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

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BRIDGEVIEW CONSULTING

SKAGIT COUNTY MULTI-JURISDICTION

2020 HAZARD MITIGATION PLAN UPDATE

VOLUME 1: PLANNING-AREA-WIDE ELEMENTS

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Skagit County 2020 Multi-Jurisdiction Hazard Mitigation Plan Update Volume 1—Planning-Area-Wide Elements

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EXECUTIVE SUMMARY

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

The DMA encourages state and local authorities to work together on pre-disaster planning, promoting 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 Skagit County and local governments worked together to create this Skagit County 2020 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. 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 Skagit 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 determined that it was in the best interests of its citizenry to develop the 2020 Skagit County Hazard Mitigation Plan. This 2020 Hazard Mitigation Plan is an update to the 2015 plan.

As time has 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 2020 update to the Skagit County Multi-Jurisdiction Hazard Mitigation Plan, to increase the resilience of the planning region.

The 2020 Skagit County Plan Update—What has changed?

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

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

Skagit County is using the five-year update process to enhance the Skagit County Multi-Jurisdictional Mitigation Plan in scope and content. Based on availability of new data and a better understanding of the Federal Emergency Management Agency's (FEMA's) guidance to develop mitigation plans, the following changes have been incorporated in the 2020 plan which differ from the previous edition:

- The layout of the plan varies significantly for ease in use by the planning partners. The 2020 edition utilizes a two-volume approach. Volume 1 includes general planning information and hazard profile data which is consistent with all entities involved, as well as the County-specific data. Volume 1 serves as the County's plan. Volume 2 includes each jurisdiction's separate annex, as well as the linkage procedure for partners wishing to join at a later date.
- Hazards of concern were modified for this 2020 update. Climate Change was added as a secondary hazard to address potential impacts on the various other hazards of concern; however, no risk assessment was performed as there currently is no damage function which addresses such impact.
- Avalanche was removed due to the lack of impact. Planning Team members felt that since the County was not impacted, nor contained areas in which Avalanche would occur within its boundaries, it was not necessary to maintain the profile.
- Drought profile was modified to include potential impact from Climate Change, as well as the potential economic impact resulting from a drought situation in the County and its planning partners during 2018/2019.
- Included within the Flood profile, a new section related to dams and dam safety was included, incorporating, to the greatest extent possible because of protected data, dam inundation information for the County.
- Erosion was added to the Landslide profile, although limited data is available. It is hoped that over the life cycle of this plan, that additional erosion studies will be completed, which data can then be incorporated in future updates.
- Wildfire was enhanced due to the increase in wildfire occurrences throughout Washington over the course of the last several wildfire seasons, and the large amount of wooded lands. The Conservation District updated the County's Comprehensive Wildfire Protection Plan, conducting a countywide risk assessment as well as community-based analysis. The CWPP will now serve as the County's Wildfire chapter, and by reference, is incorporated herein as though fully set forth within the body of this document. Once fully adopted, the CWPP will be placed on the County's website.
- Severe Storm was changed to Severe Weather, now inclusive of additional elements, including high winds, tornado, and hail.
- The risk assessment was expanded to use additional methodologies and new studies to define risk and determine vulnerability. This edition is based on analysis using both GIS and Hazus (FEMA's hazard-modeling program). The previous plan utilized primarily only GIS, limited Hazus analysis, and Mitigation 20/20.
- A significant effort was made concerning the critical infrastructure data which was developed for the 2020 plan as no such list existed previously. The list includes new structures within the planning area as identified throughout the process by those planning partners wishing to provide the information, and provides additional detail and information on the building age and the associated hazards of concern, as well as potential impact. Due to their sovereign status and the need to protect its cultural resources, the Tribal planning partners involved in this update elected to not provide an updated structure list, and therefore data from the previous plan was carried forward, as well as data provided within the various FEMA reports utilized. It should

be noted that the structure data identified within the various FEMA reports with respect to the Tribes who were part of this effort cannot be verified, and therefore should be used only to identify potential areas of impact rather than structure loss data, as that loss data does not accurately reflect the number of structures or potential losses associated with the hazards of concern.

- Due to the lack of Assessor/parcel data available for use, no analysis could be conducted for this plan at the parcel level, and therefore, various FEMA reports were utilized to assist in identifying potential impact for several of the hazards as indicated within the profiles. All FEMA reports were cited. The lack of Assessor's data is noted as a strategy by the County.
- 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.
- The method of risk ranking is now based on a Calculated Priority Risk Index Ranking rather than Mitigation 20/20.
- The risk assessment was broken down by planning partnership as appropriate, to include an analysis of the unincorporated areas of the County, and further by each planning partner involved. This will allow planning partners to annually review and determine accuracy of the greatest hazards of concern based on their impact, versus the entire planning area.
- All charts, graphs and maps have been updated with the most current data.
- All Census and Census-related data has been updated with the most current data available.
- Goals and objectives were reviewed and confirmed with no modifications.
- Strategies from the old edition were updated, and new strategies identified for the 2020 update. A new method of prioritizing strategies was used, including benefit cost analysis.
- Many new planning partners were included, as identified in the Planning Process.
- A modified plan maintenance strategy was developed for use with the 2020 plan, including the addition of an advisory committee to meet annually to review the success of various mitigation strategies completed during the course of the year, but also to review and determine the effectiveness of public outreach and dissemination of information specifically related to the flood hazard as it exists throughout the County.

THE PLANNING PARTNERSHIP

The planning partnership assembled for this plan was expanded to again include all cities and towns, but also several of the special purpose districts as defined as "local governments" under the Disaster Mitigation Act. Jurisdictional annexes for those partners are included in Volume 2 of the plan. Jurisdictions not covered by this process can link to this plan at a future date by following the linkage procedures identified in Volume 2 of this plan.

STEERING COMMITTEE

For this process, the partnership also elected to utilize a Steering Committee to help guide the process. These Steering Committee members were selected from the overall planning partnership to assume responsibilities associated with the plan's development. The Steering Committee served as the overall authority for the plan, developing information as necessary, which was then presented to the general planning team. The Steering Committee operated under an established list of rules, engaging the public at all meetings within the scope identified during the initial kick-off meeting. Jack Moore, during the kick-off meeting, was elected to serve as the Chair of the Steering Committee during the duration of the plan's development.

PLAN DEVELOPMENT METHODOLOGY

Update of the Skagit County Hazard Mitigation Plan included seven phases:

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

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

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

MITIGATION GOALS

The 2015 goals were reviewed during the initial kick-off workshop with no modifications for the 2020 update. Objectives were also reviewed with no updates for the current mitigation plan.

The goals and objectives were utilized to allow further assessment of mitigation strategies. Strategies were assessed to determine association with several general categories related not only to emergency management as a whole, but also inclusive of the Community Rating System, as follows:

- Prevention
- Public Information and Education
- Property Protection
- Emergency Services / Response
- Natural resources
- Structural projects
- Recovery

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 primary focus of the selection. Rather, the focus was the initiatives' effectiveness in achieving the goals of the plan and whether they are within each entities' capabilities.

This planning process resulted in the identification of mitigation actions to be targeted for implementation by individual planning partners. These initiatives and their priorities can be found in Volume 2 of this plan. In addition, the planning partnership identified countywide initiatives benefiting the whole partnership that will be implemented by pooling resources based on capability. These county's initiatives are identified in Chapter 13.

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. In 2010, the guidance was further enhanced and expanded, with this document incorporating all required changes.

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

The Skagit County 2020 Multi-Jurisdiction Hazard Mitigation Plan Update has been developed pursuant to the requirements of 44 CFR 201.6 and 44 CFR 201.7. The plan meets FEMA's guidance for multi-jurisdictional and tribal mitigation planning.

1.2 ACKNOWLEDGEMENTS

Many groups and individuals have contributed to development of the Skagit County 2020 Multi-Jurisdiction Hazard Mitigation Plan Update. The Skagit County Department of Emergency Management provided support for all aspects of plan development. Skagit County GIS also provided assistance, including providing data identifying critical facilities and infrastructure, mapping, and statistical analysis with respect to land use. The Skagit and Whatcom County Conservation Districts, Jenny Coe and Al Craney, provided assistance with the public outreach portions of the effort, as well as development of the County's updated Community Wildfire Protection Plan (published separately), which is utilized as the County's Wildfire hazard chapter. The Skagit County Planning Department provided assistance with respect to existing plans and studies in place, as well as guidance and information concerning implementation of the Growth Management Act countywide. The Skagit County Public Works and Planning and Development Services Departments provided information concerning facilities, previous hazard impact, the National Flood Insurance Program, and the Community Rating System, among other information. Jerry Franklin with the

Washington State Department of Ecology provided assistance and information which was utilized throughout this document. The Steering Committee and 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 HAZARD MITIGATION 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 Skagit 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 Skagit 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 Skagit 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.

Planning efforts such as the Hazard Mitigation Plan also integrate into other planning efforts, which provide even greater benefits to the planning community and its citizens. Three such efforts which further benefit from a Hazard Mitigation Plan is the National Flood Insurance Program (NFIP), the Community Rating System (CRS), and Washington State's Flood Control Assistance Account Program (FCAAP), among others.

1.3.1 National Flood Insurance Program

The National Flood Insurance Program (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; however, in order to be a part of the NFIP, participants must regulate development in floodplain areas in accordance with NFIP criteria. More detail on the NFIP is provided within the flood hazard profile (Chapter 7). A part of the NFIP is the ability to administer a floodplain management program, regulated by the Community Rating System, which is an incentive program helping to reduce the flood insurance premiums.

1.3.2 CRS Steps for Comprehensive Floodplain Management

Throughout this Plan, activities that could count toward the Community Rating System (CRS) are included. As indicated, the CRS is a voluntary incentive program that recognizes and encourages community floodplain activities that exceed the minimum NFIP requirements. As a result, flood insurance premiums are discounted to reflect the reduced flood risk resulting from community actions that meet the three (3) goals of the CRS: (1) reduce flood losses; (2) facilitate accurate insurance rating; and (3) promote education and awareness of flood insurance.

For participating communities, flood insurance premium rates are discounted in increments of 5 percent. For example, a Class 1 community would receive a 45 percent premium discount, and a Class 9 community would receive a 5 percent discount. (Class 10 communities are those that do not participate in the CRS; they receive no discount.) A minimum of 500 points are necessary to enter the CRS program and receive a 5% flood insurance premium discount. This HMP could contribute points toward participation in the CRS.

Savings in flood insurance premiums are proportional to the points assigned to various activities. The CRS classes (1-10) for local communities are based on 18 creditable activities in the following categories:

- Public information
- Mapping and regulations
- Flood damage reduction
- Flood preparedness.

The CRS program credits NFIP communities a maximum of 100 points for organizing a planning committee composed of staff from various departments; involving the public in the planning process; and coordinating among other agencies and departments to resolve common problems relating to flooding and other known natural hazards. The County's planning team incorporates a wide variety of planning partners which serve a role in the review and application of floodplain management. For Skagit County purposes, this was developed as a plan oversight committee referred to as the Steering Committee. This group was in addition to the regular planning team members, and provided assistance, guidance and oversight based on a set of criteria which were established, reviewed and adopted by the whole of the planning partnership.

Developing a comprehensive floodplain management plan is also among the activities that earn CRS credits toward reduced flood insurance rates. To earn CRS credit for a floodplain management plan, the community's process for developing the plan is very similar to that of developing a Hazard Mitigation Plan. The floodplain management plan must include at least one item from each of the 10 steps.

- Planning process steps:
  - ✓ Step 1 – Organize
  - ✓ Step 2 – Involve the public
  - ✓ Step 3 – Coordinate

- Risk assessment steps:
  - ✓ Step 4 – Assess the hazard
  - ✓ Step 5 – Assess the problem

- Mitigation strategy steps:
  - ✓ Step 6 – Set goals
  - ✓ Step 7 – Review possible activities which reduce the flood risk (mitigation strategies)
  - ✓ Step 8 – Draft an action plan

- Plan Maintenance Steps:
  - ✓ Step 9 – Adopt the plan
  - ✓ Step 10 – Implement, evaluate and revise the plan content as needed.

CRS activities can help to save lives and reduce property damage. Communities participating in the CRS represent a significant portion of the nation's flood risk, with over 66 percent of the NFIP's policy base is located in these communities. Communities receiving premium discounts through the CRS range from small to large and represent a broad mixture of flood risks, including both coastal and riverine flood risks.

At the time of this planning effort, the several of the planning partners are participating CRS communities as discussed within the Flood Hazard Chapter. Other planning partners may be moving forward during the life cycle of this plan to gain CRS points. As such, each annex profile may have additional data to support those efforts to gain CRS points. Additional information specific to FEMA's Community Rating System program is available for review at: https://www.fema.gov/community-rating-system

Additional information concerning the County's efforts with respect to the Community Rating System and the Flood Hazard throughout the County is available on the County's website at: https://www.skagitcounty.net/Departments/PublicWorks/main.htm

1.3.3 FCAAP Requirements for Comprehensive Flood Control Management Plan

Washington has had a legislatively established flood control maintenance program for more than 50 years. In 1984, the state Legislature established the Flood Control Assistance Account Program to help local jurisdictions in comprehensive planning and flood control maintenance efforts. This is one of very few state programs in the country that provides grant funding to local governments for flood plain management planning and implementation actions. The account is funded at $4 million per state biennium, unless modified by the state Legislature. Projects include planning, maintenance projects, feasibility studies, match for federal projects, and emergency projects. Eligibility for Washington's FCAAP funding for flood projects requires that the requesting jurisdiction complete a comprehensive flood control management plan. The plan must include six components, as summarized below.

- Determination of the need for flood control work;

- Alternative flood control work;
- Identification and consideration of potential impacts of in-stream flood control work on the in-stream uses and resources;
- Coverage, at a minimum, of the area of the 100-year floodplain within a reach of the watershed of sufficient length to ensure that a comprehensive evaluation can be made of the flood problems for a specific reach of the watershed, as well as flood hazard areas not subject to riverine flooding (e.g., coastal flooding, flash flooding, or flooding from inadequate drainage);
- Conclusion and proposed solutions;
- Certification from Washington State Military Department, Emergency Management Division that the local emergency management organization is administering an acceptable comprehensive emergency operations plan.

Additional information on the FCAAP program is available at the following link: https://www.ecology.wa.gov/About-us/How-we-operate/Grants-loans/Find-a-grant-or-loan/Flood-control-assistance

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. Approval Pending Adoption was issued on May 7, 2020, with the County's adoption taking place May 18, 2020.

1.5 SCOPE AND PLAN ORGANIZATION

The process followed to update the Skagit County 2020 Multi-Jurisdiction Hazard Mitigation Plan included the following:

- Review and prioritize disaster events that are most probable and destructive. For planning purposes, this plan covers those incidents and information which have occurred since the previous plan was developed (2014), through December 31, 2018. Future updates shall begin assimilation of data beginning January 1, 2019.
- Update and identify new critical facilities.
- Review and update areas within the community that are most vulnerable.
- Update and identify new goals for reducing the effects of a disaster event.
- Review and identify new projects to be implemented for each goal.
- Review and identify new procedures for monitoring progress and updating the hazard mitigation plan.
- Review the draft hazard mitigation plan.
- Adopt the updated hazard mitigation plan.

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

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

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

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

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

CHAPTER 2.
PLANNING PROCESS

To develop the Skagit County Hazard Mitigation Plan, the County applied 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; and
  - 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 Program (PDM) grant from FEMA. Skagit County was the applicant agent for the grant. The grant covered 75 percent of the cost for development of this plan; the County and its planning partners covered 12.5 percent of the cost through in-kind contributions, and the state of Washington provided the balance.

2.2 INTERNAL PLANNING GROUP FORMATION

Hazard mitigation planning enhances collaboration and support among diverse parties whose interests can be affected by hazard losses. A steering committee was formed to oversee all phases of the plan update process. The members of this committee included key planning partner staff, citizens and other stakeholders from within the planning area. Skagit County also 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, reporting directly to a County-designated project manager and the Steering Committee. The Steering Committee formed to lead the planning effort was made up of the following members:

Skagit County Hazards Mitigation Plan Development Steering Committee

Douglas ten Hoopen	Director and Project Manager Department of Emergency Management (until July 1, 2019)
Hans Kahl	Emergency Management Specialist/ Interim Director of Emergency Management (from July 1, 2019 until project completion)

Jack Moore	Skagit County Floodplain Manager, Planning and Development Services. Served as Steering Committee Chair.
Bronela Mishler	Skagit County Communications Director
Beverly O'Dea	Bridgeview Consulting, LLC Project Manager Lead Planner
David O'Dea	Bridgeview Consulting, LLC Strategic Analyst and Public Facilitator
Cathy Walker	Bridgeview Consulting, LLC GIS Analyst

2.3 PLANNING PARTNERSHIP

Skagit County opened this planning effort to those eligible entities within the county which expressed an interest in participating in the planning process, including all cities, towns, tribal entities, and special purpose districts. Emergency Management personnel made presentations at various meetings and conducted one-on-one meetings with potential planning partners to solicit letters of intent to participate. Each jurisdiction wishing to join the planning partnership was asked to provide an executed Letter of Intent to Participate. That letter designated a point of contact for the jurisdiction and confirmed the jurisdiction's commitment to the process and understanding of expectations.

During the 2020 update cycle, the towns of La Conner and Lyman did not participate, but the planning partnership did increase significantly from the previous plan. Table 2-1 summarizes the planning partners, as well as the level of participation and involvement throughout the planning process.

Table 2-1- Hazard Mitigation Planning Partners and Level of Participation

County, City, Town or Entity Represented	Primary Point of Contact	Alternate Point(s) of Contact	Date of Previous Plan	Letter of Participation	Kick-Off Meeting	Completed Risk Ranking	Completed Annex Template	Draft Plan Review	Final Plan Review	Adoption Month
County	Douglas ten Hoopen*, Planning Team Chair, Skagit County Emergency Management Director	Hans Kahl* Project Coordinator, Skagit County Emergency Management	2015	X	X	X	X	X	X	May
County	Jack Moore* County Floodplain Manager, Steering Committee Chair	Ron Wesen, County Commissioner			X	X	X	X	X	
County	Sean Carson GIS Specialist					X		X	X	
County	John Cooper*									

County, City, Town or Entity Represented	Primary Point of Contact	Alternate Point(s) of Contact	Date of Previous Plan	Letter of Participation	Kick-Off Meeting	Completed Risk Ranking	Completed Annex Template	Draft Plan Review	Final Plan Review	Adoption Month
	Geologist, Planning and Development Services Dept.									
Municipalities										
Anacortes, City of	Chief Dave Oliveri	Asst. Chief Jack Kennedy Richard Curtis	2015		X	X	X	X	X	May
Burlington, City of	Kelly Blaine	Brad Johnson	2015	X	X	X	No			
Concrete, Town of	Andrea Fletcher, Clerk	Marianne Manville-Ailles, Planner	2015	X	X	X	X	X	X	
Hamilton, Town of	Mayor Joan Cromley (until 12/31/19)	Mayor Carla Vandiver (1/1/20)	2015	X	X	X	X	X	X	
La Conner, Town of	Scott Thomas		2015				No			
Lyman, Town of	Debbie Boyd		2015				No			
Mount Vernon, City of	Chief Bryan Brice	Asst. Chief Bryan Harris Scott Horton	2015		X	X	X	X	X	
Sedro-Woolley, City of	John Coleman, Director	Katherine Ware, Planning	2015	X	X	X	X	X	X	
Special Purpose Districts										
Skagit County PUD	Jay Sedivy				X	X	X	X	X	
Skagit Drainage District Consortium (representing all Dike, Drainage, and Irrigation Districts	Jenna Friebel, Director	John Wolden	2015		X	X	X			
Skagit County Drainage District #16	Commissioner Ron Wesen				X	X	X			
Skagit County Dike District #17	Daryl Hamburg				X	X	X			
Skagit County Dike District #12	Dan Lefeber	Merina Metz			X	X	X			
School Districts										
LaConner School District	Dr. Whitney Meissner	John Aguilar Brian Masonholder	2015	X	X		No			
Concrete School District	Wayne Barrett	Paul Carter	2015		X	X	X	X	X	
Sedro-Woolley School District #101	Chet Griffith	Scott McPhee Phil Brockman	2015		X		No			

County, City, Town or Entity Represented	Primary Point of Contact	Alternate Point(s) of Contact	Date of Previous Plan	Letter of Participation	Kick-Off Meeting	Completed Risk Ranking	Completed Annex Template	Draft Plan Review	Final Plan Review	Adoption Month
Tribal Partners										
Swinomish Indian Tribal Community	Keri Cleary Sr. Planner Planning & Community Development	Jim Sande Emergency Manager	2015	X	X	X	X	X	X	
Sauk-Suiattle Tribe	Billie Burtenshaw, Public Safety	Joni Soriano, Planning			X	X	No	X	X	N/A
Upper Skagit Indian Tribe	Dan Tolliver, PE	Lisa Hainey, GIS	2015		X	X	No	No	No	
Stakeholders										
Al Craney, District Forester, Skagit County Conservation District		Developed CWPP Risk Assessment								
Jenny Coe, Whatcom County HIP Coordinator		Developed CWPP								
Consultants and Planning Team Facilitator										
Bridgeview Consulting, LLC										
Beverly O'Dea, Project Manager and Lead Facilitator										
David O'Dea, Meeting Facilitator, Planning										
Cathy Walker, GISP										

For those jurisdictions invited but who could not participate, linkage procedures have been established (see Volume 2 of this plan) for any jurisdiction wishing to join the Skagit County plan in the future; the process was revised from the previous plan to include the required items for this 2020 update edition.

Responsibilities of the planning partners included participating in mandatory planning workshops and 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.

The initial kickoff planning workshop took place on May 28, 2019. Key workshop objectives were as follows:

- Provide an overview of the Disaster Mitigation Act.
- Describe the reasons for a plan.
- Outline the County work plan.
- Outline and adopt planning partner expectations necessary to establish a jurisdictional annex to the County's Plan.

- Confirm hazards of concern.
- Review and update, as appropriate, the Goals and Objectives.
- Establish the Planning Partnership's definition of Critical Facilities.
- Establish a Public Outreach Strategy for use during this update cycle.
- Discuss strategy development.
- Provide overview of Capability Assessment.

During the initial workshop, the planning partners also established meeting guidelines which applied to all meetings. In addition, the planning partnership also 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 authority by majority vote; identified the concept of alternative representatives for Planning Team members unable to attend, and identified the method in which the public would address the Steering Committee and Planning Team during meetings. Specific guidelines concerning public comments followed the same public meeting regulations as utilized by the Skagit County Board of Commissioners. During the initial workshop meeting, Jack Moore, CFM was elected Chairperson of the Steering Committee and Planning Team. The Planning Team also determined that actions taken by either the Steering Committee or Planning Team would be by majority vote of attendees.

In advance of each meeting, an agenda and materials to be discussed (i.e. example mitigation strategies, examples of projects eligible for FEMA funding, etc.) were sent to meeting participants. All members issuing Letters 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:

- Invitations for participation were sent out to County Commissioners, local mayors, public administrators, emergency managers, the County's floodplain coordinator, personnel from county and local planning and development services, public works, the GIS departments, the Skagit County Health Department, Conservation District, PUDs, Port and Hospital Districts, local fire and law enforcement, and all surrounding tribal entities.
- The County's LEPC was also provided an opportunity to participate in the process during their quarterly meetings. Their participation included providing data, attending public meetings, and reviewing the draft hazard mitigation plan.
- Washington State stakeholders and information included various representatives from the Department of Natural Resources, Department of Ecology, Emergency Management Division, Department of Transportation, the State Hazard Mitigation Officer, and the Hazard Mitigation Grant Program Officer. Local academia was also included, such as the University of Washington and Western Washington University. Their participation included providing data, attending meetings, and reviewing the draft hazard mitigation plan.
- Federal agency stakeholders and information included the FEMA Region X, 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, among others. These agencies provided information on

plan development, attended public meetings, and were invited to review the draft hazard mitigation plan.

- Non-government stakeholders included the American Red Cross, Chambers of Commerce, and local private industries, among others.

The County's Emergency Management email distribution list was utilized, reaching individuals from various departments, agencies, and organizations throughout the region. The County's LEPC was utilized as a public outreach venue, as all quarterly meetings are open to the public, and regularly attended by planning partners and citizens alike. Many of these entities provided information for plan development, attended the public meetings, and/or reviewed the draft hazard mitigation plan update.

Facebook and Twitter accounts from several planning partners were utilized, with information distributed to several hundreds of citizens throughout the planning effort at various stages, including to announce the availability of the survey, when meetings were being held, when the risk assessment was available for viewing, and on completion of the draft plan.

In addition, the school districts also utilized their robo-calling to advise parents and others throughout the process of the various milestones and stages of the planning process in an effort to keep parents informed and solicit input and information.

Stakeholders received a variety of information during the project, including meeting notices, documents for review, and the draft mitigation strategy. Stakeholders also provided input on the plan, particularly for the risk assessment.

Table 2-2- Hazard Mitigation Stakeholders and Areas of Participation

Stakeholders			Data and Information Provided
Samish Tribe	Nora Pederson (Initial POC), Planning	David Strich, Planning	Data concerning Tribe.
Sauk-Suiattle Tribe	Billie Burtenshaw, Public Safety/ Emergency Manager		Data concerning Tribe
Skagit Council of Government	Katie Bunge, Planning		Data and review of plan
Skagit Valley Herald	Kimberly Cauvel, Reporter		Assisted with dissemination of public information through the Skagit Valley Herald
PeaceHealth	Robert Taylor, Facilities		Provided information on private hospital facilities in area, emergency management practices, and preparedness efforts on-going within PeaceHealth organization.
FEMA Region X	Kate Skaggs, FEMA Contracted Plan Reviewer	John Schelling, Mitigation Program	Review of data; discussion re: issues with Risk Map reports and data gaps in county
Island County Emergency Management	Eric Brooks, Director, DEM		Deception Pass Bridge potential impact, various other regional planning efforts underway.
Western Washington University			Tsunami Inundation Study (2019)
WA DNR- Geological Survey	Daniel Eungard, LG		Tsunami Hazard maps and data

WA DNR	Recep (Ray) Cakir		Landslide information and data
WA DOE	Jerry Franklin, Risk Map Coordinator		Flood data, SRL and CRS data and information
WA DOE	Diane Fowler, Community Rights to Know Coordinator		Reporting Hazmat sites in county
WA DOE	George Kaminsky, PE		Coastal erosion 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 14. The list of references at the end of this volume presents sources used to capture information necessary to complete this planning effort. In addition to data referenced as footnotes, additional plans, studies, and reports used for this process include, but are not limited to:

- Skagit County Hazard Mitigation Plan (2015)
- Skagit County Comprehensive Emergency Management Plan (CEMP) (2019 under development)
- Skagit County Comprehensive Land Use Management Plan
- Flood Insurance Study; Skagit County and Incorporated Areas (Various)
- Skagit County Draft Critical Areas Protection Ordinance
- Skagit River Basin Climate Science Report (2011)
- Washington State Enhanced Hazard Mitigation Plan (2013 and 2018)
- Washington Department of Natural Resources (WDNR) Landslide Report
- Coastal erosion data (various)
- NOAA Global Sea Level Rise Scenarios for the United States National Climate Assessment (2012).
- Mount Baker-Glacier Peak Coordination Plan (2011)
- Climate change data – various reports and information
- Washington Department of Ecology Coastal Zone Atlas
- Washington State Department of Ecology Drought Studies/Data (2015, 2016)
- Washington Department of Ecology Hazardous Materials 2018 Annual Report
- Tsunami Study (March 2018/2019)
- Washington State Department of Natural Resources Annual Report (various years)
- FEMA Risk Map Reports (various as cited)

Data obtained from the plan and regulation review was incorporated into various sections of the hazard mitigation plan. The risk assessment beginning in Chapter 5 refers to plans and ordinances that affect the management of each hazard. Chapter 15, Section 15.2 describes how mitigation can be implemented through existing programs. An assessment of all planning partners' regulatory, technical, and financial capabilities to implement hazard mitigation initiatives is presented in the jurisdiction-specific annexes in Volume 2 and in Chapter 14. 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 Steering Committee and 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 distributed a news release to the local papers and identified the survey on the hazard mitigation website. The Skagit Valley Herald provided meeting dates and information at several intervals throughout the planning process to inform readership.
- Several Planning Team Members throughout the County also posted the link to the survey on their various Facebook and Twitter accounts, while also announcing meetings and outreach efforts.
- Attempt to reach as many citizens as possible using multiple formats. This is important because of the somewhat geographically remote areas in the county.
- Identify and involve planning area stakeholders.
- Provide newsletter articles about mitigation efforts, such as the of FEMA flood maps, National Flood Insurance Program, and other hazard-specific outreach, etc.
- Utilize outreach activities for CWPP development to combine efforts to include both Hazard Mitigation and Community Wildfire Protection Planning.
- Utilize the annual Safety Fair and the County Fair to present risk information and maps; provide an opportunity for discussions on strategy and mitigation opportunities, and solicit response to survey.
- Utilize the Flood Hazard Awareness Week (September 28, 2019-October 4, 2019) to present information on the mitigation planning effort, with specific emphasis on Flood Hazard Awareness, including the presentation of flood insurance information, potential mitigation efforts which citizens can address, and general awareness information on the flood hazard.

- Utilize various school events (parent-teacher conferences, calling/email lists, etc.) to provide information to parents.
- Utilize Flood Awareness Week and other designated safety-recognition weeks to provide information and awareness of the hazards of concern throughout Skagit 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 Emergency Management webpage, which hosted a mitigation section (see Figure 2-1), wherein all notices and survey links were posted. During meetings within the planning area or attended elsewhere by Planning Team members, individuals were directed to the website to gain better insight of the County's endeavors and to solicit input. The Planning Team identified stakeholders to target through the public involvement strategy. Members of the Planning Team attending conferences or meetings provided updates to those in attendance, asking for input and review of the plan. Some of the outreach sessions are identified in Table 2-3. This list is not all-inclusive, but rather demonstrative of the various efforts of the Planning Team.

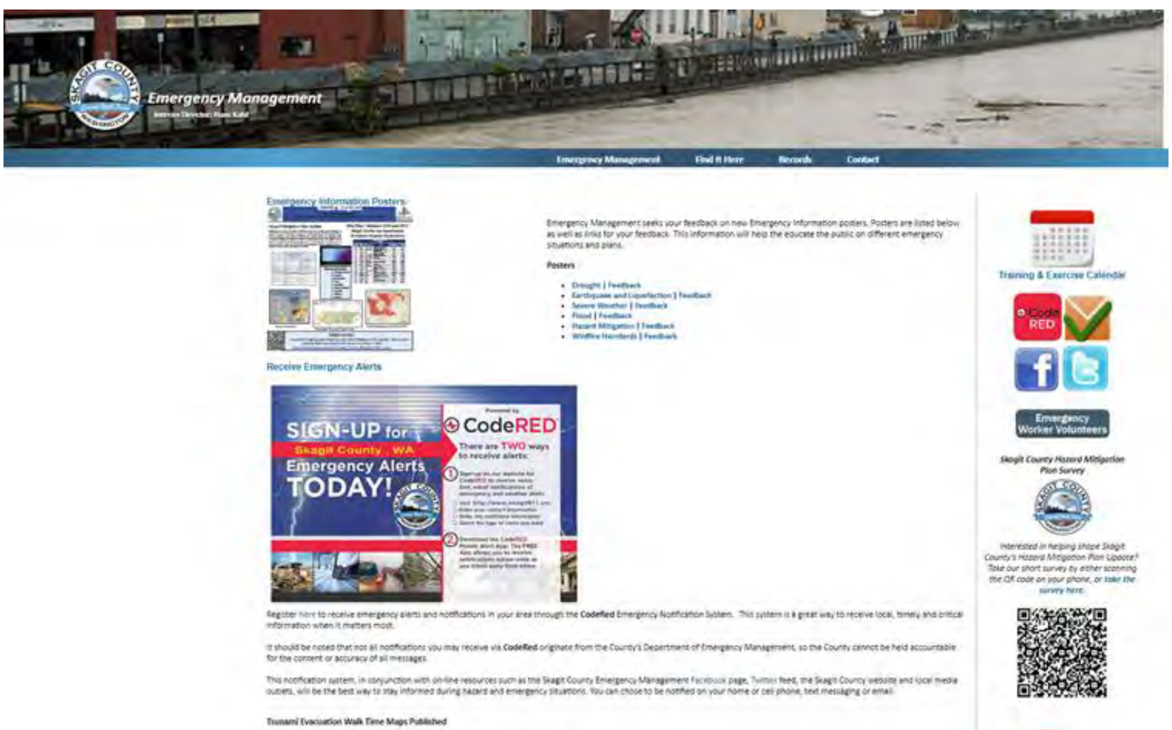


Figure 2-1 Skagit County Web Page

(https://www.skagitcounty.net/Departments/EmergencyManagement/main.htm#)

2.6.2 Hazard Survey

A hazard mitigation plan survey developed by the Planning Team was used to gauge household preparedness for natural hazards and the level of knowledge of tools and techniques for reducing risk and loss from natural hazards. This questionnaire was designed to help identify areas vulnerable to one or more natural hazards. The answers to its questions 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, which was distributed and announced during meetings, during public outreach sessions, and announced through twitter and email distributions countywide. Appendix B presents the questionnaire and a summary of its findings. Figure 2-2 illustrates a sample from the web-based questionnaire.

The survey, as well as the public outreach efforts, also provided an opportunity for citizens to provide comments during the entire process, from the initial drafting stages when the survey was deployed, until the draft plan was available for review. Comments received, which were relevant to the planning process and provided applicable information to the various sections of the plan were incorporated as appropriate.

Generally, most comments received were of the "response" nature with respect to evacuation areas in the event of a tsunami or earthquake, and various mechanisms and efforts citizens have performed already to prepare themselves – an information exchange.

Figure 2-2 Sample Skagit County Survey

A few citizens discussed mitigation efforts underway, such as the City of Mount Vernon's levee project, and the buyouts in the flood-prone areas.

One of citizens' greatest concern is the limited time for evacuation associated with a tsunami event along the coast, especially when attempting to evacuate with supplies. Several citizens offered volunteer assistance to local emergency management.

Praise was also given to all of the effort extended by all of the planning team with respect to dissemination of information, and the ability for the citizens to learn of the hazards of concern, and ways in which to better prepare themselves.

With respect to the survey responses as they relate to the hazards of concern, the responses closely match the hazards of greatest concern as identified through the Planning Team's risk ranking.

Additional points of interest from the survey results include:

- Over 60 percent of respondents have experienced a severe weather event; 54 percent have experienced an earthquake; 6 percent have experienced a volcanic eruption; 56 percent have experienced a flood event, and 32 percent have experienced a wildland fire. Of the 25 disaster declarations occurring in the County, 8 have been as a result of Severe Storms, while seven (7) have been as a result of Flood events. Floods, when coupled with the severe storm event which customarily includes some level of flooding, is the primary hazard to have impacted the County since 1971.
- Earthquake and Wildfire are the hazards of greatest concern to citizens. When compared to the prioritized scoring, earthquake was identified by the HMP Planning Team as the primary hazard of concern, followed by Severe Weather and Flood in order of significance. The majority of respondents took the survey during the summer months, when wildfire was discussed daily within the news, as was the drought situation, which increased wildfire danger.
- 13 percent of respondents indicate they have flood insurance through the NFIP, while 22 percent indicate they have earthquake insurance. One respondent also had wildfire insurance.
- 47 percent of respondents indicated some level of self-preparedness. The type of preparedness varies.
- 49 percent of respondents indicated that the impact of disaster incidents played a role in their decision to purchase their residence.
- 47 percent of respondents indicated that the disclosure of natural hazard risk information would influence their decision to buy or rent a home in a hazard area.
- 69 percent of respondents stated that if their property was located in a high-hazard area, they would consider a buyout.

2.6.3 News Releases

The County regularly takes part in public discussions concerning public safety issues in the county, including the development of the hazard mitigation plan update. At the onset of this project, the effort was announced via a Press Release, which included an invitation to the general public to participate in the planning process and available website where additional information throughout the planning process was maintained, including the hazard maps and posters (see Figure 2-3). When the draft plan was available for public review, notice was published in an effort to draw in as many comments as possible.

In addition, the County also ran an extensive 13 page separate insert in the local newspaper, detailing all hazards of concern, including specific risk data and risk maps, as well as preparedness guides, information concerning insurance, volunteer opportunities, and other on-going mitigation and emergency preparedness events (see Figure 2-4 through Figure 2-6) .

From: Press_Releases@skagitcounty.net <Press_Releases@skagitcounty.net>
Sent: Tuesday, April 23, 2019 9:58 AM
To: Douglas ten Hoopen <douglasth@co.skagit.wa.us>
Subject: Emergency Management Department updating its preparedness plans for natural disasters

Press Release
FOR IMMEDIATE RELEASE: April 23, 2019
Doug ten Hoopen, Director, Department of Emergency Management
douglasth@co.skagit.wa.us - 360-416-1852

Emergency Management Department updating its preparedness plans for natural disasters

How can we better prepare for the impacts from natural disasters? That's a question the Skagit County Department of Emergency Management (DEM) and its partners plan to answer with an update to the county's Natural Hazard Mitigation Plan (NHMP).

