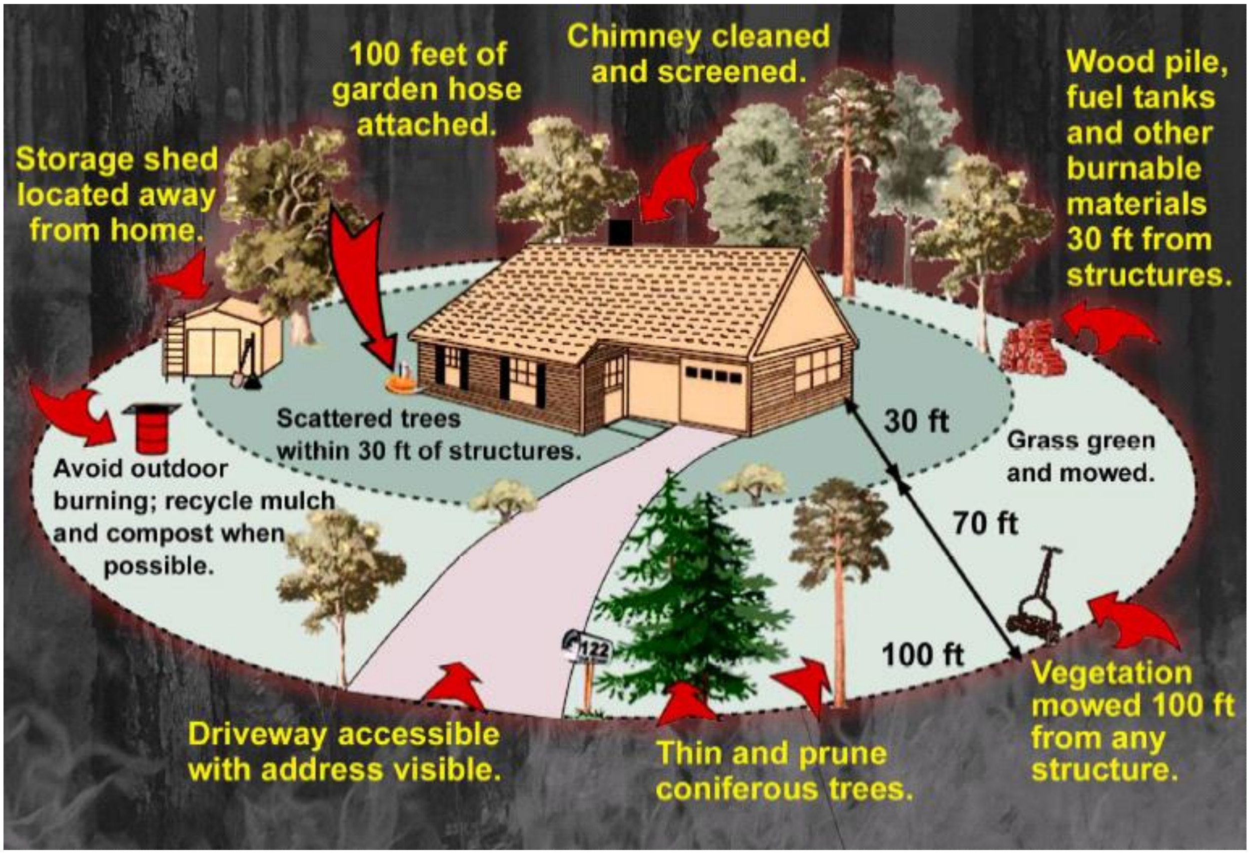


Figure 14-8. Measures to Protect Homes from Wildfire

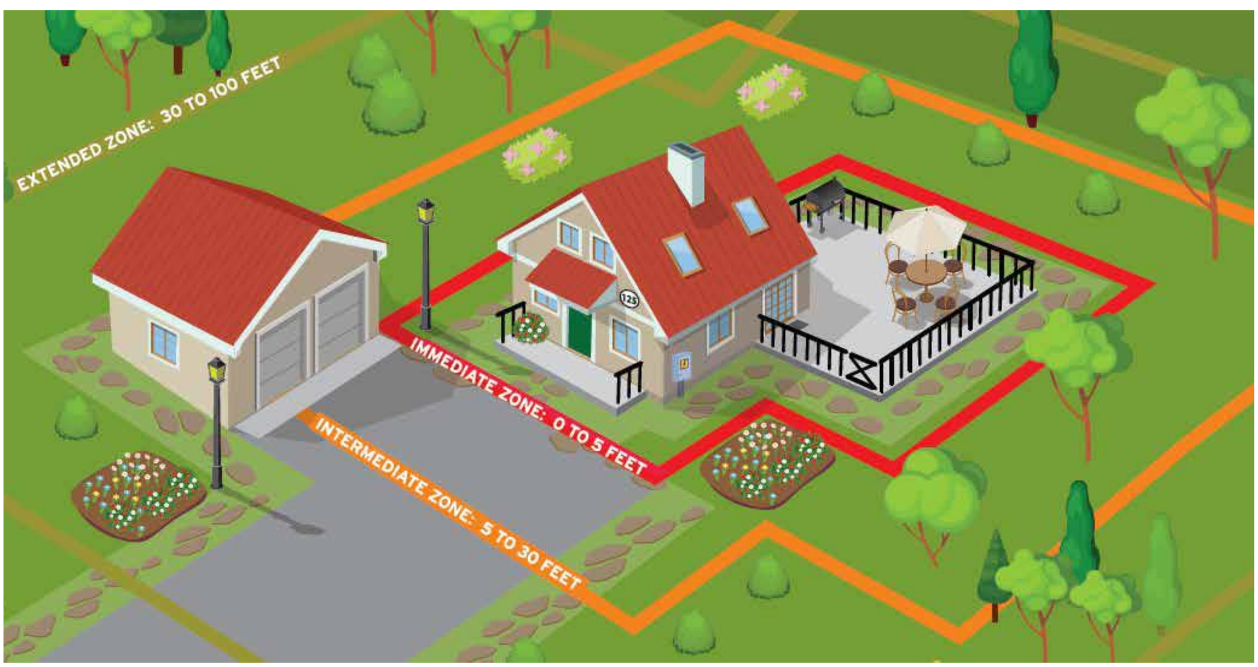


Figure 14-9 Firewise USA Ember Threat and Home Ignition Zones

Source: Firewise USA

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.

State and local officials, employers, and the public are coming to grips with the fact that wildfires—and their attendant toxic smoke—need deeper solutions, as climate change is causing fires out West to erupt earlier in spring and last later into the winter, a conclusion also reached in the latest scientific assessment of U.S. climate change effects (Saiyid).

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, 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.

14.7 IMPACT AND RESULTS

While wildfires in the County have been successfully managed to date by wildfire suppression activities, with the added impact from climate change, the wildfire environment is changing. Thankfully, the County has not experienced any deaths or (significant) injuries as a result of historic wildfire events; however, since completion of the last plan, the number of wildfires has increased (Camano), as has the area impacted.

Wildfires can generate a range of secondary effects, which in some cases may cause more widespread and prolonged damage than the fire itself. Health impacts from wildfire, particularly in an area of increased vulnerability due to a higher population of elderly, could increase the number of individuals experiencing breathing (or other) health-related issues, and could increase the number of calls for service. Some areas of the County could be isolated as a result of a wildfire incident, which would impact potential evacuation and first responder activities.

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.

The Planning Team for this 2020 update did not concur with either WDNR or the State's assessment of the level of risk at high based on historical occurrences and previous impact. While the County does have a high percentage of construction in the WUI areas, fire suppression tactics and building codes have significantly helped manage impact. While the County as a whole has a higher-than-average population of elderly who are at higher risk to impacts from wildfire, the County and its Planning Partners have been able to successfully manage wildfire events that have occurred to date, limiting historic impact, injuries, and damages. Based on the potential impact, the Planning Team determined the CPRI score to be 1.85, with overall vulnerability determined to be a medium-low level.

CHAPTER 15.
RISK ASSESSMENT OVERVIEW

15.1 CACULATED PRIORITY RISK INDEX CALCULATIONS

Once the risk analysis contained in the hazard profiles were completed, the Planning Team applied the data captured during that process to further analyze the hazards of concern, adding any additional hazards specific to each planning partner as applicable, and discussed within their annex document.

In completing this process, the Planning Team utilized the Calculated Priority Risk Index (CPRI), which examines five criteria for each hazard as identified in Chapter 4 (probability, magnitude/severity, extent/location, warning time, and duration). The CPRI defines a risk value for each criteria according to four levels (e.g., 1-4) which was assessed during the risk analysis portion of the process, and then applies a weighting factor based on the significance of that criteria (see Chapter 4, Figures 4-1 and 4-2 for samples).

In order to complete this process, the Planning Team was provided the hazard profiles, which discusses the probability of impact, a loss matrix for the various hazards which identify impact to people, property, economy and environment at the local level, and the critical facilities list which was developed by the Planning Partners, and which identifies impact to each facility for each hazard of concern. The result is a score that has been used to rank the hazards equitably based on specific local impact.

Table 15-1 presents the results of the Calculated Priority Risk Index scoring for all hazards impacting the County. Each planning partner's spreadsheet in their entirety are presented in Section 15.4 for ease in review. Additional hazard information specific to each planning partner is also contained within their respective annex template.

TABLE 15-1.
ISLAND COUNTY CALCULATED PRIORITY RISK INDEX SCORE

Hazard	Probability	Magnitude and/or Severity	Geographic Extent and Location	Warning Time	Duration	Calculated Priority Risk Index Score
Coastal Erosion	3	1	2	1	4	2.15
Dam Failure	1	1	2	4	2	1.70
Drought	2	2	3	1	4	2.15
Earthquake	4	3	4	4	1	3.65
Flood	3	2	2	1	1	2.15
Landslide	3	2	2	4	1	2.65
Severe Weather	4	2	3	4	1	3.25
Tsunami	2	1	1	4	2	1.90
Volcano	1	2	3	1	3	1.70
Wildfire	2	1	2	4	1	2.05

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.

15.2 RISK RANKING

Once the CPRI calculations were determined, the Planning Team then prioritized the hazards of concern based on a numeric value. During this risk ranking process, Planning Team members were asked to consider their experience and knowledge in identifying items which are relevant, but not necessarily captured otherwise, such as local capabilities, or gaps that may exist within their communities, looking also at the potential social vulnerabilities (discussed below). During the ranking process, in some cases, the hazards ranked equally even though their CPRI scores were different based on the application of subjectivity on the part of the team members. This provided an opportunity for the inclusion of information and detail that otherwise may not be included in the risk assessment. Each Planning Team Member identified those variations in their respective annex template. Table 15-2 is a summary of the CPRI score and hazard ranking for the municipal planning partners. Table 15-3 contains the CPRI score and hazard ranking for the special purpose district Planning Team Members.

**TABLE 15-2.
MUNICIPAL PLANNING PARTNERS' HAZARD RANKING SUMMARY**

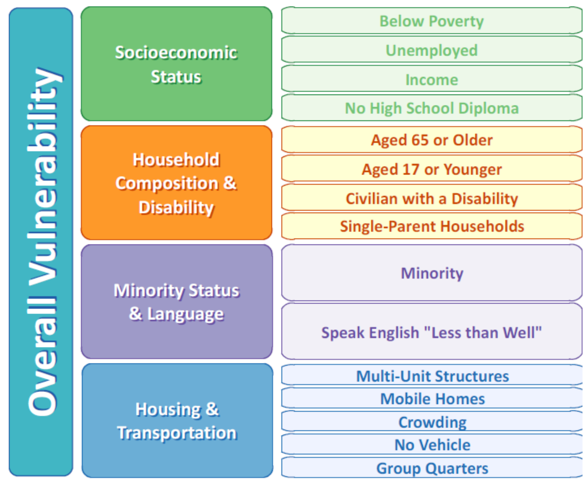
	County		Coupeville		Langley (Pending)		Oak Harbor	
Hazard	**Rank**	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**	**Score**
Coastal Erosion	5	2.15	3	3.05			4	2.35
Dam Failure	8	1.70	NR				10	1.5
Drought	5	2.15	7	1.40			9	1.75
Earthquake	1	3.65	1	3.65			2	3.4
Flood	4	2.20	5	2.05			7	2.05
Landslide	3	2.65	4	2.45			3	2.45
Severe Weather	2	3.25	2	3.25			1	3.7
Tsunami	7	1.90	6	1.85			6	2.15
Volcano	8	1.70	7	1.40			5	2.2
Wildfire	6	2.05	5	2.05			8	2.0

**TABLE 15-3.
SPECIAL PURPOSE DISTRICTS' HAZARD RANKING SUMMARY**

	Hospital		Camano Fire		CWIFR		SWFR	
Hazard	**Rank**	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**	**Score**
Coastal Erosion	6	1.60	4	1.95	6	1.45	3	2.80
Dam Failure	9	1.0	NR	NR	6	1.45	9	1.35
Drought	8	1.15	8	1.35	2	2.65	6	1.95
Earthquake	1	3.65	1	2.65	1	2.80	1	3.85
Flood	9	1.0	7	1.45	8	1.15	8	1.4
Landslide	7	1.45	3	2.3	9	1.0	4	2.65
Severe Weather	2	2.70	5	1.9	3	2.30	2	3.45
Tsunami	4	1.85	2	2.35	5	1.65	7	1.75
Volcano	3	2.55	6	1.85	4	1.70	10	1.15
Wildfire	5	1.70	3	2.3	7	1.40	5	2.05

15.3 SOCIAL VULNERABILITY

As indicated, the Planning Team also discussed the impact of Social Vulnerability for the selected hazards. When determining risk, it is significant to remember that risk is measured by not only the hazard, but also on how resilient a population is, or will be during the hazard. Resilience is influenced by many factors, including: age or income; available social networks, and neighborhood characteristics, all of can be used to measure the social vulnerability of the area and its citizens. Factors that contribute to the level of vulnerability of a population are customarily associated with four areas of impact, as follows:



- Socioeconomic status:
  - Below Poverty Level
  - Employment Status
  - Income level
  - No High School Diploma
- Household composition:
  - Age 65 or older
  - Age 5 or younger (the North Carolina study references age 17 or younger)
  - Disability (the North Carolina study referenced "Older than Age 5 with a Disability")
  - Single Parent Households
- Minority Status and Language:
  - Minority – race or ethnicity
  - Language barrier (Speak English "Less than Well"
- Housing/transportation:
  - Multi-Unit Structures, including Group Quarters
  - Mobile Homes
  - Crowding
  - No Vehicle

The purpose of the classifications are to better understand whose needs are not being addressed through traditional service providers, or who cannot safely access and use the standard resources offered for disaster preparedness, relief, and recovery. Special focus on these groups during emergency situations is crucial because not only are they more likely to be affected by an event, but they are many times also less likely to recover.