The NHMP is a multijurisdictional planning document that benefits city, town and tribal partners throughout Skagit County. Its overarching goal is to reduce vulnerability and lessen the impact of disasters on the local community by creating plans for taking action in advance. It was last updated in 2014.

"Skagit County has historically faced floods, severe windstorms, winter storm and even volcanic activity," said Doug ten Hoopen, Director of Emergency Management. "We can't predict when the next natural disaster might strike, but we can plan ahead – and work with our community – to find ways to minimize the risks. The NHMP basically acts as our risk-reduction roadmap."

As part of the update, Skagit County DEM will solicit input from residents, specifically looking for local knowledge of the community's vulnerability to hazards based on past events. The community can participate in public meetings, submit feedback online, review draft maps, and track the plan's progress online. This process will be directed by a Steering Committee and Planning Team made up of representatives from local jurisdictions, tribal partners, special purpose districts, citizens, and other stakeholders from within the planning area.

The NHMP update is funded by a planning grant from the Federal Emergency Management Agency (FEMA). Skagit County is working with Beverly O'Dea of Bridgeview Consulting, LLC, to complete the planning and update process. Updates will be posted online at skagitcounty.net/dem.

Any questions or comments regarding this process are encouraged and should be directed to Douglas ten Hoopen - douglasth@co.skagit.wa.us, Hans Kahl - hkahl@co.skagit.wa.us, or to Bev O'Dea, Bridgeview Consulting, LLC at (253) 301-1330 or email: [illegible]

###

You are currently subscribed to Skagit County's pressreleases e-mail list
as: douglasth@co.skagit.wa.us.
To unsubscribe send a blank email to [illegible]

Figure 2-3 April 23, 2019 Press Release

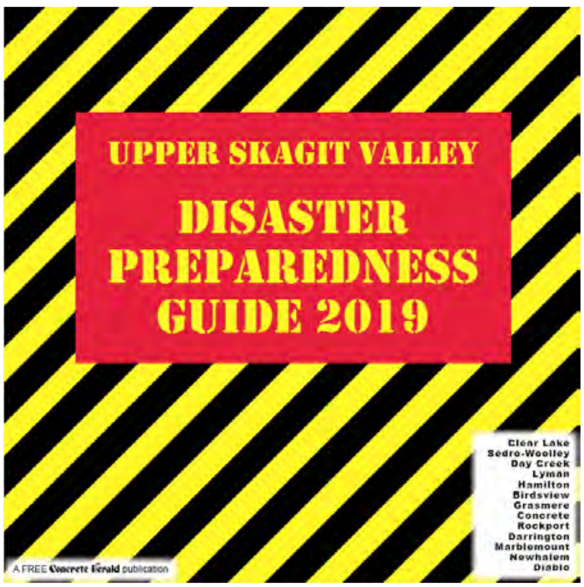


Figure 2-4 Concrete Herlad Newspaper Insert

Want to help? Volunteer.

Community Preparedness & Prevention Fair

Learn what to do before disaster strikes

Concrete Herald

The Voice of the Upper Skagit Valley

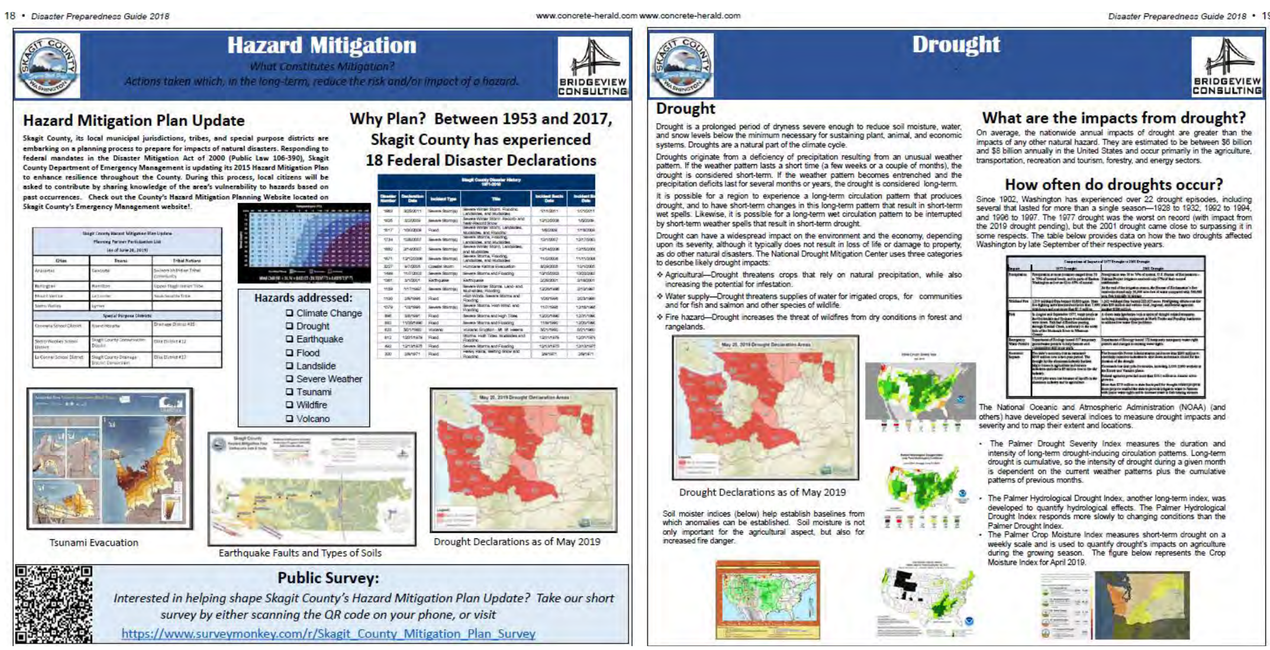
From the editor

Inside

FLOODS & WINTER STORMS

Get to know your DEM

Figure 2-5 Concrete Herald Newspaper Insert



Hazard Mitigation

What Constitutes Mitigation?

Actions taken which, in the long-term, reduce the risk and/or impact of a hazard.

Hazard Mitigation Plan Update

Why Plan? Between 1953 and 2017, Skagit County has experienced 18 Federal Disaster Declarations

Hazards addressed:

- Climate Change
- Drought
- Earthquake
- Flood
- Landslide
- Severe Weather
- Tsunami
- Wildfire
- Volcano

Tsunami Evacuation

Earthquake Faults and Types of Soils

Drought Declarations as of May 2019

Public Survey:

Interested in helping shape Skagit County's Hazard Mitigation Plan Update? Take our short survey by either scanning the QR code on your phone, or visit

https://www.surveymonkey.com/r/Skagit_County_Mitigation_Plan_Survey

Drought

What are the impacts from drought?

How often do droughts occur?

Drought Declarations as of May 2019

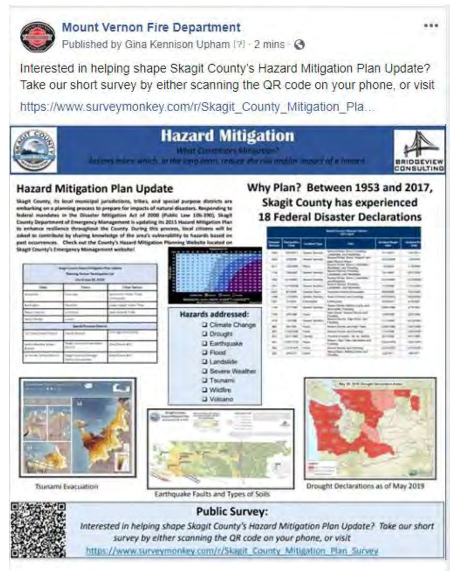
Figure 2-6 Concrete Herald Newspaper Insert

2.6.4 Internet

At the beginning of the plan development process, a website was created to keep the public posted on plan development milestones and to solicit input. The County and several of the planning partners intend 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's website address was publicized in all press releases, mailings, questionnaires and public meetings. Information on the plan development process, the use of a Steering Committee and Planning Team, the questionnaire and phased drafts of the plan were made available to the public on the site throughout the process. Hazard maps were published on this site, and were available for download. A link was also made available to the County's survey, available at: https://www.surveymonkey.com/r/Skagit_County_Mitigation_Plan_Survey

In addition, several of the planning partners also posted information on their respective websites, posting frequently asked questions, and asking for citizen comments. As comments were received, they were reviewed by the planning team and integrated into the plan if appropriate.



2.6.5 Social Media

In addition to the website, the County and several of the planning partners also have Twitter and Facebook accounts which were utilized reaching several thousand followers (see figure right from Mount Vernon Fire Department). The County's Facebook account is located at: https://www.facebook.com/SkagitCountyEMD. That account will remain active to provide on-going information over the life cycle of the plan. Both Facebook and Twitter were utilized to distribute information concerning the plan's update; to distribute information concerning the survey; advise citizens of the availability of the hazard maps for review and comment; announcing public outreach events, and when the final plan was complete, alerting citizens to the draft plan, asking for review and comment during the open public comment period.

2.6.6 Public Meetings

Several public meetings and events which were open to the public were held during this effort. All planning meetings were open to the public, and citizens did attend those meetings, providing information and input. Table 2-3 highlights some of the public outreach efforts conducted. All public meetings which were held in conjunction with County Commissioner's Meetings were also recorded for viewing at a later date by citizens or other interested parties. In addition, the Fire Districts each held monthly meetings, all of which were open to the public, during which various elements of the HMP process were discussed, in addition to the hazard risks associated with each district. The County also utilized the quarterly LEPC meetings as a means to gain input and disseminate information. Several of the LEPC members are also members of the Steering Committee and Planning Team.

Table 2-3
Public Outreach Events

Date	Jurisdiction	Description	Attendance
2019			
April 23	Countywide	Press release announcing the up-coming project released.	N/A
April	Countywide	During regularly scheduled Commissioner's Meeting, Director ten Hoopen and Project Manager Hans Kahl discussed the various planning efforts underway, and discussed the involvement countywide of the various planning partners.	

Table 2-3
Public Outreach Events

Date	Jurisdiction	Description	Attendance
Weekly	Countywide	Throughout the entire process, Director Douglas ten Hoopen and/or Project Manager Hans Kahl provided weekly briefings and sitrep reports (see sample below Figure 2-12) at both the Commissioner's Meetings and the department head meetings, which are all open to the public, as well as at the various study sessions. The SitReps contained information on the overall process, as well as information specific to each hazard during various awareness events.	
May	Countywide	Website developed; announcement of upcoming meeting posted. Agenda posted for upcoming meeting.	
May	Countywide	County Commissioners issued a Proclamation identifying May as the Wildfire Awareness Month. Presenters on the agenda at the Commissioners' meeting included State DNR, NW Region DNR, USFS, the County Conservation District, and EM Doug ten Hoopen, who talked about the Natural Hazards Mitigation Plan. Presenters identified areas of concern for wildfire, and identified mitigation efforts which homeowners can undertake to help reduce the risk of the wildfire hazard. Jenny Coe of the Skagit & Whatcom County Conservation District also discussed the on-going update of the County's Community Wildfire Protection Plan. The event was televised on local channels (See Figure 2-10).	Televised
May 28	Countywide	Initial Kick-off meeting was held, which was open to the public, all planning partners, and stakeholders. Notice of kick-off meeting distributed throughout County via several medians, including various email lists and direct emailing, as well as announcing the meeting on the County's website. Stakeholders, citizens, volunteers and planning partners were in attendance.	35
April	Countywide	Frequently asked questions and minutes were posted	N/A
Monthly Meetings	Countywide	Discussions and presentation on the status of project to senior leadership, representatives from all local communities, county departments, and local departments.	15-20 monthly
May 30	Anacortes School District	EM conducted outreach to Anacortes Middle School, staff and faculty concerning the geological natural threats in the County, while also providing preparedness information. (Figure 2-7)	~300
June	Countywide	Survey deployed	
July-Aug	Countywide	Various neighborhood presentations to HOA and community groups concerning hazards of concern; CERT and Map Your Neighborhood Presentations	200
September	Countywide	Local newspaper released a 13-page flyer written by EMD personnel concerning hazards of concern, volunteer opportunities, mitigation efforts for citizens, link to HMP survey, on-going outreach activities (e.g., flood awareness week, etc.).	Unknown

Table 2-3
Public Outreach Events

Date	Jurisdiction	Description	Attendance
Sept 22	Skagit County DEM	Preparedness Fair— Information presented included maps and posters presenting risk information for all hazards of concern. Presenters at the event included subject matter experts addressing all hazards, including, among others: the USGS, providing information sessions concerning lahar/volcano and seismic information; representatives from both the Skagit and Whatcom County Conservation Districts, who conducted the wildfire risk assessment and updated the 2019 CWPP, providing information on the wildfire risk throughout Skagit County; personnel from Forestry and Agriculture discussing health-related issues, air quality standards and impact from the hazards of concern, and large animal disposal after disasters. In addition, 20 vendors were present for various programs, including Run-for-the-Hills, insurance representatives for hazard-specific insurance information, such as flood and earthquake. All presenters provided presentations on not only the hazards, but also potential impact from the hazards, and provided a question and answer session for all attendees. Surveys were also made available both in hard copy and via a computer which attendees could utilize.	+100
Sept 22	Skagit County Conservation District	Hosted booth at DEM preparedness fair providing public education materials on wildfire prevention activities and information.	100
Sept 25	Skagit Conservation District Board Meeting	Provided Board with update on CWPP process and integration of the plan into the Hazard Mitigation Plan.	11
Sept 26	Dike, Drainage and Irrigation District Meeting	During the regularly scheduled and advertised meeting which is open to the public, Executive Director Jenna Friebel of the Skagit Drainage and Irrigation District Consortium presented information concerning the hazard mitigation plan status, presented the results of the risk assessment conducted during the HMP process, and led the discussion for identification of strategies to be included in the 2020 HMP update. Commissioners and representatives from all districts attended the meeting and actively participated in the identification of strategies, risk ranking process, and discussions concerning district-specific impact from the hazards of concern. The meeting resulted in confirmation of the risk ranking process, and a series of mitigation strategies identified by each of the Dike, Drainage and Irrigation Districts countywide for inclusion in their annex templates. (Sign in sheets available from the Consortium.)	~45

Table 2-3
Public Outreach Events

Date	Jurisdiction	Description	Attendance
Sept 27-Oct 4	Countywide	Flood Hazard Awareness Week – Coordinated by DEM, presentations and information was provided concerning the hazard mitigation plan in general, with a specific focus on the flood hazard and flood awareness. The week kicked-off with a 5k run. At the end of the race line, the County had a Preparedness and Safety Awareness Fair booth in addition to providing information on flood, potential flood mitigation efforts, flood insurance, and the Community Rating System. The event was staffed with local planning partners, the County's Floodplain Manager, and emergency management personnel. Attendees also included local news agencies. (See figure below for Agenda of the week-long events.)	+150
October	Countywide	Acting DEM Director/Project Manager Hans Kahl provided an update to the LEPC concerning the Hazard Mitigation Plan during the regularly scheduled meeting	40
October	Countywide	During the planning team meeting, the risk assessment findings were presented. This meeting was announced via the County's website in the same fashion as Commissioner's meetings, inviting citizen attendance. The meeting was also announced on other planning team members' websites. While advertised to the public, no citizens attended.	20
January 3	Skagit County	The County issued a Press Release announcing plan availability for review on its website, as well as hard copy availability. Facebook and Twitter announcements also went out. Each of the planning partners utilized their existing social media tools to distribute the plan's availability, and some of the Planning Partners posted notices on reader boards. The County also provided hard copies of the plan at Mt. Vernon, Anacortes and Sedro-Woolley Libraries for review by citizens.	NA
January 7, 2020	Sedro-Woolley	Planning Team Member John Coleman, Planning Director for the City of Sedro-Woolley, provided an overview to the City Council during its regularly scheduled and televised Council Meeting. The Director also provided information on the draft plan's availability for citizen review and comment during the meeting (as well as the department-head meeting on 1/6/2020). The City also posted notice of the plan's availability on its website, providing a link to the County's plan.	NA
January 7, 2020	Skagit PUD	Skagit PUD provided a feed on its website announcing completion of the plan, inviting citizen review and comment. The PUD also utilized social media to distribute information on the plan's availability.	NA
March	Skagit County Board of Commissioners	Plan review before Commissioners; invitation extended to citizens to review existing plan; announcement of website address and that hard a copy is available for review at the office of Skagit County Department of Emergency Management. The Commissioner's meeting is televised, and can be viewed by citizens at any time.	~20+

The kickoff meeting was open to the public and was publicized in the local paper. Table 2-4 summarizes the review and analysis of the 2015 plan discussed at that meeting. Figure 2-3 are photos of the kick-off meeting.

Table 2-4
Review and Analysis of 2010 Hazard Mitigation Plan

2010 PDM Sections	How Reviewed and Analyzed
Section 1—Introduction and Purpose	Reviewed existing section through discussion at public meeting. No analysis needed.
Section 2—Planning Process	Reviewed and analyzed existing section through discussion at public meeting. Planning process expanded by utilizing project website and scoring hazards using Calculated Priority Risk Index rather than Mitigation 20/20.
Section 3—Hazard Identification and Vulnerability Analysis	Reviewed and analyzed existing section through discussion during public meeting and Planning Partner conference calls. Reviewed and updated hazards, critical facilities and vulnerable populations. Updated section with recent hazard data.
Section 4—Critical Facilities and Infrastructure	CIKR data was developed for the 2020 edition. This information was utilized during the risk assessment portion of the planning effort, although it was not utilized within the Hazus model due to the amount of data necessary for the Hazus program to be effective.
Section 5—Mitigation Initiatives	Reviewed by planning partners during conference calls, meetings and subsequent mitigation workshop. New projects developed, existing projects re-worded and/or deleted, completed projects documented.
Section 6—Plan Maintenance	Reviewed and analyzed existing section through discussion during Planning Partner conference calls. Determined that plan maintenance procedures outlined in previous plan had not been implemented.

Presentation of Risk

During various public outreach events, maps from the various hazards were presented (see figures below for examples). The meeting formats allowed attendees to examine maps and handouts, and have direct conversations with project staff. Risk data was shared with attendees, as were various mitigation strategy efforts developed to help reduce risk. Maps and posters were set up for each primary hazard to which the planning area is most vulnerable. This allowed citizens to see information related to their property. Each citizen attending was also asked to complete a survey, and each was given an opportunity to provide comments to Planning Team members concerning the hazard maps. The Planning Team reviewed those comments, and as appropriate, incorporated the comments into the plan. In addition, once completed, the County also posted all of the hazard maps on its website to allow citizens who were unable to attend any of the public outreach sessions to view the maps online, and provide comments. Notice of the availability of the maps on the County's website was distributed via social media and press releases.

Figure 2-7 Kick-Off Meeting

Figure 2-8 Anacortes Middle School Presentation on Geological Natural Hazards

Figure 2-9 Presentation of Risk Results

SKAGIT COUNTY

PROCLAMATION

IN SUPPORT OF

WASHINGTON WILDFIRE AWARENESS MONTH

WHEREAS, wildfires increasingly pose a threat to homes and communities throughout Washington State as more people are moving into the wildland areas. Most wildfires in Western Washington are human caused; and

WHEREAS, Western Washington is becoming increasingly susceptible to wildfire with increasing temperatures, decreasing summer rain, and earlier snowmelt; and this has elevated the need for wildfire prevention and preparedness at both the community and individual homeowner levels; and

WHEREAS, Skagit County residents must be encouraged to move from the expectation of being protected from wildfire to the understanding that they must be prepared to survive wildfire and work together to prepare their homes and community to survive wildfire; and

WHEREAS, when whole communities implement appropriate pre-fire activities they improve the survivability of their individual homes and community during wildfire; and

WHEREAS, local, state and federal agencies and organizations are working together in Skagit County to increase awareness of wildfires; and

NOW, THEREFORE, the Skagit County Board of Commissioners supports the month of May 2019 as Washington Wildfire Awareness Month as a means for education and a call for residents of Skagit County to take action to reduce the wildfire threat to their homes and help their community move toward becoming more fire-adapted.

Signed this 7th day of May, 2019.

BOARD OF COMMISSIONERS
SKAGIT COUNTY, WASHINGTON

Lisa Janicki
Lisa Janicki, Chair

Ron Wesen
Ron Wesen, Commissioner

Kenneth A. Dahlstedt
Kenneth A. Dahlstedt, Commissioner

ATTEST:
Linda Hammons
Clerk of the Board

Figure 2-10 Skagit County Wildfire Awareness Proclamation

Figure 2-11 Wildfire Risk Presentation

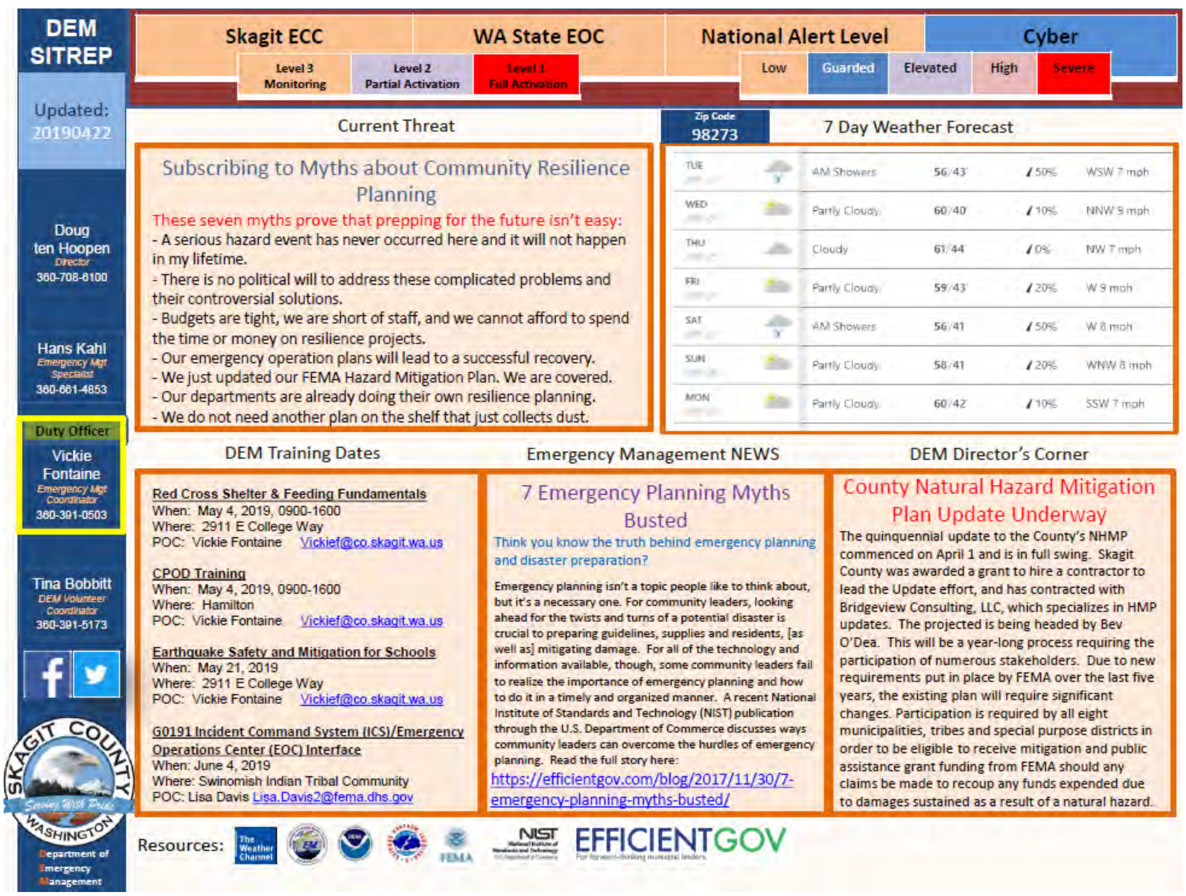


Figure 2-12 Sample Weekly Situation Report (April 22, 2019)

Proposed Date	Events	Objectives	Mission Areas
Sept 27	Proclamation	Recognize FAW Activities Importance	Prevention
Sept 27	Facilities EAP review	Review building specific EAPs and emergency actions	Prevention
Sept 28	5K (Run for the Hills) Fun run/walk/roll	Public outreach and participation	Response
Sept 28	Skagit Emergency Preparedness Fun Fair	Public outreach and participation	Prevention/ Protection/ Response/ Recovery/ Mitigation
Sept 29	Faith Based Flood Awareness preparedness messaging	Public outreach and participation	Prevention
Sept 30	Neighborhood Evacuation drill	Map your Neighborhood and SKAT	Response / Prevention
Sept 30	Meet DEM (Library outreach)	Q&A on preparedness	Prevention
Sept 30	Mt Vernon Flood Wall Set-up DEMO	Video or Actual	Prevention / Mitigation
Oct 1	Kick off with the USACE	Q&A on preparedness	
Oct 1	Resource Coordinator and Field Observer workshop	Review of responsibilities	Response
Oct 1	First Annual PPI meeting	Initial Charter meeting	Mitigation/ Prevention
Oct 1	ECC equipment update by IS	Complete updates on computers for ECC	Response / Recovery
Oct 2	Meet and Greet (DD12)	See Proposed Agenda	Prevention/ Protection/ Response/ Recovery/ Mitigation
Oct 2	UAS (Drone) DEMO WSDOT	Damage Assessment Discussion	Response
Oct 2	Water SAR Presentation	DEMO / Discussion	Response
Oct 3	High School Sandbagging Exercise	Certify teams by USACE	Response/ Protection
Oct 3	ECC Activation and Set Exercise	Function check the ECC equipment and staff activities	Response/ Recovery
Oct 4	Dike Districts meeting and presentation	Meet and discuss issues with districts	Prevention/ Mitigation/ Response
Oct 4	Flood Awareness Week Wrap UP	AAR / Hotwash	

Figure 2-13 Flood Awareness Week Calendar of Events

Figure 2-14 USGS Presentation at October Public Outreach Session

Figure 2-15 Emergency Management Booth with Hazard Posters and Risk Assement Information

Figure 2-16 FEMA Flood Insurance Information at October Outreach

2.6.7 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 January 3, 2020 lasting through January 20, 2020. The County and its planning partners completed the following outreach activities:

– The draft plan was posted on the project website and stakeholders were notified through press releases and e-mail messages of its availability, including Twitter and Facebook. This included notification on reader boards in the communities, and planning partners' websites, Twitter and Facebook accounts, and announcements at various other public meetings, such as the January LEPC meeting.
– During the Commissioner's Meetings and Department Head Meetings, Interim Director of Emergency Management Hans Kahl announced that the draft plan was available for review, and citizens were asked to review the draft plan and provide comments. Each Commissioner was provided the plan for review. A brief overview of the planning process was provided, including an overview of the hazards of concern, and the various types of data and reports which were utilized to help profile the hazards, and identify associated risk. While citizens were provided an opportunity to provide feedback and ask questions, that opportunity provided very minimal feedback. The one question raised related to clarification of the high/medium/low cost benefit assignment for strategies. A clarifying sentence was included in both Volumes 1 and 2 which addressed this question for clarification purposes. No other comments were received which required modification of any portion of the plan.
– Planning partners provided notification of the plan's availability for review during their respective council and commission meetings, advising citizens of the plan's availability.
– Each planning partner held their own final public meeting, at which the plan was presented to their commission or council and the approving authority adopting the plan.

No comments other than the one referenced were received during the public review period. Once the review period closed, the plan was submitted to FEMA for review. Once pre-adoption approval was received from FEMA, the plan was provided to the Board of County Commissioners and the remaining communities for adoption. After adoption, final copies of the plan were submitted to the Washington State Department of Emergency Management and FEMA. Appendix C includes the adoption resolutions.

The final plan will remain on the County's website over the next five years. Future comments on the plan will continue to be captured and incorporated as appropriate, and should be addressed to:

Hans Kahl, Interim Director
Skagit County Department of Emergency Management
(360) 416-1852
hkahl@co.skagit.wa.us

2.7 PLAN DEVELOPMENT MILESTONES

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

Table 2-5
Plan Development Milestones

Date	Event	Description	Attendance
2017			
2017	Submit initial grant application	Seek funding for plan development process	N/A
2018			
2018	Receive notice of grant award	Funding secured.	N/A
2019			
March	Initiate consultant procurement	Seek a planning expert to facilitate the process	N/A
April	Contractor secured	Select Bridgeview Consulting to facilitate plan development	N/A
April	Commission Presentation	Identification of Hazard Mitigation Project discussed; vendor selection identified; contract with consultant approved by Commissioners	
April	Begin identifying Planning Team members	Begin formation of the Planning Team; identify members for Steering Committee participation; Consultant begins review of various documentation and assimilating data, reports, studies, etc.	N/A
May	County HMP Teams Identified	Formation of the County's HMP planning and core project management team. Continue review of existing plan and existing documentation supporting effort (e.g., studies, other planning documents, etc.). Working with local municipalities, begin assimilation of Critical Infrastructure data to be utilized during the planning process.	N/A

Table 2-5 Plan Development Milestones			
Date	Event	Description	Attendance
May	Kick-Off 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 were reviewed and confirmed. The Planning Team discussed public presentation of hazard maps at the Skagit County Safety Fair in August 2019, as well as during the Flood Hazard Awareness Week occurring September 27 – October 4, 2019. Goals and objectives were reviewed, updated and confirmed. Steering Committee members were identified; ground rules for Steering Committee reviewed and approved; public outreach process identified and approved. The survey was also provided for review and comment, with the finalized version made public via Survey Monkey. Notice of the survey's availability and a link to the survey was posted on the County's website.	26
Aug-Sept	Planning Partnership Email Distribution	Hazard profiles distributed for internal review. Initial maps were distributed to the Steering Committee and Planning Team members for review and comment. Risk ranking exercise conducted; strategy/ action item information distributed and discussed; incorporation of risk data into other planning mechanisms discussed (e.g., land use, CEMP, evacuation plans, etc.).	
Oct	Workshop	Review and confirmation of the Risk Ranking completed by each planning partner; citizen survey results utilized to identify the community's perception of risk as compared to that identified by the planning partnership. Survey results (as of 10/21/19) presented.	20
Oct	Workshop	Annex development workshop conducted. After the general workshop was completed where the risk assessment data was again presented and reviewed, the Annex Development Workshop was conducted for those planning partners needing assistance in completing their annex templates. Planning team members brought staff from their respective jurisdictions to continue working on their annex templates throughout the workshop session.	12
Dec	Draft Plan Internal Review	Draft provided by Planning Team to Planning Team (additional strategies added during review process).	All
Jan	Public Review	Draft provided on website with press releases inviting citizens to review and comment for 17 day period (Jan 3-21). Also distributed at libraries in hard copy for citizen review and comment.	All
2020			
Jan	State Review	Plan submitted for state review.	
May 7	FEMA Approval	Approval Pending Adoption (APA) was received, and Planning Partners began the adoption process.	
May 18	County Adoption and Final FEMA approval	County presented plan to Board of Commissioners for adoption; thereafter final FEMA approval issued	

2.8 CHANGES IN 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.

During the time period of 2010-2018, population increased 9.7 percent. Based on U.S. Census data, 2017 saw a total of 663 permits of all types issued countywide. The County and its cities have adopted comprehensive plans that govern land use decision and policy making 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 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: additional 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.

All new development is regulated pursuant to the various programs and initiatives discussed throughout this plan as they relate to the identified hazards, including (but not limited to): flood; landslide; wildfire; earthquake, and load capacity for snow, ash, and wind. Each hazard profile is inclusive of impact based on potential increased exposure from new development that has occurred since completion of the last plan. Impact and/or exposure are identified within the hazard profiles for each municipal planning partner, inclusive of all increased potential risk factors, if any.

For Skagit County, prior to construction occurring, Planning & Development Services reviews properties for environmental impacts and if found, requires mitigation. Common examples of oversight include an area which is designated as a high potential for soil liquefaction and landslide hazards would require County staff geologist to assess the property, and if found hazardous, an engineer must assess the risk and design the building to mitigate the risk.

As such, while exposure for the planning partners may have increased due to a higher population base, and increased structure base, its vulnerability remained consistent due, in part, to the strength of these land use regulations and programs, and the restrictions or requirements for development in hazard-prone areas as required under Growth Management. Such regulatory authority in place is identified within the capability assessment portion of the base plan, as well as each planning partner's capability assessment contained in their specific annex.

In an effort to further expand upon this element, this was an additional level of discussion which occurred in March 2020 based on a recommendation from the state to enhance this element beyond already identified. As such, those planning team members which submitted their annex templates were queried specifically with the intent of identifying any potential areas where land use development has impacted vulnerability, either positively or negatively, beyond that already interfaced with respect to increased population and building count. As a result of that query, all planning team members responded. All indicated that there were no negative implications due to development trends since completion of the last plan.

Unless otherwise addressed within each planning team member's respective annex document, as validated through this planning process and workshop discussions on two separate occasions, the planning team members felt that there was no greater risk or vulnerability beyond that previously identified within the hazard areas as assessed.

It should be assumed that outputs from the risk assessment discussed in detail within the profiles include those areas intended to address changes in the land use development trends. Those elements include, but are not limited to:

1) New areas where geographic boundaries for hazard areas exist (e.g., updated flood maps);
2) Any new areas of land mass in which development has occurred (e.g., annexations or increased urban growth areas), or where potential growth is anticipated; and
3) Identification of increased risk with respect to development trends, which are reflected by:
    a. increased building count since the last plan's completion (as available or applicable);
    b. increased impact to critical facilities, which information was updated during this plan development; and
    c. increased vulnerability incorporating current population trends and areas of future growth.

CHAPTER 3.
COMMUNITY PROFILE – DEFINING THE PLANNING AREA

3.1 PHYSICAL SETTING

Skagit County is situated in northwestern Washington approximately 60 miles north of the city of Seattle. With a geographical area of 1,735 square miles (approximately 95 miles west to east and 24 miles north to south) Skagit County ranks a modest 21st in size among Washington's 39 counties. The City of Mount Vernon is the county seat.

Skagit County is one of marked contrasts ranging from broad, flat floodplain to jagged exposed rock peaks and elevations ranging from sea level to 8,966 feet above sea level at the summit of Mount Logan. The western one-third of the county includes a broad delta and flood plain that extend inland through the rich and fertile Skagit flats. The rugged and heavily forested mountains of the Cascade Range dominate the eastern two thirds of the county.

At its western extreme, the county's boundary envelops some of the islands located on the leeward edge of the San Juan Archipelago including Sinclair Island, Cypress Island, Guemes Island, and Fidalgo Island. In addition to the waters of Puget Sound, there are 89 named lakes, 6 rivers (the Baker, Cascade, Samish, Sauk, Skagit, and Suiattle) and numerous small streams located within Skagit County.

From its source in Canada, the Skagit River flows 135 miles and empties into Skagit Bay. The river drains an area of approximately 3,115 square miles. Based on discharge flows of rivers that empty into saltwater, the Skagit River is the third largest river system on the West Coast of the contiguous United States with only the Columbia River and the Sacramento River being larger.

The Skagit River provides natural beauty, abundant wildlife, and varied recreational opportunities. The Skagit River is a source of electrical power and drinking water and has generated economic growth and promoted quality of life for many generations of county residents. Portions of the Skagit River, as well as portions of the Sauk River, the Suiattle River, and the Cascade River have been designated by the federal government as *WILD AND SCENIC*.

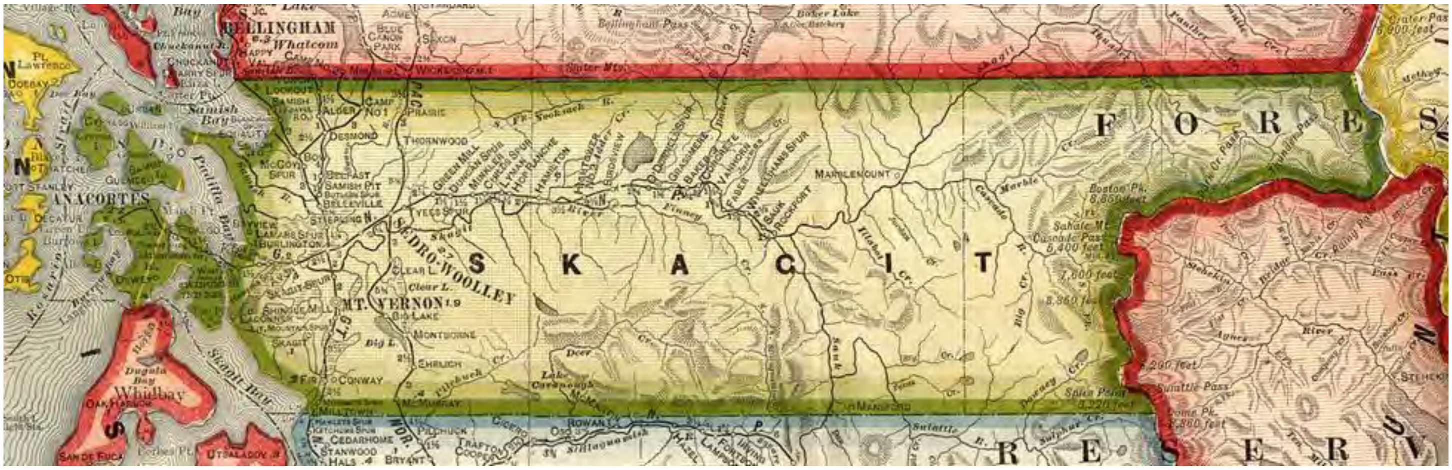


Figure 3-1 Skagit County

3.1.1 Soils and Geology

Skagit County lies near the Cascadia Subduction Zone where the Juan de Fuca Plate (moving east) subducts under the overriding North American Plate (moving west) as they collide off the coast of Washington. The volcanic mountains of the Cascade Range were formed over the centuries as the buoyant, melted rock of the subducted Juan de Fuca Plate rose to the surface as magma.