15.3.1 Classifications

Socioeconomic status considers things such as income, poverty, employment status, and education level. Those who are economically disadvantaged will be affected by an event more significantly. The monetary value of their possessions may be less, but they represent a larger proportion of total household assets. These groups are less likely to have renter's or homeowner's insurance, so their possession will be costlier to replace, and individuals are less likely to evacuate in order to ensure the protection of their belongings. In the event of injury or death, those who are unemployed will not have the benefits or the income to assist with costs for recovery. In addition, in most cases, the poor lack the assets and the resources to prepare for a disaster in advance, and once impacted, to recover.

Household composition and disability grouping is comprised of age (those under the age of 5 and above the age of 65), single parent homes, and any disability. These groups are more likely to need financial support, transportation, medical care, or assistance with day to day activities during disasters. The elderly and the children, especially the younger ones often lack the resources, knowledge, or life experiences to effectively address the situation and cannot protect themselves. Elderly living alone, and people who have a physical, sensory, or cognitive challenges are more likely to be vulnerable during an incident. These groups often need a higher level of assistance than others, and may have caretakers who are less able to assist during a crisis if those caretakers have families of their own. This places a heavier burden on medical and first responders.

Minority status and language includes race, ethnicity, and proficiency of the English language. The social and economic marginalization of certain racial and ethnic groups have made these populations more likely to be vulnerable at all stages, and are automatically associated with a higher vulnerability rate. Many citizens are not fluent in English, which makes providing them with real time information difficult. Because Spanish is the most prominent second language, there are often translators available, and many times emergency notifications are provided in Spanish; however, those who speak other languages are at greater risk if notifications are not provided in the appropriate languages. These groups often rely on family, friends, neighbors and social media for information.

Housing and transportation considers the structure of the home (e.g., building codes, age of structure, etc.), crowding, and access to vehicles or public transportation. The quality of the housing in crucial when calculating vulnerability and is often tied to the person's wealth. Those who are economically disadvantaged often live in poorly constructed houses or mobile home, neither of which are designed to withstand strong winter storms (ice and snow loads), wind events, earthquakes, or flooding. In addition, mobile homes are often located in places without easy access to highways or public transportation, are in cluster communities, and many times not tied down to a foundation, all of which add another layer of vulnerability. Multi-unit housing in densely populated areas are difficult to evacuate because of the limited amount of space and crowding. Urban areas often have a lower automobile ownership rate (e.g., walkable communities), especially in the lower income populations, which can make evacuations more challenging. Despite the lower proportion of people with vehicles, urban areas often have to deal with congestion on highways and major roads because of crowding. Group quarters are another housing situation that cause concern during evacuations, especially nursing homes and long term care facilities because many institutions are unprepared to quickly remove staff and residents, and as with private group/independent living homes, the data that such facilities exist is not publicly known and/or identified.

15.3.2 Results and Discussion

Table 15-4 again illustrates the percent of the total population identified within Island County meeting the various classifications identified as influencing the resilience of a community. It should be noted that in an effort to present the most detailed data, different Census datasets were used, which in some cases reflect different values; as such, variations may exist. Not all data was available for each population group or area of the County.

TABLE 15-4.
VULNERABLE POPULATIONS

	Percent of Total Population			
Population Group	**County**	**Oak Harbor**	**Coupeville**	**Langley**
Households Children 5 and Under	5.7%	9.4%	4.1%	2.6%
Populations 65 and Older	24.6%	12.0%	27.5%	28.4%
Population Below Poverty Level	9.5%	*	*	*
Language Other Than English	8.1%	17.2%	*	*
Total Population with any Reported Disability	15.6%	*	*	*
At Least One Disability Under 65	10.0%	9.1%	*	*
At Least One Disability 18 years and under	4.3%	*	*	*
At Least One Disability 18-64	12.1%	*	*	*
At Least One Disability 65 and over	31.8%	*	*	*

Sources: US Census[24]

*Data Not available at municipality level from Census Bureau or WA State Office of Financial Management

TABLE 15-5.
POTENTIAL SPATIAL DISTRIBUTION OF EXPOSURE BY JURISDICTION

Jurisdiction	Building Count	Exposed Value	10% Damage	30% Damage	50% Damage
Coupeville	843	$440,648,701	$44,064,870.10	$132,194,610.30	$220,324,350.50
Langley	714	$231,125,633	$23,112,563.30	$69,337,689.90	$115,562,816.50
Oak Harbor	8,060	$4,016,992,564	$401,699,256.35	$1,205,097,769.05	$2,008,496,281.75
Unincorporated County	30,426	$8,681,024,425	$868,102,442.45	$2,604,307,327.35	$4,340,512,212.25
Total	**40,043**	**$13,369,791,322**	**$1,336,979,132**	**$4,010,937,397**	**$6,684,895,661**

24 US Census Data Accessed 5 Fe 2020. Available online at: https://data.census.gov/cedsci/profile?g=0500000US53029&tid=ACSDP1Y2018.DP02&hidePreview=true&vintage=2018

TABLE 15-6.
VULNERABILITY OVERVIEW

Hazard	Overview	Population Groups Impacted: Business	Children	Disabled	Elders	Families	Low Income	Language	Level of Vulnerability Low, Medium High	Synopsis of Potential Impact
Climate Change	Climate change is often measured in terms of impact on other hazards of concern. Impact varies, but can include drought conditions, water shortage, increased flood incidents, increased wildfire danger, environmental changes which impact habitats and species. Given the economy of the area and its dependence on tourism and agriculture, among others, economic impact could be significant.	X	X	X	X	X	X	X	Medium	Climate change itself does not impact structures; however, it has the potential to exacerbate the other hazards of concern. As such, the entire population, structure, economy and natural resources of the area will be impacted by climate change in some form. For example, wildfire danger may increase. Flood depths may increase due to additional or more significant storms, causing additional damage and impact throughout the area, both in areas previously flooded (more severe flooding), and in areas which previously have not flooded. Severe weather events may be impacted in frequency and severity. Drought situations may increase in severity. Due to the area's high demand on individual wells, this may impact growth in the area due to more limited water supplies. While the County and some planning partners do have plans in place for contingency water supplies, this would not address long-term issues.

TABLE 15-6.
VULNERABILITY OVERVIEW

Hazard	Overview	Population Groups Impacted: Business	Children	Disabled	Elders	Families	Low Income	Language	Level of Vulnerability Low, Medium High	Synopsis of Potential Impact
Drought	Drought is typically measured in terms of water availability in a defined geographical area, and is not a sudden-onset hazard, allowing some preparation. Socioeconomic droughts occur when physical water shortage begins to affect people, individually and collectively. Social impacts mainly involve public safety, health, reduced quality of life, and inequities in the distribution of impacts and disaster relief. Many impacts identified as economic and/or environmental also have a social component. During warm seasons, water suppliers are often faced with more demand for water than they are able to distribute. This may lead to rationing and curtailment, with business that rely heavily on water usage (landscapers, farmers, golf courses, car washes, etc.) suffering financially. Most socioeconomic definitions of drought associate it with supply, demand, and economic goods.	X	X	X	X	X	X	X	Medium	Drought customarily does not impact structures, but could adversely impact people, resources, agricultural businesses, and recreation (among others) within the area. Therefore, all populations would be susceptible, although the degree would be determined by the severity of the drought, and the availability of water. Most of Island County receives its water supply from local wells, with the exception of Oak Harbor, which receives water from the City of Anacortes, although the City does have wells that can be utilized under specific conditions, and does maintain capacity for 4.5-5 million gallons of water storage. Impact to well supply is, in part, determined on whether the wells are shallow, which may see levels rise more quickly with the return of rain, whereas deeper wells tend to withstand drought. However, in extreme circumstances, it may take several months of adequate rain or snow to restore supply. Some planning partners do have some type of water-shortage plan in place, and have identified additional water sources should a shortage occur. Currently, there are almost 590 Class B wells Countywide, as well as 283 Class A wells. Camano Island has a total of 33 wells (both A & B). Land use development trends in the area have not been impacted by issues with water supply yet; however, there are fewer farms in the area now than previous (down 18 percent during the period 2007-2012 - the most recent USDA report), yet the size of acres per farm increased by ~3%, from 39 to 40 acres on average. Individual well owners do have the ability to expand its services to new construction.

TABLE 15-6.
VULNERABILITY OVERVIEW

Hazard	Overview	Population Groups Impacted: Business	Children	Disabled	Elders	Families	Low Income	Language	Level of Vulnerability Low, Medium High	Synopsis of Potential Impact
Earthquake	Older structures (pre ~1970) have high probability of collapse due to building code standards; Non-English speakers may have issues gaining hazard information for preparedness. Low-income individuals may not be able to stockpile supplies or medications. Elderly populations are vulnerable due to health issues, the lack of physical strength to extricate themselves, etc. Businesses many times do not carry insurance which will help them recover from losses. Impact to the area would not only include direct impact from structure losses, injuries, etc., but also disruption of commodities along the I-5 corridor, and along the ferry services between the United States and Canada. Impact could also include an influx of evacuees from the Canada. Such influx would impact commodities, medical services in hospitals, and first responder resources. Resources could also be taxed based on mutual aid agreements in place in conjunction where the epicenter occurred and the type of earthquake event.		X	X	X	X	X	X	High	Many structures in the area were built pre-1970 when lower codes were in place, especially in the historic or older parts of the county (such as Coupeville and portions of Oak Harbor). Lower codes make the older structures more vulnerable to collapse and increasing the potential for injury. The entire area is susceptible to the impacts from an earthquake based on PGA and liquefiable soils. Bluff areas are also subject to landslide susceptibility. While building codes restrict construction in high-landslide areas, many structures along the bluff are pre-code or not permitted. The North Whidbey planning area, (Oak Harbor, the Naval Air Station, and the Deception Pass State Park), is the most developed region in the County, and the only area without a ferry connection to the mainland. This area has historically absorbed more population growth than others. Most future growth is related to the expansion at the Navy Base. Growth in the Central Whidbey Planning area, (Town of Coupeville, Greenbank Community, and Eby's Landing around Penn Cove) is largely driven by retirees, and those commuting to Oak Harbor. Camano Island with its proximity to Snohomish and Skagit Counties make residence on Camano attractive to commuters. Review of the 2016 Comp Plan indicates less than 22% of undeveloped parcels. The South Whidbey Planning Area, (Clinton Ferry Terminal, Langley and Freeland), is the largest planning area by land mass. The Clinton Ferry Terminal would be impacted significantly by an EQ, potential ensuing Tsunami, and liquefaction. The ability for evacuation as a result of an earthquake would be impacted if the ferry terminal were unusable.

TABLE 15-6.
VULNERABILITY OVERVIEW

Hazard	Overview	Population Groups Impacted: Business	Children	Disabled	Elders	Families	Low Income	Language	Level of Vulnerability Low, Medium High	Synopsis of Potential Impact
Flood / Dam	Year of construction will influence the building code and the height to which the structures were built when compared to the Base Flood Elevation. In most instances, weather patterns which cause flooding are identified in advance, allowing pre-planning for evacuation, thereby potentially reducing the individuals at risk. Individuals without homeowner's insurance which covers flooding may suffer extreme financial risk. Businesses impacted many times do not carry insurance which will help them recover from losses. In many instances, those businesses do not return to the area because they cannot overcome the financial loss.	X	X	X	X	X	X	X	Medium-Low	Flooding in the area occurs annually at some level. Flooding has impacted transportation, causing roadways to be blocked, and causing landslides which also block major arterials. Access into the county is limited, with much of the county heavily dependent on ferry transportation, or limited roadways, which have the potential for landslides. Some portions of the County have only one major roadway into the area – Camano Island. There are currently only two major roadways which traverse the entire county (SR 525 to I-5 and SR 20 to SR 1010), either of which, if impacted, would hamper evacuation. Both of those transportation corridors connect to two of the state's ferry routes – Mukilteo/Clinton and Pt. Townsend/Keystone. All areas within the floodplain would be vulnerable, however, given the higher-than-average population of elderly, the level of vulnerability is higher than when compared to other areas of the state. Impact from flood events on structures has historically been limited, with the most frequent impact occurring to roadways, and increased landslide risk. The County also has increased populations from tourists who frequent the area, and travel through to the county en route for Canada. Ferry ridership also increases seasonal population counts. This is particularly true during summer months, when tourist activity increases for recreational purposes at the County's state parks or Canada.