The underlying bedrock of Skagit County is comprised of a variety of sedimentary, volcanic, and metamorphic rocks; most of this bedrock is overlaid with glacial deposits. Much of the lower valley is comprised of glacial fill deposits, Glacier Peak ash and lahar deposits, and sediments deposited by the Skagit River and Samish River. It has been estimated that these deposits cover the underlying bedrock as much as 1,000 feet in depth throughout most of the lower Skagit floodplain.

Skagit County is home to many seismic faults, including the Bellingham Bay—Lake Chaplain Fault, the Ross Lake Fault and the Hamilton Fault, which may or may not be active. However, the Devils Mountain Fault that runs east to west through the central part of the county has been determined to be active. (Source: Alternative Interpretations of the Seismic and Geologic Hazards to the Skagit Nuclear Power Site, Eric Cheeney, 1977).

3.1.2 Drainage Basins

Skagit County drainage basins are identified in Figure 3-2 (Skagit County HMP, 2015). Within Skagit County, this basins collect water from different sources, and drain out into Puget Sound. One of these, the Skagit River, provides approximately 20 percent of fresh water flowing into Puget Sound, or nearly 10 billion gallons per day.

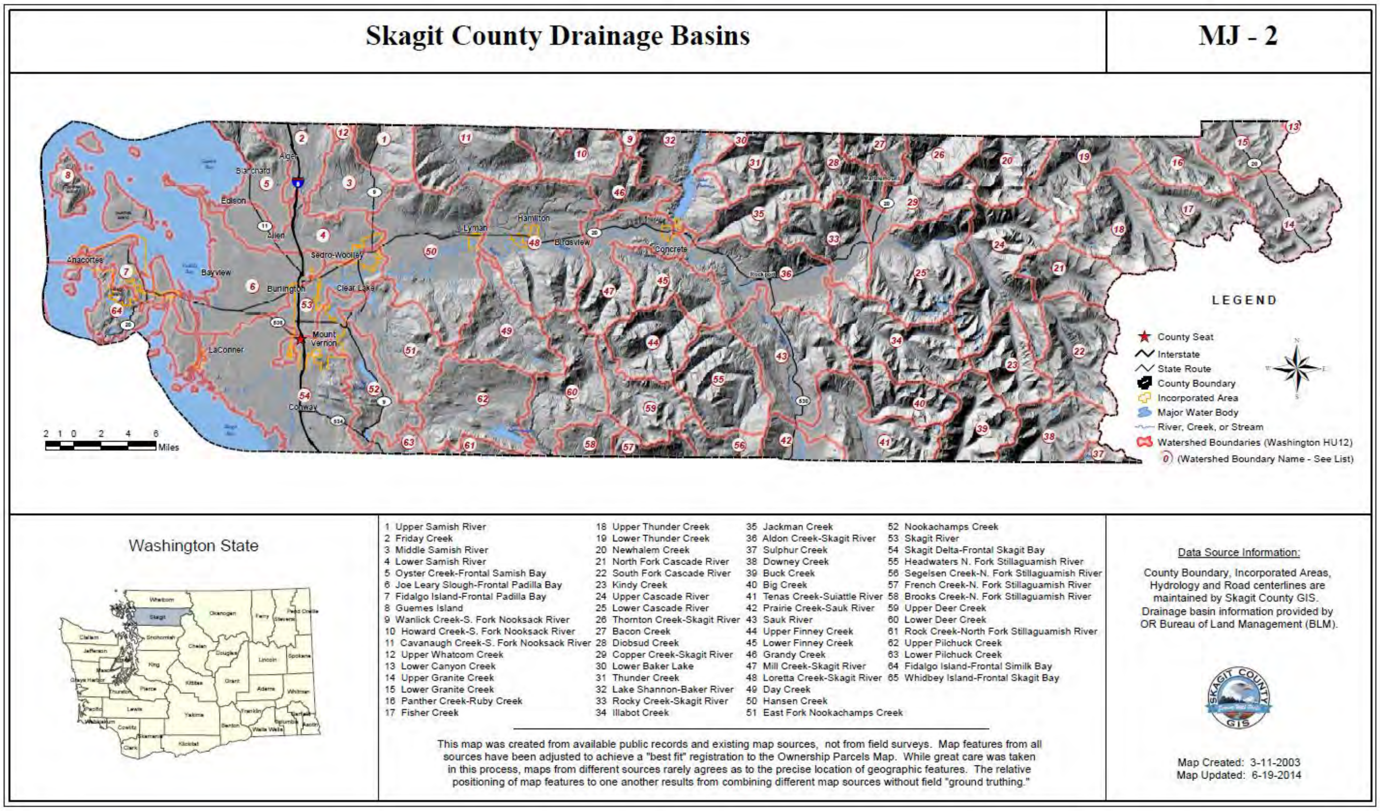


Figure 3-2 Skagit County Drainage Basins

3.2 CLIMATE

The ocean currents that flow along Washington State's coast and the Pacific westerlies (also known as the jet stream or storm track) significantly influence Skagit County's moderate climate. Figure 3-3 illustrates the prevailing wind path for the area.

The air is generally moist, and the fluctuation in annual temperature is moderate. Summer highs can often be in the 80's to low 90's and winter lows may dip as low as 10°. The annual average temperature is 50° and the frost-free growing season averages 193 days.

Rainfall is sparse during the summer months and increases during the fall months with moderate to heavy rains occurring from November through January. Historic precipitation is illustrated in Figure 3-4.[1] Snowfall is seldom heavy and varies greatly from year to year.

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[1] NOAA. Accessed June 2019. Available online at: https://www.ncdc.noaa.gov/cag/county/time-series/WA-057/pcp/all/5/1950-2019?base_prd=true&firstbaseyear=2010&lastbaseyear=2018&trend=true&trend_base=10&firsttrendyear=1950&lasttrendyear=2019

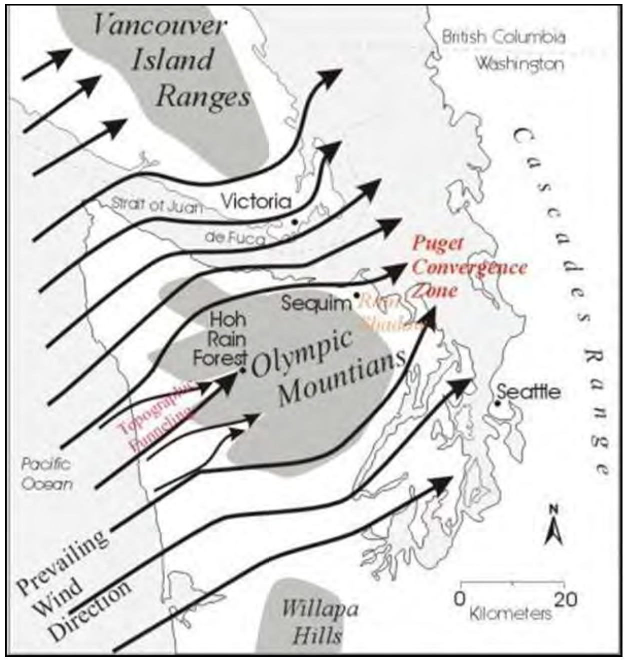

Figure 3-3 Prevailing Wind Path

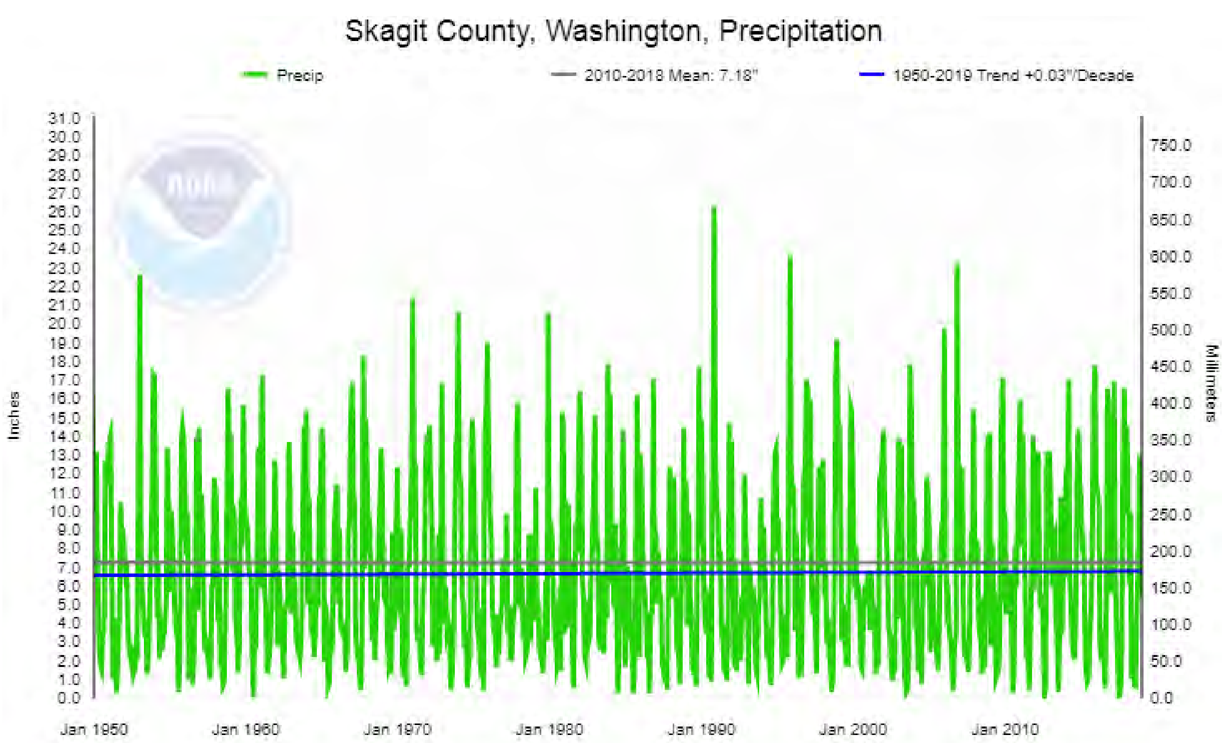

Figure 3-4 Skagit County Historic Precipitation

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 1951 until December 31, 2018, 18 federal disaster declarations have affected Skagit County, as listed in Table 3-1 (FEMA, 2012b). Review of these events helps identify targets for risk reduction and ways to increase a community's capability to avoid large-scale events in the future. Still, many natural hazard events do not trigger federal disaster declaration protocol but have significant impacts on their communities. These events are also important to consider in establishing recurrence intervals for hazards of concern.

There have been no disaster declarations since completion of the 2015 plan within Skagit County.

Table 3-1
Skagit County Disaster History 1970-2018

Disaster Number	Declaration Date	Incident Type	Title	Incident Begin Date	Incident End Date
1963	3/25/2011	Severe Storm	Severe Winter Storm, Flooding, Landslides, And Mudslides	1/11/2011	1/21/2011
1825	3/2/2009	Severe Storm	Severe Winter Storm And Record And Near Record Snow	12/12/2008	1/5/2009
1817	1/30/2009	Flood	Severe Winter Storm, Landslides, Mudslides, And Flooding	1/6/2009	1/16/2009

Table 3-1
Skagit County Disaster History 1970-2018

Disaster Number	Declaration Date	Incident Type	Title	Incident Begin Date	Incident End Date
1734	12/8/2007	Severe Storm	Severe Storms, Flooding, Landslides, And Mudslides	12/1/2007	12/17/2007
1682	2/14/2007	Severe Storm	Severe Winter Storm, Landslides, And Mudslides	12/14/2006	12/15/2006
1671	12/12/2006	Severe Storm	Severe Storms, Flooding, Landslides, And Mudslides	11/2/2006	11/11/2006
3227	9/7/2005	Coastal Storm	Hurricane Katrina Evacuation	8/29/2005	10/1/2005
1499	11/7/2003	Severe Storm	Severe Storms And Flooding	10/15/2003	10/23/2003
1361	3/1/2001	Earthquake	Earthquake	2/28/2001	3/16/2001
1159	1/17/1997	Severe Storm	Severe Winter Storms, Land & Muds Slides, Flooding	12/26/1996	2/10/1997
1100	2/9/1996	Flood	High Winds, Severe Storms And Flooding	1/26/1996	2/23/1996
1079	1/3/1996	Severe Storm	Severe Storms, High Wind, And Flooding	11/7/1995	12/18/1995
896	3/8/1991	Flood	Severe Storms & High Tides	12/20/1990	12/31/1990
883	11/26/1990	Flood	Severe Storms & Flooding	11/9/1990	12/20/1990
623	5/21/1980	Volcano	Volcanic Eruption, Mt. St. Helens	5/21/1980	5/21/1980
612	12/31/1979	Flood	Storms, High Tides, Mudslides & Flooding	12/31/1979	12/31/1979
492	12/13/1975	Flood	Severe Storms & Flooding	12/13/1975	12/13/1975
300	2/9/1971	Flood	Heavy Rains, Melting Snows & Flooding	2/9/1971	2/9/1971
Significant Events Not Rising to Disaster Declaration					
NA	5/23/13	Non-Natural	Skagit River Bridge Collapse		
FM-5109	8/2015	Fire (Lightening Strike)	Goodell Fire		

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. Loss of a critical facility could also result in a severe economic or catastrophic impact. These facilities 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.

Under the Skagit County hazard mitigation plan definition, the Steering Committee utilized the below as its definition of critical facilities for the 2020 update. It should be noted that the Skagit County Department of Emergency Management had attempted to develop an updated critical facilities listing prior to initiation of this project, having worked with the local jurisdictions to capture the information. As such, consultant assisted in the process by working with the local municipalities and planning partners by providing an initial list extracted from Hazus and other County datasets to serve as a starting point for those entities who had not yet begun the process of completing their list. However, the data did not include all of the information necessary to complete a Comprehensive Data Management System (CDMS) update for the Hazus program due to the level of information (attributes) necessary for each structure. Several avenues were attempted to capture the information, including the potential of the Assessor's database and the most current FEMA Risk Report, but the data was not available for use. The potential of going back to the planning partners to attempt to gain the additional information was discussed, but the Steering Committee determined that to do so would place an unfair burden on the planning team as a whole. In addition, while the outputs from Hazus would have provided some limited additional information, there are no new data sets available with respect to flood maps or Shakemaps for Skagit County which have changed from the last edition of the plan in 2015, during which time FEMA completed Hazus runs for the County. Therefore, the Steering Committee determined the most practical course of action would be to utilize the critical facilities list for GIS exposure analysis, and identify the expansion of the data to include those attributes necessary to perform a CDMS update in the Hazus program as a strategy to be completed over the five-year life cycle of this plan by either capturing the data ultimately through the Assessor's data, or by capturing the information from the planning team members. Once completed, the data will then be utilized to further expand the risk assessment during the next update cycle in 2025. As previously mentioned, the Tribal planning partners involved in this update elected to not provide additional critical facilities data due to the sensitive nature of the data. Therefore, in an effort to meet FEMA guidance for plan development, the election was made to utilize data from the previous plan, supplemented by information contained within the various FEMA reports utilized through this update; however, such FEMA reports do not clearly define how such Tribal data was captured. It should therefore be noted that the structure data identified is limited in scope, while still meeting the plan requirements for plan approval. The data as illustrated should be used only to identify potential areas of impact rather than structure loss data, as the loss data does not accurately reflect the number of structures or potential losses associated with the hazards of concern. Readers wishing additional impact data for the specific tribes should contact the tribe directly.

The following represents the 2020 critical facilities definition:

- Police stations, fire stations, vehicle and equipment storage facilities, communication centers and towers (9-1-1), and emergency operations centers needed for disaster response before, during, and after hazard events.

- Public and private utilities and infrastructure vital to maintaining or restoring normal services to areas damaged by hazard events. These include, but are not limited to:
  - Public and private water supply infrastructure, water and wastewater treatment facilities and infrastructure, potable water pumping, flow regulation, distribution and storage facilities and infrastructure. This does not include lines, piping, or individual wells.
  - Public and private power generation (electrical and non-electrical), regulation and distribution facilities and infrastructure (no lines or poles).
  - Data and server communication facilities.
  - Airports, marine and rail terminal facilities.
- Educational facilities, including K-12 public schools.
- Hospitals, nursing homes (not in-home care facilities), 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 or feeding centers (or major suppliers) during large-scale disasters, including those with which the County and/or its municipalities have MOU's or MOA's for use during disaster incidents.
- Governmental facilities central to governance and quality of life along with response and recovery actions taken as a result of a hazard event, including primary administration buildings.

While all critical facilities identified are incorporated into this planning process, due to the sensitivity of this information, a detailed list of facilities is not provided. The list is on file with each planning partner.

Figure 3-5 illustrates the location of critical facilities and infrastructure in the planning area. Table 3-2 and Table 3-3 provide summaries of the general types of critical facilities and infrastructure. These tables indicate the location of critical facilities and infrastructure, not jurisdictional ownership. All critical facilities/infrastructure were analyzed outside of Hazus to help rank risk and identify mitigation actions. The risk assessment for each hazard qualitatively discusses critical facilities with regard to that hazard.

3.4.2 Comprehensive Data Management System Update

This process did not include an update of the database contained in FEMA's Hazus software (a hazard-modeling program) due, in part, to the reasons stated above. In addition, the general building stock could not be updated via the customary process of utilizing the Assessor's database due to issues with the point source of location data being skewed. A remedy for this issue is identified as a potential strategy, for which the County may attempt to seek grant funding. A user defined approach was utilized for the critical facilities data developed during this update process, with exposure analysis.

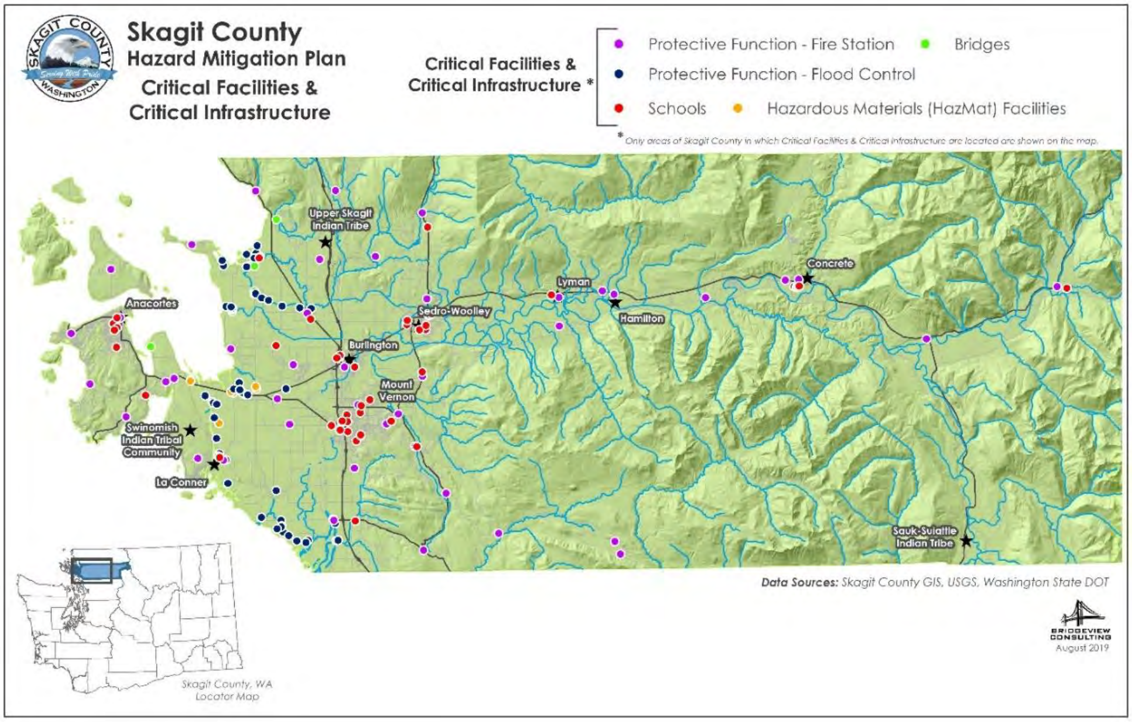

Figure 3-5 Planning Area Critical Facilities and Infrastructure

Table 3-2
Countywide Critical Facilities

Jurisdiction	Medical and Health	Government Functions	Protective Functions	Schools	Hazmat*	**Other Critical Functions	Total
Anacortes, City of	1	3	9	5	19	3	40
Burlington, City of	1	12	5	5	18	0	41
Concrete Town of	0	6	3	7	2	2	20
Hamilton, Town of	0	3	5	0	3	0	11
La Conner, Town of	0	2	1	3	2	0	8
Lyman, Town of	0	4	1	1	1	0	7
Mount Vernon, City of	3	12	16	16	19	0	66
Sedro-Woolley, City of	1	6	6	11	13	0	37
Sauk-Suiattle Tribe	0	0	2	0	5	0	7
Swinomish Indian Tribal Community	1	1	1	1	0	1	5
Unincorporated Skagit County	0	10	98	9	60	1	178
Total	7	59	147	58	142	7	420

**HazMat includes critical facilities categorized as HazMat by Planning Partners and WA-DOE Tier II HazMat Facilities*
***Other Critical Functions include levees and flood prevention mechanisms identified by diking and drainage districts*

Table 3-3
Countywide Critical Infrastructure

Jurisdiction	Bridges	Water Supply	Waste-water	Power	Communi-cations	Transpor-tation	Total
Anacortes, City of	0	5	1	0	0	7	13
Burlington, City of	0	1	1	1	0	3	6
Concrete Town of	0	2	6	1	0	1	10
Hamilton, Town of	1	1	0	0	1	0	3
LaConner, Town of	0	1	1	0	0	0	2
Lyman, Town of	0	1	0	0	0	0	1
Mount Vernon, City of	0	5	9	0	2	1	17
Sedro-Woolley, City of	0	0	17	0	2	1	20
Sauk-Suiattle Tribe	1	0	1	0	0	0	2
Swinomish Indian Tribal Community	0	0	0	0	0	0	0
Unincorporated Skagit County	103	38	0	4	1	2	148
Total	105	54	36	6	6	15	222

3.5 WATER SYSTEMS

Throughout Skagit County, the cities are primarily served by public water systems – Skagit PUD and the City of Anacortes. Some of those systems also serve people outside of city limits, such as the Town of La Conner and some of the other communities that purchase water from the PUD or City of Anacortes. The remaining areas of the county are served primarily by small private systems or individual wells. By population, the Skagit PUD and City of Anacortes water systems serve the majority of the population. Washington State and Skagit County's Health Department have oversight and jurisdiction over the healthful delivery and sanitary operation of the public water supply in the County. As a large rural area, Skagit County continually works with the State, PUD, and other stakeholders to ensure that rural landowners are able to utilize their land consistent with rural zoning requirements, while also ensuring adherence to new well requests which may be impacted during minimum instream flow.

3.6 LEVEES AND DIKES

There are 14 Dike, Drainage and Irrigation Districts throughout Skagit County, who collectively through an Interlocal Operating Agreement have formed the Skagit County Drainage and Irrigation District Consortium, LLC. Situated in the Skagit River Basin, this complex system of levees includes 50 miles of nonfederal levees and 39 miles of sea diking. (See Figure 3-6 and Figure 3-7.) The extensive diking of the lower river has allowed the floodplain to be farmed and developed for residential, commercial, and industrial purposes. The existing levees are based on earthen levees built in the 1890s by the original European settlers. Many of these older levees have been raised and strengthened in recent years, but foundation materials make them vulnerable to failure during major floods due to both seepage and internal erosion.[2], [3] The majority of the population and development in the basin is clustered around the Interstate 5 corridor in the lower Basin.

3.7 TRANSPORTATION

Skagit County Ferry Service

In the State of Washington, there are four counties that own and operate their own ferry system. One of the four is Skagit County, which operates a ferry between Anacortes and Guemes Island. The Skagit County ferry operating system equipment and facilities are functionally categorized as: ferry vessel, structures, parking and auto staging facilities, ferry service, and ferry operations. Most of the operating system facilities were built in the 1979-1980 time period to accommodate the M/V Guemes. The 2014 value of the facilities, and vessel, after depreciation is estimated to be $13,551,771. The replacement costs for these facilities, and the vessel, is estimated to be $25,236,678 in 2015 dollars.

The current ferry, the M/V Guemes, was built in 1979 and has served Skagit County and the residents of Guemes Island for 36 years. The ferry operates seven days a week, 365 days a year between Anacortes and Guemes Island. Skagit County has operated the ferry since the early 1960's when it was purchased from a private operator. The vehicle and passenger ferry, M/V Guemes, is a U.S. Coast Guard inspected vessel and is rated for 3 crew, 99 passengers and 22 vehicles. Vessel characteristics are listed in Exhibit 14. The M/V Guemes requires three crew members to staff each regularly scheduled crossing of Guemes Channel; a Captain and two Deckhands. A round-trip crossing of the three-quarter-mile channel normally takes 20-25 minutes.

Ferry System Structures and Parking - The ferry system structures include docks, transfer spans and machinery, dolphins, wingwalls, and terminal buildings on both sides of Guemes Channel. The County also owns and maintains three parking lots and loading approach facilities.

The current dock facilities were built in 1980 when the M/V Guemes was put into service. The bridge mechanical, electrical, and hydraulic systems have been well maintained over the years keeping the bridges operational. However, the mechanical and electrical systems were upgraded in 2014.

The dock structures had minimal maintenance until 2010; as a result, they were in need of major work. In 2010, the two remaining creosote dolphins at the Guemes Island landing were replaced with steel pilings. In the same year, the wing walls at the Anacortes and Guemes Island landings were replaced. A dock rehabilitation project took place in the spring of 2011. This project included the replacement of girders on the approach spans on both the Anacortes and Guemes Island ferry docks. The remaining five creosote dolphins at the Anacortes landing were replaced with steel pilings in 2014. Skagit County also replaced creosote sections of the Anacortes breakwater in 2016.

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[2] Go Skagit.com Levee repairs on track. 2018. Available at: https://www.goskagit.com/skagit/levee-repairs-on-track/article_cab49b7a-f760-590b-8c1b-8f357c697635.html
[3] USACE Skagit River Flood Risk Management General Investigation. https://www.skagitcounty.net/PublicWorksSalmonRestoration/Documents/SkagitGI-Draft-FR-EIS-MAY2014.pdf

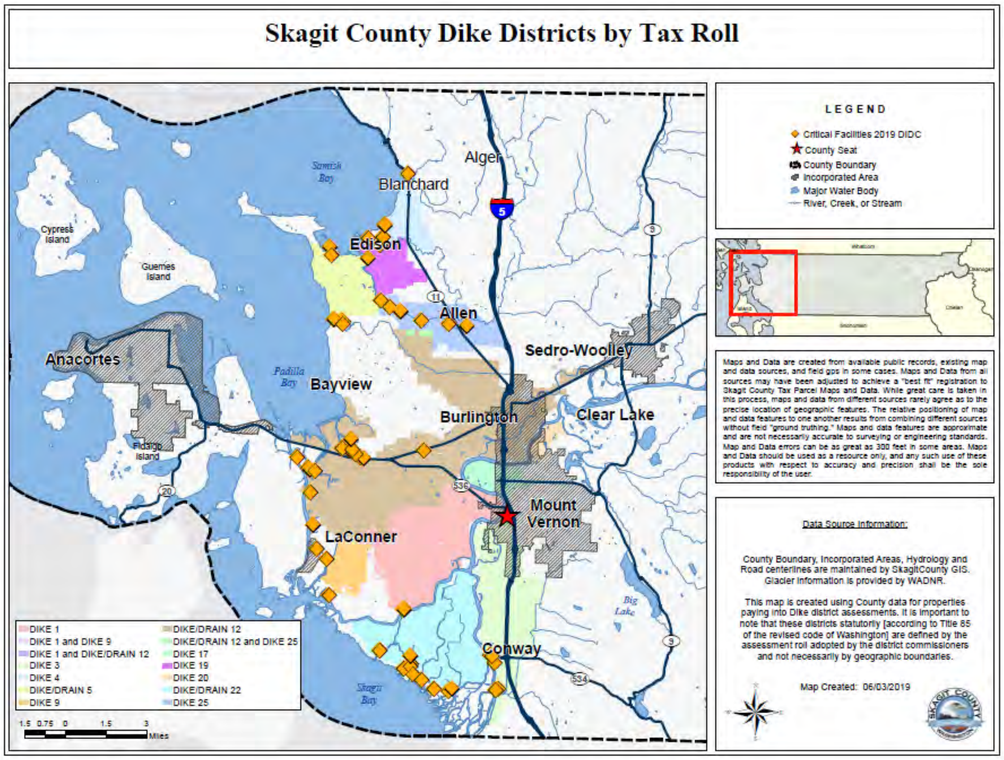


Figure 3-6 Skagit County Dike Districts

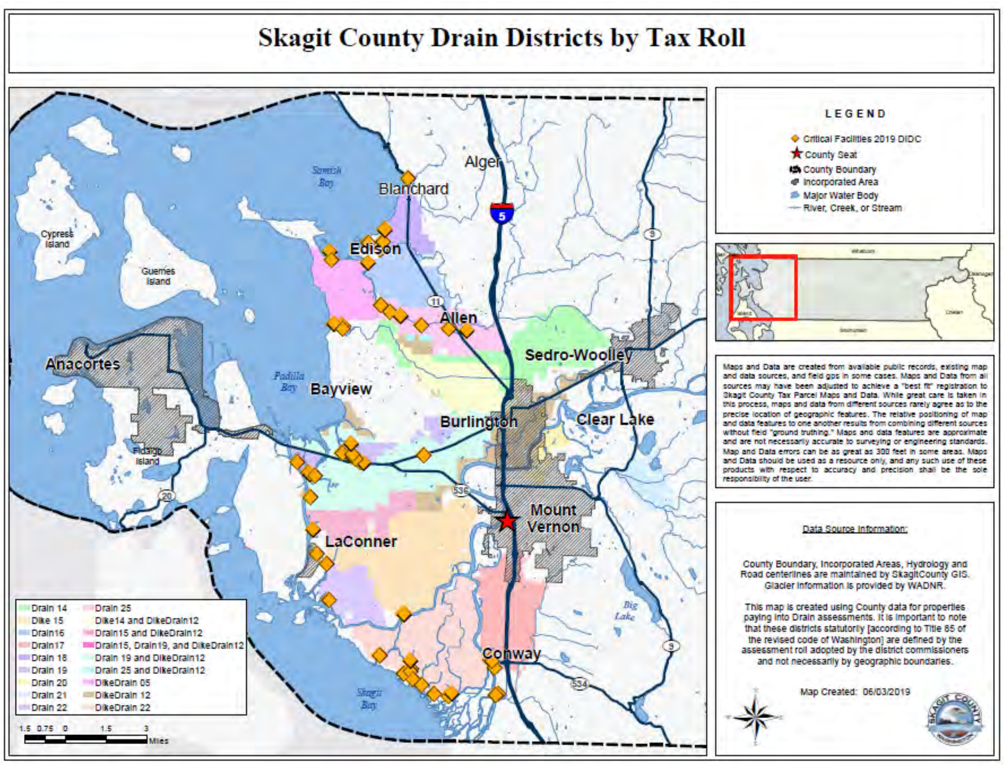


Figure 3-7 Skagit County Drainage Districts

State Ferry Service

The Washington State Department of Transportation (WSDOT) Marine Division provides ferry service to the San Juan Islands and to Vancouver Island in British Columbia (Sidney, B.C.) through its terminal facility in Anacortes. In addition to this service being the transportation lifeline for the residents of the San Juan Islands, it also serves the needs of vacationers and recreational visitors to the area. Historic data illustrates that in 2014, Washington State ferry service from Anacortes accommodated 2,023,281 total riders, including 941,812 vehicle and drivers and 1,091,469 passengers (both vehicle passengers and foot passengers). Of the total riders, 1,911,264 were traveling to and from destinations in the San Juan Islands and the remaining 122,017 were traveling to and from Sidney, British Columbia. On an average about 5,545 riders use the system daily, with about 2,500 being vehicle and drivers and about 3,000 passengers. Historic data further shows that August is the month with the highest ridership while January is usually the month with the lowest. August ridership is generally about triple that in January.

Bridges

Skagit County's bridges are in reasonably good condition. There are some structural deficiencies on a few bridges in the County handling heavy loads. While a number of the bridges are considered functionally obsolete by state and federal standards for bridge reconstruction, none meet the level of service problems, based on vehicle traffic congestion measures in place (Skagit County HMP, 2015).

The County did experience a bridge collapse in 2013 involving a portion of the I-5 bridge near Mount Vernon, but the collapse was due to a vehicle striking the bridge, and not the bridge itself being defective (see Figure 3-8 and Figure 3-9).

The Washington State Department of Transportation filed a $17 million lawsuit to attempt to recover the costs associated with the bridge loss. According to the Seattle Times, the National Transportation Safety Board said that insufficient route planning, a distracted pilot driver and an inadequate permitting process by the state of Washington all played a part in the accident.[4]

Figure 3-8 Skagit County Bridge Collapse

[4] http://blogs.seattletimes.com/today/2015/02/state-dot-files-17-million-lawsuit-for-skagit-river-bridge-collapse/

Figure 3-9 Extended View of Skagit County Bridge Collapse

Roads

I-5 is the central north/south link in Skagit County, with SR-9, SR-11 (Chuckanut Drive) and SR-530 (Rockport to Snohomish County) also providing north/south connections. In the east/west direction, SR-20 is the central link crossing through six of the eight cities and towns of Skagit County. Other east/west highways making shorter connections are SR-536 (Memorial Highway), SR-538 (College Way), and SR-534 connecting Conway and Lake McMurray. While the state and federal highway system provides a basic structure for the surface transportation system in Skagit County, it is the extensive nature of the county road system itself that fills out the overall interconnecting Countywide network. Skagit County maintains an inventory of ~800 miles of public roads in the County, with approximately 108 miles classified as urban.

Heritage Corridors Program

Scenic and Recreational Highways were originally designated in the State of Washington in 1967 in response to a desire for the removal of billboards along State highways. In 1991 new formal designation criteria were developed, and in 1993 the Scenic Highway designation list was updated. There were two highway links in Skagit County on the original list. They are: 1) SR-20 in the eastern part of the County from about three miles east of Sedro- Woolley to the eastern County line, and 2) SR-20 on Fidalgo Island from Sharpe's Corner to Deception Pass. The 1993 additions to the list include: the remainder of SR-20 from Sharpe's Corner to east of Sedro-Woolley; the entire length of SR-9; and Chuckanut Dr/SR-11 from I-5 to the Whatcom County line.

SR20 is also part of the “Cascade Loop” Scenic and Recreational Highway that includes the Whidbey Island Scenic Byway, the North Cascades Scenic Highway, and the Stevens Pass Greenway National Scenic Byway. I-5 in Skagit County was also recently designated the State’s first and only Agricultural Scenic Corridor.

Marine Shipping

The marine ports in Skagit County function as important intermodal transportation centers as well as important centers for economic and recreational activity. Fifteen commercial piers, wharfs, and docks are located in the Anacortes area along Guemes Channel, along Swinomish Channel, on the west shore of Fidalgo Bay, and at March's Point.

Port of Anacortes Marine Terminal

The Port of Anacortes marine terminal facilities and services include a natural deep-water port with two piers and a wharf. Currently a port tenant, Dakota Creek Industries, Inc. operates a major shipbuilding and repair facility and has the primary use of Pier 1. The Curtis Wharf is a working wharf for commercial boats and ships providing periodic moorage for a variety of vessel types including the US Navy, tenants staging project cargoes, and short term project assembly (Port of Skagit, 2015). Pier 2 is used primarily for exporting dry bulk cargoes along with some short term moorage for barges and other vessels.

March's Point

The two petroleum refineries at March's Point, Shell Puget Sound Refinery and Marathon, both have deep water terminals which can accommodate ocean going oil tankers. At this location, crude oil, refined petroleum products, and byproducts from the refinery process are transported in and out by ship, rail, and truck. Pipelines to the refinery facilities provide for the transport of oil products as well. The Marathon refinery employs 360 full time employees and has a crude oil capacity of 120,000 barrels per day (bpd) (Tesoro, 2015). The Shell Refinery processes as much as 145,000 bpd. The shell refinery is one of the area's largest employers and taxpayers in Skagit County (Shell, 2015).

Other Marine Terminal Facilities

Other marine terminal facilities in Skagit County include the Dakota Creek Shipyard; the City of Anacortes's barge dock, boat launch, and boat ramp on Fidalgo Bay; Dunlop Towing's log-rafting facility in Swinomish Village; and the Swinomish Tribe's Industrial District pier at the north end of Swinomish Channel. The Swinomish channel generated $86.2 million in business revenue during 2013 according to a 2014 Economic Study by the Port of Skagit. The channel also directly supports 499 jobs with an income of $21 million while the combined activity on the channel generates 1,048 jobs with a total income of $49.4 million (Port of Skagit, 2014).

Marinas & Boat Harbors

There are 14 marinas and boat harbors in Skagit County. The City of Anacortes is the location for three of the five largest. The La Conner area is the location of the other two.

Airports

There are three municipal airports in Skagit County, the Anacortes Airport, the Skagit Regional Airport, and the Concrete Airport.

Skagit Regional Airport

The Skagit Regional Airport is operated by the Port of Skagit County and is adjacent to the Bayview Business & Industrial Park west of Burlington. The airport is used for general aviation and has runways of 5,475 feet and 3,000 feet in length which can accommodate all aircraft with 30 passenger capacity or less.

Anacortes Airport

The Anacortes Airport is a general aviation airport operated by the Port of Anacortes with a 3,018-foot runway serving Bellingham and the San Juan Islands. Numerous charter flights originate from the airport serving SeaTac Airport and Boeing Field (business travelers), and the San Juan Islands (tourist travelers). The airport has 39 covered hangars and 62 open tie-downs for private and recreational craft.

Concrete Airport

The Concrete Airport, known as "Mears Field," operates a charter service for business and tourist travel, and provides a general aviation facility for the eastern part of Skagit County. The runway is 2,600 feet long.

Multi-modal Center

The City of Mount Vernon built the Skagit Transportation Center in 2004, a multi-modal center in the heart of downtown Mount Vernon to accommodate the needs of rail and bus passengers as well as pedestrians and bicyclists in Skagit County. Amtrak Cascades passenger rail service is accommodated as well as Skagit Transit public transportation and Greyhound bus service to local and regional airports and ferry terminals. The location in downtown Mount Vernon will allow pedestrians and bicyclists easy access to local sidewalks and trails in central Skagit County.

Freight Rail

The Burlington Northern Santa Fe (BNSF) Railroad is the one major railroad that serves Skagit County. It is an international company with a vast network of tracks in the Midwest and Western United States. It also owns a huge fleet of rolling stock to serve its customers. In Skagit County, it has one mainline, two branch lines, and numerous active spurs in the western part of the County that provides a freight rail service with connectivity regionally, nationally, and internationally. The main switching yards for the BNSF Railroad in Skagit County are located in Burlington. The north/south BNSF mainline generally runs along the I-5 corridor connecting the urban centers of Seattle and Vancouver, British Columbia. The segment from Burlington to Everett is designated as an R1 freight railway, which carry the highest volumes of freight. From the Snohomish County line, it runs north along Pioneer Highway to Conway. From there it runs more or less parallel to I-5 all the way to Cook Road then veers northwest to eventually parallel SR -11 (Chuckanut Drive) all the way to the Whatcom County line. An east/west branch follows along SR20 connecting the March's Point refineries to the mainline in Burlington. A second branch line runs along SR-20 from Burlington to Sedro-Woolley, then turns north and eventually parallels SR9 to the Whatcom County line. That branch line eventually crosses the Canadian border at Sumas. The location of the Burlington Northern Santa Fe Railroad tracks is shown in Figure 3-10.

Figure 3-10 Rail Corridor

Source: WSDOT, 2013

Passenger Rail

In 1993 the rail corridor from Eugene Oregon to Vancouver, British Columbia was selected by the federal government as one of several high priority passenger rail corridors eligible for funding for upgrades. In response to this designation, the State of Washington (in conjunction with the then Burlington Northern Railroad) committed substantial funding to make track improvements in order to accommodate the reestablishment of Amtrak passenger rail service between Seattle and Vancouver. The Burlington/Mount Vernon area was selected for the future location of a new passenger terminal. The new multimodal transportation center opened in 2004.

3.8 POPULATION

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

Knowledge of the composition of the population, how it has or may change in the future is needed for 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 April 1, 2018, Skagit County had a population of 126,520 residents. Table 3-4 presents County population data as established by the Washington State Office of Financial Management (OFM).[5]

Table 3-4
2018 Population, Housing, Units and Mobile Homes

Geographic area	Population*	Housing units**
Unincorporated Skagit County	51,540	23,396
Anacortes, City of	16,990	8,125
Burlington, City of	9,025	3,613
Concrete Town of	740	367
Hamilton, Town of	300	139
LaConner, Town of	940	550
Lyman, Town of	455	179
Mount Vernon, City of	35,180	13,078
Sedro-Woolley, City of	11,350	4,527
Total	**126,520**	**53,974**

*2018 Washington State Office of Financial Management Data
**2017 Skagit Council of Governments
*** April 1 2017 Land Area and Population Estimates – Skagit Council of Governments
https://www.scog.net/Demographics/SkagitCountyDemographicProfile-2017.pdf

[5] Office of Financial Management http://www.ofm.wa.gov/pop/april1/

For all other demographic data, the U.S. Census Bureau data was utilized; however, it should be noted that variations in population totals between OFM and U.S. Census data does exist as it does not adjust as frequently as OFM data. For planning purposes, however, the Census data provides greater variations of relevant data which has been utilized throughout this document. As such, numerical values may not coincide.

3.8.1 Population Trends

Population changes are useful socio-economic indicators. A growing population generally indicates a growing economy, while a decreasing population signifies economic decline. Population from the 2000 Census data for Skagit County was 116,893. Population for 2018 (estimates) for Skagit County are projected to be 126,520, an increase between 2010 to 2018 of 9.7 percent. Table 3-5 illustrates the population trends from 2010-2018.

Table 3-5
Countywide Population Changes by Jurisdiction 2010-2018

City or Town	2010	2011	2012	2013	2014	2015	2016	2017	2018
Unincorporated Skagit County	48,112	48,255	48,345	48,411	48,720	49,220	49,860	50,875	51,540
Incorporated Skagit County	68,789	69,145	69,605	70,189	70,780	71,400	72,410	73,225	74,980
Anacortes	15,778	15,860	15,960	16,080	16,190	16,310	16,580	16,780	16,990
Burlington	8,388	8,420	8,435	8,445	8,445	8,485	8,675	8,715	9,025
Concrete	710	710	715	710	720	730	735	740	740
Hamilton	301	300	300	304	305	305	305	300	300
La Conner	891	885	895	890	895	895	905	925	940
Lyman	438	440	440	440	445	445	450	455	455
Mount Vernon	31,743	31,940	32,250	32,710	33,170	33,530	33,730	34,360	35,180
Sedro-Woolley	10,540	10,590	10,610	10,610	10,610	10,700	11,030	10,950	11,350
TOTAL	116,901	117,400	117,950	118,600	119,500	120,620	122,270	124,100	126,520

Source: http://www.ofm.wa.gov/pop/april1/poptrends.pdf

The Office of Financial Management updates county and state long-range population forecasts every five years to support Growth Management Act planning. The most recent forecasts, which project out to 2040, were issued in May 2012 and are shown in Table 3-6. 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.

Since 2010, Skagit County population growth has increased by 7.41 percent. Current population in the county is in par with OFM projected levels for increase (see Figure 3-11).

Table 3-6
County and State Population Projections

	Census	Projections					
	2010	2015	2020	2025	2030	2035	2040
Washington	6,724,540	7,022,200	7,411,977	7,793,173	8,154,193	8,483,628	8,790,981
Adams	18,728	20,257	21,640	22,964	24,289	25,690	27,205
Asotin	21,623	21,818	22,033	22,196	22,313	22,358	22,356
Benton	175,177	184,882	197,806	210,803	223,689	236,007	247,856
Chelan	72,453	75,180	78,586	81,885	84,778	87,168	89,246
Clallam	71,404	71,868	73,616	75,022	76,112	76,786	77,224
Clark	425,363	447,201	477,884	508,124	536,717	562,207	585,137
Columbia	4,078	4,047	4,013	3,968	3,895	3,800	3,700
Cowlitz	102,410	105,130	108,588	111,706	114,158	115,798	116,897
Douglas	38,431	40,603	43,619	46,662	49,583	52,256	54,762
Ferry	7,551	7,619	7,706	7,751	7,754	7,740	7,692
Franklin	78,163	87,755	100,926	115,142	130,284	146,103	162,900
Garfield	2,266	2,238	2,220	2,210	2,202	2,175	2,143
Grant	89,120	95,822	104,078	112,525	121,204	129,779	138,337
Grays Harbor	72,797	73,575	74,408	75,529	76,428	76,905	77,070
Island	78,506	80,337	82,735	85,073	87,621	90,239	93,205
Jefferson	29,872	30,469	32,017	33,678	35,657	37,914	40,093
King	1,931,249	2,012,782	2,108,814	2,196,202	2,277,160	2,350,576	2,418,850
Kitsap	251,133	262,032	275,546	289,265	301,642	311,737	320,475
Kittitas	40,915	42,592	45,255	47,949	50,567	53,032	55,436
Klickitat	20,318	20,606	20,943	21,225	21,430	21,492	21,439
Lewis	75,455	77,621	80,385	82,924	85,165	87,092	88,967
Lincoln	10,570	10,616	10,707	10,800	10,865	10,862	10,817
Mason	60,699	63,203	67,545	71,929	76,401	80,784	84,919
Okanogan	41,120	42,230	43,163	43,978	44,619	45,127	45,707
Pacific	20,920	20,860	20,990	21,261	21,495	21,736	22,042
Pend Oreille	13,001	13,289	13,692	13,977	14,129	14,149	14,116
Pierce	795,225	831,944	876,565	923,912	967,601	1,006,614	1,042,341
San Juan	15,769	15,907	16,256	16,606	16,939	17,216	17,443
Skagit	116,901	121,624	128,249	136,410	144,953	153,632	162,738
Skamania	11,066	11,282	11,548	12,014	12,447	12,816	13,082
Snohomish	713,335	750,358	805,015	857,939	908,807	955,281	997,634
Spokane	471,221	489,491	513,910	537,428	558,614	576,763	592,969
Stevens	43,531	44,262	45,212	46,447	47,834	49,340	50,929
Thurston	252,264	266,224	288,265	307,930	326,426	343,019	358,031
Wahkiakum	3,978	3,931	3,877	3,830	3,772	3,716	3,669
Walla Walla	58,781	60,015	61,685	63,368	64,978	66,378	67,655
Whatcom	201,140	210,050	225,307	241,138	256,643	271,142	284,901
Whitman	44,776	46,139	47,826	49,346	50,577	51,563	52,504
Yakima	243,231	256,341	269,347	282,057	294,445	306,636	318,494

Note: OFM Forecasting – May 2012 Differences in 2010 figures compared to other tables due to Census corrections. Data may not add due to rounding; unrounded figures are not meant to imply precision.

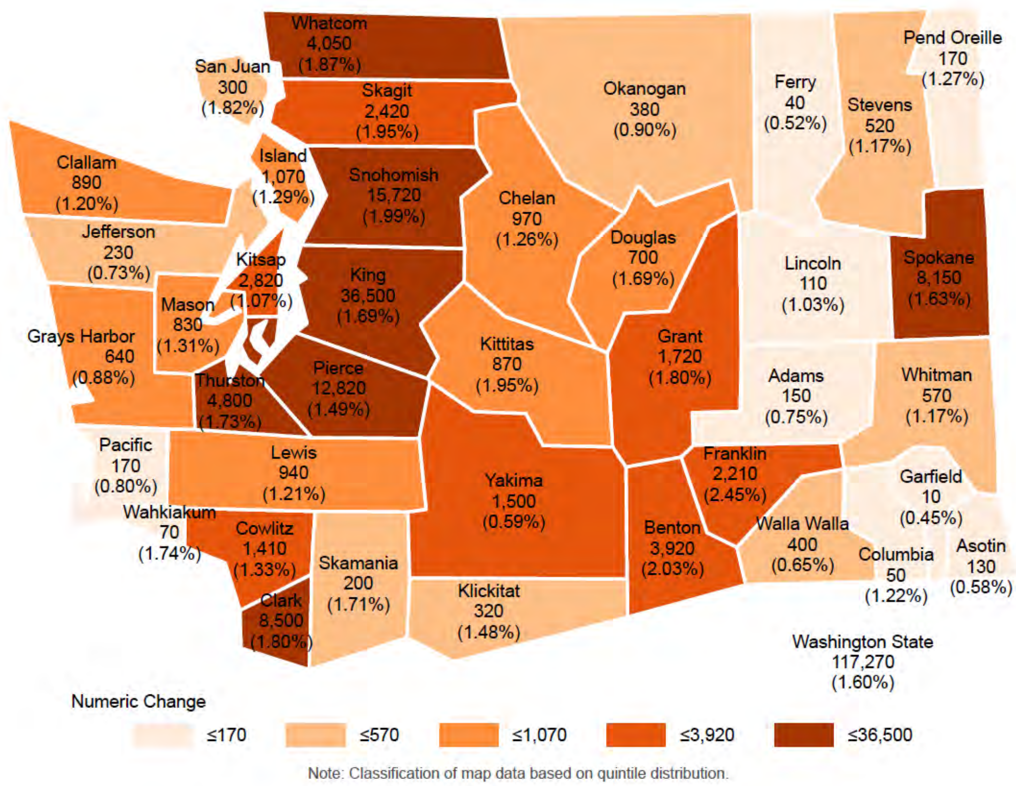
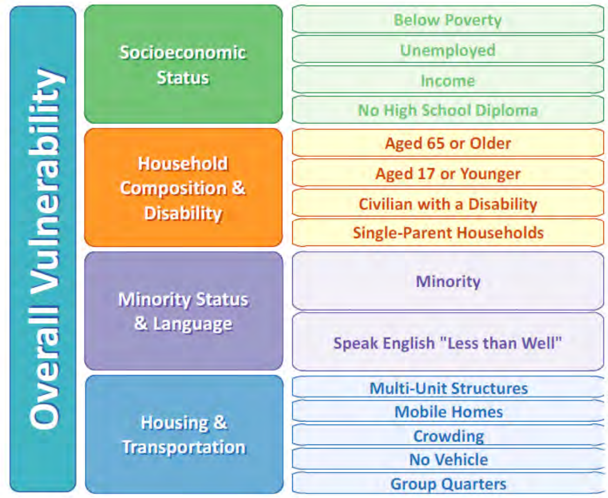


Figure 3-11 Statewide Distribution of Population Change by County

Source: Office of Financial Management
https://www.ofm.wa.gov/sites/default/files/public/dataresearch/pop/april1/ofm_april1_poptrends.pdf

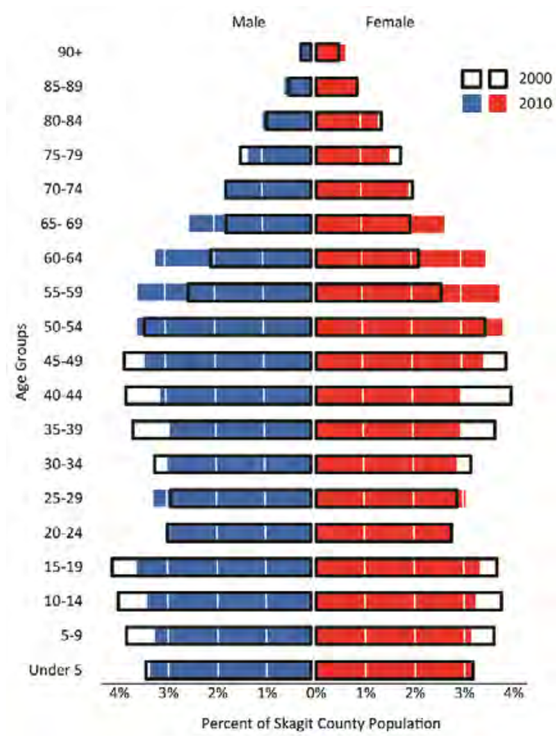
3.8.2 Social Vulnerability

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



During emergencies, real-time evacuation information may not be provided to people with limited English proficiency, the hearing and visually impaired, and other special needs group. Many low-income people may be stranded because they have no personal transportation, and no mass transit (especially during emergencies) is available. For the poor, they are less likely to have the income, or assets needed to prepare for a possible disaster, or to recover after a disaster. Although the monetary value of their property may be less than that of other households, it likely represents a larger portion of the total household assets. As such, lost property is proportionately more expensive to replace, especially without insurance. Additionally, unemployed persons do not have employee benefits that provide health cost assistance. High-income populations who suffer higher household losses (absolute terms) find their overall position mitigated by insurance policies and other financial investments not available to lower income households.

3.8.3 Age Distribution



As a group, the elderly is more apt to lack the physical and economic resources necessary for response to hazard events and 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 require extra notice to implement evacuation.

Elderly residents 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.

The Skagit Council of Government annually prepares reports and information which identify population trends within the County of varying types.[6] Based on the 2017 report (most currently available as of the 2019 writing of this update), population age groups "have been shifting in Skagit County, showing an aging population."

[6] https://www.scog.net/Demographics/SkagitCountyDemographicProfile-2017.pdf

The share of 30–49 year old residents has decreased from 2000–2010 with a corresponding rise in the share of 50–69 year old residents. These demographic shifts are similar to what is occurring in communities around the United States. Along with the aging of population at or near retirement age, there is also a reduction in the share of persons under 20 years old in the 2000–2010 timeframe.

Children under 5 are particularly vulnerable to disasters because of their dependence on others for basic necessities. Very young children are additionally 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. The U.S. Census QuickFacts identifies 6.0 percent of the County's population under the age of 5 years, which is 0.2 percent lower than the statewide average of 6.2 percent.

3.8.4 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 2016 U.S. Census Bureau's QuickFacts, racial makeup of the county is: 90.5 percent white; 2.7 percent American Indian; 2.3 percent Asian; 1.1 percent black or African American; 0.3 percent Pacific Islander; and 3.1 percent two or more races. Those of Hispanic or Latino origin made up 18.3 percent of the population. The County also had a Veteran population base during the time period of 2011-2017 of 10,533.[7] Census data also indicates that 16.7 percent of the Skagit County population spoke a language other than English at home.

3.8.5 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, ethnicity, and those medically dependent on electricity, all of which mean that housing is more likely to be substandard.

Census data identifies 10.5 percent of Skagit County's population under age 65 living with a disability during the time period 2013-2017. This represents a higher rate than statewide, which is 9 percent for the same time period. In addition, Skagit Council of Governments has identified poverty rates for persons with a disability (based on 2015 Census data) at 21.2 percent (see Figure 3-12).

[7] https://www.census.gov/quickfacts/fact/table/skagitcountywashington,wa/PST045218?

		Persons with A Disability or Disabilities					
Total Population		Total Population		Income Below Poverty Level in Past 12 months			
Estimate	Margin of Error (+/-)	Estimate	Margin of Error (+/-)	Estimate	Margin of Error (+/-)	Rate	Margin of Error (+/-)
119,789	808	15,934	1,648	3,375	847	21.2%	5.3%

Source: 2015 American Community Survey 1-year Estimates, Table B18130
Notes: estimates highlighted in red indicate unreliable data. Coefficients of variation for these data were above the rate of 15%. 2011–2015 5-year Estimates, which likely would have produced more reliable data, were not available for Table B18130.

Figure 3-12 Persons with Disability Below Poverty Level

3.8.6 Homeless Population

In emergency planning, the needs of homeless people are usually categorized within the needs of all "special populations." People who are homeless have limited resources to evacuate, stockpile food, store medications, and shelter in place. In addition, people who are homeless have limited access to Internet and television, and are often the last to know about emergencies. Most do not own vehicles for evacuation purposes, and do not know safe locations to which to evacuate. For these reasons, communities often struggle in their approach to prepare homeless people for disasters. While informational leaflets, coupled with personal trainings, have been effective in helping homeless people prepare for disasters, most jurisdictions are unaware of the number of homeless in their community, and even where they are located.

According to the January 2018 Point in Time Count data captured by the Washington State Department of Commerce, Skagit County has a total of 338.[8] Table 3-7 provides additional data from the Commerce Department.

Table 3-7
2018 Countywide Homeless Population Totals

County	Sheltered				Unsheltered				Total
	HH w/ adults & children	HH w/out children	HH w/ only children	Sheltered Total	HH w/ adults & children	HH w/out children	HH w/ only children	Unsheltered Total	
Skagit County	137	73	1	211	18	109	0	127	338
State Totals	5,164	6,400	119	11,683	716	9,737	167	10,620	22,304

HH = Households / Minors = less than 18 / Adults 18+

[8] http://www.commerce.wa.gov/wp-content/uploads/2013/01/hau-pit-county-summary-new-update-2018-online.pdf

3.9 ECONOMY

Knowing the economic characteristics of a community can assist in the analysis of the community's ability to prepare, respond, and rebuild safer after a natural hazard. Categorizing economic vulnerability can encompass many factors, including median household income, poverty rates, employment and unemployment rates, housing tenure, and community building inventory.

Skagit County is home to a diverse agricultural community which is the number one industry in the county. Local farmers produce over $300 million worth of crops, livestock, and dairy products on approximately 100,000 acres of land. Skagit County produces more than 90 different crops, including 95% of the state's red potato crop and is the largest producer of tulip, iris, and daffodil bulbs in the country.

A large portion of Skagit County is comprised of commercial forest under DNR Management or private companies. Although the large lumber mills have mostly vanished from the local landscape, the timber industry in Skagit County still remains a viable and active industry. In order to meet the needs of the fishing industry (as well as recreational boaters) a substantial number of marine suppliers, repair facilities and custom boat builders are located within Skagit County.

As the population of the county has increased over the past 20 years, a greater percentage of the local economy has shifted toward service-based companies, with many shopping malls, motels, and restaurants within the County.

While Skagit County is best known for its agriculture, in 2017, the U.S. Bureau of Economic Analysis estimated that manufacturing was quickly becoming one of the largest contributors to the county's real gross domestic product. Manufacturing accounted for 22.4 percent of total GDP for the Mount Vernon/ Anacortes Metropolitan Statistical Area. Agriculture, forestry, fishing and hunting accounted for 3.4 percent of GDP. Like the national economy, Skagit County's largest job-providing sector is the private service-providing sector, making up about 57 percent of total nonfarm employment in 2017. This share of employment has not changed substantially over the past several years. The county has some heavy industry including oil refineries in Anacortes and a number of manufacturers that support the marine and aerospace industries, food manufacturing and other niche manufacturing businesses that contribute to a fairly well-rounded economy.[9] Government employers supplied about 23 percent of Skagit County jobs in 2017. Most government jobs are local, and many are attributable to local K-12 school districts.

[9] https://esd.wa.gov/labormarketinfo/county-profiles/skagit

Skagit County had an average of 50,100 nonfarm jobs in 2017, up 1,100 or 2.2 percent from the level observed in 2016. Washington state as a whole saw the addition of 77,900 jobs over the year, an increase of 2.4 percent.

Skagit County's manufacturing base is diverse. The three largest manufacturing industries in terms of employment are food manufacturing, machinery manufacturing and wood product manufacturing. Petroleum and coal products manufacturing has also historically been one of the largest employers in the region. Manufacturing is one industry that has played an instrumental role in Skagit County's recovery.

In 2017, job holders in Skagit County's labor market were, as a whole, slightly older than Washington job holders as a whole. Statewide, 22.3 percent of the workforce was age 55 or older, compared with Skagit County where 25.2 percent of the workforce was age 55 or older. Skagit County was also slightly over-represented among young job holders; 12.2 percent of Skagit County job holders were age 14 to 24, compared to 11.6 percent of job holders statewide. This data is consistent with the population of the county, which is aged when compared to other parts of Washington State.

3.9.1 Income and Employment

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.

Economic sustainability is encouraged through employment and job security. The higher the employment rate, the more financial stability is accomplished on an individual level. In addition, a healthy job market brings economic growth to communities. Unemployment rate in Skagit County was averaged at 5.6 in 2018, lower than it was the previous year, but higher than the state average (see Figure 3-13 and Figure 3-14). In 2017, Skagit County averaged 50,664 jobs, with a total payroll of nearly $2.4 billion dollars. The County's median hourly wage was $21.92, lower than the state median of $24.89. The county's 2017 average annual wage was $47,042. According to the U.S. Census Bureau, Skagit County's median household income in 2017 was $62,058, which is below the state's median household income ($68,289), but higher than the national median ($58,633).

In 2017, 11 percent of Skagit County's population was estimated to be living below the official poverty line. The statewide average was 11 percent, while the national average stood at 13.4 percent. The poverty rate for children in Skagit County was 15.8 percent.[10] Figure 3-15 identifies density of citizens living in poverty throughout Skagit County.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	7.5%	7.5%	7.1%	6.6%	6.3%	6.3%	6.1%	6.1%	5.9%	5.8%	6.0%	6.2%
2017	6.9%	6.7%	6.0%	5.4%	5.2%	5.1%	5.1%	5.1%	4.7%	4.6%	5.1%	5.8%
2018	6.3%	6.3%	5.6%	5.1%	4.8%	4.9%	4.8%	4.8%	4.4%	4.7%	5.0%	5.6%
2019	6.3%	6.8%										

Employment and unemployment, not seasonally adjusted
Skagit

	2019	2018	2017
	February	March	March
Civilian Labor Force	61,750	59,169	59,010
Employment	57,548	55,850	55,458
Unemployment	4,202	3,319	3,552
Unemployment Rate	6.8%	5.6%	6.0%

Figure 3-13 Skagit County Unemployment Statistics 2016-2019

Source: https://fortress.wa.gov/esd/employmentdata/reports-publications/regional-reports/labor-area-summaries

[10] https://esd.wa.gov/labormarketinfo/county-profiles/skagit

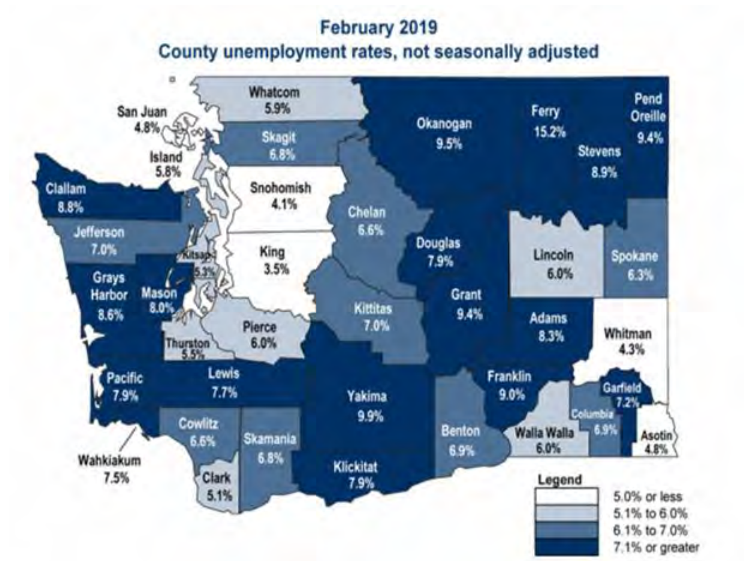


Figure 3-14 Statewide Unemployment Rates February 2019

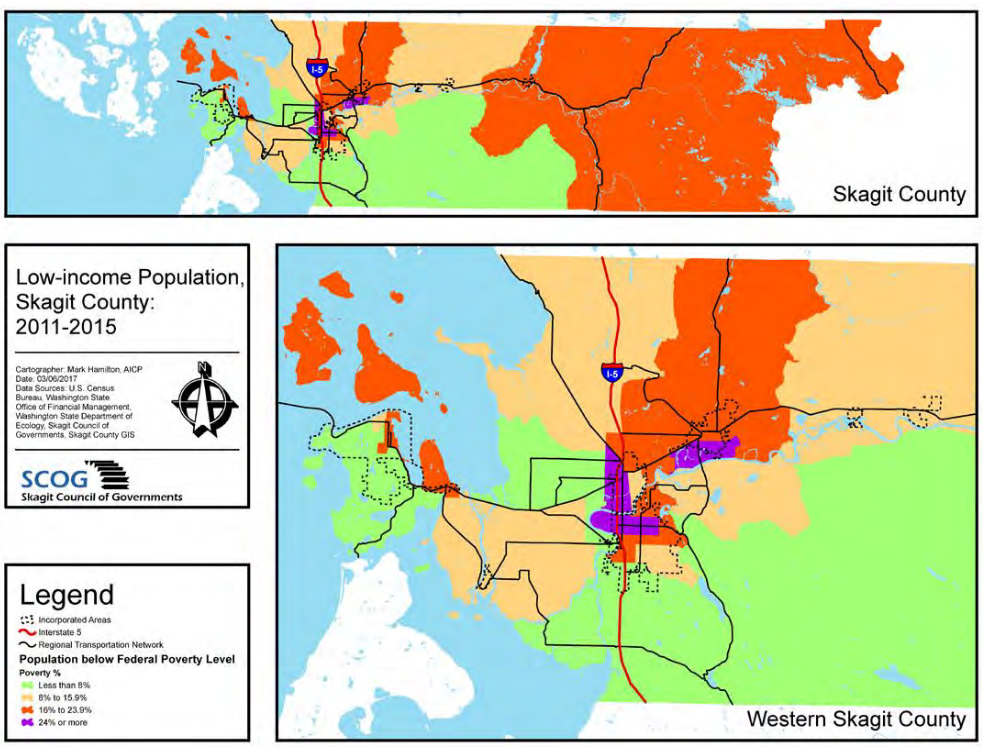


Figure 3-15 Low-Income Population Distribution 2011-2015

Source: Skagit Council of Governments Demographic Profile (2017)

3.10 LAND USE PLANNING AND FUTURE DEVELOPMENT TRENDS

The Skagit County Comprehensive Plan (updated 2019) includes components that help to guide the vision for the County: Planning Policies, Future Land Use Analysis, Critical Areas, and Capital Facilities. Within Washington State, the State Growth Management Act (GMA) requires state and local governments to manage Washington's growth by identifying and protecting critical areas and natural resource lands, designating urban growth areas, preparing comprehensive plans and implementing them through capital investments and development regulations.

Washington's Growth Management Act (GMA) requires that jurisdictions select a population projection to use for planning projections. Section 3.6 details the population projects for Skagit County. 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. Skagit County does fully participate under the GMA. The County has adopted a comprehensive plan that governs its land use decision- and policy-making process in accordance with GMA guidelines. 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 Skagit County.

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. The County recently updated its Critical Area Protection Ordinance in 2019. Information from this mitigation plan will help identify the critical areas throughout the county and its incorporated jurisdictions in future updates as appropriate.

The County's Planning and Development Services Department is responsible for updating the Comprehensive Land Use Plan and for overseeing and regulating land use and development in unincorporated Skagit County to protect the health, safety, and welfare of County residents. The department is also responsible for floodplain management in the County. The Planning and Development Services Department works with other government departments (including emergency management); various agencies and municipalities (including special purpose districts); the general public; land-owners; special interest groups; and businesses to oversee development in unincorporated Skagit County, ensuring land use remains consistent with federal, state and county regulations. Table 3-8 identifies the County's present land use planning distribution by acres. Figure 3-16 illustrates the County's land use distribution and zoning.

Table 3-8
Present Land Use in Planning Area

Present Use Classification	Area (acres)
Commercial	680
Natural Resource Lands	474,004
Open Space	571,915
Rural	80,988
UGA-Zoning	11,230
Urban – City	22,904
Mineral Resources	[61,991]
Total	**1,107,717**

* Acreage figures are based on the best information and technology available. Accuracy may vary depending on the source of the information, changes in political boundaries or hydrological features (water areas removed), or the methodology used to map and calculate a particular land use. Bracketed figures represent an overlay to other land uses and do not contribute to the total acreage.

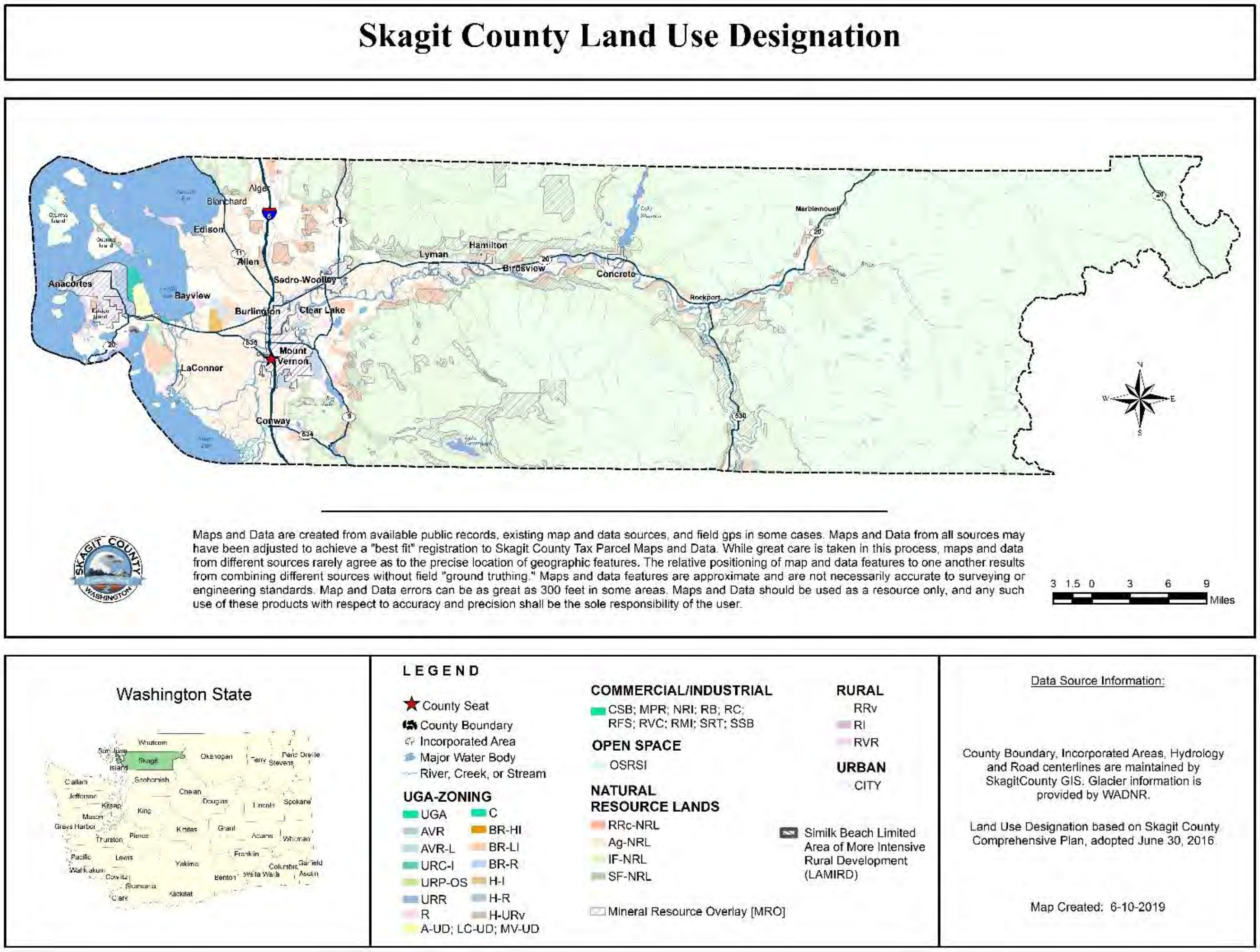


Figure 3-16 Skagit County Land Use and Zoning Map (Skagit County Comprehensive Plan 2019)

Research in the area of growth management has demonstrated that communities experiencing economic growth who are able to invest in new development, including mitigation efforts, increase the resilience of both existing and new buildings and infrastructure. Newly constructed buildings and infrastructure are more resilient to hazards of concern and the associated impact by those hazards (e.g., ground shaking) as they are built to higher building code standards. The use of data within plans such as these play a significant role in education with respect to identifying those areas of concern addressed within Growth Management. According to U.S. Census QuickFacts, a total of 663 building permits were issued within the County in 2017. The U.S. Census Data combined with data from OFM identify annual housing permits issued within Skagit County from 1980-2016 in Figure 3-17.[11] Based on review of that data, 1990 appears to be the year during which most building permits were issued by the County. OFM further identifies that Skagit County ranks 14th out of 21 in the State of Washington for persons per square mile, at 71.68, based on 2017 population.

[11] Source: https://esd.wa.gov/labormarketinfo/county-profiles/skagit#links

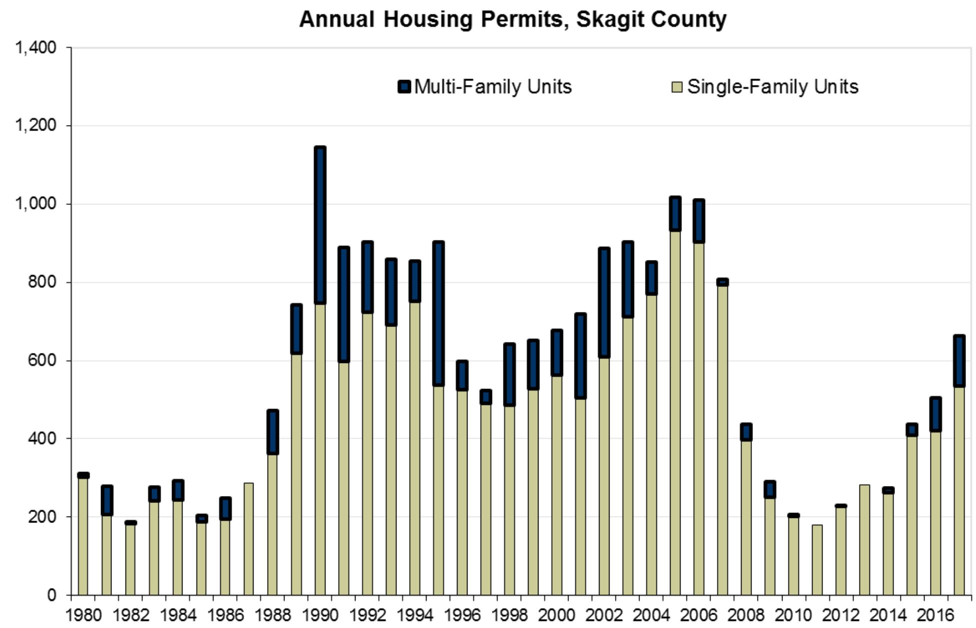


Figure 3-17 Annual Housing Permits Issued 1980-2016

All municipal planning partners will seek to incorporate by reference the Skagit County Multi-Jurisdiction 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. On the next update of its Comprehensive Land Use Plan, this hazard mitigation plan will provide information that will be utilized to support that effort.