**TABLE 15-6.
VULNERABILITY OVERVIEW**

Hazard	Overview	Population Groups Impacted: Business	Children	Disabled	Elders	Families	Low Income	Language	Level of Vulnerability Low, Medium High	Synopsis of Potential Impact
Severe Weather	Severe weather occurs regularly throughout the planning area. In most instances, weather patterns are forecasted in advance, allowing for preparation. Individuals with lower income may not have the ability to stock supplies, nor afford the cost of increased energy costs for both heating or cooling, depending on the weather event. Elderly and the young are especially susceptible to cold, ice, and heat conditions. Wind is a common occurrence in the area, although long term power outages are rare. Power lines are above ground throughout the county. Snow and ice are not commonplace, but do occur. The planning region is prepared to deal with accumulations, having identified priority snow routes for clearing. Lighting strikes also occur in the planning area. In densely wooded areas, such as the National and State Forests or any of the timber land areas, fires could go un-noticed, allowing the fire to gain strength and severity, especially during drought situations. Lightning risks also increases life-safety due to the large number of watercraft in the area, and the time necessary to get to safety. The area also has extensive hiking trails and other outdoor tourist attractions (including golf courses), which are open and provide little cover from lightning strikes.	X	X	X	X	X	X	X	High	The entire region is susceptible to severe weather incidents, including impact to people, property, economy, and the environment. Incidents of some nature and degree occur annually, although the extent of impact is limited in nature unless flooding occurs, or landslide hazards are elevated as a result of precipitation. Depending on the type of event, roadways may be impassible. Power outages, while they do occur, do not occur often, and do not customarily last for a long period of time. However, when coupled with cold conditions which would cover the entire planning area, the impact to vulnerable populations increases. The County and its municipalities do have shelter capacity for warming and cooling, and longer-term if necessary. With extreme heat events, physical manifestation on the young and elder rise. The County does have a higher-than-average number of elderly and retirees, which could increase need for response activities by first responders. In addition, the increased fire danger impacts the entire area.

TABLE 15-6.
VULNERABILITY OVERVIEW

Hazard	Overview	Population Groups Impacted: Business	Children	Disabled	Elders	Families	Low Income	Language	Level of Vulnerability Low, Medium High	Synopsis of Potential Impact
Volcano	Volcanic eruption would impact the area primarily through ash accumulations. The area is outside of the lahar zone. Ash accumulations could impact structures due to not only machinery, but also from the weight of the ash itself, and load capacity. Individuals with health concerns, especially breathing or lung issues, would be more susceptible and at risk. Economic impact could be significant, given the planning areas' reliance on agriculture, the timber industry, and outdoor recreational activities – all of which would be impacted by ash and the acidic nature when mixed with precipitation.	X	X	X	X	X	X	X	Low	One incident of volcanic eruption has occurred in the area which rose to the level of a disaster declaration statewide. No dollar loss figures were captured on which to base economic impact; however, due to the areas reliance on agriculture and aquaculture, economic impact could be significant. Prevailing winds would more likely than not push the ash away from Island County, but even small amounts of ash can cause issues with respect to the environment. Environmental impact would be a major concern throughout the entire area, as ash spread would be carried both through wind (at some level) and also vehicles traveling through the area, which are carrying ash. Emergency vehicles, intake valves for HVAC systems, etc., could be impacted by even small amounts of ash. Small amounts of ash can also negatively impact water sources and vegetation due to the acidic nature of the ash itself. Groundwater infiltration into wells is also of concern. Physical impact from a Lehar is limited in nature; however, impact from a Lehar would be significant when considering access along the I-5 corridor, which would likely be impassable. Such impact would impede evacuation and commodity flow.

**TABLE 15-6.
VULNERABILITY OVERVIEW**

Hazard	Overview	Population Groups Impacted: Business	Children	Disabled	Elders	Families	Low Income	Language	Level of Vulnerability Low, Medium High	Synopsis of Potential Impact
Wildfire	Statewide, impact from wildfires has increased over time due to effective suppression tactics. This has now caused fires to burn with greater intensity, with the traditional fire regimes being modified. Embers from wildfires can be carried significant distances (miles). With climate change impacting drought conditions, the potential for wildfire increases as moisture content is depleted. People are one of the major causes to wildfires, which can spread very quickly, leaving little to no time to evacuate. The County has a high population of hikers and campers to its parks, increasing the risk for ignition, particularly during dry summer months. Individuals with access and functional needs, the young and elderly are at greater risk due to their potential dependence on others to assist with evacuation. Individuals with health concerns are impacted significantly by smoke. Increased rates of death due to smoke can occur.	X	X	X	X	X	X	X	Medium-Low	Wildfire danger can impact the entire planning area as illustrated by State DNR assessments; however, the area has been fortunate to date that no significant fires have occurred in the recent past. The various Fire Regimes do identify areas of higher levels of risk. Due to the wind patterns in the area, embers have the potential to travel great distances (miles) and ignite fires in areas which are densely wooded. In some instances, these fires can burn for periods of time, going un-noticed until ignition consumes a large area, making containment difficult. The County does have large areas of densely wooded forests and parks, as well as a high number of campgrounds, which maintain firepits. Elderly, young and individuals with breathing/health issues are more vulnerable due to smoke and particulates. The County does have a higher-than-average rate of elderly, which could be impacted by smoke if a large wildfire erupted. Certain portions of the county could also be restricted with respect to evacuation, increasing the potential risk to firefighters and first responders. Language may also be a barrier for non-English speaking populations due to the inability to understand evacuation orders, which can be very short-notice.

15.3.3 Level of Vulnerability

The final step in the risk assessment process provided for the application of a qualitative rating of significance based on all information gathered, applying a high, medium or low level as identified below. Such application would allow for ease in identifying and prioritizing not only the hazards, but also when considering strategies. The Planning Team felt this summary was also particularly beneficial when discussing the hazards of concern with the public, as it provided a manner in which to define the risk associated with the hazards in simple terminology.

The Planning Team established the following descriptors for identifying the levels of significance:

- Extremely Low—The occurrence and potential cost of damage to life and property is very minimal to nonexistent.
- Low—Minimal potential impact. The occurrence and potential cost of damage to life and property is minimal.
- Medium—Moderate potential impact. This ranking carries a moderate threat level to the general population and/or built environment. Here the potential damage is more isolated and less costly than a more widespread disaster.
- High—Widespread potential impact. This ranking carries a high threat to the general population and/or built environment. The potential for damage is widespread. Hazards in this category may have occurred in the past.
- Extremely High—Very widespread with catastrophic impact.

The end result of the process is illustrated in Table 15-7. This information was presented at various public outreach efforts to help identify risk countywide. Utilizing a process such as this is beneficial when discussing risk with the public and while attempting to gain their perspective of risk as it provides a means for the planning team to describe risk in a manner easily applied and understood, while also providing a mechanism of identifying how citizens view risk. Such process was utilized to help validate the risk information as established throughout the planning process in the view of the citizens, further validated by the surveys completed, which utilize a high/medium/low priority.

TABLE 15-7.
COUNTYWIDE VULNERABILITY RATING

City or Town	Coastal Erosion	Dam Failure	Drought	Earth-quake	Flood	Land-slide	Severe Weather	Tsunami	Volcano	Wildfire
Unincorporated County	Medium	Low	Medium	High	Medium	Medium	High	Medium/ Low	Low	Medium /Low
Coupeville, Town of	High	NR	Low	High	Low	Medium	High	Low	Low	Low
Oak Harbor, City of	Medium	Low	Low	High	Low	Medium	Ex. High	Low	Medium	Low
Camano Island Fire & Rescue	Medium	NR	Low	High	Low	Medium	Medium	Medium	Low	Medium
South Whidbey Fire/EMS	Medium	Low	Low	High	Low	Medium	High	Low	Low	Medium

TABLE 15-7.
COUNTYWIDE VULNERABILITY RATING

City or Town	Coastal Erosion	Dam Failure	Drought	Earth-quake	Flood	Land-slide	Severe Weather	Tsunami	Volcano	Wildfire
Central Whidbey Fire & Rescue	Ex. Low	Ex. Low	Medium	High	Ex. Low	Ex. Low	Low	Ex. Low	Ex. Low	Ex. Low
Whidbey General Hospital District	Low	Low	Low	High	Low	Low	High	Low	Medium	Low

15.4 CALCULATED PRIORITY RISK INDEX SPREADSHEETS

The following represent the Calculated Priority Risk Index input and results as prepared by each of the planning partners involved in this process. A summary of the findings is also contained within each annex, which further illustrates the hazard ranking which was completed by each planning partner.

15.4.1 Municipal Planning Partners

Town of Coupeville

Hazard	Probability of Occurrence				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration				CPRI Score	Level of Vulnerability
	Unlikely /Low (1)	Possible / Medium (2)	Likely / High (3)	Highly Likely / Very High (4)	Negligible (1)	Limited (2)	Critical (3)	Catastrophic (4)	Negligible (1)	Limited (2)	Significant (3)	Extensive (4)	< 6 hours (4)	6 - 12 hours (3)	12 - 24 hours (2)	> 24 hours (1)	< 6 hours (1)	< 24 hours (2)	< 1 week (3)	> 1 week (4)		Extremely Low / Low / Medium / High / Extremely High
Coastal Erosion				4			3					1	4				1				3.05	High
Dam Failure																					0.00	NR
Drought		2			1				1							1	1				1.40	Low
Earthquake				4			3					4	4				1				3.65	High
Flood		2				2			1				4				1				2.05	Low
Landslides			3			2			1				4				1				2.45	Medium
Severe Weather				4		2					3		4				1				3.25	High
Tsunami		2			1				1				4				1				1.85	Low
Volcano	1				1						3					1				1	1.40	Low
Wildfire		2			1					2			4				1				2.05	Low

City of Oak Harbor																					
	Probability of Occurrence				**Magnitude / Severity**				**Geographic Extent and Location**				**Warning Time**				**Duration**				**Level of Vulnerability**
Hazard	**Unlikely / Low (1)**	**Possible / Medium (2)**	**Likely / High (3)**	**Highly Likely / Very High (4)**	**Negligible (1)**	**Limited (2)**	**Critical (3)**	**Catastrophic (4)**	**Negligible (1)**	**Limited (2)**	**Significant (3)**	**Extensive (4)**	**< 6 hours (4)**	**6 - 12 hours (3)**	**12 - 24 hours (2)**	**> 24 hours (1)**	**< 6 hours (1)**	**< 24 hours (2)**	**< 1 week (3)**	**> 1 week (4)**	**CPRI Score**	**Extremely Low / Low / Medium / High / Extremely High**
Coastal Erosion			3			2				2						1				4	**2.35**	Medium
Dam Failure	1					2				2						1			3		**1.50**	Low
Drought		2			1					2						1				4	**1.75**	Low
Earthquake			3					4			3		4							4	**3.40**	High
Flood		2				2				2					2				3		**2.05**	Low
Landslide			3			2				2					2				3		**2.45**	Medium
Severe Weather				4			3				3			3	2				3		**3.70**	Extremely High
Tsunami	1					2					3		4						3		**2.15**	Low
Volcano		2				2				2				3					3		**2.20**	Medium
Wildfire		2				2				2					2			2			**2.00**	Low

15.4.2 Special Purpose Districts

Whidbey General Public Hospital District																							
	Probability of Occurrence				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration					CPRI Score	Level of Vulnerability
Hazard	Unlikely / Low (1)	Possible / Medium (2)	Likely / High (3)	Highly Likely / Very High (4)	Negligible (1)	Limited (2)	Critical (3)	Catastrophic (4)	Negligible (1)	Limited (2)	Significant (3)	Extensive (4)	< 6 hours (4)	6 - 12 hours (3)	12 - 24 hours (2)	> 24 hours (1)	< 6 hours (1)	< 24 hours (2)	< 1 week (3)	> 1 week (4)			Extremely Low / Low / Medium / High / Extremely High
Coastal Erosion	1					2				2					2			2				1.60	Low
Dam Failure	1				1				1							1	1					1.00	Low
Drought	1				1				1							1				4		1.15	Low
Earthquake				4			3					4	4				1					3.65	High
Flood	1				1				1							1	1					1.00	Low
Landslide	1				1				1				4				1					1.45	Low
Severe Weather			3				3				3					1			3			2.70	High
Tsunami	1					2				2			4				1					1.85	Low
Volcano		2					3			2			4						3			2.55	Medium
Wildfire	1				1					2			4					2				1.70	Low

Camano Island Fire & Rescue																						
	Probability of Occurrence				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration length of				CPRI Score	Level of Vulnerability
Hazard	Unlikely / Low (1)	Possible / Medium (2)	Likely / High (3)	Highly Likely / Very High (4)	Negligible (1)	Limited (2)	Critical (3)	Catastrophic (4)	Negligible (1)	Limited (2)	Significant (3)	Extensive (4)	< 6 hours (4)	6 - 12 hours (3)	12 - 24 hours (2)	> 24 hours (1)	< 6 hours (1)	< 24 hours (2)	< 1 week (3)	> 1 week (4)		Extremely Low / Low / Medium / High / Extremely High
Coastal Erosion		2			1				1				4						3		1.95	Medium
Dam Failure - Not Rated	0				0				0				0				0				0.00	Not Rated
Drought	1				1					2						1				4	1.35	Low
Earthquake			3			2				2			4				1				2.65	High
Flood		2			1				1							1		2			1.45	Low
Landslide		2				2				2			4					2			2.30	Medium
Severe Weather		2				2				2						1			3		1.90	Medium
Tsunami		2				2				2			4						3		2.35	Medium
Volcano		2				2				2						1		2			1.85	Low
Wildfire		2				2				2			4					2			2.30	Medium