Each planning partner's specific annex to this plan (see Volume 2) includes an assessment of regulatory, technical and financial capability to carry out proactive hazard mitigation. Refer to these annexes for a review of regulatory codes and ordinances applicable to each planning partner. In addition, Chapter 14 of this plan provides a general overview of the municipalities' regulatory authority.

3.10.1 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: people in lower income brackets often live in more poorly constructed homes that are especially vulnerable to strong storms or earthquakes. Mobile homes are not designed to withstand severe weather or flooding, and typically do not have basements. They are frequently found outside of metropolitan areas and, therefore, may not be readily accessible by interstate highways or public transportation. Also, because mobile homes are often clustered in communities, their overall vulnerability is increased.

Office of Financial Management's Forecasting Division provides data on Housing Units by Structure Type for Skagit County and its cities. Table 3-9 identifies structure types by jurisdiction.

Table 3-9
Skagit County Housing Units By Structure Type (2018)

Jurisdiction	Total	One Unit	Two or More Units	Mobile Home/Special
Unincorporated Skagit County	23,396	18,001	536	4,859
Anacortes, City of	8,125	6,492	1,450	183
Burlington, City of	3,613	2,093	1,437	83
Concrete Town of	367	263	73	31
Hamilton, Town of	139	97	0	42
LaConner, Town of	550	387	128	35
Lyman, Town of	179	129	3	47
Mount Vernon, City of	13,078	8,684	3,558	836
Sedro-Woolley, City of	4,527	2,961	1,106	460
TOTAL	**53,974**	**39,107**	**8,291**	**6,576**

Source: Office of Financial Management Forecasting Division April 2018.
Data accessible at: https://ofm.wa.gov/washington-data-research/population-demographics/population-estimates/adjusted-2000-population-and-housing-structure-type-and-group-quarters-state-counties-cities-and-towns

3.10.2 Building Stock Age

The age of a building is a significant factor in determining vulnerability as it helps identify the building code to which a structure was built. Homes built prior to 1975 are considered pre-code since there was no statewide requirement to include specific standards to address the various hazards of concern (e.g., there were no seismic provisions contained within the building code). Structures built after 1975 are considered of moderate code. It was at that point in time in which all Washington jurisdictions were required to adhere to the provision of the most recently adopted version of the Uniform Building Code (UBC) (Noson et al., 1988). 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 (and other) standards and have less vulnerability. Issues such as code enforcement and code compliance could impact this assumption. Construction material is also important when determining the potential risk to a structure. However, for planning purposes, establishing this line of demarcation can be an effective tool for estimating vulnerability. In 1994, seismic risk Zone 3 standards of the UBC went into effect in Washington, requiring all new construction to be capable of withstanding the effects of 0.3 g. More recent housing stock is in compliance with Zone 3 standards. In July 2004, the state again upgraded the building code to follow International Building Code Standards. While the "zones" are still referenced, they are, in large part, no longer used in the capacity they once were as there can be different zones within political subdivisions, making it difficult to apply. For instance, within Washington, there are both Seismic Zones 2B and 3.

Hazus identifies key changes in earthquake building codes based on year. Homes built prior to 1941 are considered pre-code; they were constructed before earthquake building codes were put in place. Homes constructed after 1941 are considered moderate code and may include some earthquake building components.

Table 3-10
Timeline of Building Code Standards

Time Period	Code Significance for Identified Time Period
Pre-1974	No standardized earthquake requirements in building codes. Washington State law did not require the issuance of any building permits, or require actual building officials
1975-2003	UBC seismic construction standards were adopted in Washington.
1994-2003	Seismic Risk Zone 3 was established within the Uniform Building Code in 1994, requiring higher standards.
2004-Present	Washington State upgrades its building codes to follow the International Building Code Standard. As upgrades occur, the State continues to adopt said standards.

Data from 2017 U.S. Census data for Skagit County reported the highest percentage of its buildings had been built before 1959 (see Figure 3-18).[12] The median year that a house in Skagit County was built is 1981, which is newer than the median year for a house built in the state of Washington, which is 1980. This is also newer than the median year for a house built in the USA, which is 1976. The period 1990-1990 showed the second highest rate of growth for housing units built within Skagit County. Table 3-11 identifies the percent of homes constructed during the identified time periods.[13,14]

Customarily, within FEMA's Hazus Program, homes built prior to 1941 are considered pre-code; they were constructed before any type of earthquake building codes were put in place. Homes constructed after 1941 are considered moderate code as they may include some earthquake building components.

It should be noted that the data may be slightly skewed due to the fact that actual building code adoption dates may vary slightly by jurisdiction. Also, structures may have undergone remodel, or improvements which changed the building code classification, increasing the level of code applied. That data may not have been captured or applied in a manner which would reflect a change in the year of construction. Additionally, while building codes may not have been in place, houses may have been constructed to higher standards. Therefore, this data should be used for planning purposes only. Questions concerning actual structural integrity should be determined by appropriate subject matter experts in the field.

[12] http://www.usa.com/skagit-county-wa-housing--historical-year-structure-built-data.htm
[13] https://www.towncharts.com/Washington/Housing/Skagit-County-WA-Housing-data.html
[14] https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF

Skagit County	Washington	U.S.
1981	1980	1976

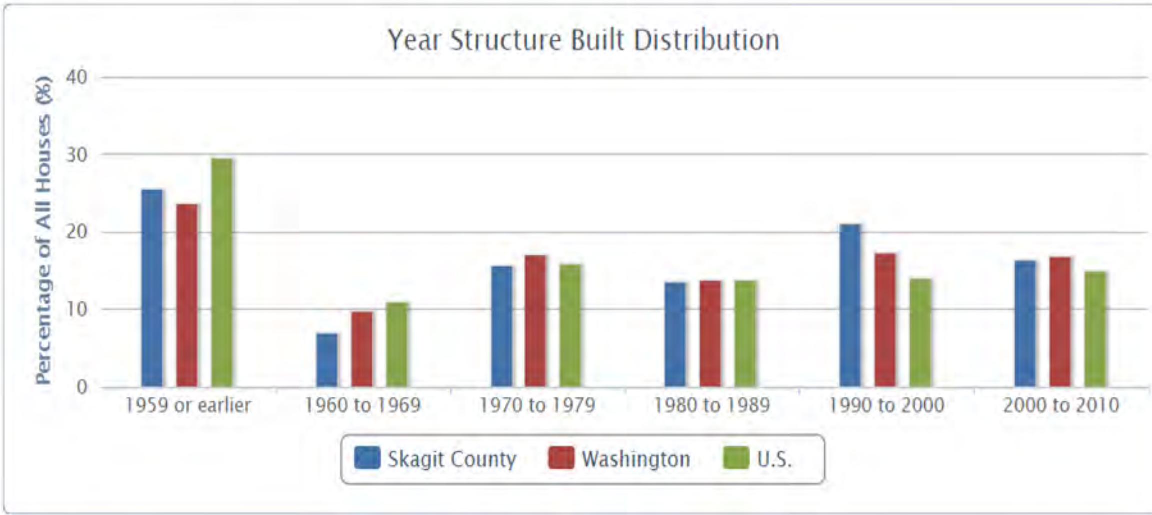


Figure 3-18 Skagit County Year Structures Built

Table 3-11
Skagit County Year / Percent House Built Distribution

YEAR STRUCTURE BUILT		
Total housing units	52,971	52,971
Built 2014 or later	366	0.7%
Built 2010 to 2013	1,209	2.3%
Built 2000 to 2009	8,913	16.8%
Built 1990 to 1999	11,149	21.0%
Built 1980 to 1989	6,933	13.1%
Built 1970 to 1979	7,357	13.9%
Built 1960 to 1969	3,270	6.2%
Built 1950 to 1959	4,054	7.7%
Built 1940 to 1949	2,299	4.3%
Built 1939 or earlier	7,421	14.0%

3.11 CLIMATE CHANGE

3.11.1 What is Climate Change?

Climate, consisting of patterns of temperature, precipitation, humidity, wind, and seasons, plays a fundamental role in shaping natural ecosystems and the human economies and cultures that depend on them. "Climate change" refers to changes over a long period of time. Worldwide, average temperatures have increased more than 1.4ºF over the last 100 years (NRC, 2010). Although this change may seem small, it can lead to large changes in climate and weather.

The warming trend and its related impacts are caused by increasing concentrations of carbon dioxide and other greenhouse gases in the earth's atmosphere. Greenhouse gases are gases that trap heat in the atmosphere, resulting in a warming effect. Carbon dioxide is the most commonly known greenhouse gas; however, methane, nitrous oxide and fluorinated gases also contribute to warming. Emissions of these gases come from a variety of sources, such as the combustion of fossil fuels, agricultural production, and changes in land use. According to the U.S. Environmental Protection Agency (EPA), carbon dioxide concentrations measured about 280 parts per million (ppm) before the industrial era began in the late 1700s and have risen 41 percent since then, reaching 394 ppm in 2012 (see Figure 3-19). The EPA attributes almost all of this increase to human activities (U.S. EPA, 2013f).

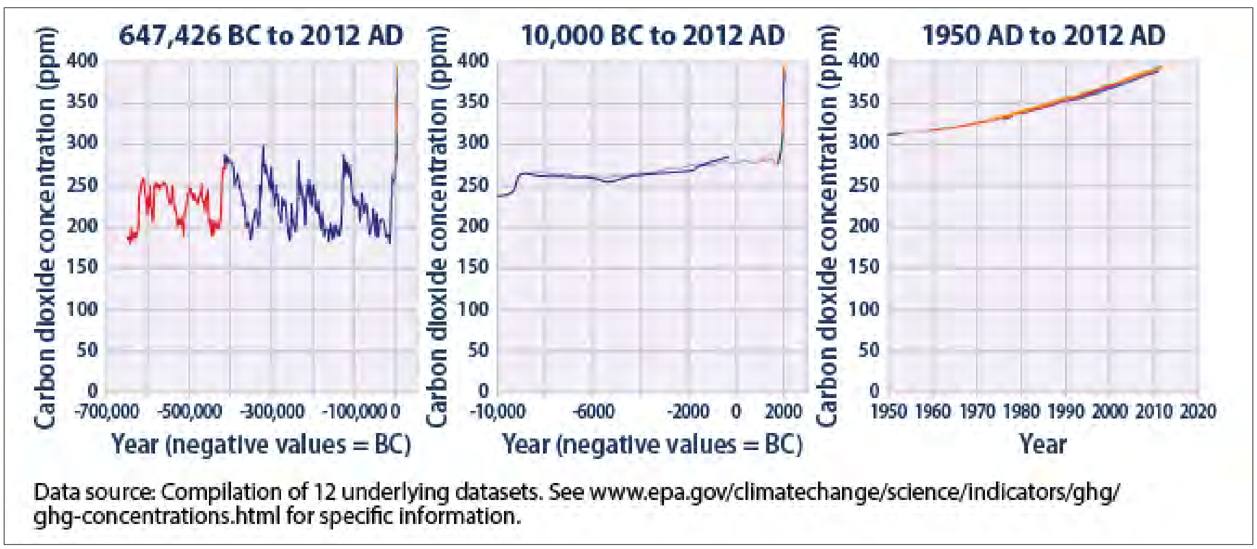


Figure 3-19. Global Carbon Dioxide Concentrations Over Time

Climate change will affect the people, property, economy, and ecosystems of the Skagit County in a variety of ways. Some impacts will have negative consequences for the region, while others may present opportunities. The most important effect for the development of this plan is that climate change may have a measurable impact on the occurrence and severity of natural hazards.

3.11.2 How Climate Change Affects Hazard Mitigation

An essential aspect of hazard mitigation is predicting the likelihood of hazard events in a planning area. Typically, predictions are based on statistical projections from records of past events. This approach assumes that the likelihood of hazard events remains essentially unchanged over time. Thus, averages based on the past frequencies of, for example, floods are used to estimate future frequencies: if a river has flooded an average of once every five years for the past 100 years, then it can be expected to continue to flood an average of once every five years.

For hazards that are affected by climate conditions, the assumption that future behavior will be equivalent to past behavior is not valid if climate conditions are changing. As flooding is generally associated with precipitation frequency and quantity, for example, the frequency of flooding will not remain constant if broad precipitation patterns change over time. The risks of landslide, severe weather, severe winter weather and wildfire are all affected by climate patterns as well.

For this reason, an understanding of climate change is pertinent to efforts to mitigate natural hazards. Information about how climate patterns are changing provides insight on the reliability of future hazard projections used in mitigation analysis.

3.11.3 Indicators

The major scientific agencies of the United States—including the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA)—agree that climate change is occurring (U.S. EPA, 2013). Multiple temperature records from all over the world have shown a warming trend (U.S. EPA, 2011). According to NOAA, the decade from 2000 to 2010 was the warmest on record, and 2010 was tied with 2005 as the warmest year on record (NOAA, 2011). Worldwide, average temperatures have increased more than 1.4ºF over the last 100 years (NRC, 2010). Many of the extreme precipitation and heat events of recent years are consistent with projections based on that amount of warming (USGCRP, 2009).

Rising global temperatures have been accompanied by other changes in weather and climate. Many places have experienced changes in rainfall resulting in more intense rain, as well as more frequent and severe heat waves. The planet's oceans and glaciers have also experienced changes: oceans are warming and becoming more acidic, ice caps are melting, and sea levels are rising (U.S. EPA, 2010). Global sea level has risen approximately 9 inches, on average, in the last 140 years (U.S. EPA, 2010). This has already put some coastal homes, beaches, roads, bridges, and wildlife at risk (USGCRP, 2009).

By all accounts, by mid-century, Washington is likely to regularly experience average annual temperatures that exceed the warmest conditions observed in the 20th century. Washington is also expected to experience more heat waves and more severe heavy rainfall events. The summer of 2017 was the warmest on record, followed by 2014, 2015 and 2013 ranking as the third, fourth and fifth (respectively) warmest on record for western Washington; however, it is anticipated that those temperatures will be the norm by mid-century. 2017 was also one of the driest on record, with just over half an inch of rain, with 2018 experiencing 11 days above 90 degrees, and 2015 recording 12 days.

3.11.4 Projections

Scientists project that Earth's average temperatures will rise between 2ºF and 12ºF by 2100 (NRC, 2011a). Some research has concluded that every increase of 2ºF in average global average temperature can have the following impacts (NRC, 2011b):

- 3 to 10 percent increases in the amount of rain falling during the heaviest precipitation events, which can increase flooding risks
- 200 to 400 percent increases in the area burned by wildfire in parts of the western United States
- 5 to 10 percent decreases in stream flow in some river basins
- 5 to 15 percent reductions in the yields of crops as currently grown.

The amount of sea level rise expected to occur as a result of climate change will increase the risk of coastal flooding for millions to hundreds of millions of people around the world, many of whom would have to permanently leave their homes (IPCC, 2007). By 2100, sea level is expected to rise another 1.5 to 3 feet (NRC, 2011b). Rising seas will make coastal storms and the associated storm surges more frequent and destructive. What is currently termed a once-in-a-century coastal flooding event could occur as frequently as once per decade (USGCRP, 2009).

For Washington, current indicators include a potential rise along coastal communities from 4-56 inches: "Sea level is projected to rise in most areas[15] of the state, increasing the likelihood for permanent inundation of low-lying areas, higher tidal and storm surge reach, flooding, erosion, and loss of habitat. Sea level rise, rising coastal ocean temperatures, and ocean acidification will also affect the geographical range, abundance, and diversity of Pacific Coast marine species. These include key components of the marine food web (phytoplankton and zooplankton) as well as juvenile Chinook salmon and commercially important species" (Climate Impact, 2013).

The report goes on to state that the "[p]rojected regional warming and sea level rise are expected to bring new conditions to Washington State. By mid-century, Washington is likely to regularly experience average annual temperatures that exceed the warmest conditions observed in the 20th century. Washington is also expected to experience more heat waves and more severe heavy rainfall events, despite relatively small changes in annual and seasonal precipitation amounts" (p. ES-3).[16] Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, the entire state is expected to be affected by an increased incidence of drought and wildfire.

Over the next 50 to 100 years, the potential exists for significant climate change impacts on Washington's coastal communities, forests, fisheries, agriculture, human health and natural disasters. These impacts could potentially include increased annual temperatures, rising sea level, increased sea surface temperatures, more intense storms and changes in precipitation patterns. Therefore, climate change has the potential to impact the occurrence and intensity of natural disasters, potentially leading to additional loss of life and significant economic losses. Recognizing the global, regional and local implications of climate change, Washington

[15] Recent research projects +4 to +56 inches of sea level rise by 2100 for Washington State, compared to 2000, which will be modulated by local vertical land movement. The potential for continued decline in local sea level for the Northwest Olympic Peninsula cannot be ruled out at this time.
[16] http://cses.washington.edu/db/pdf/snoveretalsokexecsum819.pdf

state has shown great leadership in addressing mitigation through the reduction of greenhouse gases. The forces that shape the climate are also critical to farm productivity. Human activity has already changed atmospheric characteristics such as temperature, rainfall, levels of carbon dioxide (CO2) and ground level ozone. Warmer climate may give positive effects on food production like the possibility of longer growing seasons; however, the increased potential for weather extremes will pose challenges for farmers. Increased frequency of heat stress, drought and flood negatively affect crop yields and livestock. Moreover, water supply and soil moisture could make it less feasible to continue crop production in certain areas. The potential loss of snowpack in the Cascades will diminish water needed for summer irrigation for crops in the Columbia Basin and impact salmon recovery across the Northwest. Finally, climate variability and change will modify the risks of fires, weeds, pests and pathogen outbreaks.

3.11.5 Washington's Response to Climate Change

In 2009, the Washington state Legislature approved the State Agency Climate Leadership Act Senate Bill 5560. The Act committed state agencies to lead by example in reducing their greenhouse gas (GHG) emissions to: 15 percent below 2005 levels by 2020; 36 percent below 2005 by 2035; and 57.5 percent below 2005 levels (or 70 percent below the expected state government emissions that year, whichever amount is greater). The Act, codified in RCW 70.235.050-070, directed agencies to annually measure their greenhouse gas emissions, estimate future emissions, track actions taken to reduce emissions and develop a strategy to meet the reduction targets. Starting in 2012 and every two years thereafter, each state agency is required to report to Washington State Department of Ecology the actions taken to meet the emission reduction targets under the strategy for the preceding biennium.

3.11.6 Mitigation and Adaptation

Communities and governments are working to address, evaluate, and prepare for climate changes that are likely to impact communities in coming decades. Generally, climate change discussions encompass two separate but inter-related considerations: mitigation and adaptation. The term "mitigation" can be confusing, because its meaning changes across disciplines:

- Mitigation in restoration ecology and related fields generally refers to policies, programs or actions that are intended to reduce or to offset the negative impacts of human activities on natural systems. Generally, mitigation can be understood as avoiding, minimizing, rectifying, reducing or eliminating, or compensating for known impacts.
- Mitigation in climate change discussions is defined as "a human intervention to reduce the impact on the climate system." It includes strategies to reduce greenhouse gas sources and emissions and enhance greenhouse gas sinks (U.S. EPA, 2013g).
- Mitigation in emergency management is typically defined as the effort to reduce loss of life and property by lessening the impact of disasters (FEMA, 2013).

Adaptation refers to adjustments in natural or human systems in response to the actual or anticipated effects of climate change and associated impacts. These adjustments may moderate harm or exploit beneficial opportunities (U.S. EPA, 2013g).

Mitigation and adaptation are related, as the world's ability to reduce greenhouse gas emissions will affect the degree of adaptation that will be necessary. Some initiatives and actions can both reduce greenhouse gas emissions and support adaptation to likely future conditions.

Societies across the world are facing the need to adapt to changing conditions associated with natural disasters and climate change. Farmers are altering crops and agricultural methods to deal with changing rainfall and rising temperature; architects and engineers are redesigning buildings; planners are looking at managing water supplies to deal with droughts or flooding.

Most ecosystems show a remarkable ability to adapt to change and to buffer surrounding areas from the impacts of change. Forests can bind soils and hold large volumes of water during times of plenty, releasing it through the year; floodplains can absorb vast volumes of water during peak flows; coastal ecosystems can hold out against storms, attenuating waves and reducing erosion. Other ecosystem services—such as food provision, timber, materials, medicines, and recreation—can provide a buffer to societies in the face of changing conditions.

Ecosystem-based adaptation is the use of biodiversity and ecosystem services as part of an overall strategy to help people adapt to the adverse effects of climate change. This includes the sustainable management, conservation and restoration of specific ecosystems that provide key services.

CHAPTER 4.
RISK ASSESSMENT METHODOLOGY

4.1 OVERVIEW

The DMA requires measuring potential losses to critical facilities and property resulting from natural hazards. 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 goal of the risk assessment is to determine which hazards present the greatest risk and what areas are the most vulnerable to hazards. Skagit County and its planning partners are exposed to many hazards. The risk assessment and vulnerability analysis help identify where mitigation measures could reduce loss of life or damage to property in the planning region. Each hazard-specific risk assessment provides risk-based information to assist Skagit 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), Hazus hazard-modeling software, and hazard-impact 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. In all instances, this assessment used Best Available Science and data to ensure the highest level of accuracy possible.

The risk assessment is broken down into three phases, as follows:

> The first phase, hazard identification, involves the identification of the geographic extent of a hazard, its intensity, and its probability of occurrence (discussed below). This level of assessment typically involves producing a map. The outputs from this phase can be used for land use planning, management, and development of regulatory authority; public awareness and education; identifying areas which require further study; and identifying properties or structures appropriate for mitigation efforts, such as acquisition or relocation.
>
> The second phase, the vulnerability assessment, combines the information from the hazard identification with an inventory of the existing (or planned) property and population exposed to the hazard. It then attempts to predict how different types of property and population groups will be impacted or affected by the hazard of concern. This step assists in justifying changes to building codes or regulatory authority, property acquisition programs, such as those available through various granting opportunities; developing or modifying policies concerning critical or essential facilities, and public awareness and education.
>
> The third phase, the risk analysis, involves estimating the damage, injuries, and costs likely to be incurred in the geographic area of concern over a period of time. Risk has two measurable components:
>
> 1. The magnitude of the harm that may result, defined through the vulnerability assessment; and
> 2. The likelihood or probability of harm occurring.

Utilizing those three phases of assessment, information was developed which identifies the hazards that affect the planning area, the likely location of natural hazard impact, the severity of the impact, previous occurrences, and the probability of future hazard events. That data, once complete, is utilized to complete the Risk Ranking process described in Chapter 12, which applies all of the data capture to the Calculated Priority Risk Index (CPRI). Each planning partner completes this process for their own community, as well as conducting the analysis on a countywide level.

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/Extent: The area of potential or demonstrated impact within the area in which the analysis is being conducted. In some instances, the area of impact is within a geographically defined area, such as a floodplain. In other instances, such as for severe weather, there is no established geographic boundary associated with the hazard, as it can impact the entire area.
- Severity/Magnitude: The extent or magnitude upon which a hazard is ranked, demonstrated in various means, e.g., Richter Scale.
- Vulnerability: The degree of damage, e.g., building damage or the number of people injured.
- Probability of Occurrence and Return Intervals: These terms are used as a synonym for likelihood, or the estimation of the potential of an incident to occur.

4.2 METHODOLOGY

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

4.2.1 Hazard Identification and Profiles

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

The Planning Team reviewed the hazards considered during the 2015 plan. Based on the review, the Planning Team, at its kick-off meeting, identified the following natural hazards that this plan addresses as the hazards of concern (2020 changes to the hazards of concern are indicated in italics):

- Avalanche (removed)
- Climate Change (*New* with qualitative assessment based on secondary impact to hazards)

- Earthquake (*Updated* to include new Devils Mountain (2017) scenario)
- Flood (*Updated* to include current NFIP data; 1985 flood maps remain only ones in existence; *added* identification of dams)
- Hazardous Materials (Exposure analysis to hazards of concern where applicable utilizing WDOE's FY2018 reports)
- Landslide (*Expanded* to include updated DNR data and updated erosion data)
- Severe Weather (*Expanded* to include additional related hazard types, including Wind)
- Tsunami (*Expanded* to include information from 2019 studies)
- Volcano (*Expanded* to include lahar data impact)
- Wildfire (*Removed* as Skagit County Conservation District is completing a detailed Community Wildfire Protection Plan which will assume the place of the Wildfire profile in this plan).

The hazard profiles describe the risks associated with identified hazards of concern. Each chapter describes the hazard and the planning area's vulnerabilities. For those municipal planning partners with defined geographic boundaries, this data is identified within the associated tables in the base plan in which the risk at the county level is also identified. The following steps were used to define the risk of each hazard:

Identify and profile the following information for each hazard:

- General overview and description of hazard;
- Identification of previous occurrences;
- Geographic areas most affected by the hazard;
- Event frequency estimates;
- Severity estimates;
- Warning time likely to be available for response;
- Risk and vulnerability assessment, which includes identification of impact on people, property, economy and the environment.

4.2.2 Risk Assessment Process

Once the profiles identified above were completed, the following steps were used by each planning partner to define the risk of each hazard:

- 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 risk associated with 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 terms, 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 index.

- The final step in the process was to determine the cumulative results of the level of vulnerability based on the risk assessment and Calculated Priority Risk Index (discussed below) scoring, assigning a final qualitative assessment based on the following classifications:
  - 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 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, Hazus-MH, with new models for estimating potential losses from hurricanes and floods. The most recent model of Hazus now allows for Tsunami modeling to occur in certain regions. At the time of this update, FEMA was in the process of developing some new tsunami data conducted in Hazus. As such, the resulting data was utilized in this update process when presenting impact data for the Tsunami hazard.

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 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. In order to calculate losses due to flooding, Hazus uses the following inputs about the built environment: structure location, occupancy type, square footage, first floor height above grade, as well as replacement and content values.
- 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.

Building Inventory

During FEMA's 2010, 2015, and 2017 hazard runs for Skagit County, FEMA identifies that a User Defined Facilities (UDFs) approach was used to model exposure and vulnerability. Countywide GIS building data utilizing detailed structure information for facilities was reported to have been loaded into the GIS and Hazus model by FEMA analysts based on data the provided by the County. As discussed in Section 3.4 above, similar such data is currently not available for use in this update due to a discovered flaw in the Assessor's database. As such, these reports were determined to be the best available data for update purposes. Readers wishing greater detail may review the various reports referenced to additional data on FEMA's methodology.

Loss Calculations

Hazus loss calculations for essential facilities are performed at the site level rather than at the census block level. In order to best assess loss to a specific building within Hazus, it is necessary to have detailed building specific information such as a building's first floor height above grade and construction type. Because this information could not be obtained from the Assessor's database, the essential facilities analysis was conducted outside of Hazus and was based on general exposure rather than estimated losses. Risk to structures is identified based on the structure location and the corresponding exposure to hazard location, where geographically established.

Skagit County and several of its planning partners electing to do so did provided critical facilities data which included geospatial data for fire, police, schools, medical facilities, etc. The process itself took approximately three months to complete, and started with the initial list utilized in the previous plan edition, and then each planning partner was asked to update the list with additional or revised data. For those partners not wishing to provide updated information, the previous facility list was utilized. It is recognized that this list may or may not be accurate both in number and value; however, in order to show loss data for the planning partners wishing to be part of this process, it was determined by the planning team to remain the best available data.

As with all mitigation planning documents, the purpose of this plan is not to identify the actual losses, but more to raise awareness to the fact that structures may be at risk. The dollar value of loss would be determined at the time the loss occurred, and therefore, for planning purposes, this process was deemed appropriate when discussed with County, State and FEMA personnel as the best available data and process to follow.

As indicated, the planning process also included identification of the critical facilities within each jurisdiction. On completion of the analysis, each planning partner was provided the critical facilities list, on which impact from each hazard is identified for each critical facility. That data was then utilized by each planning partner to determine dollar value at risk. Specific critical facility structure impact data is further identified within the various Critical Facilities tables contained in each hazard profile, identified by critical facility type, e.g., power, water, wastewater, etc.

Hazus Application for this Plan

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

- **Flood**—A Hazus Level 1 analysis was performed. Analysis was based on current FEMA regulatory 100- and 500-year flood hazard data based on the 1985 Flood Study.
- **Earthquake**—A Hazus Level 1 analysis was performed to assess earthquake risk and exposure. Earthquake shakemaps and probabilistic 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. The one scenario-based shake map event utilized was the Devils Mountain (2017) event.
- **Tsunami** – A Hazus Level 1 analysis was performed to assess inundation risk and exposure.

GIS Application for this Plan

Dam, Hazardous Materials, Landslide, Severe Weather, Volcano, and Wildfire - For these hazards, 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 critical facilities 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, staff, emergency management personnel, and others. The primary data source was Skagit County GIS data, augmented with state and federal data sets, including FEMA, USGS, NOAA, WADOE, and WADNR data. Additional data sources for specific hazards are identified within the various profiles. In general analysis was completed as follows:

- **Climate Change** – Existing information was utilized to present future impact of climate change on the planning area. No specific analysis was conducted; however, existing data which illustrates potential impact was incorporated to the greatest extent possible in a qualitative manner.
- **Dam Failure**—Inundation data was unavailable for all of the high- or medium-hazard dams in the County. Therefore, available dam data was used to identify the location and hazard classification of dams located within the planning area, and where dam safety plans were available, specific numbers of impact were included based on existing data.
- **Hazardous Materials** – Hazardous materials data was utilized, captured from the Department of Ecology's FY2018 Tier II reporting data, which requires updates by March of each year within the State of Washington. No plume modeling was conducted.

- **Landslide**—Historic landslide hazard data was used to assess exposure to landslides using Washington DNR 2016 Landslide Susceptibility data, in conjunction with Skagit County landslide data. This data depicts landslide susceptibility at a 10 meter resolution, across the state of Washington. Landslide damages are illustrated based on the number of critical facilities intersecting the landslide zone. FEMA's 2017 Risk Map report was also utilized to illustrate structure impact based on their analysis.
- **Severe Weather**—Severe weather data was downloaded from the Natural Resources Conservation Service and the National Climatic Data Center, as well as PRISM Precipitation, Average Low, and Average High data. Tornado Project data was utilized to identify any events which have occurred in the planning area.
- **Wildfire**—The Skagit County Conservation District developed the County's Community Wildfire Protection Plan during the same time the HMP was under development. As such the County has elected to utilize the CWPP as its Wildfire Chapter to reduce redundancy of effort, and to ensure data does not conflict. Information on wildfire analysis was captured from various sources, including Washington DNR Wildfire History data, Wildfire Protection data, US Forest Service data, LAND FIRE data, and Wildland Urban Interface Zone data, among other sources. Readers should view the CWPP to obtain additional information. While the profile was published as a separate document, the hazard was included in the risk ranking exercise, with specific strategies identified within both the HMP and CWPP.

4.2.4 Calculated Priority Risk Index Scoring Criteria

The 2015 plan utilized a mixture of Mitigation 20/20, GIS and Hazus to conduct its risk assessment. 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 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. Those elements are further defined as follows:

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

Chapter 16 summarizes all of the analysis conducted by way of completion of the Calculated Priority Risk Index (CPRI) for hazard ranking. 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.

4.3 PROBABILITY OF OCCURRENCE AND RETURN INTERVALS

Natural hazard events with relatively long return periods, such as a 100-year flood or a 500- or 1,000-year 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, having 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.

Seismic Design Categories based on statewide site class map assessments for Skagit County are D-0 and D-1.[17]

4.4 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, 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.

4.5 LIMITATIONS

Various data sets were utilized in developing the risk assessment incorporated into this planning effort. In attempting to utilize the various sources, discrepancies became apparent, and were not of a nature which could be easily corrected within the scope of this project. County Maps and Data are created from available public records and existing map and data sources, not from field surveys. Maps and Data from all sources may have been adjusted to achieve a "best fit" registration to Skagit County Tax Parcel Maps and Data. While great care is taken in this process, maps and data from different sources rarely agree as to the

[17] https://www.dnr.wa.gov/programs-and-services/geology/geologic-hazards/geologic-hazard-maps#seismic-design-categories

precise location of geographic features. The relative positioning of map and data features to one another results from combining different sources without field "ground truthing." Map and Data features are approximate and are not necessarily accurate to surveying or engineering standards. Map and Data errors can be as great as 300 feet in some areas. Map and Data should be used as a resource only, and any such use of map and data products with respect to accuracy and precision shall be the sole responsibility of the user.

The models and information presented in this document does not replace or supersede any official document or product generated to meet the requirements of any state, federal, or local program, which may be much more detailed and encompassing beyond the scope of this project. This document is intended for planning purposes only. This document and its contents have been prepared and are intended solely for Skagit County and its planning partners' information and use with respect to hazard mitigation planning, incorporating other relevant data into other planning mechanisms as appropriate. While this process utilized best available science and scientific data, the Planning Team, consultant, nor any of the planning partners conducted any scientific analysis within this document, and none should be construed. Our process only reproduced existing data in different ways to meet the guidelines and requirements of 44 CFR 201.6. All data layers utilized are identified within the various sections of this document should reviewers wish greater clarification and information.

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 receive 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, Skagit County and its planning partners will continue to collect additional data to assist in better estimating potential losses associated with other hazards as science increases the validity of data.

Some assumptions were made by the planning partnership in an effort to capture as much data as necessary to supplant any significant data gaps. One example of this is the valuation for structures within the assessed data. For structures for which data was not provided, the missing information was determined using averages of similar types of structures, determining square footage and applying a multiplier. This process 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. 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. 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. DROUGHT

5.1 GENERAL BACKGROUND

> **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.

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 of 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 long-term. It is possible for a region to experience a long-term circulation pattern that produces drought, and to have short-term changes in this long-term pattern that result in short-term wet spells. Likewise, it is possible for a long-term wet circulation pattern to be interrupted by short-term weather spells that result in short-term drought.

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

- 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.

5.2 HAZARD PROFILE

5.2.1 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.

5.2.2 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 5-1 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 5-2 has data on how the two droughts affected Washington by late September of their respective years.

Table 5-1
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

Table 5-1
Drought Occurrences

January – August 1973	Dry in the Cascades.
October 1976 – September 1977	Worst drought in Pacific Northwest history. Below normal precipitation in Olympia, Seattle, and Yakima. Crop yields were below normal and ski resorts closed for much of the 1976-77 season. 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 6-1.)

Table 5-1 Drought Occurrences	
2019	As of May 20, 2019, Governor Jay Inslee issued an emergency drought declaration in 24 watersheds statewide (see Figure 5-2). 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 6-3).[18] 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.