Central Whidbey Island Fire & Rescue																						
	Probability of Occurrence				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration				CPRI Score	Level of Vulnerability
Hazard	Unlikely / Low (1)	Possible / Medium (2)	Likely / High (3)	Highly Likely / Very High (4)	Negligible (1)	Limited (2)	Critical (3)	Catastrophic (4)	Negligible (1)	Limited (2)	Significant (3)	Extensive (4)	< 6 hours (4)	6 - 12 hours (3)	12 - 24 hours (2)	> 24 hours (1)	< 6 hours (1)	< 24 hours (2)	< 1 week (3)	> 1 week (4)		Extremely Low / Low / Medium / High / Extremely High
Coastal Erosion	1				1				1				4				1				**1.45**	Extremely Low
Dam Failure	1				1				1				4				1				**1.45**	Extremely Low
Drought			3			2				2			4				1				**2.65**	Medium
Earthquake				4			3			2						1	1				**2.80**	High
Flood	1				1				1							1				4	**1.15**	Extremely Low
Landslide	1				1				1							1	1				**1.00**	Extremely Low
Severe Weather			3		1				1				4					2			**2.30**	Low
Tsunami	1				1					2			4				1				**1.65**	Extremely Low
Volcano	1				1					2			4					2			**1.70**	Extremely Low
Wildfire	1					2				2						1	1				**1.40**	Extremely Low

South Whidbey Fire & Rescue																						
	Probability of Occurrence				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration length of					Level of Vulnerability
Hazard	Unlikely / Low (1)	Possible / Medium (2)	Likely / High (3)	Highly Likely / Very High (4)	Negligible (1)	Limited (2)	Critical (3)	Catastrophic (4)	Negligible (1)	Limited (2)	Significant (3)	Extensive (4)	< 6 hours (4)	6 - 12 hours (3)	12 - 24 hours (2)	> 24 hours (1)	< 6 hours (1)	< 24 hours (2)	< 1 week (3)	> 1 week (4)	CPRI Score	Extremely Low / Low / Medium / High / Extremely High
Coastal Erosion			3			2				2			4							4	**2.80**	Medium
Dam Failure		1			1				1					3				2			**1.35**	Low
Drought		2				2				2						1				4	**1.95**	Low
Earthquake				4				4				4	4				1				**3.85**	High
Flood		2			1				1							1	1				**1.40**	Low
Landslide			3			2				2			4				1				**2.65**	Medium
Severe Weather				4			3				3		4				1				**3.45**	High
Tsunami		2			1				1					3				2			**1.75**	Low
Volcano	1				1				1							1				4	**1.15**	Low
Wildfire		2			1					2			4				1				**2.05**	Medium

CHAPTER 16.
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.

16.1 HAZARD MITIGATION GOALS AND OBJECTIVES

During the October 28, 2019 meeting, the Planning Team reviewed the 2015 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 2015 Island County Hazard Mitigation Plan had four goals, with supporting objectives associated with each. For the 2020 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.

16.1.1 Goals

Goals for the 2020 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.

16.1.2 Objectives

The 2015 objectives were reviewed, and after careful discussion, they were slightly modified to better reflect the needed strategies for the 2020 update to ensure that they were addressing multiple hazards. Objectives for the 2020 mitigation strategy are presented in Table 16-1.

**TABLE 16-1.
2020 HAZARD MITIGATION PLAN OBJECTIVES**

Objective Statement	Goal Addressed
1. Sustain continuity of local emergency and government operations, including the operation of identified critical facilities, during and after a disaster.	1, 3
2. Reduce natural hazard-related risks and damages to Island County residents, with a focus on providing assistance and information to isolated/vulnerable populations within the planning area.	1, 2, 3, 4
3. Utilizing the best available data and science, continually share updated information on hazards, risk, and ways to reduce risk with all stakeholders within the planning area.	1, 2, 3, 4, 5
4. Strengthen codes, land use planning and their enforcement, so that new construction can avoid or withstand the impacts of natural hazards.	1, 3, 4
5. Provide/improve protection and response measures by applying mitigation actions that reduce impact through established plans, policies, procedures, and systems.	1, 2, 4
6. Retrofit, purchase or relocate structures based on one or more of the following criteria: level of exposure, repetitive loss history, and previous damage from natural hazards.	1, 4
7. Seek mitigation projects that minimize environmental impacts, improve the environment's ability to absorb the impact of natural disasters, or seek ways to mitigate their impacts on the environment.	1, 4, 5
8. Encourage public/private partnerships to strengthen the resilience throughout the County, including continuity planning, and individual awareness programs such as (but not limited to) NFIP, CERT, Firewise and Storm Ready programs for residents.	1, 2, 3, 4, 5

16.2 IDENTIFICATION AND ANALYSIS OF MITIGATION ACTION ITEMS

After the goals and objectives were reviewed and approved, the planning team developed specific mitigation initiatives or action items to further increase resilience.

FEMA defines mitigation initiatives as sustained measures, which if enacted, will reduce or eliminate the long-term risk from hazards. Whether by preparing citizens for disasters, training responders, or structural infrastructure protection, the actions ultimately should help protect our citizens, and enhance social and economic recovery during such times when disasters do strike.

FEMA identifies four categories of actions that constitute natural hazard mitigation, which become the core competencies for developing an effective mitigation program. Those categories, divided further into hard or soft mitigation initiatives, include:

1) Local planning and regulations (soft mitigation);
2) Education and awareness programs (soft mitigation);
3) Structural or infrastructure projects (hard mitigation); and
4) Natural systems protection (hard mitigation).

These competencies allow organizations to assess mitigation efforts, and where lacking, develop processes, programs, rules, regulations, and standards on which to enhance resilience when considering the hazards of concern, and their potential impact on a community.

In an effort to help develop sound mitigation initiatives for this update, 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.

16.2.1 CRS Analysis of Mitigation Initiatives

Each Planning Partner further reviewed its recommended initiatives to classify them based on the hazard it addresses and the type of mitigation it involves. This analysis incorporated, among others, the Community Rating System scale, identifying each mitigation action item by type. 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. This includes planning and zoning, floodplain laws, capital improvement programs, open space preservation, and stormwater management regulations.
- **Public Information and Education -** Public information campaigns or activities which inform citizens and elected officials about hazards and ways to mitigate them – a public education or awareness campaign, including efforts such as: real estate disclosure, hazard information centers, and school-age and adult education, all of which bring awareness of the hazards of concern.
- **Structural Projects** —Efforts taken to secure against acts of terrorism, manmade, or natural disasters. Types of projects include levees, reservoirs, channel improvements, or barricades which stop vehicles from approaching structures to protect.
- **Property Protection** – Actions taken that protect the properties. Types of efforts include: structural retrofit, property acquisition, elevation, relocation, insurance, storm shutters, shatter-resistant glass, sediment and erosion control, stream corridor restoration, etc. Protection can be

at the individual homeowner level, or a service provided by police, fire, emergency management, or other public safety entities.

- **Emergency Services / Response** —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 (e.g., sandbagging).
- **Natural Resource Protection** – Wetlands and floodplain protection, natural and beneficial uses of the floodplain, and best management practices. These include actions that 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.
- **Recovery** —Actions that involve the construction or re-construction of structures in such a way as to reduce the impact of a hazard, or that assist in rebuilding or re-establishing a community after a disaster incident. It also includes advance planning to address recovery efforts which will take place after a disaster. Efforts are focused on re-establishing the planning region in such a way as enhance resiliency and reduce impacts to future incidents. Recovery differs from response, which occurs during, or immediately after an incident. Recovery views long-range, sustainable efforts.

16.2.2 Categorization of Mitigation Initiatives

In addition to identifying potential funding sources available for each project, the Planning Team also developed strategies/action items that are categorized and assessed in several ways:

- By what the alternative would impact – new or existing structures, to include efforts which:
  - Manipulate/mitigate a hazard;
  - Reduce exposure to a hazard;
  - Reduce vulnerability to a hazard;
- By who would have responsibility for implementation:
  - Individuals;
  - Businesses;
  - Government (County, Local, State and/or Federal).
- By the timeline associated with completion of the project, based on the following parameters:
  - 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.
- By who benefits from the initiative, as follows:
  - A specific structure or facility;
  - A local community;
  - County-level efforts;
  - Regional level benefits.

16.2.3 Benefit/Cost Review

Once the general analysis was completed for each mitigation initiative, 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 in some cases is subjective based on the entity's financial situation. 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.

16.3 MITIGATION INITIATIVES

For the 2020 update, particular attention was given to new and existing buildings and infrastructure, and developing appropriate mitigation strategies for these facilities. Priority was also given to flood-prevention strategies. Table 16-2 lists the identified 2020 Hazard Mitigation Initiatives for Island County, inclusive of some strategies which will be implemented countywide. As such, several of these initiatives may also identified by other planning partners who support the effort. Initiatives carried forward from the 2015 plan have been identified as such.

TABLE 16-2.
ISLAND COUNTY 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?	Initiative Type	*Who Benefits
C-1 Assess, and as appropriate, retrofit county-owned facilities to better withstand damage from a major earthquake or impact from other hazards of concern. Utilize information gathered to further expand and enhance structure data utilized for HMP development.									
Existing	EQ	1, 3, 4, 6, 7	Planning	High	General Fund, HMGP, HUD	Short-Term	No	Structural Property Protection	C
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, 2, 3, 6, 7	PW-Roads	High	PDM, HMGP, WADOT, USDOT	Long-Term	Yes	All	R

**TABLE 16-2.
ISLAND COUNTY 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?	Initiative Type	*Who Benefits
C-3 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	PW - Roads & Surface Water	High	PDM, HMGP, USDOT, WADOT	Long-Term	Yes	Prevention Natural Resource Protection, Emergency Services / Response	C
C-4 Seek grant funding for acquisition of properties within high-hazard areas.									
Existing	EQ, F, LS, SW, WF	1, 2, 3, 4, 6, 7	DEM, Commissioners	High	PDM, HMGP	Long-Term	Yes	Prevention, Natural Resource Protection, / Response	R
C-5 Maintain 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, 3, 4, 5, 8	DEM	Low	General Fund	On-Going	Yes - modified	Emergency Services	R
C-6 Develop public outreach which supports community participation in incentive-based programs, such as NFIP, FireWise, StormReady, and TsunamiReady									
New and Existing	F, EQ, LS, SW, T, WF	1, 5, 8	DEM	Low	General Fund	Short-Term	Yes	Emergency Services	C
C-7 Work with Public Health to determine suitable points of distribution and locations for test administration.									
Existing	All	2, 5, 8	PH and EM	Low	General Fund, Department of Health (DOH)	Short-Term	Yes - modified	Protection, Public Information, Emergency Services/ Response	R
C-8 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	3, 4, 5, 7, 8	PH, Surface Water	Medium	General Fund, DOH, EPA, Ecology	Short-Term	Yes	Structural, Emergency Services	C
C-9 Seek grant funding to construct a new emergency operations center location which can support countywide efforts.									
New	All	1, 5, 6, 8	DEM, Commissioners	High	HLS	Long-Term	Yes-Modified	Emergency Services	C
C-10 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	3, 4, 5, 6	Planning	Medium	PDM, HMGP	Long-Term	No	Structural, Property Protection	C

TABLE 16-2.
ISLAND COUNTY 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?	Initiative Type	*Who Benefits
C-11 Conduct activities that support mitigation efforts to reduce the negative influence of natural hazards impacting Island County and which enhance public safety. This includes actions such as hazard identification, alert and warning, dissemination of relevant information and data, and public outreach campaigns to educate citizens about the hazards of concern. This includes programs such as CERT Training, the FireWise Program, alerting citizens to landslide/steep slope hazards, and Tsunami hazard areas and existing evacuation/walking maps, among other activities.									
New	All	All	DEM, Planning, PH	Low	General Fund, HLS, PH	On-Going	Yes – Modified	Prevention, Emergency Services, Recovery	C
C-12 Conduct threat identification and risk assessment of identified critical infrastructure to determine potential risk.									
New and Existing	All	All	DEM, Sherriff	Medium	DOJ Grants, HLS	Short-Term	Yes	Structural, Property Protection, Emergency Services, Recovery	C
C-13 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, 4, 5, 6, 7	DEM	Low	General Funds, Grants	Long-Term	Yes	Structural, Recovery	C
C-14 Consider projects enhancing resistance of county 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	All	1, 2, 3, 4, 5, 6, 7	Building & Planning, PW, DEM	High	General Funds, WA DOT, US DOT, PDM, HMGP	Long-Term	Yes	Structural, Recovery, Property Protection	C
C-15 Enhance 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	1, 5, 8	Auditor, DEM, Risk Management	Medium	EMPG, General Fund	On-Going	Yes-partial	Recovery	R
C-16 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	1, 3, 8	IT, DEM, Auditor, Sheriff	Medium	HLS, General Fund, HMGP, HUD	On-Going	Yes	Recovery	R
C-17 Utilize data from the current risk assessment and comprehensive land use planning effort to update GIS capacity and capabilities.									

TABLE 16-2.
ISLAND COUNTY 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?	Initiative Type	*Who Benefits
New and Existing	All	1, 3, 4, 8	Planning, PW, DEM	Low	General Fund, HMGP	On-Going	Yes - partial	Prevention, Public Information, Emergency Services, Recovery	C
C-18 Work with Island County Transit to develop an exercise related to evacuation of citizens or other type event.									
New	All	1, 3, 8	DEM, Human Services, IC Transit	Medium	DOT, HMEP, EMPG, Fire Grants, HUD, DOH	Short-Term	Yes	Public Information, Prevention, Recovery, Emergency Services	C
C-19 Work with the local communities and municipalities to leverage resources and partnerships to plan, train and exercise together to ensure continuity during real world events through continuity of government, businesses, and community resilience.									
New	All	1, 8	DEM, Planning & Development	Medium	General Budget, Grants	On-Going	No	Public Information, Emergency Services, Prevention	R
C-20 Develop (or update) plans to ensure response and recovery efforts. This includes working with the Board of Commissioners to develop appropriate committees, such as potentially an economic business committee or continuity of operations team, which will update the countywide continuity of operations plan, and provide guidance to businesses in the area to develop continuity of business plans.									
New and Existing	All	1, 3, 8	Commissioners & DEM	Medium	Various depending on plan	On-Going	Yes	Emergency Services, Prevention, Recovery	C
C-21 Utilizing data from the current risk assessment and COMP plan, 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	1, 3, 4, 8	DEM, PW, Commissioners	Low	General Fund, Enterprise System	Short-Term	Yes	Emergency Services, Prevention, Recovery	C
C-22 Conduct public outreach on risk-reduction techniques for communicable diseases through public education campaigns which increase awareness of healthy behaviors, including during times of potential pandemics and when shelters are established.									
New	All	1, 2, 8	PH, DEM, Human Services	Low	General Fund	Short-Term	No	Public Information, Prevention	R
C-23 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.									

TABLE 16-2.
ISLAND COUNTY 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?	Initiative Type	*Who Benefits
New	All	1, 2, 8	DEM, PH, HHS	Low	DOH, Health and Human Service Grants, HUD, HMGP	Long-Term	Yes	All	C
C-24 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. Seek out grant funding to assist in implementing this effort.									
New and Existing	All	1, 3, 4, 8	Public Works, Planning, GIS, Assessor's Office	Low	General Fund, HMGP	Short-Term	Yes – partial	Emergency Services	C
C-25 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, 4, 6, 7, 8	DEM	Low	Earthquake and Tsunami Program, HMGP, PDM, HUD, DOT, EPA	Long-Term	No	Prevention, Structural, Property Protection, Natural Resource Protection, Recovery	C
C-26 Continue to expand CERT training, involving local teams in exercises and training with first responders.									
New and Existing	All	1, 2, 8	DEM	Low	EMPG	On-Going	Yes	Prevention, Recovery	C
C-27 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, 5, 8	DEM/ PW	Low	General Fund, various grants.	Long-Term	Yes	Emergency Services, Recovery	C
C-28 Review designated emergency shelter structural and utility readiness for occupancy after a significant incident.									
New and Existing	All	1, 2, 5, 6, 8	DEM / Facilities	Medium	PDM, HMGP, General Funds	Short-Term	No	Emergency Services, Recovery	C
C-29 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, 8	DEM, County and Local PW, WDNR	Medium	PDM, HMGP, General Funds	Long-Term	No	All	C
C-30 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, 2, 3, 5, 8	DEM, Local EM, PW/ Roads	Medium	US DOT and WA DOT Grants, HLS	Long-Term	Yes	Emergency Services, Recovery	C
C-31 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.									

**TABLE 16-2.
ISLAND COUNTY 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?	Initiative Type	*Who Benefits
New and Existing	All	1, 2, 3, 5, 8	DEM, Local EM	Medium	General Funds, Grant Opportunities as they arise	Long-Term	No	Emergency Services, Recovery	C
C-32 Continue to enhance local emergency planning committee involvement with all fire organizations throughout the County with the goal of quarterly meetings.									
Existing	HazMat	1, 2, 3, 5, 8	DEM, Local EM, Fire Depts. & Districts	Low	General Funds	On-Going	No	Emergency Services, Recovery	C
C-33 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	1, 2, 3, 5, 8	DEM	High	EMPG, DOJ Grants, Fire Training Grants, EMPG	Long-Term	No	Emergency Services, Prevention, Recovery	C
C-34 Develop countywide mutual aid agreements with both public and private agencies in support of preparedness and response activities.									
New	All	1, 2, 3, 5, 8	DEM	Low	General Funds	On-Going	No	All	C

*Who Benefits = Structure (S), Local (L), County (C), Regional (R)

16.4 PRIORITIZATION OF INITIATIVES

The method for prioritizing initiatives for the 2020 update differs from the method used for the previous mitigation initiatives. 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 allow for the addition of new strategies over the life cycle of this plan, without having to numerically re-prioritize the entire list. Table 16-3 identifies the priority of each county 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.

TABLE 16-3.
PRIORITIZATION OF COUNTY 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	5	H	L	Y	Y	Y	H
2	5	H	H	Y	Y	Y	H
3	5	H	M	Y	N	Y	M
4	6	H	M	Y	N	Y	M
5	5	H	L	Y	Y	Y	H
6	3	H	L	Y	Y	Y	H
7	3	H	M	Y	Y	Y	H
8	5	H	M	Y	Y	Y	H
9	4	M	M	Y	Y	N	M
10	4	M	L	Y	Y	N	L
11	8	M	M	Y	Y	Y	M
12	8	M	M	Y	Y	N	M
13	6	M	L	Y	N	Y	M
14	7	L	M	N	Y	N	L
15	3	H	M	Y	N	Y	M
16	3	H	M	Y	Y	Y	H
17	4	H	H	Y	Y	N	H

**TABLE 16-3.
PRIORITIZATION OF COUNTY 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)
18	3	M	H	Y	Y	Y	M
19	2	H	L	Y	N	Y	H
20	3	H	H	Y	N	N	L
21	4	H	L	Y	Y	N	H
22	3	H	L	Y	Y	Y	H
23	3	H	L	Y	Y	Y	H
24	4	H	L	Y	N	Y	H
25	5	H	M	Y	N	Y	M
26	3	H	L	Y	Y	Y	H
27	3	H	L	Y	N	Y	H
28	4	H	M	Y	Y	Y	H
29	5	H	M	Y	Y	Y	H
30	5	M	M	Y	Y	N	M
31	5	H	H	Y	N	N	M
32	5	H	H	Y	Y	N	H
33	5	M	L	Y	N	Y	M
34	5	H	H	Y	Y	N	M

16.5 2015 ACTION PLAN STATUS

A comprehensive review of the 2015 action plan was performed to determine which 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 16-4 identifies the results of this review. Each jurisdictions' annex contains information concerning their own respective strategies.

**TABLE 16-4.
2015 STATUS OF 2008 HAZARD MITIGATION ACTION PLAN**

		Current Status			
Mitigation Strategy	Project Status	Completed	Continual /Ongoing Nature	Removed -/No Longer Relevant / No Action Required / Normal Operations	Carried Over
C-1 Study and retrofit county-owned facilities to better withstand damage from a major earthquake.	No studies have been completed since the 2015 HMP.				X
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.	While this matter has been discussed, no decisions or actions have been initiated since completion of the 2015 plan.				X
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.	Since completion of the last plan, the County has modified roadway designs as appropriate to ensure reduced flooding, as well as to reduce risk from potential landslides. This is a regular function of the transportation/roads division of Public Works.	X		X	
C-4 Seek steep slope stability project funding or relocation funding for county roads with histories of instability.	The County has completed several slope stability projects since the last plan was completed both from general funds and from transportation funds.				
C-5 Seek grant funding for acquisition of properties within high-hazard areas.					X
C-6 Develop database of grocery stores and fueling stations who have generators in order to determine potential need.	This project is under way, and has been assigned to the Logistics Section of IC EOC.				X
C-7 Work toward becoming a StormReady & TsunamiReady Community.	No action taken, but this remains a goal for the County at some point in the future.				X
C-8 Work with Public Health to determine suitable points of distribution.	There have been on-going discussions between PH and IC DEM for support in this area.				X
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.	The County worked with various water purveyors to identify needs and to develop a database of water providers.				X

TABLE 16-4.
2015 STATUS OF 2008 HAZARD MITIGATION ACTION PLAN

		Current Status			
Mitigation Strategy	Project Status	Completed	Continual /Ongoing Nature	Removed -/No Longer Relevant / No Action Required / Normal Operations	Carried Over
C-10 Seek grant funding to construct a new emergency operations center location which can support countywide efforts.	The County entered into an MOA with the City of Oak Harbor to utilize a portion of its Fire Headquarters Building for use as an EOC; however, the County will continue to see grant funding for construction of a new facility.				X
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.	All structures have been built to the most current codes in place at the time of construction.				X
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.	The County has expanded its efforts to present hazard information, warning notifications and general public outreach through the hiring of an EM Coordinator in 2019. Information from this HMP will be utilized to further inform our citizens as well.	X	X		X
C-13 Conduct threat identification and risk assessment of identified critical infrastructure to determine potential risk.					X
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.	The County has worked with PSE and Snohomish County Power to ensure measures are in place to protect the power infrastructure. The County has also worked with dam owners to ensure response plans are in place.	X			
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.	IC Public Health and WA DOH works directly with water purveyors in the County to address these issues. PH will continue to work with WA DOH to ensure water purveyors are aware of the issue.			X	

TABLE 16-4.
2015 STATUS OF 2008 HAZARD MITIGATION ACTION PLAN

		Current Status			
Mitigation Strategy	Project Status	Completed	Continual /Ongoing Nature	Removed -/No Longer Relevant / No Action Required / Normal Operations	Carried Over
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.	IC DEM works closely with IC PW and Facilities personnel to ensure data from the risk assessment are considered when CIP are identified during budget cycles. IC DEM also provides information concerning potential funding opportunities as well to further enhance CIP to include additional mitigation efforts.	X	X		X
C-17 Consider projects enhancing resistance of county 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.	This is an on-going effort by the County which is completed during routine maintenance for some elements, as well as when remodeling or new construction occurs.	X	X		X
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.	IC DEM has established a system implemented through IC Finance to capture relevant costs in a more expedited manner. That system is utilized during significant events for ease in maintaining the information.	X			
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.	Some action on this strategy was developed during the two disaster declarations since completion of the 2015 plan. The County continues to look to enhance this data, and will continue to look for grant opportunities to fund a system which will be in place for future events.	X	X		X
C-20 Utilize data from the current risk assessment and comprehensive land use planning effort currently underway to update GIS capacity and capabilities.	Information from the HMP was reviewed and incorporated as appropriate during the 2017 update of the IC CEMP.	X			X

TABLE 16-4.
2015 STATUS OF 2008 HAZARD MITIGATION ACTION PLAN

		Current Status			
Mitigation Strategy	Project Status	Completed	Continual /Ongoing Nature	Removed -/No Longer Relevant / No Action Required / Normal Operations	Carried Over
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.	This was completed since the last plan's completion with the new Oak Harbor facility identified as needing upgrade. The County will review grant opportunities to enhance and expand capabilities in this respect. However, this is now a course of normal operations, and therefore is removed as a strategy.	X	X	X	X
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.	IC DEM and IC Risk Management, in conjunction with IC Sheriff's Dept., has completed several different trainings for employees to address OSHA/WISHA regulations. This is an on-going, continual process which is now considered normal operations. As such, it has been removed as a strategy.	X		X	
C-23 Work with Island County Transit to develop an exercise related to evacuation of citizens or other type event.	IC DEM worked with IC Transit during the Cascadia Rising Exercise, and will again work with IC Transit to assist in developing evacuation plans, policies and protocols during the 2022 Cascadia Exercise.	X			X
C-24 Leverage resources and partnerships to train and exercise together to ensure continuity during real world events.	With the hiring of the EM Coordinator in 2019, the County will further embark on the process of working with the businesses in IC over the course of the life cycle of the 2020 plan to assist them in developing Continuity of Business Plans. This strategy is redundant to other strategies identified above, and is therefore removed and joined with other strategies.	X			X
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.	Since completion of the 2015, IC has updated and developed several new plans, including the 2019 COOP plan, and the update to the CEMP. Over the life cycle of this plan, with the response to COVID-19, additional planning efforts will occur to update the COOP based on COVID response activities, as well as to develop an economic development plan to assist local businesses, and ensure continued business growth.	X			X

TABLE 16-4.
2015 STATUS OF 2008 HAZARD MITIGATION ACTION PLAN

		Current Status			
Mitigation Strategy	Project Status	Completed	Continual /Ongoing Nature	Removed -/No Longer Relevant / No Action Required / Normal Operations	Carried Over
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.					X
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.	The Health District regularly provides this type of information to IC residents, working with other partners such as Health and Human Services and Red Cross. This is a normal operation, and therefore removed as a strategy.	X	X	X	X
C-28 Replace outdated telephone infrastructure to a modern unified communications system at all County facilities.		X			
C-29 Develop public outreach which supports community participation in incentive-based programs, such as FireWise, StormReady, and TsunamiReady.					X
2015 COUNTYWIDE INITIATIVES					
CW-1 Continue data gathering for facility information to continue to improve the risk assessment and identification of infrastructure countywide.	Similar in nature to previous strategy. Will be carried over but joined with other strategy to not be redundant.	X	X		X
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.					X
CW-3 Develop points of distribution in areas of potential isolation	This is repetitive in nature from previous strategy.			X	