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

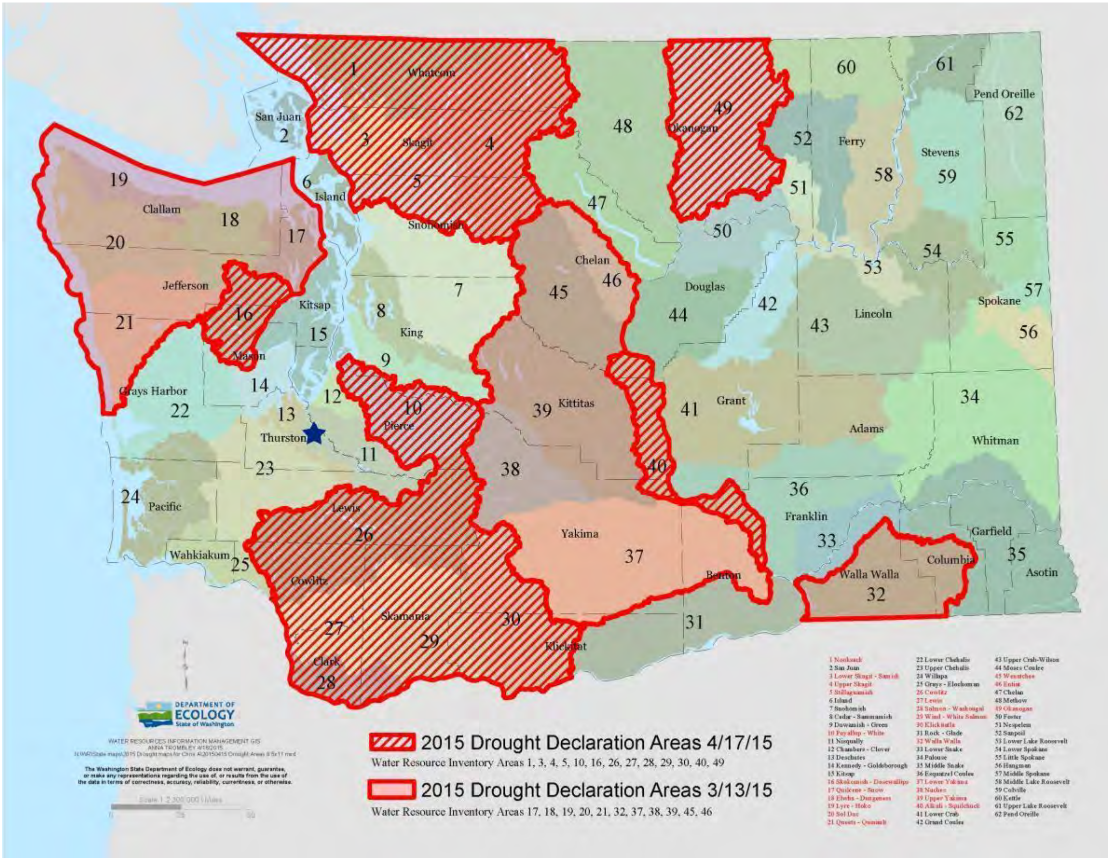


Figure 5-1 Washington State Department of Ecology 2015 Drought Map

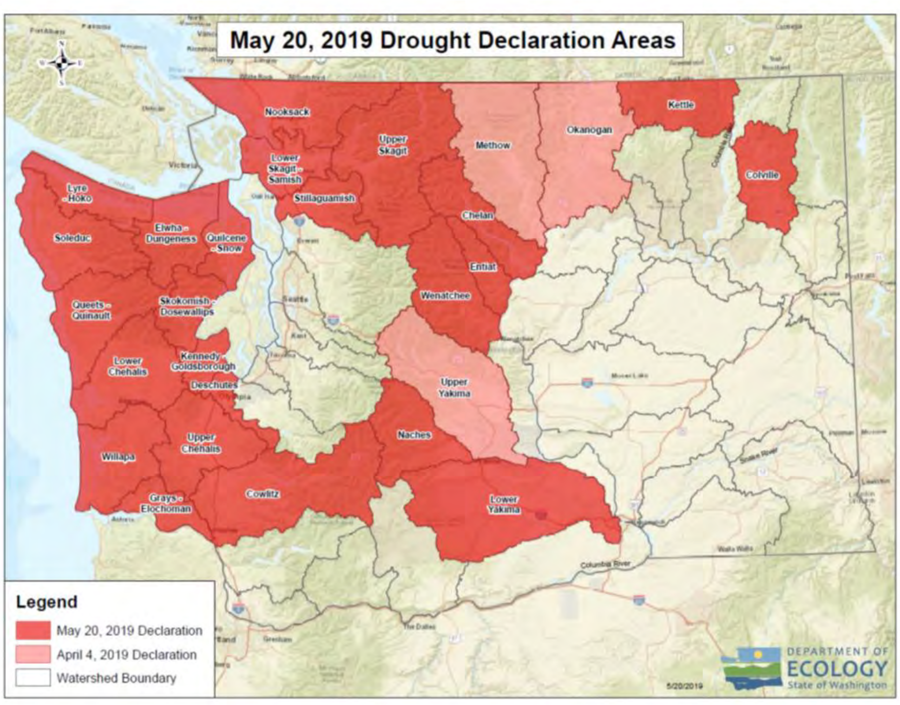


Figure 5-2 Washington State Department of Ecology May 2019 Drought Declaration Areas

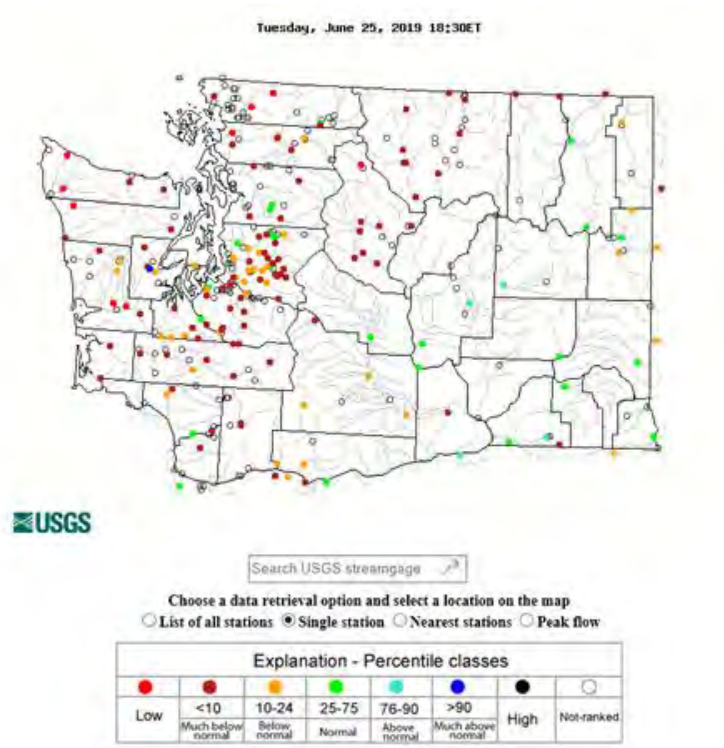


Figure 5-3 USGS Streamflow Comparison for Day of Year

Table 5-2
Comparison of Impacts of 1977 Drought to 2001 Drought

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

The following information relates to the drought issue within Skagit County, including years of low precipitation and snowpack, as well as sources of power, drinking water, and the fishing/tourism industry:

- Three energy curtailments resulted from drought periods prior to 1977, which caused temporary unemployment within various industry sectors.
- 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.
- 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.

- 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. Statewide, 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 in central Columbia and Garfield Counties, 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. The fire's origin was traced to a dead pine tree which fell across power lines, causing the lines to arc and send sparks to the ground, which ignited dry grass.
- 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 6-1 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 within Yakima, Methow and Okanogan Counties. Federal water supply forecasters predicted lower available water supplies this summer in all areas except the southern part of the state. Several Skagit County watersheds were impacted, and as of May 2019, Skagit County was among those counties identified as being in a drought condition by WA DOE (see Figure 5-2 above).

5.2.3 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.

Within Skagit County, as a large part of the County's economic vitality is associated with the agricultural community, review of data concerning historic drought conditions will help in determining measures necessary to protect crops, such as water rationing.

A drought lasting for more than one season would most likely reduce the annual snow-pack accumulated at high elevations in the Cascade Mountains, thereby reducing normal stream flows in local rivers and creeks. Should an extreme, long-term drought occur, a large portion of the population of Skagit County would be impacted. As of this 2019 writing, the County is experiencing drought conditions, and has instituted voluntary water conservation measures, as have surrounding communities which receive water supplies from the Skagit River watersheds.

The water supply for most of Skagit County is obtained from the Skagit River or large creeks with reliable, glacial sources. The effects of an extreme, long-term drought could result in inadequate streams flows and ground water recharge, thereby resulting in the implementation of strict water conservation measures.

A severe drought may result in large numbers of wells going dry. Many residents in rural areas of the county rely on private wells or private water systems for their domestic water supply. Those areas that could be most vulnerable to drought situations are Fidalgo Island and Guemes Island in western Skagit County. Guemes Island relies totally on an island aquifer for domestic water. It is unknown what effect a long-term drought would have on this aquifer. While the number of full-time residents living on Guemes Island is relatively few, a large number of residents living on rural Fidalgo Island rely on private, stand-alone water systems for their domestic water supply. A severe or long-term drought situation could severely impact a large number of citizens living and working on Fidalgo Island. In addition, a severe or long-term drought would subject persons living on Guemes Island and portions of Fidalgo Island to a significant fire risk.

The agricultural industry relies on a consistent and ample water supply. Annual crops may be damaged or lost in a single growing season, but usually rebound with normal precipitation amounts the following year. Many farmers have drilled wells or have the ability to pump water directly from the Skagit River or drainage ditches to irrigate fields during short-term dry periods. In the case of a long-term drought that lasts for several growing seasons, there is a possibility that saltwater may intrude and contaminate freshwater aquifers. Employment associated with agriculture would drop in drought years due to low crop production.

Approximately 80% of Skagit County is forested or agricultural in nature. This is particularly true in the eastern portion of the county. A long-term drought event would most likely cause all industrial logging operations to cease due to severely reduced moisture levels in the soil and timber thereby leading to extreme fire risk. If industrial logging operations were to be suspended for a long period of time due to drought conditions, the overall economy of Skagit County could be severely affected.

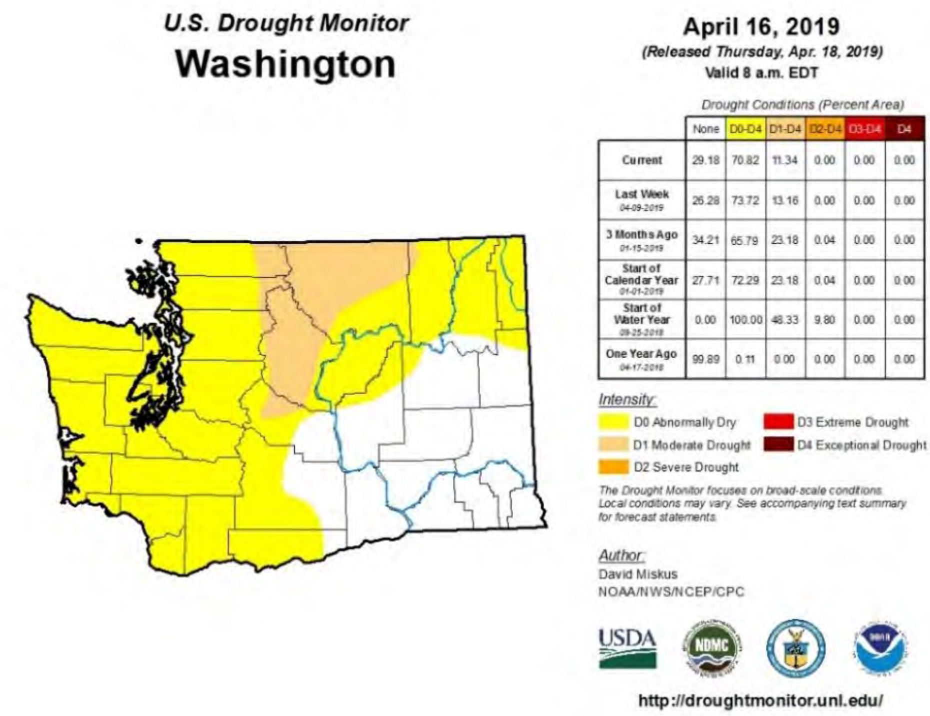
A substantial reduction in stream flows could severely impact the generation of electricity from the hydro-electric dams located on the Skagit River and the Baker River in Eastern Skagit County. A reduction in hydro-electric generation will result in increased electricity rates for all residents and businesses in the area.

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 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.

What follow are a series of maps indicating current conditions as it relates to Drought. These maps change very frequently and are intended to demonstrate information available to viewers. Additional information and current monthly data are available from the NOAA website:

http://www.ncdc.noaa.gov/oa/climate/research/prelim/drought/palmer.html



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	29.18	70.82	11.34	0.00	0.00	0.00
Last Week 04-09-2019	26.28	73.72	13.16	0.00	0.00	0.00
3 Months Ago 01-15-2019	34.21	65.79	23.18	0.04	0.00	0.00
Start of Calendar Year 01-01-2019	27.71	72.29	23.18	0.04	0.00	0.00
Start of Water Year 09-25-2018	0.00	100.00	48.33	9.80	0.00	0.00
One Year Ago 04-17-2018	99.89	0.11	0.00	0.00	0.00	0.00

Figure 5-4 April 2019 Washington Drought Monitor

Source: NOAA http://go.usa.gov/3eZGd

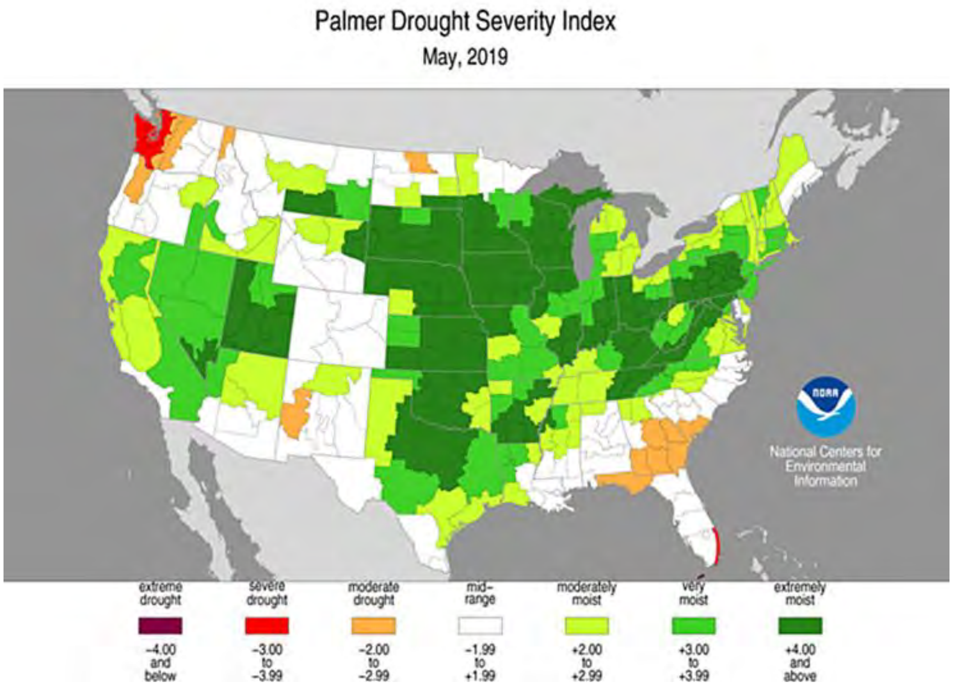


Figure 5-5 Palmer Drought Severity Index - May 2019

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. See figure below for the current information available as of this update.

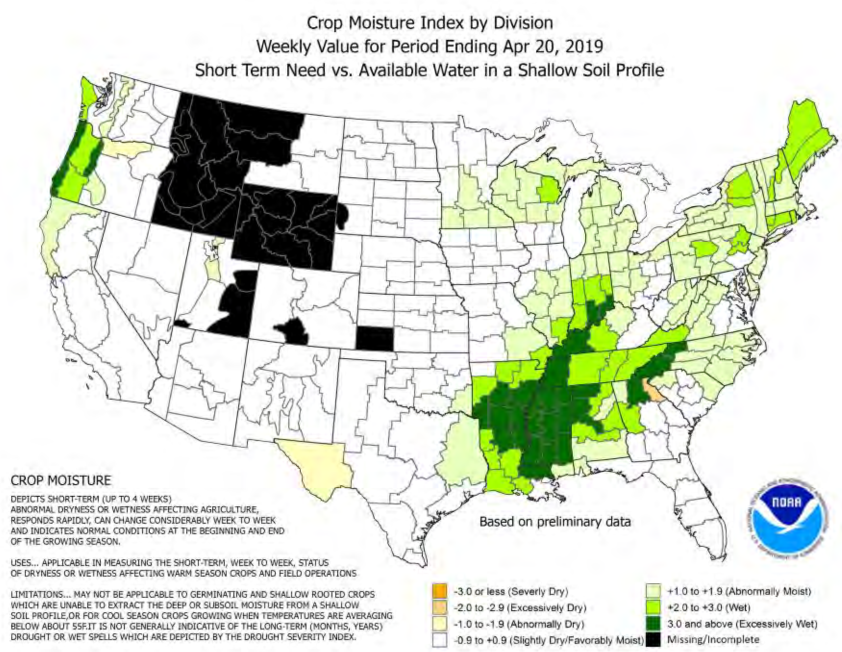


Figure 5-6 Palmer Crop Moisture Index

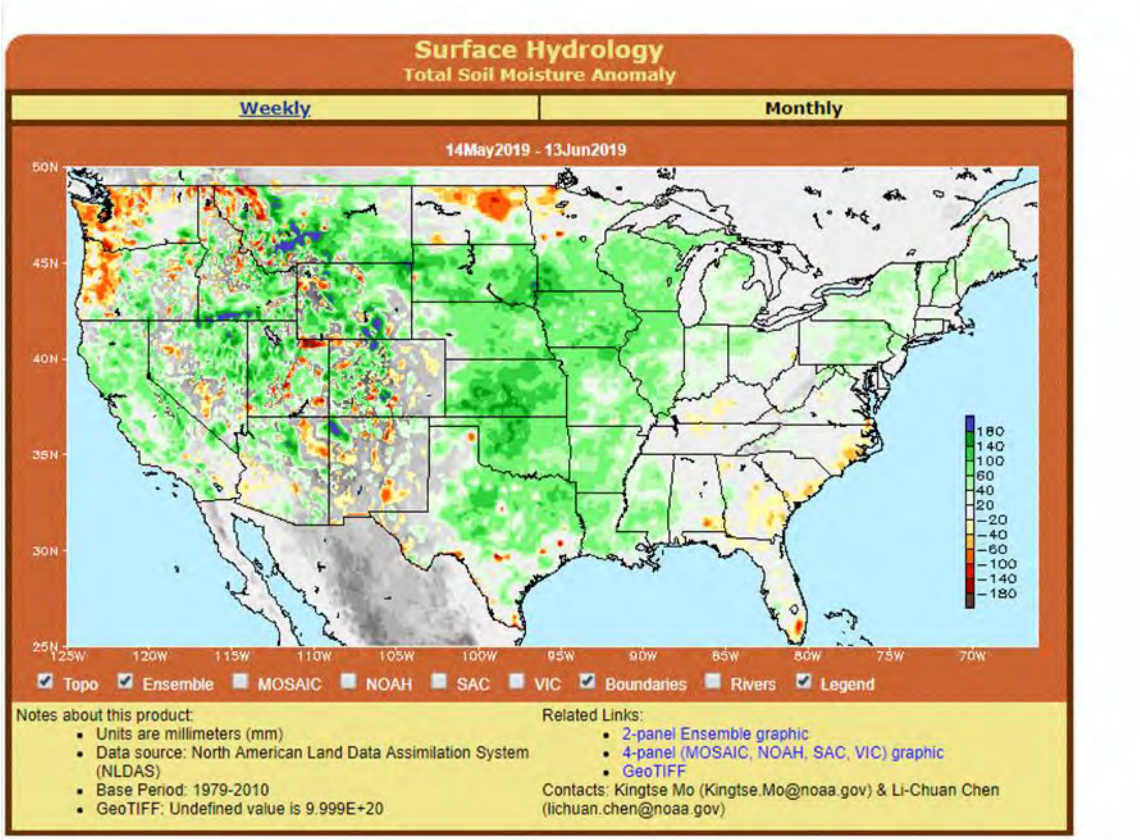


Figure 5-7 Soil Moisture Impact - Surface Hydrology June 2019

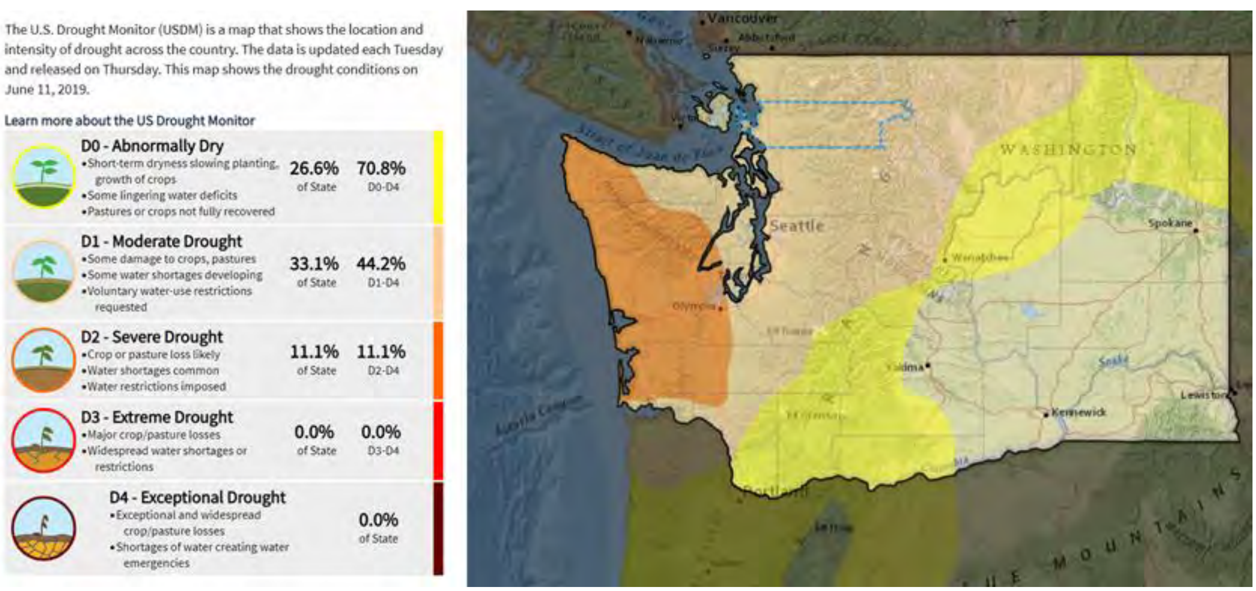


Figure 5-8 NIDIS Drought In Washington as of June 11, 2019

Source: https://www.drought.gov/drought/states/washington

5.2.4 Frequency

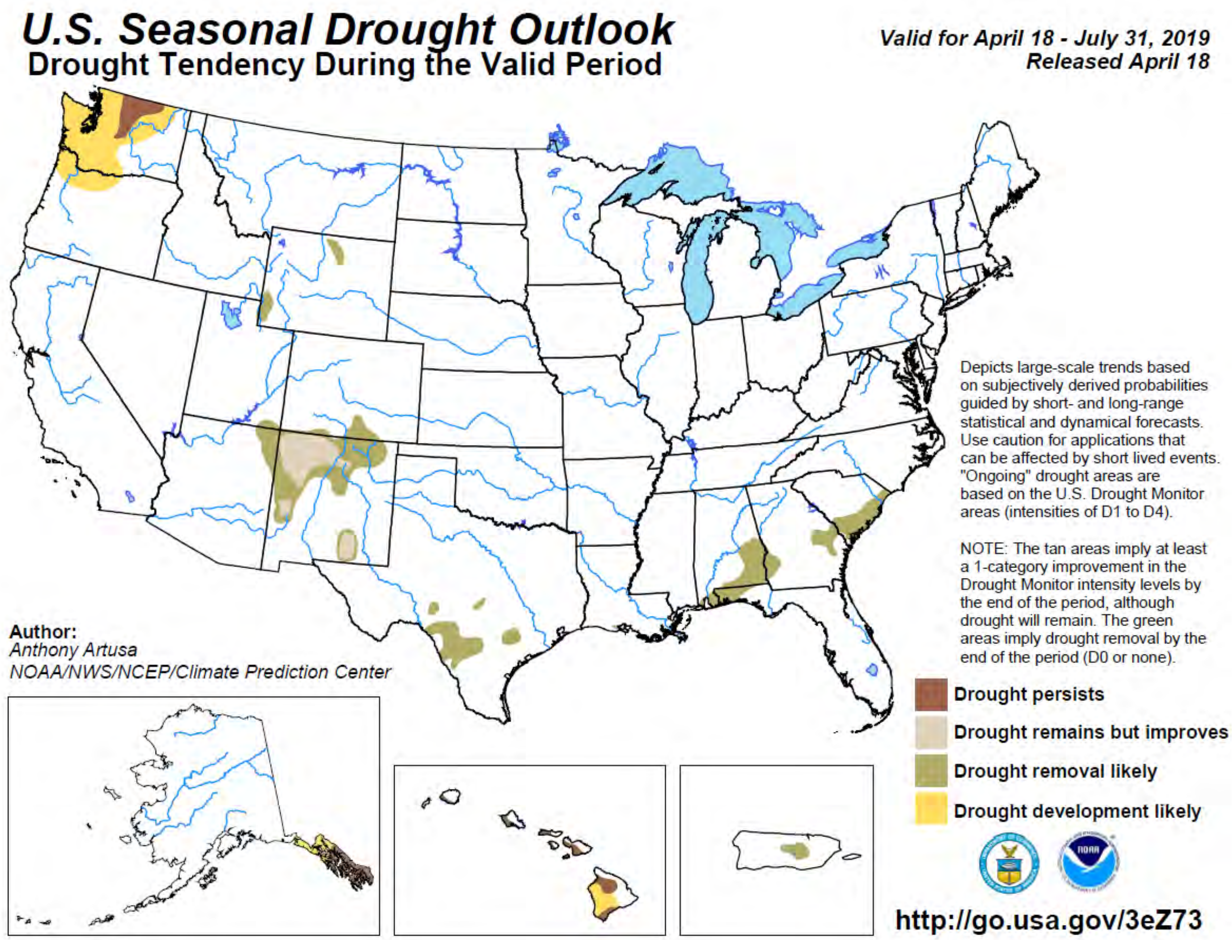
Empirical studies conducted over the past century have shown that meteorological drought is never the result of a single cause. It is the result of many causes, often synergistic in nature; these include global weather patterns that produce persistent, upper-level high-pressure systems along the West 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.” (WA EMD, 2012)

The potential for improved drought predictions in the near future differs by region, season, and climatic regime. Based on Palmer Z Short-Term predictions (above), the planning area as of this update is experiencing areas of both moderate and severe drought situations (NOAA, May 2019; WA DOE, 2019).



5.3 VULNERABILITY ASSESSMENT

5.3.1 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 Skagit County is among the nine counties referenced as being in a "medium-low" status with respect to vulnerability to drought in the Washington State Enhanced Hazard Mitigation Plan.

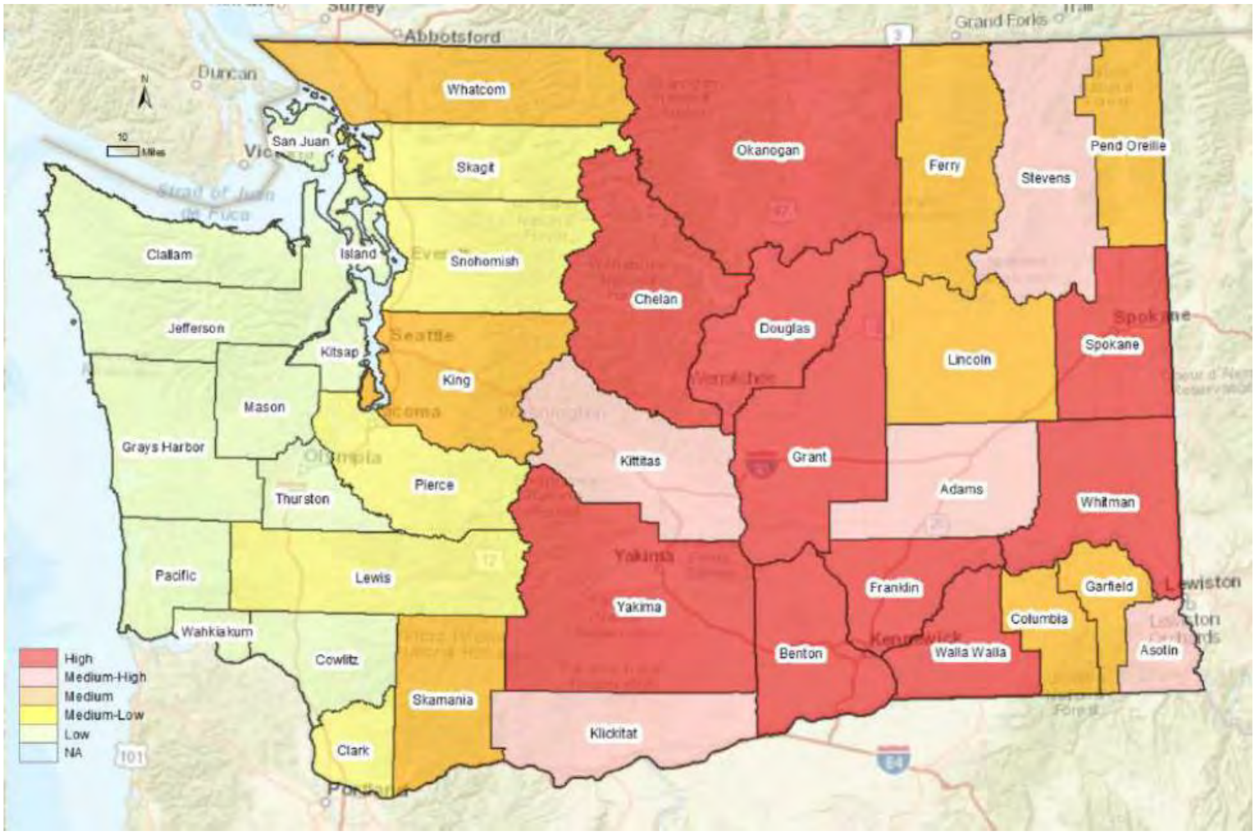


Figure 5-9 WA EMD Drought Risk Index (2018)

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., snowpack 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 depend 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.

5.3.2 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 through conservation techniques to some degree; however, the County does have a fairly large number of privately owned wells, which may be impacted by reduced water flows and aquifer. The county has initiated voluntary water curtailment measures as a result of the 2019 drought situation.

The entire population is at risk to being exposed to a drought impact. The State's HMP does not identify any portion of the County's population as at being at increased risk to the Drought hazard when considering the social vulnerability impacts (WA EMD, p. 116, 2018). The planning team does feel, however, that with the increased age of the population in Skagit County when compared to other areas, as well as the increased number of retirees (see Chapter 3 for demographic data), the level of impact on the more vulnerable population is higher than other counties whose aged population is at statewide averages.

5.3.3 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.

5.3.4 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.

5.3.5 Impact on Economy

As indicated above, economic impact from a drought is associated with different aspects, including potential loss of agri- and aqua-cultural production and, of importance within Skagit County, tourism. Skagit County agricultural producers are among the less than two percent of the population in the United States today that produce the food and fiber consumed by the remaining population and they do it more efficiently and at less cost to the consumer than any other industrialized country in the world.

Skagit County has over 1,040 farms identified in the 2017 Census of Agriculture, with net cash of farm income of operations over $7.4 million annually, and a market value of crops and livestock over $287 million. The Census indicates that 12.4 percent of Skagit County is in woodlands, 62.7 percent croplands, 14 percent pastureland, and 11 percent for other uses.[19] The county is also well known for the production of quality cut-flowers including daffodils, tulips, calla lilies, gladiolus, and dahlias. Other crops include Christmas trees, vegetables, melons, fruits, berries, potatoes and beans. In some categories, Skagit County ranks number one statewide, and in several categories, ranks within the top 15 statewide for agricultural production, livestock sales, and aquaculture.

In addition, there is also the potential impact to the salmon and salmon runs, which could have a significant economic impact on the county, both for commercial fishing and recreational/tourist related activities. The loss of salmon would also have additional environmental impact.

Combined, the impact from a drought situation on the County's agricultural markets for economic sustainability could be high. 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 aquaculture and 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. With drought conditions increasing pressure on aquifers and increased pumping, which can result in saltwater intrusion into freshwater 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, impact to or the lack of hydroelectric generating capacity associated with drought conditions as a result of reduced precipitation levels could raise electric prices throughout the region.

A substantial reduction in stream flows could severely impact the generation of electricity from the hydro-electric dams located on the Skagit River and the Baker River in Eastern Skagit County. A reduction in hydro-electric generation will result in increased electricity rates for all residents and businesses in the area.

5.3.6 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.

The Skagit River and its watershed is the only river in Washington State that is home to five (5) species of salmon. The Skagit River supports some of the largest and healthiest Chinook runs and Pink salmon stock in Washington. (Ecology, 2014) A severe drought could cause reduced stream flows thereby creating a

[19] https://www.nass.usda.gov/Publications/AgCensus/2012/Online_Resources/County_Profiles/Washington/cp53057.pdf

major environmental and economic impact on local salmon runs due to potentially warmer waters and low water levels. Decreased stream flows would severely impact local sport fishing as well as recreational use of many lakes and streams within Skagit County.

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. Life-cycles for fish spawning in the area would have environmental impacts years into the future.

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 Skagit County could experience setbacks, especially in water dependent industries.

5.3.7 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.

5.4 FUTURE DEVELOPMENT TRENDS

With an increase in population, the rezoning of land from agricultural or woodland to residential would have the propensity to increase water demands, as well as increase demands on other infrastructure, and increase the potential for wildfires. The County and some of its cities have established comprehensive plans or water regulations that includes policies directing land use and dealing with issues of water supply and the protection of water resources, as well as fire regulations. 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 also be identified as mitigation actions to increase the capability to deal with future trends in development.

One example of pre-planning is currently on-going by Skagit PUD. Use of Skagit PUD's water resources comes from many sources, including population growth, in-stream flows (protecting fish, wildlife and recreation), and business needs. Water systems using their water efficiently allow growth in their communities and water for other environmental uses. The efficient use of water helps ensure reliable water supplies are available for our customers.

In 2007, the Washington State Department of Health (DOH) established a Water Use Efficiency Program to ensure efficient operation and management of water systems. With it came new requirements that require municipal water suppliers to set conservation goals and report annually on their performance to customers and the DOH.

Through a public forum process, the PUD established measurable water-saving goals for 2014-2019 for both the supply- and demand-sides of the distribution system. These goals provide a benchmark for achievement and play a significant role in defining the success of the PUD's water use efficiency program.

As a whole, Skagit County and its planning partners continue to move forward in developing policies directing land use and dealing with zoning, density and permitting for any new development. This will provide the capability to protect future development from the impacts of drought.

5.5 ISSUES

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.

5.6 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 a drought incident occurring in 2015. 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, including Skagit County, already issuing declarations in April and June 2019. With anticipated increase in temperatures as a result of climate change, drought situations will only intensify. With the planning area's dependence on agriculture, there is a significant potential economic loss in the region. 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.

Skagit County 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 and governmental agencies work cooperatively with the Washington State Department of Health and the Washington State Department of Ecology 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 2.55, with overall vulnerability determined to be a low level.

CHAPTER 6.
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.

6.1 GENERAL BACKGROUND

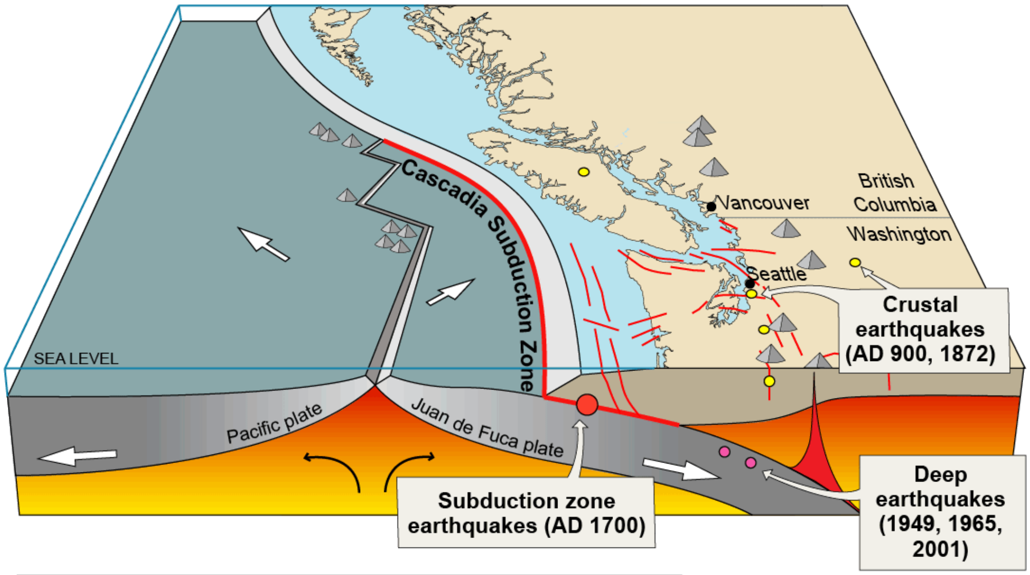
Most destructive quakes are caused by dislocations of the crust. The crust may first bend and then, when the stress exceeds the strength of the rocks, break and snap to a new position. In the process of breaking, vibrations called "seismic waves" are generated. These waves travel outward from the source 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 6-1. More than 90 percent of Pacific Northwest earthquakes occur along the boundary between the Juan de Fuca plate and the North American plate.



Source	Max. Size	Recurrence
Subduction zone	M 9+	200–600 years
Deep Juan de Fuca plate	M 7+	30–50 years
Crustal faults	M 7+	Hundreds of years?

Volcano

Active crustal fault

Active plate boundary fault

*figure modified from USGS Cascadia earthquake graphics at http://geomaps.wr.usgs.gov/pacnw/pacnweq/index.html

Figure 6-1 Earthquake Types in the Pacific Northwest and Recurrence Intervals

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.

6.1.1 Earthquake Classifications

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

Magnitude

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

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

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

Intensity

There are many measures of the severity or intensity of earthquake ground motions. The Modified Mercalli Intensity scale (MMI) (Table 7-1) was widely used beginning in the early 1900s. MMI is a descriptive, qualitative scale that relates severity of ground motions to the types of damage experienced. MMI values range from I to XII (USGS, 1989):

TABLE 6-1 MODIFIED MERCALLI INTENSITY (MMI) SCALE DESCRIPTIONS

MMI VALUE	DESCRIPTION
I	Not felt except by a very few under especially favorable conditions
II	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it is an earthquake. Standing cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.

TABLE 6-1 MODIFIED MERCALLI INTENSITY (MMI) SCALE DESCRIPTIONS	
IV	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like a heavy truck striking building. Standing cars rocked noticeably.
V	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Felt by all; many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Damage negligible in buildings of good design and construction; slight in well-built ordinary structures; considerable in poorly built or badly designed structures. Some chimneys broken.
VIII	Damage slight in specially designed structures; considerable damage in ordinary buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
XI	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
X	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 (see Figure 6-2).[20]

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.

[20] USGS. Accessed 6/5/19. Available at: https://earthquake.usgs.gov/earthquakes/byregion/washington.php

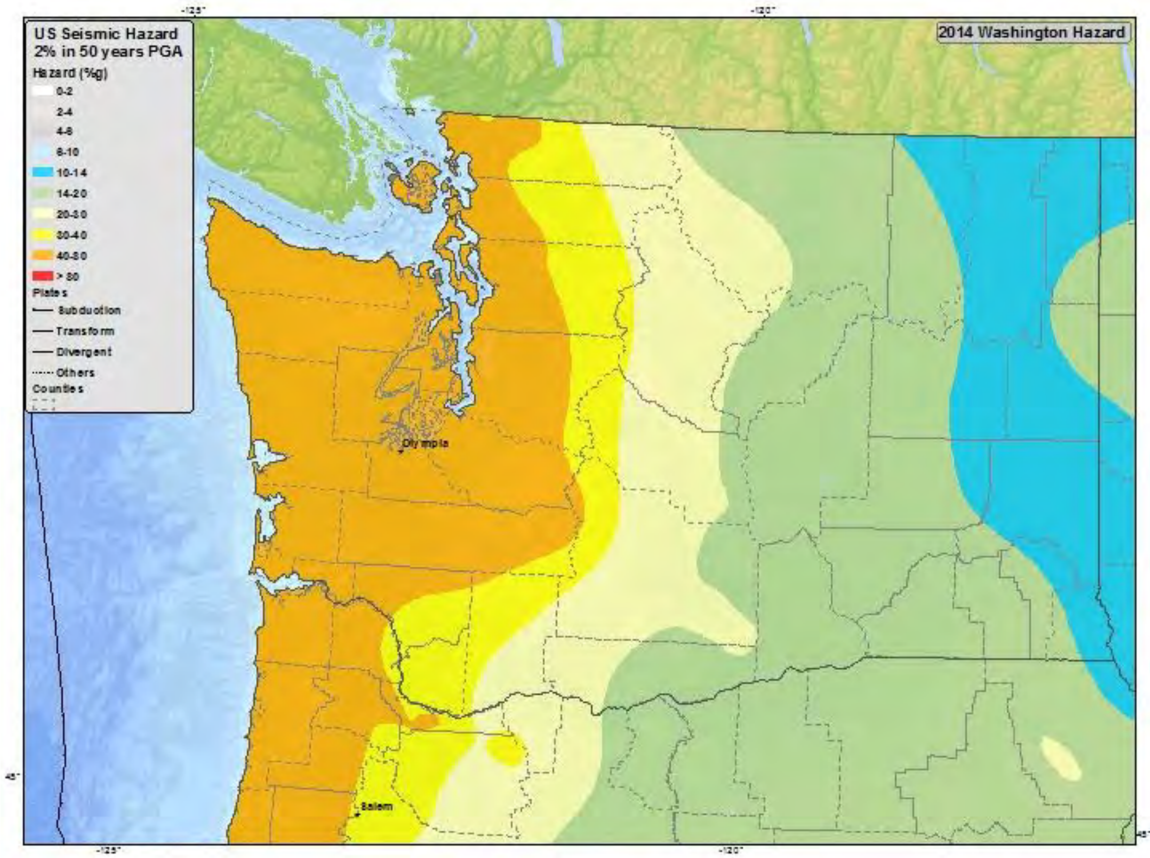


Figure 6-2 USGS PGA for Washington State (2014)

PGA is the basis of seismic zone maps that are included in building codes such as the International Building Code. Skagit County's Seismic Zone Map is illustrated in Figure 6-3.[21] 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.

[21] Washington State Department of Natural Resources (2007). Accessed May 2019. Available at: https://www.dnr.wa.gov/programs-and-services/geology/geologic-hazards/geologic-hazard-maps#seismic-design-categories

- 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.
- A 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 6-2 identifies damage potential and perceived shaking by PGA factors, compared to the Mercalli scale.

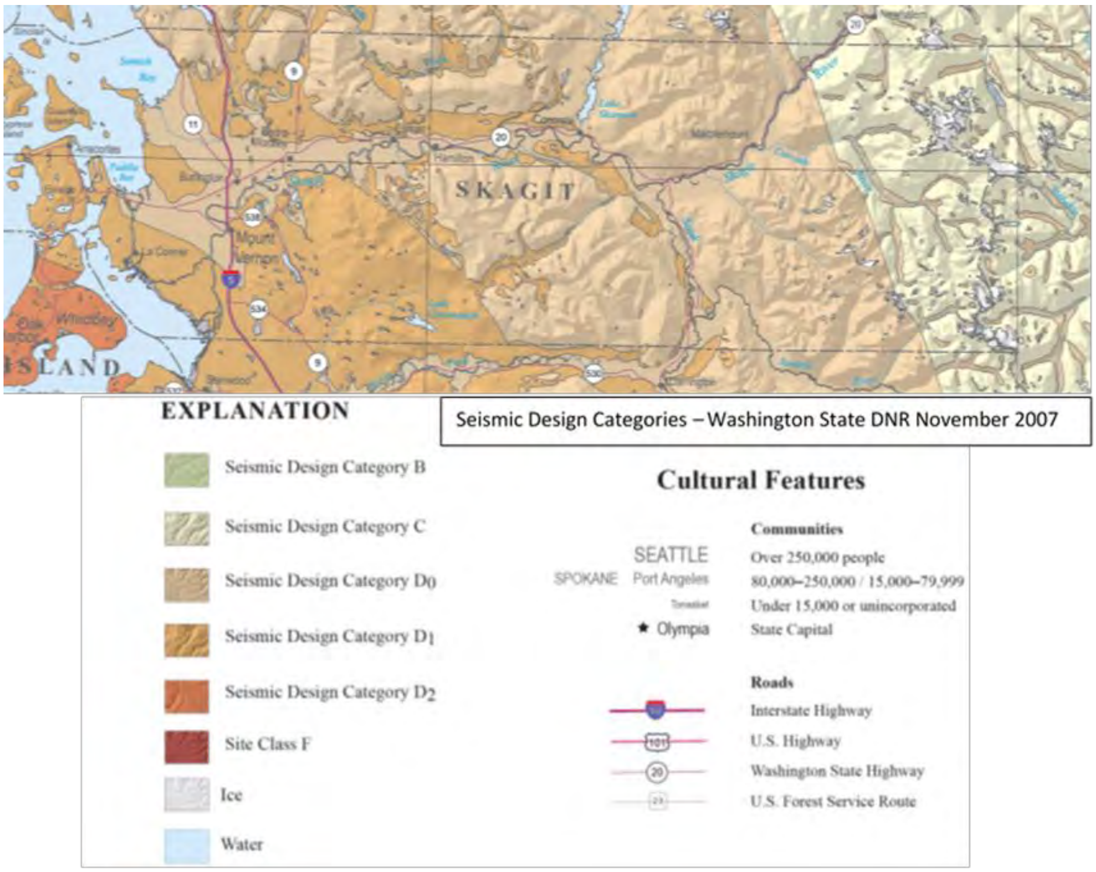


Figure 6-3 Skagit County Seismic Design Codes

Table 6-2
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

6.1.2 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. Figure 6-4 identifies the soils classifications for Skagit County.

Table 6-3 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 6-3
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)	

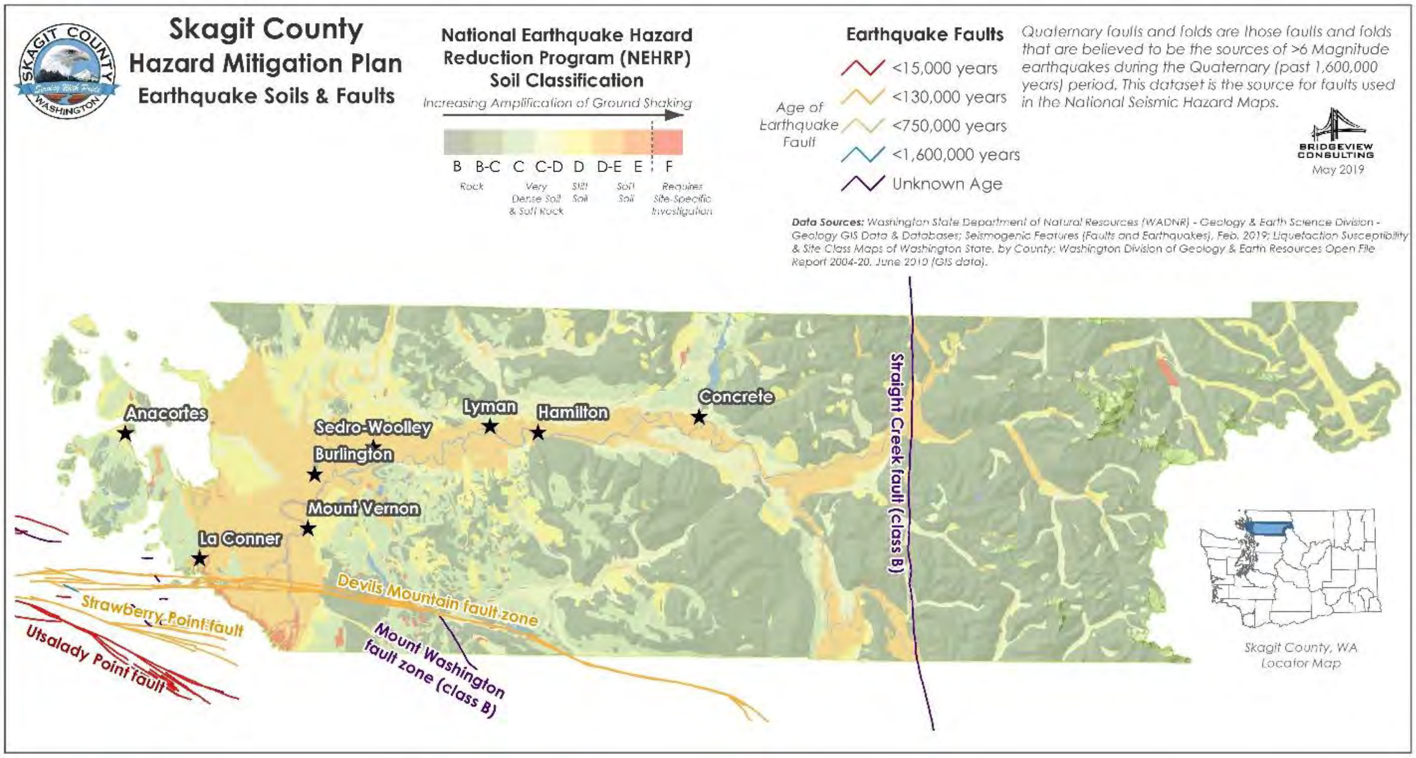


Figure 6-4 Skagit County NEHRP Soils Classifications and Local Area Faults

Table 6-4
Acres of NEHRP Soil Classification by Type Countywide

NEHRP Soil Type	Description	Mean Shear Velocity to 30 Meters (m/s)	# of Acres within Unincorporated Skagit County	# of Acres w/in Anacortes	# of Acres w/in Burlington	# of Acres w/in Concrete	# of Acres w/in Hamilton	# of Acres w/in La Conner	# of Acres w/in Lyman	# of Acres w/in Mount Vernon	# of Acres w/in Sedro-Woolley	# of Acres w/in Swinomish Indian Tribal Community	# of Acres w/in Upper Skagit Indian Tribe	# of Acres w/in Sauk-Suiattle Tribe
A	Hard Rock	1,500	15,634.1	0	0	0	0	0	0	0	0	0	0	0
B	Firm to Hard Rock	760-1,500	606,265.8	2,696.9	114.1	43.7	0	48.1	0	353.9	59.7	280.2	0	0.02
C	Dense Soil/Soft Rock	360-760	121,986.6	3,198.1	17.7	0	0	0	0	1,674.2	0	5,508.5	127.0	4.9

Table 6-4
Acres of NEHRP Soil Classification by Type Countywide

NEHRP Soil Type	Description	Mean Shear Velocity to 30 Meters (m/s)	# of Acres within Unincorporated Skagit County	# of Acres w/in Anacortes	# of Acres w/in Burlington	# of Acres w/in Concrete	# of Acres w/in Hamilton	# of Acres w/in La Conner	# of Acres w/in Lyman	# of Acres w/in Mount Vernon	# of Acres w/in Sedro-Woolley	# of Acres w/in Swinomish Indian Tribal Community	# of Acres w/in Upper Skagit Indian Tribe	# of Acres w/in Sauk-Suiattle Tribe
D	Stiff Soil	180-360	192,864.3	1,215.3	0	152.8	248.2	0	11.2	3.520.3	555.5	278.6	616.9	19.4
E	Soft Clays	< 180	154,124.7	635.7	2,707.7	568.9	466.1	220.2	477.2	2,502.8	2,127.7	1,347.2	4.1	320.4
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 m thick)	0.0	0	0	0	0	0	0	0	0	0	0	0	0

6.1.3 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.

6.2 HAZARD PROFILE

Seismic-related hazards in Skagit 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. The Puget Sound region is entirely within Seismic Risk Zone 3, requiring that buildings be designed to withstand major earthquakes measuring 7.5 in magnitude. It is anticipated, however, that earthquakes caused from subduction plate stress can reach a magnitude greater than 8.0.

High-magnitude earthquakes are possible in Skagit County when the Juan de Fuca slips beneath the North American plates. Deep zone or Benioff zone quakes have occurred within the Juan de Fuca plate (1949, 1965, and 2001) and can be expected in the future.

6.2.1 Extent and Location

Washington State as a whole is one of the most seismically active states in United States. Figure 6-4 depicts the faults known or suspected to be active within Skagit and the immediately-surrounding areas, while Figure 6-5 identifies faults statewide.

Local Faults

There are a number of faults running near or through Skagit County, including the Bellingham Bay—Lake Chaplain Fault, the Ross Lake Fault and the Hamilton Fault, which may or may not be active (Skagit County HMP, 2015.)

One of the most notable faults, according to the Washington State Department of Natural Resources Geology Division, is the Devils Mountain Fault lying near Mt. Vernon which is roughly 125 km (78 miles) long, runs generally east to west through Darrington in Snohomish County to Vancouver Island, Canada, and has been determined to be active with at least one earthquake generated about 2,000 years ago (Personius and others, 2014). If a magnitude seven (M7) or greater the event was to occur, it would affect 15 counties with Skagit County being the greatest impacted. Additional information is available from Washington State Department of Natural Resources Scenario catalogue, available at: https://fortress.wa.gov/dnr/seismicscenarios/index.html?config=canyonRiver.xml.

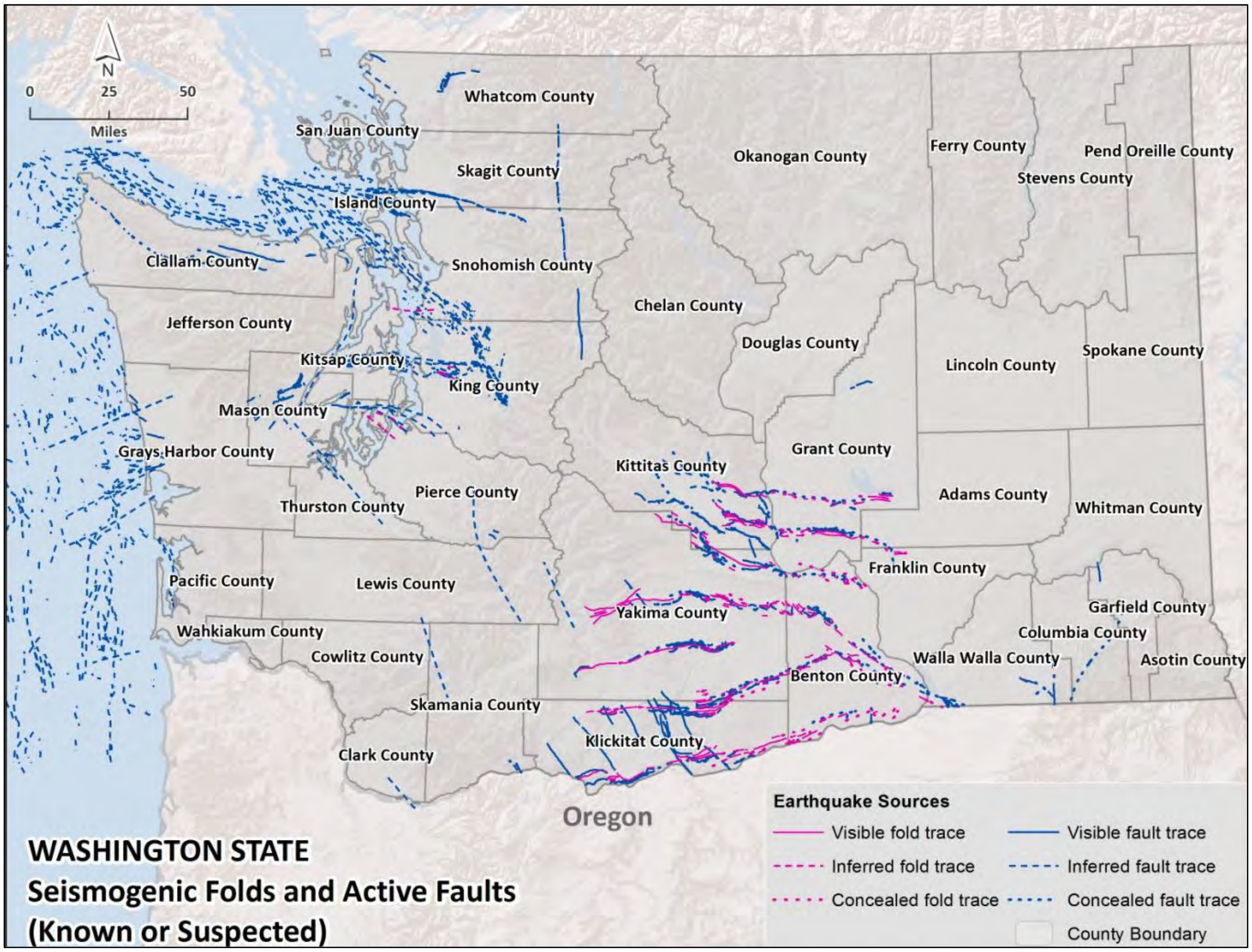


Figure 6-5 Washington State Seismogenic Folds and Active Faults (2013 HMP)

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.

ShakeMaps

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

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

- A probabilistic seismic hazard map shows the hazard from earthquakes that geologists and seismologists agree could occur. The maps are expressed in terms of probability of exceeding a certain ground motion, such as the 10 percent probability of exceedance in 50 years. This level of ground shaking has been used for designing buildings in high seismic areas. Hazard maps for the 100-year and 500-year probabilistic earthquakes, as well as a comparison map of the two, are shown on Figure 6-6, Figure 6-7 and Figure 6-8.
- 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. The Devils Mountain M7.5 Earthquake (Figure 6-9) was chosen for this plan.

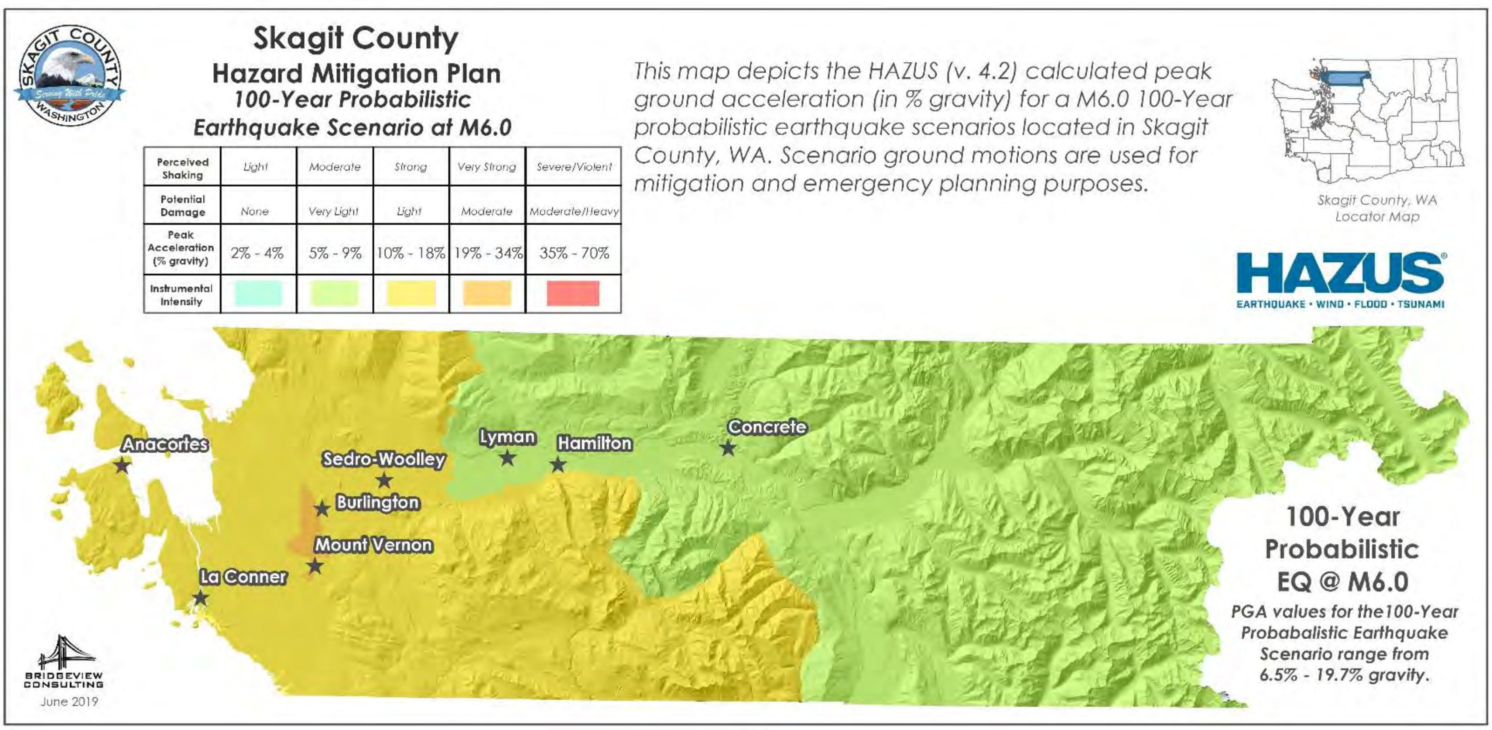


Figure 6-6 100-Year Probabilistic Earthquake Event

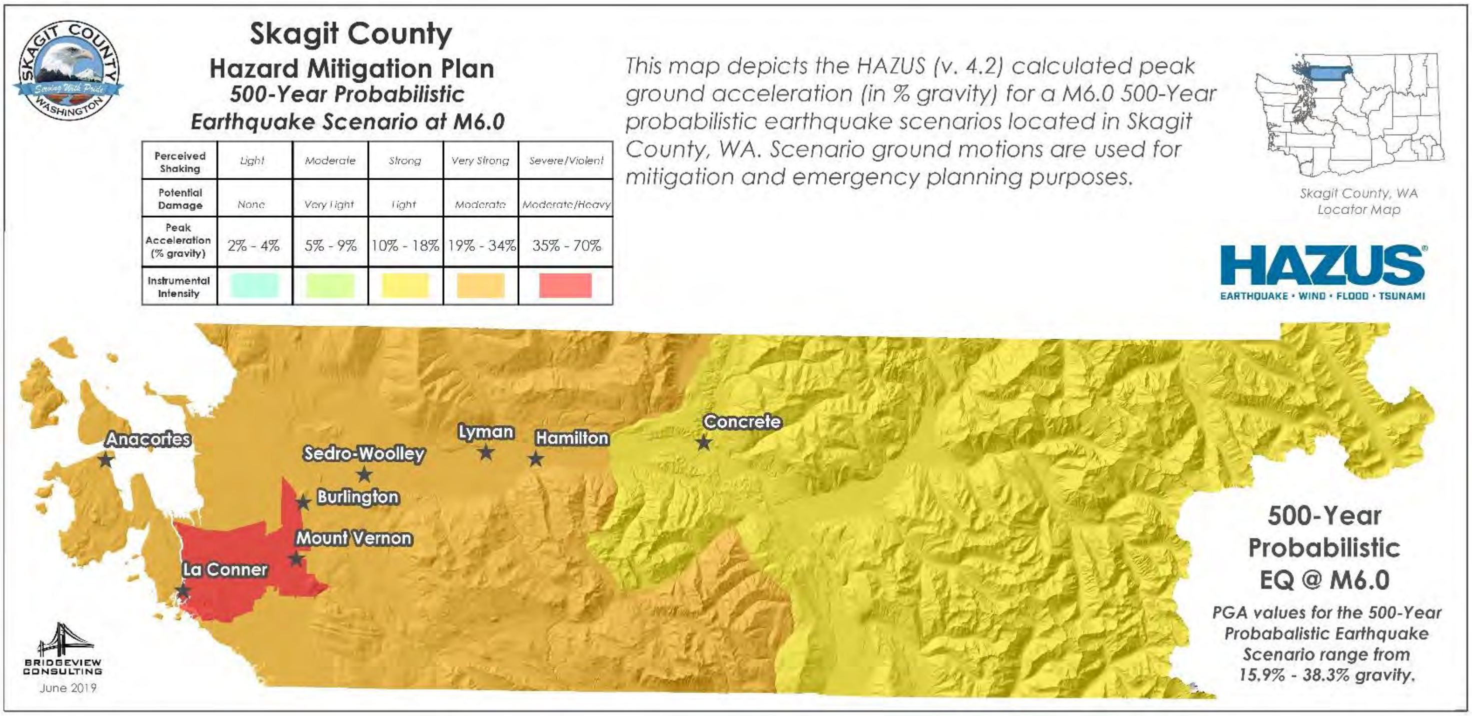


Figure 6-7 500-year Probabilistic Earthquake Event

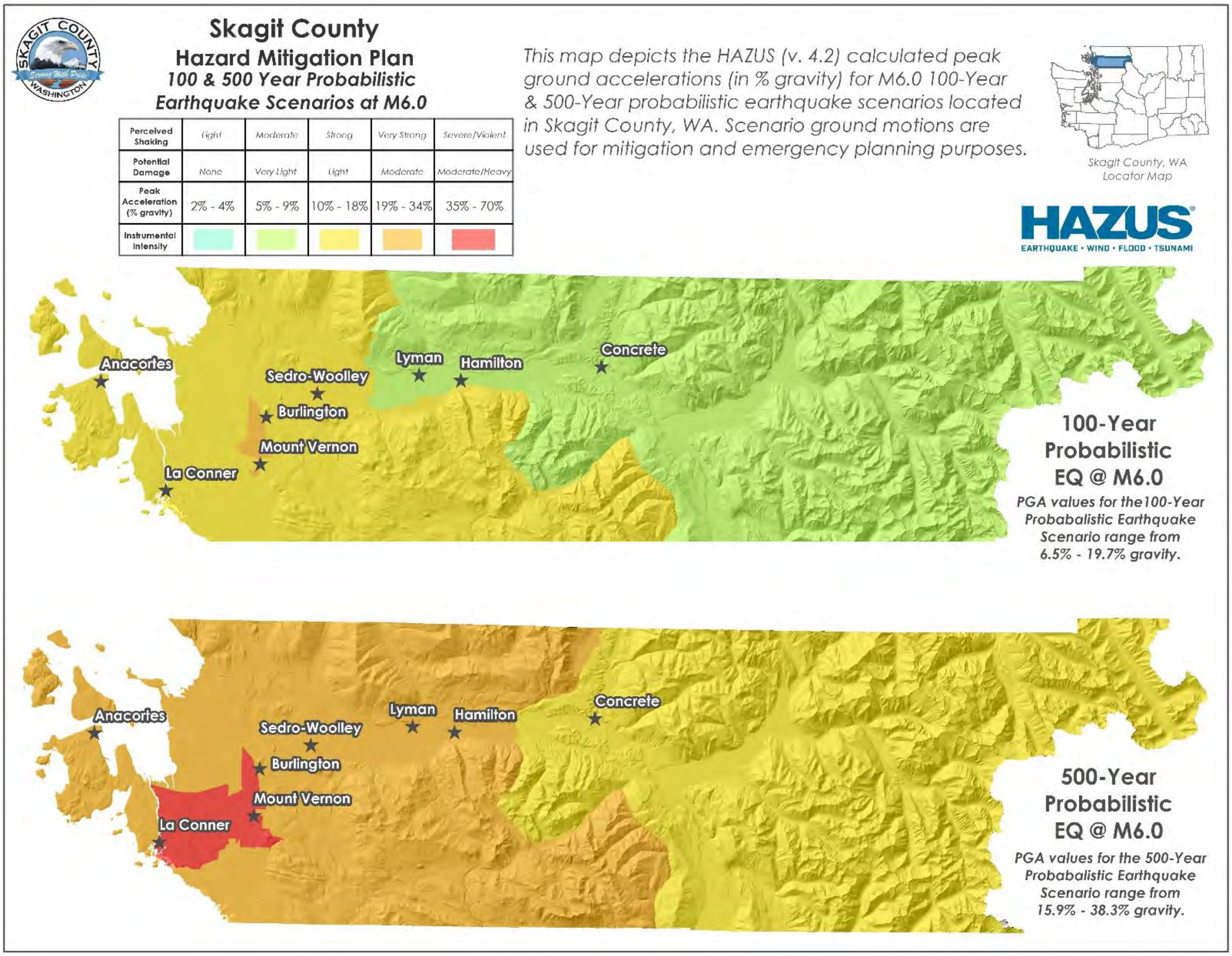


Figure 6-8 Comparison of 100- and 500-year Probabilistic Earthquake Events

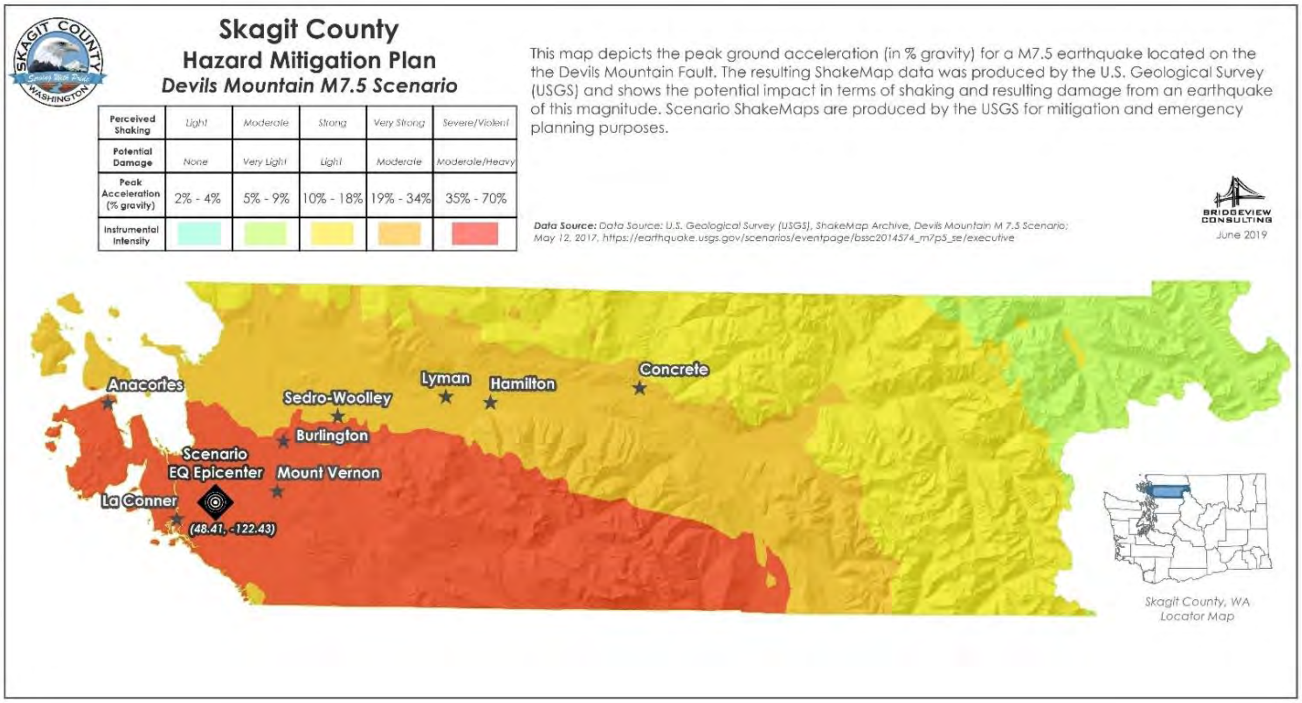


Figure 6-9 Devils Mountain M7.5 Fault Scenario - Modified Mercalli Shaking Intensity

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. Figure 6-10 shows liquefaction susceptibility throughout the County.

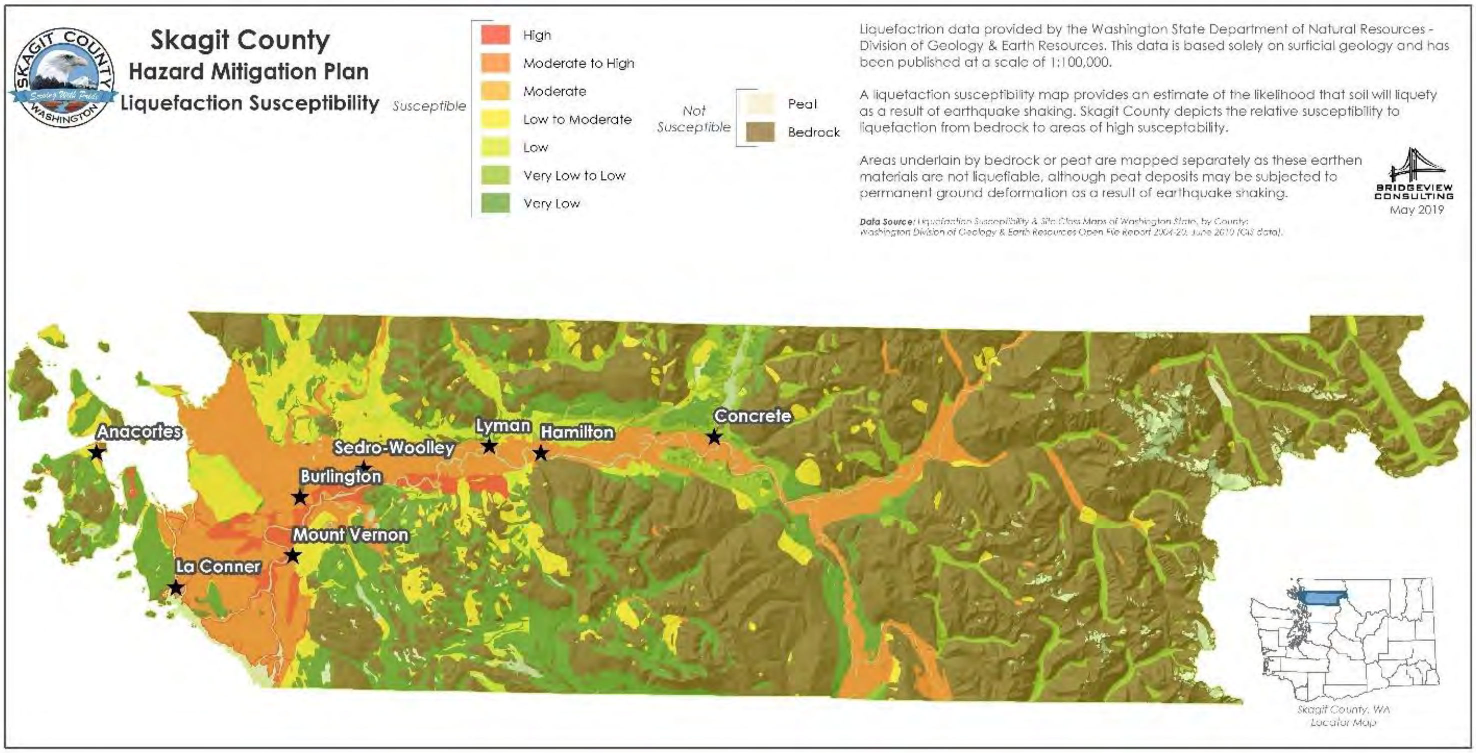


Figure 6-10 Liquefaction Susceptibility Zones

6.2.2 Previous Occurrences

Earthquakes have been reported in Skagit County from as early as the 1872 North Cascades quake, and include earthquake events occurring in 1909, 1915, 1920 (Ludwin, 2006), 1949, 1965 (Noson and others, 1988). No major damaging earthquakes have been definitively identified to have occurred within the county prior to the advent of the Puget Sound Seismic Network in 1969.

The largest earthquake recorded in Skagit County by PNSN was a magnitude 4.6 event on November 9, 1969, near Marblemount. It was located at a depth of about 8 miles, which makes it a shallow crustal event, rather than an earthquake that takes place in the subducting crust. This earthquake had M4.3 and M4.0 foreshocks and a rich aftershock sequence, all at depths of less than about 1 mile.