**TABLE 16-4.
2015 STATUS OF 2008 HAZARD MITIGATION ACTION PLAN**

		Current Status			
Mitigation Strategy	Project Status	Completed	Continual /Ongoing Nature	Removed -/No Longer Relevant / No Action Required / Normal Operations	Carried Over
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.					X
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.			X		X
CW-6 Coordinate among all jurisdictions to seek out and apply for grants for site hardening of facilities.					X
CW-7 Maintain and regularly update fire hydrant layer countywide.	The local fire districts have initiated this action within their respective areas.	X		X	
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.	Similar in nature to previous strategy. Will be carried over but joined with other strategy to not be redundant.	X	X		X
CW-9 Continue to expand CERT training, involving local teams in exercises and training with first responders.	CERT training was completed during the life cycle of the 2015 plan; however, this initiative is on-going in nature and is part of normal operations. Therefore, it will be removed as a strategy.	X		X	
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.					X

**TABLE 16-4.
2015 STATUS OF 2008 HAZARD MITIGATION ACTION PLAN**

		Current Status			
Mitigation Strategy	Project Status	Completed	Continual /Ongoing Nature	Removed -/No Longer Relevant / No Action Required / Normal Operations	Carried Over
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.	This was completed as a result of the CEMP update.	X		X	
CW-12 Review designated emergency shelter structural and utility readiness for occupancy after a significant incident.					X
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.	Similar in nature to previous strategy. Will be carried over but joined with other strategy to not be redundant. (C-12)			X	
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.	Tsunami Walking Maps were developed in 2019 for a portion of Island County; AHAB radios were allocated, and are scheduled to be installed sometime during 2020. Additional maps are underway. (C-12)	X	X	X	X
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.	Similar in nature to previous strategy. Will be carried over but joined with other strategy to not be redundant.		X		X
CW-16 Work with local jurisdictions and planning partners to develop various emergency planning efforts to ensure continuity of business and resiliency.	Repetitive in nature; already identified in strategy above.			X	X
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.	This task was identified in the COOP document developed in 2019.	X		X	

TABLE 16-4.
2015 STATUS OF 2008 HAZARD MITIGATION ACTION PLAN

		Current Status			
Mitigation Strategy	Project Status	Completed	Continual /Ongoing Nature	Removed -/No Longer Relevant / No Action Required / Normal Operations	Carried Over
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.	This was done, in part, during the Cascadia exercise, but will again be a focus of the upcoming Cascadia exercise.	X			X
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.	Similar in nature to previous strategy. Will be carried over but joined with other strategy to not be redundant.				X
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.	Similar in nature to previous strategy. Will be carried over but joined with other strategy to not be redundant.			X	X
CW-21 Continue to enhance local emergency planning committee involvement with all fire organizations throughout the County with the goal of quarterly meetings.	The County and the fire districts meet regularly as a normal course of business. Therefore, this strategy will be removed for future updates.	X		X	
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.	The County and all of the necessary parties have had various TTX and exercises during its normal course of operations. As such, this strategy will be removed.	X		X	
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.				X	

TABLE 16-4.
2015 STATUS OF 2008 HAZARD MITIGATION ACTION PLAN

		Current Status			
Mitigation Strategy	Project Status	Completed	Continual /Ongoing Nature	Removed -/No Longer Relevant / No Action Required / Normal Operations	Carried Over
CW-24 Develop countywide mutual aid agreements with both public and private agencies in support of preparedness and response activities.	These have been executed to some degree since completion of the last plan, but the County feels this is a valid strategy, and as such, it will be carried forward but joined with other similar strategies.	X			X
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.	Similar in nature to previous strategy. Will be carried over but joined with other strategy to not be redundant.				X
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.	Similar in nature to previous strategy. Will be carried over but joined with other strategy to not be redundant.				X
CW-27 Develop countywide debris management plan.	The County has developed a DMP, which is regularly updated by solid waste as a general course of action, utilizing, in part, information from this HMP. As such, this strategy will be removed.	X	X	X	

16.6 ADDITIONAL COMPLETED MITIGATION EFFORTS

In addition to those mitigation strategies identified above, the County, working in conjunction with other agencies and public-private partnerships has also completed additional projects which have the potential to reduce impact from the hazards of concern since completion of the 2015 plan. A few examples include:

- The Iverson Improvement Project: Led by the Island County Department of Natural Resources, the intended goal of the project is to "integrate community ideas into the development and evaluation of solutions to improve the drainage in the Iverson Preserve and neighboring community.[25]" The Task Force is made up of a public - private partnership, with the intent to address issues such as sedimentation, saltwater intrusion into the aquifer system, impact from the Oso Landslide with respect to materials in the Stillaguamish watershed, groundwater levels and water quality in the area, and drainage and ditch elevations, among others.

- The SR 532 Davis Slough Bridge Replacement: A joint effort with WA DOT which was completed in May 2016, a new, wider bridge was constructed between the Camano Gateway Bridge and the west side of the slough, replacing an outdated bridge, parts of which were constructed in 1887. The new bridge was constructed to current building and earthquake standards.
- Eby's Prairie Watershed Stormwater Remediation Project: Funded by the EPA through Washington State Department of Ecology, Island County Natural Resources, in a multi-agency coordinated effort which included a public-private partnership, completed a stormwater restoration project in June 2017 to help reduce contaminants flowing into the stormwater system at Ebey's Landing, while also reducing the flood hazard in the area. New catch basins were installed to divert runoff into a buried pipeline which flowed to a 70,000 gallon stormwater overflow swale with enough capacity to capture the equivalent of a 25-year storm event, pumping additional stormwater to an existing lagoon. The project benefits included elimination of approximately 2 million gallons of stormwater discharge from one farm area; mitigate stormwater flows; provide supplemental irrigation water for crops, and create a wildlife habitat.[26]

16.7 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 16-5 identifies some of those grant requirements.

TABLE 16-5.
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	☑	☐

25 Iverson Improvement Project Newsletter. (2016). Vol. 1, Issue 1. Available online at: https://www.islandcountywa.gov/Health/EH/Documents/Iverson%20Newsletter%20July%202016%20Final.pdf

26 Eby's Landing Stormwater Restoration Project. (2017). Available at: https://www.islandcountywa.gov/Health/DNR/WRAC/Documents/Science/WRAC%20Presentation_09%2007%2017.pdf

**TABLE 16-5.
GRANT OPPORTUNITIES**

Program	Enabling Legislation	Funding Authorization	Hazard Mitigation Plan Requirement: Grantee	Hazard Mitigation Plan Requirement: Sub-Grantee
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

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: https://www.hud.gov/grants/
- **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: https://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: https://www.fema.gov/hazard-mitigation-grant-program
- **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: https://www.fema.gov/pre-disaster-mitigation-grant-program
- **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: https://www.blm.gov/services/financial-assistance-and-grants
- **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.
- **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.
- **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: https://www.phmsa.dot.gov/grants/hazmat/hazardous-materials-grants-program

CHAPTER 17.
CAPABILITY ASSESSMENT

17.1 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.

The planning team performed an inventory and analysis of existing authorities and capabilities called a capability assessment, creating an inventory of the County's mission, programs and policies, and evaluates their capacity to carry them out. Each planning partner also completed a similar type assessment within their annex document. Additional data is also contained within Section 3.10.

Table 17-1 summarizes the legal and regulatory capabilities of the County. Table 17-2 summarizes the administrative and technical capability. Table 17-3 summarizes fiscal capability. Table 17-4 identifies mitigation efforts which are on-going in the County.

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 17-1.
LEGAL AND REGULATORY AUTHORITY

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.

**TABLE 17-1.
LEGAL AND REGULATORY AUTHORITY**

Location	Description
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).
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.

TABLE 17-1.
LEGAL AND REGULATORY AUTHORITY

Location	Description
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.
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.

TABLE 17-1.
LEGAL AND REGULATORY AUTHORITY

Location	Description
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 17-2.
ADMINISTRATIVE AND TECHNICAL CAPABILITY

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Y	Planning & Community Services
Professionals trained in building or infrastructure construction practices (building officials, fire inspectors, etc.)	Y	Planning & Community Services; Public Works
Engineers specializing in construction practices?	Y	
Scientists, planners or engineers with an understanding of natural hazards	Y	The county has hazard-specific subject matter experts on staff in various departments; SMEs are also available via contracting mechanisms, and available through state resources. Examples of staff include: Geologists, Floodplain Manager, Hydrologists, Epidemiologists
Staff with training in benefit/cost analysis	Y	Various personnel in different departments

**TABLE 17-2.
ADMINISTRATIVE AND TECHNICAL CAPABILITY**

Staff/Personnel Resources	Available?	Department/Agency/Position
Surveyors	Y	
Personnel skilled or trained in GIS applications	Y	
Personnel skilled or trained in Hazus use	N	
Emergency Manager	Y	Emergency Management Department with trained personnel and volunteers.
Grant writers	Y	Various County departments have internal personnel who write grants; county staff monitors grants.
Warning Systems/Services (Reverse 9-1-1, outdoor warning signs or signals, flood or fire warning program, etc.?)	Y	CodeRED with alert notifications; Public Works signage available as needed; Evacuation signage; Sirens.
Hazard data and information available to public	Y	GIS maintains data for various departments which have knowledge of and responsibility for specific types of hazards, such as flood, landslide, snow- and wind-load capacity, as well as and other hazards of concern.
Maintain Elevation Certificates	Y	

**TABLE 17-3.
FISCAL CAPABILITIES**

Financial Resources	**Accessible or Eligible to Use?**
1. Community Development Block Grants	Yes
2. Capital Improvements Project Funding	Yes
3. Authority to Levy Taxes for Specific Purposes	Yes
4. User Fees For Water, Sewer, Gas or Electric Service	No
5. Impact Fees for Buyers or Developers of New Development/Homes	Yes
6. Incur Debt through General Obligation Bonds	Yes
7. Incur Debt through Special Tax Bonds	Yes
8. Incur Debt through Private Activity Bonds	Yes
9. Withhold Public Expenditures in Hazard-Prone Areas	Yes
10. State-Sponsored Grant Programs	Yes
11. Stafford Act Grants	Yes

TABLE 17-4. ON-GOING MITIGATION EFFORTS		
Mitigation Effort	Available? Yes/No	Department/Agency/Position
Hazard Mitigation Planning Committee	Y	The County maintains an active HMP Committee as a regular planning group to discuss on-going issues, provide information on granting opportunities, and to address/capture hazard information.
Hazardous Vegetation Abatement Program	Y	Through various partnerships with the Forest Service, Conservation District, and Public Works and Facilities
Defensible space inspections program	N	
Creek, stream, culvert, or storm drain maintenance or cleaning program	Y	Actively involved in management on the Reservation and throughout the watershed.
Stream restoration program	Y	Various on-going efforts as well as several completed efforts.
Erosion or sediment control program	Y	Actively involved in various restoration projects throughout the county in support of erosion and sediment control efforts.
Other		

17.2 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.

17.2.1 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 17-5 identifies the Public Protection Classification for Island County and its planning partners.

**TABLE 17-5.
COUNTYWIDE PUBLIC PROTECTION CLASSIFICATION**

Community	Protection Class Grade
Coupeville	4
Island County F.P.D. 1	6
Island County F.P.D. 2	5
Island County F.P.D. 3	7
Island County F.P.D. 5	6
Langley	6
Oak Harbor	4

17.2.2 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 17-6 identifies the BCEGS for the planning partnership.

**TABLE 17-6.
BUILDING CODE EFFECTIVENESS GRADING**

Community	Commercial	Dwelling
Coupeville	4	4
Langley	4	4
Oak Harbor	3	4
Unincorporated County	99	99

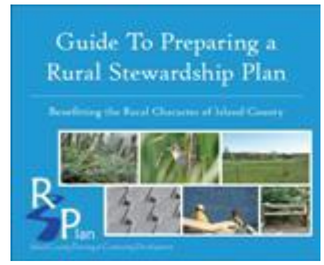
*Unincorporated Island County is Class 99 because they chose not to participate in the CBEGS Program
Data effective 5/19/19

17.2.3 Additional Land Use Programs to Reduce Hazard Impact

Public Benefit Open Space Rating System (PBRS)

The Public Benefit Open Space Rating System is part of the Open Space Taxation Act. "The Open Space Taxation Act, enacted in 1970, allows property owners to have their open space...valued at their current use rather than at their highest and best use. The Act states that it is in the best interest of the state to maintain, preserve, conserve, and otherwise continue in existence adequate open space lands for the production of food, fiber, and forest crops and to assure the use and enjoyment of natural resources and scenic beauty for the economic and social well-being of the state and its citizens" (Washington Department of Revenue). Island County Code Chapter 3.40, in addition to state law, governs the PBRS program in Island County. (Additional information available at: https://www.islandcountywa.gov/planning/pages/PBRS.aspx)

Rural Stewardship Plan



Island County's Rural Stewardship Plan is for property owners within unincorporated Island County whose residential parcel is one acre or larger. A Plan can be developed for anywhere conservation practices will protect water quality and habitat - it's not just for land affected by wetlands. In exchange, Rural Stewardship participants qualify for front-of-line permit processing, and may choose either a reduction in property tax valuation, or a lowered land use intensity rating.

The Rural Stewardship Plan is best suited for landowners who can make a long-term commitment to manage their land in accordance with their Plan's requirements, usually for a period of more than 10 years. The Plan's set conditions are specific to the affected property; officially recorded on the land's title; and binding upon both the original applicant and future landowners.

Island County's Rural Stewardship Plan offers a broad range of conservation options for single family residential properties. Some are mandatory; others may be selected from a specific list to fit the landowner's goals and the property's characteristics. There is a flat fee for processing and recording a completed Plan. When not accompanied by a development proposal, review of a Rural Stewardship Plan is usually completed within 30 days and is not subject to a public hearing.

CHAPTER 18.
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 Director 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).

18.1 MONITORING, EVALUATION AND UPDATING THE PLAN

18.1.1 Progress Report - 2015 Plan Status

The 2015 Hazard Mitigation Plan identified a maintenance strategy which included regular reviews during the life cycle of the plan. To a large extent, those reviews did occur with the Planning Team Members, although not annually. Since completion of the last plan, the County and many of the Planning Team Members were heavily engaged in other emergency-management related incidents (disaster declarations), events, planning efforts (COOP, CEMP update), exercises (Cascadia) and training efforts, including countywide planning for citizens and employees (including active shooter training at all county facilities).

In addition, during this period, FEMA and several state agencies such as Department of Natural Resources and Department of Ecology conducted studies in the region for various hazards of concern (flood, tsunami, and landslide). All of these efforts impeded the County's ability to do a comprehensive annual review and update. While the plan review did not occur to the depth as intended, the County nonetheless was effective in completing several of the strategies and action items identified in the plan. The status of the County's previous mitigation projects are shown in Chapter 16. Significant projects completed since 2015 include the following:

- Public Education—The County and its planning partners have been very active in this area. Regular (almost monthly) outreach sessions have occurred where risk and updated hazard specific data are discussed. The County completed in excess of 30 outreach efforts per year, where hazards of concern and potential mitigation efforts are discussed.
- Flood Reduction - During the life cycle of the 2015 plan, the County and its planning partners worked with FEMA on the RiskMap project to update the coastal flood hazard maps within the County. Those maps were adopted in 2017. Currently the County is working in tandem with FEMA in furtherance of its NFIP capabilities to enhance the program where possible, while mandating citizens to adhere to flood ordinances through enforcement actions through its Community Planning and Development Department, which is responsible for permitting, inspections, and enforcement.

  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 resulting from flooding issues. Public works has continued to work 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, particularly during high-precipitation incidents, causing and exacerbating slides in the area.
- Flood and Transportation — The Camano Gateway Project allowed for the completion of construction to sections of SR 532 on Camano Island to higher seismic building standards. The construction included raising the roadway by six inches to reduce the impact from flooding events, and widening the roadway.
- Landslide and Erosion Hazard – Working with Washington State Department of Natural Resources and Ecology, several studies are underway to identify areas of concern, and develop long-range strategies to assist in reducing the potential impacts from both landslide and erosion issues. To date, the Washington State Department of Transportation has worked with the County, and several roadways throughout the County have been shored up with bank stabilization to help reduce the potential for landslides, allowing for evacuation in areas previously impacted by slides which occurred as a result of heavy rains.
- 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 in excess of 150 trained individuals who will be able to provide safe and effective assistance to their communities after a disaster incident occurs.
- Medical Core Volunteers – The County and its planning partners have also continued to enlist and train medical core volunteers since the 2015 plan completion. These Medical Core Volunteers were fundamental during the COVID-19 response.
- Emergency Operations Staffing – The County has continued to provide training to employees, volunteers, and local planning partners over the last five years to enable staffing of the County's EOC when events unfold. This has included joint efforts with local municipalities working together to provide staffing in the EOC, serving in many instances as a Unified Command.
- Fuels Plan—The County has continued to work with local fuel providers to develop 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.

- Transportation Issues—The County, through the Regional Catastrophic Preparedness Grant Program and in conjunction with several other Washington counties has continued to work on a transportation-related issues addressing accessibility along SR 532 on Camano Island, as well as other areas of the county with limited access. Involvement in this process 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.

18.1.2 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 five (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 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 C). The 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 Director may decide to apply for a planning grant through FEMA to start the 2025 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 2020 hazard mitigation plan update.

The 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 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.

18.2 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 town are considered to be integral parts of this plan. The County and partner cities and town, 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.

18.3 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 that have the ability to do so 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.

REFERENCES

Ahrens, James. 2013. Lightning Fires and Lightning Strikes. National Fire Protection Association Fire Analysis and Research Division. Accessed online on December 10, 2019 at: https://www.nfpa.org/News-and-Research/Data-research-and-tools/US-Fire-Problem/Lightning-Fires-and-Lightning-Strikes

Base Guide: Naval Air Station Whidbey Island. Accessed online on December 4, 2019 at: https://www.mybaseguide.com/navy/13-3668-22076/nas_whidbey_island_weather_and_climate

Central Washington University Pacific Northwest Geodetic Array (PANGA). 2020. PANGA website accessed online at http://www.panga.org

Chen, J. Smithsonian.com. 2016. Melting Glaciers Are Wreaking Havoc on Earth's Crust. Accessed online on November 21, 2019 at: https://www.smithsonianmag.com/science-nature/melting-glaciers-are-wreaking-havoc-earths-crust-180960226/#RIVkEryBF52MD5be.99

Climate Central (2016). Sea level rise and coastal flood exposure: Summary for Island County, WA. Surging Seas Risk Finder file created July 21, 2016. Retrieved from http://ssrf.climatecentral.org.s3-website-us-east1.amazonaws.com/Buffer2/states/WA/downloads/pdf_reports/County/WA_Island_Countyreport.pdf

Climate Impacts Group. 2019. Climate Impacts Group website. Accessed online at http://cses.washington.edu/cig/res/res.shtml

Coe, Jeffrey. (2016). Landslide Hazards and Climate Change: A Perspective from the United States. 10.1201/9781315387789-16

CoreLogic. 2015. Lightning Risk Score. Accessed online at http://www.corelogic.com/downloadable-docs/1_lightning-risk-score_1308_01-screen.pdf

Drought Conservation Planning – Whidbey Island (Drought Conservation Plan). 2016. Whidbey Island Conservation District. Accessed online on November 15, 2019 at: https://www.whidbeycd.org/uploads/1/1/6/8/11683986/drought_conservation_plan_whidbey_6.24.16_final_web.pdf

Federal Emergency Management Agency (FEMA). 2019. FEMA 480. Floodplain Management Requirements; A Study Guide and Desk Reference for Local Officials. Accessed online at: https://www.fema.gov/floodplain-management-requirements

Federal Emergency Management Agency (FEMA). 2012a. The Disaster Process & Disaster Aid Programs. Federal Emergency Management Agency Website Accessed online at: http://www.fema.gov/disaster-process-disaster-aid-programs

Federal Emergency Management Agency (FEMA). FEMA Disaster Declaration Summary – Open Government Dataset. Spreadsheet Data Accessed Various Times. Available online at: https://www.fema.gov/disasters

Federal Emergency Management Agency (FEMA). (2013). Mitigation Ideas. A Resource for Reducing Risk to Natural Hazards. Accessed January 3, 2020 online at: https://www.fema.gov/media-library/assets/documents/30627

Federal Emergency Management Agency (FEMA). 2017. National Flood Insurance Program. "Flood Insurance Study for Island County" Available at: https://msc.fema.gov/portal/advanceSearch#searchresultsanchor

Federal Energy Regulatory Commission FERC. 2019. Engineering Guidelines for the Evaluation of Hydropower Projects. https://www.ferc.gov/industries/hydropower/safety/guidelines/eng-guide.asp

Headwater Economics. 2018. "The Full Community Costs of Wildfire". Accessed online on December 11, 2019 at: https://headwaterseconomics.org/wp-content/uploads/full-wildfire-costs-report.pdf

International Strategy for Disaster Reduction. 2008. "Disaster Risk Reduction Strategies and Risk Management Practices: Critical Elements for Adaptation to Climate Change". November 11, 2008

Island County. 2014a. Camano Island Gateway Website. Accessed online at http://www.islandcounty.net/planning/CamanoGateway.htm

Island County. 2020. Geographic Information System Geodatabase, Island County Planning Areas. Coupeville, WA.

Island County. 2020. Island County Steep and Unstable Slopes. Map available on website of Island County Public Works Department. Accessed various times. https://www.islandcountywa.gov/maps/Pages/Home.aspx

Island County. 2020. Shoreline Designations for Island County. Map available on website of Island County Planning Department. Accessed various dates at: https://www.islandcountywa.gov/maps/Pages/Home.aspx

KOMO News (2016). Erosion threatens Whidbey Island's historic Coupeville waterfront. 9 Feb. 2016. Accessed January 10, 2020. Available online at: https://komonews.com/news/local/erosion-threatens-whidbey-islands-historic-coupeville-waterfront

LeVeque, Randall J., Frank I. Gonzalez, and Loyce M. Adams, University of Washington. *Tsunami Hazard Assessment of Snohomish County, Washington: Project Report – Version 2. Draft of October 30, 2018.* Study funded by WA EMD. Accessed February 20, 2020. Available at: http://depts.washington.edu/ptha/WA_EMD_Snohomish

LeVeque and others. (2019) Tsunami Hazard Assessment of Portions of Island and Skagit Counties, Washington, Project Report, draft technical report October 2, 2019, 80 p.

McLain, K., Hancock, J., and Drennan, M. 2015 Drought and Agriculture. 2017. A Study by the Washington State Department of Agriculture. Accessed online at: http://agr.wa.gov/FP/Pubs/NaturalResourcesAssessmentPubs.aspx

Meehl, G., and Tebaldi, C. 2004. More Intense, More Frequent, and Longer Lasting Heat Waves in the 21st Century. Accessed online on December 4, 2019 at: https://science.sciencemag.org/content/305/5686/994/tab-pdf

Miller, I.M., Morgan, H., Mauger, G., Newton, T., Weldon, R., Schmidt, D., Welch, M., Grossman, E. 2018. Projected Sea Level Rise for Washington State – A 2018 Assessment. A collaboration of Washington Sea Grant, University of Washington Climate Impacts Group, University of Oregon, University of Washington, and US Geological Survey. Prepared for the Washington Coastal Resilience Project. Updated July 2019.

Miller, I, S. Petersen, M. Fougerat, D. Pucci, L. Clark, and B. Wood. 2016. Sea Level Rise and Coastal Flood Risk Assessment: Island County, Washington. Island County, Washington.

Mote, P. W. et al., 2013. Climate: Variability and Change in the Past and the Future. Chapter 2, 25-40, in M.M. Dalton, P.W. Mote, and A.K. Snover (eds.) Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities, Washington D.C.: Island Press.

NASA, 2019. NASA Global Climate Change article "Can Climate Affect Earthquakes, Or Are the Connections Shaky?" Accessed online on January 2, 2020 at https://climate.nasa.gov/news/2926/can-climate-affect-earthquakes-or-are-the-connections-shaky/

National Weather Service (NWS). 2019. Wind Chill Chart. Accessed online on December 5, 2019 at: https://www.weather.gov/safety/cold-faqs

NOAA. 2020. National Climatic Data Center website. Accessed various dates at: https://www.ncdc.noaa.gov/

Nelson, A.R., Kelsey, H.M., and Witter, R.C. 2006. Great earthquakes of variable magnitude at the Cascadia Subduction Zone, Quaternary Research, 65, pp. 354–365.

Olympic Rain Shadow. 2020. Olympic Rain Shadow Information and Resources website. Accessed online at http://www.olympicrainshadow.com/olympicrainshadowmap.html

Oregon Climate Service. 2015. Oregon Climate Service Storm King website. Accessed online at http://www.ocs.orst.edu/storm_king_site/index.html

Pacific Northwest Seismic Network (PNSN). 2015. Cascadia Historic Earthquake Catalog, 1793-1929 Covering Washington, Oregon and Southern British Columbia. Accessed online at http://assets.pnsn.org/CASCAT2006/Index_152_216.html

Peters, R., Jaffe, B., Gelfenbaum, G., and Peterson, C. 2003. Cascadia Tsunami Deposit Database, U.S. Geological Survey Open-File Report 03-13, 24 p.

Peterson, C.D., Doyle, D.L., and Barnett, E.T. 2000. Coastal flooding and beach retreat from coseismic subsidence in the central Cascadia margin, USA, Environmental & Engineering Geoscience, VI (3), pp. 255–269.

Peterson, C.D., Gelfenbaum, G., Jol, H.R., Phipps, J.B., Reckendorf, F., Twichell, D.C., Vanderburg, S., and Woxell, L. 1999. Great earthquakes, abundant sand, and high wave energy in the Columbia cell, USA, Proceedings of Coastal Sediments '99, ASCE, pp. 1676–1691.

M. D. Petersen, C. H. Cramer, and A. D. Frankel, *Simulations of Seismic Hazard for the Pacific Northwest of the United States from Earthquakes Associated with the Cascadia Subduction Zone*, Pure Appl. Geophys., 159 (2002), pp. 2147-2168.

Prest, Virginia, 2016. Personal communication regarding animal livestock operations in Washington State.

Reid, J. South Whidbey Record. (2014). Researchers find no tsunami evidence, just one big Whidbey earthquake. Accessed online at: http://www.southwhidbeyrecord.com/news/274531591.html

Saiyid, A. H. 2019. "Wildfire Season Planning Includes Guarding Against Toxic Smoke". Bloomberg Environment. Accessed online on December 11, 2019 at: https://news.bloombergenvironment.com/environment-and-energy/wildfire-season-planning-includes-guarding-against-toxic-smoke

Satake, K., Shimazaki, K., Tsuji, Y., Ueda, K., 1996. Time and size of a giant earthquake in Cascadia inferred from Japanese tsunami records of January 1700. Nature 379, 246–249.

Schuster, R. L. and Highland, L. (2001). Socioeconmic and Environmental Impacts of Landslides in the Western Hemisphere. U.S. Geological Survey, Washington, DC, Open File Report 01-0276. Available at: http://pubs.usgs.gov/of/2001/ofr-01-0276/

Schuster, R.L., Nieto, A.S., O'Rourke, T.D., Crespo, E. and Plaza-Nieto, G. (1996) Mass wasting triggered by the 5 March 1987 Ecuador earthquakes, *Engrg. Geol.*, Vol. 42, No. 1, p. 1-23.