The Nisqually earthquake occurred February 2, 2001 with the epicenter about 11 miles northeast of the City of Olympia. It was a deep magnitude 6.8 event and due to extensive damage in several counties, was declared Federal Disaster #1361. One person died of a heart attack; 700 people were injured; damages were greater than $1,000,000,000 as a result of the Nisqually Earthquake. In Skagit County, public damage totaled almost $175,000 and 402 private damage claims were submitted to FEMA totaling just over $479,000.

The largest earthquake threat to the state as a whole would likely be from a Cascadia Subduction Zone earthquake. The fault runs from California to British Columbia. Abundant physical evidence for an earthquake in AD 1700 includes evidence for abrupt tectonic subsidence. This event was probably about M9 and is one of the largest earthquakes in historic or paleoseismic record. The evidence for this earthquake is documented in Atwater and others (2005) and Goldfinger and others (2012). This fault has an average recurrence interval of approximately 500 years for earthquakes of about M9.

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 6-5 lists past seismic events that have affected the areas in and around Skagit County.[22] The county has received one disaster declaration as a result of earthquake damage – the Nisqually Earthquake, which occurred on February 28, 2001. Figure 6-11 and Figure 6-12 are news articles relating to previous occurrences of earthquakes within Washington.

Table 6-5
Historical Earthquakes Impacting The Planning Area

Year	Magnitude	Epicenter	Type
8/26/2004	3.5	Unknown*	Shallow Crustal
6/10/2001	5.0	Matlock	Benioff
2/28/2001 (DR 1361)	6.8	Olympia (Nisqually)	Benioff
7/3/1999	5.8	8.0 km N of Satsop	Benioff
8/1997	3.4	Unknown*	Unknown
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
10/25/1991	3.4	Unknown*	Unknown
4/14/1990	5.0	Deming Area	Crustal
8/23/1982	3.6	Unknown*	Unknown
2/14/1981	5.5	Mt. St. Helens (Ash)	Crustal
9/9/76	4.5	Union	Benioff Zone (28 miles deep)
12/13/1971	3.6	Unknown*	Unknown
5/11/1965 (DR 196)	6.6	18.3 KM N of Tacoma	Benioff
4/29/1965	6.5	12 miles North of Tacoma	Benioff
4/13/1949	7.1	Olympia*	Unknown
1/13/1949	7.0	12.3 KM ENE of Olympia	Benioff
6/23/1946	7.3	Strait of Georgia	Benioff
2/14/1946	6.3	Puget Sound	Benioff
4/29/1945	5.7	Northbend (8 miles south/southeast)	Unknown
11/13/1939	5.8	Puget Sound – Near Vashon Island	Unknown
5/15/1936	5.7	Southwest Washington	Crustal
7/17/1932	5.3	Central Cascades	Unknown
1/23/1920	5.5	Puget Sound	Unknown
12/6/1918	7.0	Vancouver Island	Unknown

[22] PNSN, 2019

Table 6-5
Historical Earthquakes Impacting The Planning Area

Year	Magnitude	Epicenter	Type
8/18/1915	5.6	North Cascades	Unknown
1/11/1909	6.0	Puget Sound (Grays Harbor Earthquake)	Unknown
3/6/1904		Washington coastline and Olympic Mountains	Unknown
11/30/1891		Slight earthquake felt in County*	Unknown
3/27/1884		Hoquiam*	Unknown
4/30/1882	5.8	Olympia area	Unknown
12/12/1880		2 shocks felt*	Unknown
12/15/1872	6.8	Pacific Coast	Unknown

*Earthquake Events identified in 2011; no further data available.
Source: Pacific Northwest Seismic Network


British, French Troops Violate Sovereignty of Levant, Say Russ

SECOND QUAKE WAKENS SLEEPERS!

GREEN RAPS NEW PRICE-WAGE PLAN

CLOUDY; COOLER

The Seattle Daily Times

SUNSET FINAL
LATEST CITY NEWS

ACKWARD TEP, SAYS A.F.L. HEAD

Lebanon Asks Immediate Removal Of All Forces

WHERE BRICK WALL FELL IN QUAKE

MOST OF STATE BADLY SHAKEN; LOSSES HEAVY

Daily No-Stop L. A.-to-N. Y. Flights Begin

U. S. ASKS DATA

1 Dead, 17 Hurt As Police Rout

FLYER, BAILING

F. R., Handed Note, Dec. 6,

Asylum Aides Quit; Patients Roam Streets

Figure 6-11 Seattle Times Article - February 14, 1946 Earthquake

Figure 6-12 April 29, 1965 Earthquake

6.2.3 Severity

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

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

USGS ground motion maps based on current information about fault zones show the PGA that has a certain probability (2 or 10 percent) of being exceeded in a 50-year period. The PGA is measured in %g. Figure 6-13 shows the PGA with a 2 percent exceedance chance in 50 years in Washington.

Effects of a major earthquake in the Puget Sound basin area could be catastrophic, providing the worst-case disaster short of drought-induced wildfire sweeping through a suburban area. Hundreds of residents could be killed and a multitude of others left homeless.

For Skagit County, the Devils Mountain Fault, which is roughly 78 miles long and runs east to west through Snohomish County to Vancouver Island, Canada, has been determined to be the event of greatest concern for Skagit County. If a Magnitude 7.5 event or greater were to occur, it would affect 15 counties with Skagit County being the greatest impacted.

Although recorded damage sustained to date in Skagit County has been relatively minor and has been restricted to some incidence of cracked foundations, walls and chimneys, and damage to private wells, depending on the time of day and time of year, a catastrophic earthquake could cause hundreds of injuries, deaths and hundreds of thousands of dollars in property damage.

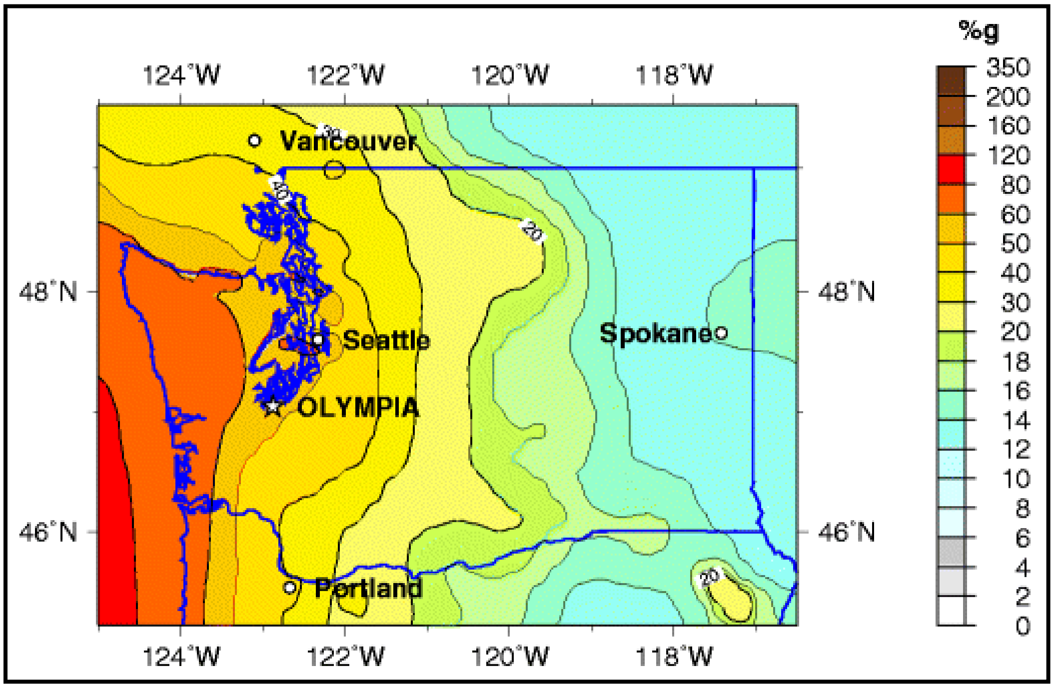


Figure 6-13 PGA with 2-Percent Probability of Exceedance in 50 Years, Northwest Region

6.2.4 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 more and more available (USGS, 2015a).

- Current estimates of the likelihood of another potentially damaging intraplate earthquake during a 50-year time window with the Puget Sound region put the probability at 84 percent, with somewhat lower probabilities as one goes southward (Earthquake Hazard Program, 2012, as cited in SKHMP 2015).

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

- The 300+ years since the last major Cascadia Subduction Zone earthquake is longer than the average of about 250 years for M8 or greater and shorter than some of the intervals between M9.0 earthquakes.
- Scientists currently estimate the frequency of deep earthquakes similar to the 1965 Magnitude-6.5 Seattle-Tacoma event and the 2001 Magnitude-6.8 Nisqually event as about once every 35 years. The USGS estimates an 84-percent chance of a Magnitude-6.5 or greater deep earthquake over the next 50 years.
- Scientists estimate the approximate recurrence rate of a Magnitude-6.5 or greater earthquake anywhere on a shallow fault in the Puget Sound basin to be once in about 350 years. There have been four earthquakes of less than Magnitude 5 in the past 20 years.
- Earthquakes on the 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.

6.3 VULNERABILITY ASSESSMENT

6.3.1 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. Impact from other parts of the state could require shipment of supplies via a barge to certain areas within Skagit County.

The following are also general areas of vulnerability to be considered:

- Large hazardous materials incidents may occur as the result of damage to local oil refineries, chemical plants, rail lines and major petroleum pipelines.
- Levees and salt-water dikes may be damaged.
- Large hydroelectric dams located in eastern Skagit County and Whatcom County may be damaged or possibly fail causing possible flooding of those areas located within the 100-year and possibly the 500-year floodplain.
- Localized seiche action in local waters may result in increased levels of damage along shoreline areas within the county.
- The arrival of outside resources to assist with debris removal, repair of critical facilities, and sheltering of victims may be delayed due to severe damage in adjacent counties with larger populations and needs.
- The overall economy of the county and possibly the region could be affected.

- Large areas of western Skagit County lying within the floodplains of the Samish River and the Skagit River are susceptible to liquefaction.

Methodology and Limitations

Due to the lack of digital parcel-based information in an acceptable GIS format for the planning area, a detailed analysis of the building stock was not possible. However, FEMA, through the RiskMap program, conducted a risk assessment of Skagit County on two separate occasions within the last five years, the most recent dated in 2017. That assessment included all hazards of concern. As such, the Steering Committee determined that the best course of action for this risk assessment was to utilize, when possible, FEMA's 2017 risk study, supplanting the information with more current or best available data where available. Readers should consider these variations when identifying inconsistencies in building counts, as different datasets were required to meet planning guidance. This deficiency has been identified as a potential strategy for the County to address during the lifecycle of this plan.

The FEMA study utilized the Devil's Mountain M7.4 scenario in addition to identification of general building losses and loss ratios for the Cascadia M9.0 and Southern Whidbey M7.4 earthquake events. FEMA loss ratios were calculated by dividing the dollar loss by the total building value. The loss values represent building losses only (additional damage to infrastructure and building contents are not captured). (NOTE: The actual geodatabase containing the FEMA data was not accessible during the update. FEMA's full methodology is contained within the 2017 RiskMap Report, available from Skagit County Department of Emergency Management.)

In addition to FEMA's analysis, during this update process, the consultant utilized the Hazus model to determine earthquake vulnerability data using the Devils Mountain M7.5 Scenario Shakemap for identification of additional impact to the earthquake hazard, including identification of debris. Utilizing the Hazus model and the USGS Shakemaps, once the location and size of an earthquake were identified, Hazus estimated the intensity of the ground shaking, a generalized assessment of the number of buildings damaged, the number of casualties, damage to transportation systems and utilities, the number of people displaced from their homes, and the estimated cost of repair and clean up.

Once the Assessor's parcel data is updated and becomes available, another analysis may be conducted, which undoubtedly will render more accurate and different results. While this level of analysis meets the intent for planning purposes, *such outputs should not be considered for any life-safety measures*.

Warning Time

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

6.3.2 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. Skagit County has a fairly high population of retirees and individuals with disabilities, both higher than the state averages. 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.

The number of people without power or water will be high, especially given the number of wells on which the County and its jurisdictions rely to supply water to individuals who most likely do not have generators to run pumps on the wells. Public water utilities anticipate damage and disruption of the distribution system, which may cause delays in delivering water to residents. These needs will increase the number of individuals seeking shelter assistance.

Based on the Devils Mountain M7.5 Shakemap Scenario, Hazus has estimated that there will be approximately 2,333 displaced households resulting from a similar event, with approximately 1,546 individuals seeking temporary public shelters.

Hazus also estimates casualties based on the number of people that will be injured or potentially killed by an earthquake. Causalities are broken down into four severity levels, as follows:

– Severity Level 1: Injuries will require medical attention, but hospitalization is not needed.
– Severity Level 2: Injuries will require hospitalization, but are not considered life-threatening.
– Severity Level 3: Injuries will require hospitalization, and can become life-threatening if not promptly treated.
– Severity Level 4: Victims are killed by the earthquake.

Causality estimates are also provided for three times per day, as follows:

– 2:00 a.m. - Considers residential occupancy load is at maximum;
– 2:00 p.m. - Estimates that educational, commercial and industrial sector loads are at maximum; and
– 5:00 p.m. - Represents peak commute times.

It should be noted that there are significant variables that exist in the data which is used to populate the inputs necessary to reach these conclusions, which include the type of structure, year built, remodeling, engineered assessments, etc. All of these factors play a significant role in determining potential impact, and therefore any outputs from the Hazus model are considered to have a high rate of error unless better, more accurate (engineered) building specific data is utilized. As such, outputs should be considered for planning purposes only, and in no manner should be considered for life-safety measures.

Based on the Hazus outputs for the Devils Mountain M7.5 scenario, casualty estimates based on the Severity Level and Time of Day are identified in Figure 6-14.

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	22.69	7.01	1.17	2.31
	Commuting	0.11	0.15	0.25	0.05
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	28.06	8.51	1.37	2.71
	Other-Residential	362.94	95.26	10.52	19.66
	Single Family	132.67	20.25	1.94	3.82
	Total	**546**	**131**	**15**	**29**
2 PM	Commercial	1356.07	418.37	70.00	137.52
	Commuting	1.02	1.31	2.27	0.44
	Educational	401.73	126.47	21.89	42.92
	Hotels	0.00	0.00	0.00	0.00
	Industrial	207.02	62.61	10.15	19.80
	Other-Residential	76.84	20.24	2.30	4.22
	Single Family	29.62	4.45	0.42	0.79
	Total	**2,072**	**633**	**107**	**206**
5 PM	Commercial	985.00	303.39	50.99	98.84
	Commuting	18.28	23.50	40.73	7.83
	Educational	25.74	8.13	1.41	2.77
	Hotels	0.00	0.00	0.00	0.00
	Industrial	129.39	39.13	6.35	12.37
	Other-Residential	134.04	35.38	4.03	7.41
	Single Family	50.69	7.69	0.74	1.40
	Total	**1,343**	**417**	**104**	**131**

Figure 6-14 Hazus Casuality Loss Outputs Devils Mountain M7.5 Scenario (2019)

6.3.3 Impact on Property

Based on Hazus outputs, there are over 48,000 buildings in the planning area (based on the 2019 Hazus analysis). Most of the buildings (92 percent) are residential, and much of the building stock is of considerable age and not supported by building codes which increase resilience to seismic events (see Section 3 for discussion of structure age). 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. Approximately 80 percent of the building inventory is wood-frame construction. Since all structures in the planning area are susceptible to earthquake impacts to varying degrees (including liquefaction and landslides), these figures represent total numbers county-wide for property exposure to seismic events.

A summary of the total potential building-related loss based on FEMA's 2017 report are identified in Table 6-6.[23] It is noted that there is a significant variation in the number of structures identified in the FEMA 2017 study versus the 2019 study of over 12,000 structures.

Table 6-6
Hazus Earthquake Results for Selected Scenarios*

Community	Total Estimated Building Value	Total Number of Buildings	Building Dollar Loss for a Devils Mountain West M7.4 Event	Loss Ratio (Dollar Losses/Total Building Value) Devils Mountain West Fault M7.4 Event	Building Dollar Loss for a Southern Whidbey M7.4 Event	Loss Ratio (Dollar Losses/Total Building Value) Southern Whidbey M7.4 Event	Building Dollar Loss for a Cascadia M9 Event	Loss Ratio (Dollar Losses/Total Building Value) Cascadia M9 Event
Anacortes	$1.3B	6,348	$127.4M	9.8%	$15.4M	1.2%	$15.1M	1.2%
Burlington	$547.2M	1,447	$ 44.6M	8.2%	$ 2.4M	<1%	$9.0M	1.6%
Concrete	$29.3M	144	$ 327.3k	1.1%	$168.9K	<1%	$868.2K	3.0%
Hamilton	$3.2M	36	$ 159.1k	5.0%	$51.3K	1.6%	$90K	2.8%
La Conner	$26.1M	140	Outputs incorrect	Outputs incorrect	$523.7K	2.0%	$633.1K	2.4%
Lyman	$12.3M	151	$ 533.9k	4.3%	$51.3K	<1%	$173.6K	1.4%
Mount Vernon	$1.5B	7,896	$274.1M	18.3%	$16.4M	1.1%	$44.3M	3.0%
Sedro-Woolley	$244.4M	1,593	$15.2M	6.2%	$589K	<1%	$4.2M	1.7%
Swinomish Indian Tribal Community	$155.4M	965	$25.4M	16.3%	$1.7M	1.1%	$2.0M	1.3%
Upper Skagit Indian Tribe	$4.8M	53	$212.1k	4.4%	$15.5K	<1%	$62.4K	1.3%
Unincorporated Skagit County	$3.2B	17,736	$382.5M	12.0%	$26.3M	<1%	$60.8M	1.9%
Total	$7.0B	36,509	$915.1M	13.0%	$63.6M	<1%	$93.0M	1.3%

**Based on FEMA RiskMap Report (October 2016)*

[23] FEMA 2017 Risk Report Data

Based on FEMA's assessment, the City of Burlington and the towns of Hamilton and Lyman have the largest percentage of buildings located in the moderate-high liquefaction zone (Risk Report, 2017). The Devil's Mountain (West) fault generates the largest amount of damages, which would total almost $875 million, which is equivalent to 16.3 percent of damage to the building stock. The losses reported above are for building losses. Therefore, additional damage to infrastructure and building contents were not included in the table above. These losses should be considered as a minimum.

Building Age

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

The State of Washington adopted the UBC as its state building code in 1972, so it is assumed that buildings in the planning area built after 1972 were built in conformance with UBC seismic standards and have less vulnerability. Issues such as code enforcement and code compliance could impact this assumption. Construction material is also important when determining the potential risk to a structure. However, for planning purposes, establishing this line of demarcation can be an effective tool for estimating vulnerability. In 1994, seismic risk Zone 3 standards of the UBC went into effect in Washington, requiring all new construction to be capable of withstanding the effects of 0.3 g. More recent housing stock is in compliance with Zone 3 standards. In July 2004, the state again upgraded the building code to follow International Building Code Standards. While the "zones" are still referenced, they are, in large part, no longer used in the capacity they once were as there can be different zones within political subdivisions, making it difficult to apply. For instance, within Washington, there are both Seismic Zones 2B and 3. The Hazus analysis also considers the age in which buildings were built to a specific building code. Hazus identifies key changes in earthquake building codes based on year. Homes built prior to 1941 are considered pre-code; they were constructed before earthquake building codes were put in place. Homes constructed after 1941 are considered moderate code and may include some earthquake building components. Chapter 3, Section 3.8.2 identifies the age of building structures countywide.

6.3.4 Impact on Critical Facilities and Infrastructure

All critical facilities in Skagit 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. This is particularly of concern in the areas with refineries, such as Anacortes. A large area of the county is also coastal. As such, hazardous materials are of particular concern with respect to spills into water bodies, including the coastline or significant rivers in the area, which could have devastating impact.

Closure of major arterials could require increased evacuation periods in some instances by several hours. In some instances, commodities would also be impacted in areas, requiring supplies by air or water. Figure 6-15 and Figure 6-16 illustrate Hazus outputs for impact to transportation systems. It should be noted by viewers that such data is based on Hazus default data, and may not reflect accurate numbers, but demonstrate the potential impact for planning purposes for response and recovery.

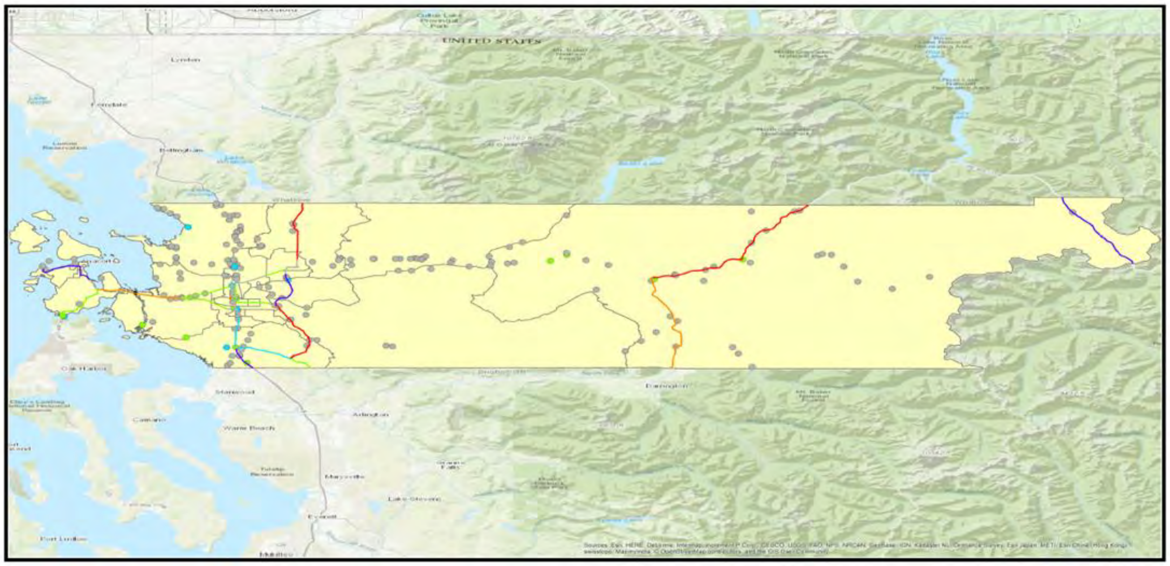


Figure 6-15 Transportation Systems Impact Skagit County (Hazus Output, 2019)

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	63	0	0	63	63
	Bridges	212	44	12	165	189
	Tunnels	0	0	0	0	0
Railways	Segments	41	0	0	41	41
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	2	2	0	1	2
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	1	0	0	1	1
Ferry	Facilities	3	0	0	3	3
Port	Facilities	23	0	0	23	23
Airport	Facilities	2	1	0	2	2
	Runways	3	0	0	3	3

Figure 6-16 Hazus Output - Expected Damage to Transportation Systems

In the event of a major earthquake, large areas of western Skagit County lying within the floodplains of the Samish River and the Skagit River are susceptible to liquefaction. Magnitude 7+ earthquakes can potentially trigger slope failures as well.

The potential for landslide-induced roadway closure is of significant concern, in addition to the steep and/or unstable slopes in various locations throughout the county which are also susceptible to landslides. Large earthquake events may cause large-scale landslides or avalanches on steep mountains slopes as well as possible structural failure of hydroelectric dams located on the Baker River and Skagit River in Eastern Skagit County.

Railways are highly vulnerable to soil liquefaction, landslides, severe ground cracking, uplifting, and subsidence. Railway routes in Skagit County are owned and operated by the Burlington Northern-Sante Fe Railroad. In Skagit County, these routes are located along shorelines and traverse the floodplains of the Skagit River and the Samish River thereby making them especially vulnerable to liquefaction, landslides, severe ground cracking, uplifting, and subsidence.

Airport facilities are also highly vulnerable to soil liquefaction, landslides, severe ground cracking, uplifting, and subsidence. The 2001 Nisqually Earthquake caused severe damage to the control tower at Seattle-Tacoma International Airport and ground cracking damaged the runway at Boeing Field. In addition, airports are highly dependent upon electrical power to maintain radar and communication systems.

The City of Anacortes, Port of Anacortes, as well as the Shell and Marathon oil refineries located on Marches Point in Skagit County are dependent upon substantial marine facilities such as piers, wharfs, and docks to conduct and support business trade and development. Construction of these facilities typically involves shoreline landfill and pilings that are vulnerable to liquefaction resulting in pile failure, loss of load carrying capacity, and possible failure of supported structures.

We are all dependent upon pipelines for the delivery and distribution of natural gas and potable water and the disposal of wastewater. The majority of underground pipelines in Skagit County are located in soils that are vulnerable to liquefaction. The City of Anacortes water system could be especially vulnerable to the effects of a major earthquake. Two water transmission lines run side-by-side for a distance of 17 miles connecting the City of Anacortes Water Treatment Plant located on the Skagit River near Mount Vernon with their distribution system within the City of Anacortes. This same system also supplies water to various areas of unincorporated Skagit County, the Town of La Conner, the oil refineries on Marches Point, as well as the City of Oak Harbor and Naval Air Station Whidbey Island located in Island County.

In addition to water, wastewater, and natural gas distribution pipelines, several major transmission pipelines carrying oil, gasoline, and natural gas are located within Skagit County. Some of these lines (in addition to one large water transmission pipeline) cross the Samish River and Skagit River – some of these pipeline crossings are located underground and some are located aboveground supported by cable suspension structures.

Two large oil refineries (Shell and Marathon) and a chemical plant are located in the Western portion of the county on Marches Point near the City of Anacortes. In addition, Olympic Pipeline Company owns and operates a 20 million gallon fuel storage tank facility and pump station within Skagit County. Each of these facilities has numerous storage tanks containing liquid hydrocarbons – some of these tanks have capacities that exceed 12.8 million gallons. During earthquake events ground movement may cause connecting piping to break and the liquids contained in these tanks may slosh resulting in partial or complete failure of the tanks. Upon tank failure, these liquid fuels may explode and burn.

Skagit County Public Utility District # 1 owns and maintains two earth-fill dams located East of Mount Vernon near Gilligan Creek. These earth-fill dams contain Judy Reservoir with a total water storage capacity of 4,630 acre-feet or 1.5 billion gallons and supplies water to more than 50,000 residents. The reservoir is located in a sparsely populated area but due to the storage capacity of the reservoir and the topography of the area, a sudden failure of either of these earth-fill dams could severely impact areas located downstream of the reservoir causing damage to homes and loss of life.

The West Pass Dike is an earth and rock-filled dam that is owned and maintained by Puget Sound Energy as part of the Baker River Project. The West Pass Dike is located in Eastern Whatcom County on the Baker River and has a water storage capacity of approximately 177,000 acre-feet. The West Pass Dike runs across a low area located to the West of the Upper Baker Dam for the purpose of impounding the waters of Baker Lake between the elevations of 680 feet and 724 feet. The West Pass Dike is located in a very remote area but a partial or total failure of this dam would most definitely have an impact on downstream areas as a result of large amounts of water entering Lake Shannon thereby leading to a possible overtopping the Lower Baker Dam near the Town of Concrete.

Puget Sound Energy and Seattle City Light own and operate large hydroelectric projects on the Baker River and Skagit River respectively. Only one of these dams, the Lower Baker Dam is located in Skagit County, the remaining dams are located in Whatcom County. All of these dams are of Portland Cement Concrete construction and are built and anchored to bedrock.

Due to their close proximity to Mount Baker, the Upper Baker Dam and the Lower Baker Dam are vulnerable to the effects of large-scale landslides, mudflows, lahars, and avalanches originating from the upper slopes of Mount Baker. Gorge Dam, Diablo Dam, and Ross Dam are not vulnerable to the hazards that could be caused by Mount Baker nor are any of the dams on the Baker River or the Skagit River vulnerable to similar hazards originating from Glacier Peak. Because of their location and the storage capacity of their reservoirs, the failure of any one of these dams will have a severe impact on the Eastern portion of Skagit County, the Town of Concrete, and those persons living within the floodway and floodplain of the Skagit River.

Figure 6-17 and Figure 6-18 identify potential infrastructure performance with respect to water, wastewater, power, and natural gas in the area. The first figure identifies the estimated pipeline miles and potential leaks and breaks (based on Hazus default data). The second identifies the total number of households potentially impacted, and the number of days the households may be without service.

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	4,976	3608	902
Waste Water	2,986	1812	453
Natural Gas	1,991	621	155
Oil	0	0	0

Figure 6-17 Potential Utility System and Pipeline Impact

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	45,557	24,715	23,464	20,713	1,155	0
Electric Power		21,260	12,841	5,114	967	30

Figure 6-18 Potable Water and Electric Power System Performance

Bridges are one of the most vulnerable component of highway transportation systems and the loss of bridges will have a direct effect the delivery of emergency services to a large number of Skagit County citizens. Very few bridges in Skagit County have been retrofitted to withstand the effects of a major earthquake. In addition, bridge foundations are typically located in soils susceptible to liquefaction thereby allowing bridge piers to move and bridge girders to collapse.

The bridges listed below are necessary to maintain emergency evacuation routes and deliver emergency services within Skagit County:

Bridge	Owner
Deception Pass State Route 20 Bridge	State
Skagit River Interstate 5 Bridge	State
Skagit River State Route 9 Bridge	State
Skagit River State Route 536 Bridge	State
Skagit River South Fork Bridge	County
Skagit River North Fork Bridge	County
Skagit River Dalles Bridge	County
Skagit River Rockport Bridge	County
Skagit River Riverside Bridge	Municipal
Swinomish Channel State Route 20 Bridge	State
Swinomish Channel Rainbow Bridge	County
Baker River State Route 20 Bridge	State
Sauk River Government Bridge	County

While large portions of Skagit County are vulnerable to ground failures caused by earthquakes, some areas in Western Skagit County are also vulnerable to tsunamis and seiches.

Most Skagit County marine and shoreline areas are protected from the direct effects of tsunamis caused by distant earthquakes. However, the shoreline areas of Fidalgo Island, Guemes Island, Sinclair Island, Cypress Island, Samish Island, March’s Point, the communities of La Conner and Bayview, as well as lakeshore areas may be vulnerable to seiche. Tsunami and seiches are discussed specifically in more detail later in this plan.

Debris

The Hazus analysis also estimated the amount of earthquake-caused debris in the planning area for a M7.5 Devils Mountain Earthquake event (see figure below). The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. The distinctions in types of materials are made due to the different types of material-handling equipment required to process the debris.

The model estimates that a total of 904,000 tons of debris will be generated as a result of a Devils Mountain earthquake. Of the total amount, brick/wood comprises 27 percent of the total, with the remainder being reinforced concrete/steel. Converting that amount to an estimated number of truckloads, this will require approximately 36,160 truckloads to remove the debris generated if the trucks utilized are 25-ton trucks (standard dump-truck load).

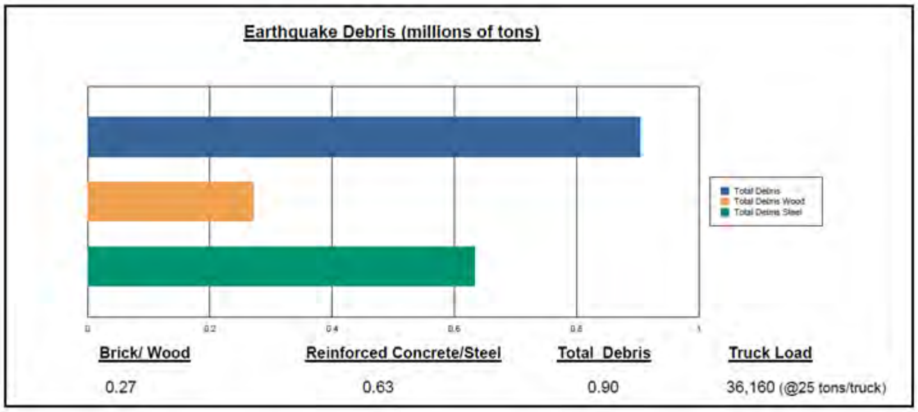


Figure 6-19 Hazus-generated Debris in Tons

6.3.5 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. No specific loss data is available with respect to loss of inventory, wages or loss of income. Economic loss would also include building impact identified above.

6.3.6 Impact on Environment

Earthquake-induced landslides can significantly impact habitat. It is also possible for streams to be rerouted after an earthquake. This can change water quality, possibly damaging habitat and feeding areas. There is a possibility of streams fed by groundwater drying up because of changes in underlying geology. There also exists the impact from hazardous materials impacting the environment, including the coastlines, estuaries, and watersheds of the County, among others.

6.3.7 Impact from Climate Change

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

Secondary impacts of earthquakes could be magnified by climate change. Soils saturated by repetitive storms could experience liquefaction or an increased propensity for slides 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.

6.4 FUTURE DEVELOPMENT TRENDS

Skagit 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.

6.5 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. Potential warning systems could give approximately 40 seconds notice that a major earthquake is about to occur. This would not provide adequate time for preparation. Earthquakes of this magnitude or higher would lead to massive structural failure of property on NEHRP C, D, E, and F soils. Levees and revetments built on these poor soils would likely fail, representing a loss of critical infrastructure. These events could cause secondary hazards, including landslides and mudslides that would further damage structures. River valley hydraulic-fill sediment areas are also vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction would occur in water-saturated sands, silts or gravelly soils.

Earthquakes can cause large and sometimes disastrous landslides and mudslides. River valleys are vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction occurs when water-saturated sands, silts or gravelly soils are shaken so violently that the individual grains lose contact with one another and float freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people. Earthen dams and levees are highly susceptible to seismic events and the impacts of their eventual failures can be considered secondary risks for earthquakes. Earthquakes at sea can generate destructive tsunamis.

Important issues associated with an earthquake include, but are not limited to the following:

- Assessor's data with respect to the number, location, and type of buildings (including general building stock) is necessary to identify potential dollar losses.
- More information is needed on the exposure and performance of construction within the planning area. Much information on the age, type of construction, or updated work on facilities is not readily available in a useable format for a risk assessment of this type.
- It is presently unknown to what standards portions of the planning area's building stock were constructed or renovated due to the inability to utilize the assessor's building layer within the GIS format.
- Based on the modeling of critical facility performance for this plan, a high number of facilities in the planning area are expected to have complete or extensive damage from scenario events. These facilities are prime targets for structural retrofits.
- The County and its planning partners are encouraged to create or enhance continuity of operations plans using the information on risk and vulnerability contained in this plan.
- Geotechnical standards should be established that take into account the probable impacts from earthquakes in the design and construction of new or enhanced facilities.
- Dam failure warning, evacuation plans and procedures should be updated (and maintained) to reflect dam risk potential associated with earthquake activity in the region, with said

information being distributed to the County and its planning partners to allow for appropriate planning to occur.

- Earthquakes could trigger other natural hazard events such as a tsunami, which would have far-reaching impacts.

In addition to the above, stakeholder and public comments and concerns associated with earthquake include:

- Utilities (above and below ground) including telephone, electricity, natural gas, water, and sewer as well as private wells and water systems could be damaged or destroyed.
- Transportation routes and/or systems including roads, bridges, railroad, and ferry transport may be damaged or destroyed.
- Emergency services could be totally overwhelmed and not able to respond to emergency situations due to damaged facilities and/or equipment, a lack of personnel, or damaged transportation routes.
- Critical facilities such as 9-1-1 centers, hospitals, emergency operations centers, fire stations, water treatment plants, and wastewater treatment facilities may be damaged or destroyed.
- Large areas of the county may be subject to liquefaction and/or land movement causing even greater damage in certain areas.
- Large hazardous materials incidents may occur as the result of damage to local oil refineries, chemical plants, rail lines and major petroleum pipelines.
- Levees and salt-water dikes may be damaged.
- Large hydroelectric dams located in eastern Skagit County and Whatcom County may be damaged or possibly fail causing possible flooding of those areas located within the 100-year and possibly the 500-year floodplain.
- Localized seiche action in local waters may result in increased levels of damage along shoreline areas within the county.
- The arrival of outside resources to assist with debris removal, repair of critical facilities, and sheltering of victims may be delayed due to severe damage in adjacent counties with larger populations and needs.
- The overall economy of the county and possibly the region could be affected.

6.6 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. A Devils Mountain-type event, such as that utilized as the scenario modeled for this update has a high probability of occurring within the region. The Devils Mountain earthquake scenario generates the largest amount of damage within the planning area at $875 million. The losses related to earthquake scenarios are largely due to the proximity to the faults.

The highest loss ratio for the Devils Mountain scenario earthquake would occur within La Conner and Mount Vernon, followed by the Swinomish Indian Tribal Community. The City of Burlington and the towns of Hamilton and Lyman have the largest percentage of buildings located in the moderate-high liquefaction zone. Also a factor is the large number of buildings being designated as pre-code buildings. 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. Based on the potential impact, the Planning Team determined the CPRI score to be 3.85, with overall vulnerability determined to be a high level.

CHAPTER 7.
FLOOD AND DAM FAILURE

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.

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.

7.1 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;
- Non-riverine flooding as a result of dike or levee breach or failure;
- 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).

Figure 7-1 Samish Basin Flooding. Photo Courtesy Of Washington State Patrol

7.