ShakeAlert. 2019. ShakeAlert Phase 1: Version 2.0 is Live. https://www.shakealert.org/implementation/shakealert-phase-1/

Sherrod, D. R., Mastin, L. G., Scott, W. E., and Schilling, S. P., 1997, Volcano hazards at Newberry Volcano, Oregon: U.S. Geological Survey Open-File Report 97-513, 14 p., 1 plate, scale 1:100,000, Accessed online on December 9, 2019 at: https://pubs.usgs.gov/of/1997/0513/

Shipman, H., MacLennan, A., and Johannessen, J. 2014. Puget Sound Feeder Bluffs: Coastal Erosion as a Sediment Source and its Implications for Shoreline Management. Shorelands and Environmental Assistance Program, Washington Department of Ecology, Olympia, WA. Publication #14-06-016, 26 p.

South Whidbey Record. 2014. Researchers find no tsunami evidence, just one big Whidbey earthquake. September 10, 2014 news article. Accessed online at http://www.southwhidbeyrecord.com/news/274531591.html

Spatial Hazard Events and Losses Database for the United States (SHELDUS). 2020. Maintained by the University of Arizona Hazard Research Lab. https://cemhs.asu.edu/SHELDUS/

Spiker, E.C. and Gori, P.L., 2000, National landslide hazards mitigation strategy – A framework for loss reduction: U.S. Geological Survey Open-File Report 00-450, U.S. Geological Survey, Washington, DC.

Spiker, E.C. and Gori, P.L., 2003, National landslide hazards mitigation strategy – A framework for loss reduction: U.S. Geological Survey Circular 1244, U.S. Geological Survey, Washington, DC.

Stillaguamish Tribe of Indians, Natural Resources Department. University of Washington Climate Impacts Group. (2017) Stillaguamish Tribe of Indians Natural Resources Climate Change Adaptation Plan.

U. S. Army Corps of Engineers (USACE). 2019. Dam Safety Program. https://www.usace.army.mil/Missions/Civil-Works/Dam-Safety-Program/

U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages. 2020. Washington D.C. Available: http://www.bls.gov/cew/data.htm.

U.S. Census Bureau. 2019. State and County QuickFacts. https://www.census.gov/quickfacts/fact/table/islandcountywashington,US/PST045218

U.S. Census Bureau. 2019a. American Community Survey (2013-2017) for Island County. Accessed November 7, 2019 at: https://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml

U.S. Census. 2017. Factfinder Data accessed online at: http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

U.S. Department of Agriculture (USDA). 2017. 2017 Census of Agriculture; Washington Highlights. Prepared by U.S. Department of Agriculture National Agricultural Statistics Service. Accessed on November 18, 2019 at: https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_County_Level/Washington/

U. S. Fire Administration. 2000a. 2000 Wildland Fire Season, Topical Fire Research Series, Vol. 1, No. 2. Washington, D. C.: U. S. Fire Administration.

U. S. Fire Administration. 2000b. Wildfires: A Historical Perspective. Topical Fire Research Series, Vol. 1, No. 3. Washington, D. C.: U. S. Fire Administration.

U.S. Geological Survey (USGS). 2000. National Assessment of Coastal Vulnerability to Sea-Level Rise: Preliminary Results for the U.S. Pacific Coast. Accessed online at http://pubs.usgs.gov/of/2000/of00-178/pages/cvi.html

U.S. Geological Survey (USGS). 2020. Quaternary fault and fold database for the United States, accessed from USGS web site: http//earthquake.usgs.gov/hazards/qfaults

U.S. Geological Survey (USGS). 2015. Evidence for Late Holocene earthquakes on the Utsalady Point fault, Northern Puget Lowland, Washington. USGS website accessed January 6, 2020. Available online at http://pubs.er.usgs.gov/publication/70026407

U.S. Geological Survey (USGS). 2019. The Modified Mercalli Intensity Scale. USGS website accessed online at: https://www.usgs.gov/natural-hazards/earthquake-hazards/science/modified-mercalli-intensity-scale?qt-science_center_objects=0#qt-science_center_objects

University of Washington Earth & Space Science (ESS). 2013. Seismic Activity and Landslide Hazard Potential on Whidbey Island. Presentation accessed online at: http://www.islandcounty.net/PublicWorks/dem/documents/Seismic%20Activity%20and%20Landslide%20Hazard%20Potential%20on%20Whidbey%20Island.ppt

University of Washington Earth & Space Science (ESS). 2015. ESS Website accessed online at: http://www.ess.washington.edu/SEIS/PNSN/

USA.com. 2019. Island County Weather web page, accessed online at: http://www.usa.com/island-county-wa-weather.htm

USGS. 2020. Active Tectonics of the Devils Mountain Fault and Related Structures, Northern Puget Lowland and Eastern Strait of Juan de Fuca Region, Pacific Northwest. Accessed on January 6, 2020. Available at: http://pubs.usgs.gov/pp/p1643/#hazards

USGS. 2009. U.S. Geological Survey. http://wrgis.wr.usgs.gov/docs/wgmt/pacnw/lifeline/eqhazards.html

USGS. 2019a. Eruption History of Glacier Peak. USGS website accessed online on December 6, 2019 at: https://volcanoes.usgs.gov/volcanoes/glacier_peak/glacier_peak_geo_hist_118.html

USGS. 2019b. Eruption History of Mount Baker. USGS website accessed online on December 6, 2019 at: https://volcanoes.usgs.gov/volcanoes/baker/baker_geo_hist_109.html

Vaisala. 2015. Lightning Fatalities by State, 1959-2013 and Lightning Fatalities Weighted by Population by State, 1959-2013. Accessed online at: http://www.lightningsafety.noaa.gov/stats/59-13_State_Ltg_Fatalities.pdf

Washington Department of Agriculture. 2019 and 2020. Agriculture-A Cornerstone of Washington's Economy, Accessed various dates.

Washington Department of Commerce. 2020. Climate Change Adaptation web page. Accessed various dates.

Washington Department of Ecology, Inventory of Dams in the State of WA. 2020. Accessed online at: https://ecology.wa.gov/Water-Shorelines/Water-supply/Dams

Washington Department of Natural Resources (WDNR). 2005. Tsunami Hazard Map of the Anacortes–Whidbey Island Area, Washington: Modeled Tsunami Inundation from a Cascadia Subduction Zone Earthquake. Accessed online at: http://www.dnr.wa.gov/Publications/ger_ofr2005-1_tsunami_hazard_anacortes_whidbey.pdf

Washington Department of Natural Resources (WDNR). 2015. Whidbey Island Coupeville Landslide web page. Accessed online at: http://washingtondnr.wordpress.com/2013/03/27/whidbey-island-coupeville-landslide/

Washington Emergency Management Division (EMD). 2012. Drought Profile from Washington State Hazard Mitigation Plan. Accessed online at: http://mil.wa.gov/uploads/pdf/emergency-management/drought_hazard_profile.pdf

Washington Emergency Management Division (EMD). 2018. Washington State Enhanced Hazard Mitigation Plan.

Washington Employment Security Department (ESD). 2019. ESD Map of County Unemployment Rates, Accessed November 8, 2019 at: https://fortress.wa.gov/esd/employmentdata/reports-publications/economic-reports/monthly-employment-report/map-of-county-unemployment-rates

Washington Employment Security Department (ESD). 2019a. Local Unemployment Statistics, 1990-2019. Olympia, WA. Accessed November 8, 2019 at: https://fortress.wa.gov/esd/employmentdata/reports-publications/regional-reports/local-unemployment-statistics

Washington Employment Security Department (ESD). 2019b. Island County Profile, 2019. Data accessed on November 8, 2019 at: https://esd.wa.gov/labormarketinfo/county-profiles/island.

Washington Employment Security Department (ESD). 2019c. Total Employment Estimates, 2019. Washington ESD, Quarterly Census of Employment and Wages; Bureau of Labor Statistics, Current Employment Statistics. Olympia, WA. Data Accessed on November 8, 2019 at: https://fortress.wa.gov/esd/employmentdata/reports-publications/industry-reports/quarterly-census-of-employment-and-wages.

Washington Employment Security Department (ESD). 2019d. Data accessed online at: https://fortress.wa.gov/esd/employmentdata/reports-publications/regional-reports/labor-area-summaries

Washington Employment Security Department (ESD). 2014e. Northwest Region Employment Projections, Employment Security Department/LMEA Industry Employment Projections. Accessed November 8, 2019 at: https://esd.wa.gov/labormarketinfo/annual-report

Washington State Building Codes. 2019. Accessed November 22, 2019 at https://apps.des.wa.gov/sbcc/Page.aspx?nid=14

Washington State Department of Archeology and Historic Preservation (WSDAHP). 2015. Hanukkah Eve Wind Storm ravages Western Washington on December 14 and 15, 2006. HistoryLink File #8402. Accessed online at: http://www.historylink.org/_content/printer_friendly/pf_output.cfm?file_id=8042

Washington State Department of Transportation (DOT). 2019. Washington State Ferries 2040 Long-Range Plan. Accessed on November 12, 2019 at: https://www.wsdot.wa.gov/sites/default/files/2019/01/07/WSF-2040-Long-Range-Plan-2019.pdf

Washington State Department of Transportation (DOT, 2011). 2011. Climate Impacts Vulnerability Assessment Accessed on November 22, 2019 at: https://www.wsdot.wa.gov/sites/default/files/2017/11/15/ENV-Climate-VulnerabilityAssessment.pdf

Washington State Department of Transportation (WSDOT). 2006. Unstable Slopes on I-90 Snoqualmie Pass; Re-assessment and Recommendations. January 2006. Accessed online at: http://www.wsdot.wa.gov/NR/rdonlyres/6E3AABB2-65B4-4CAF-90B1-149CFAC1C4E8/0/Section3_ProblemHwyCorUnstableSlopes.pdf

Washington State Department of Transportation (WSDOT). 2010. WSDOT's Unstable Slope Management Program Brochure. Accessed online at: http://www.wsdot.wa.gov/NR/rdonlyres/7D456546-705F-4591-AC5B-7E0D87D15543/78408/UnstableSlopeFinaFolioWEBSMALL.pdf

Washington State Department of Transportation (WSDOT). 2011. Climate Impacts Vulnerability Assessment. Available online at: http://www.wsdot.wa.gov/NR/rdonlyres/B290651B-24FD-40EC-BEC3-EE5097ED0618/0/WSDOTClimateImpactsVulnerabilityAssessmentforFHWAFinal.pdf

Washington Office of Financial Management (OFM). 2012a. OFM Census 2010 Data Products. Accessed October 29, 2019 at: http://ofm.wa.gov/pop/census2010/default.asp#summary

Washington Office of Financial Management (OFM). 2019. OFM Census 2010 Data Products. Accessed October 29, 2019 at: https://ofm.wa.gov/washington-data-research/population-demographics/decennial-census/census-2010#summary

Washington Office of Financial Management (OFM). 2019b. December 2017 Projections. Olympia, WA. Accessed online October 29, 2019 at: https://ofm.wa.gov/washington-data-research/population-demographics/population-forecasts-and-projections/growth-management-act-county-projections

Washington Office of Financial Management (OFM). 2019c. Forecasting Division. Accessed Various Dates Population of Cities, Towns and Counties. Used for Allocation of Selected State Revenues. Olympia, WA. Accessed online October 29, 2019 at: https://ofm.wa.gov/washington-data-research/population-demographics/population-estimates/historical-estimates-april-1-population-and-housing-state-counties-and-cities

Washington Office of Financial Management (OFM). 2014b. Long-Term Economic and Labor Force Forecast for Washington Olympia, WA. Accessed various dates and times. Accessed online October 29, 2019 at: https://www.ofm.wa.gov/washington-data-research/economy-and-labor-force/long-term-economic-forecast

Washington State University (WSU). 2019. Irrigation in the Pacific Northwest. Accessed online on November 22, 2019 at: http://irrigation.wsu.edu/Content/Washington-Irrigation.php

Wikimedia.org. 2015. Rain Shadow illustration. Accessed online 24 April 2020 at: http://commons.wikimedia.org/wiki/File:Rainshadow_copy.jpg

R. C. Witter, Y. Zhang, K. Wang, G. Priest, C. Goldfinger, L. Stimely, J. English, and P. Ferro, S*imulating tsunami inundation for a range of Cascadia megathrust earthquake scenarios at Bandon, Oregon USA*, Geosphere, 9 (2013), pp. 1783-1803.

Wood, Nathan and Christopher Soulard. 2008. Variations in Community Exposure and Sensitivity to Tsunami Hazards on the Open-Ocean and Strait of Juan de Fuca Coasts of Washington (p. 2).

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—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) Loss Estimation Program: Hazus is a GIS-based program used to support the development of risk assessments as required under the DMA. The Hazus software program assesses risk in a quantitative manner to estimate damages and losses associated with natural hazards. Hazus is FEMA's nationally applicable, standardized methodology and software program and contains modules for estimating potential losses from earthquakes, floods, and wind hazards. Hazus 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
PLAN ADOPTION RESOLUTIONS FROM PLANNING PARTNERS

APPENDIX B
PLAN ADOPTION RESOLUTIONS FROM PLANNING PARTNERS

Maintained in separate folder.

APPENDIX C
EXAMPLE TEMPLATE FOR FUTURE PROGRESS REPORTS

APPENDIX C
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 ____, 2020, 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 _____, 202_. 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]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
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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: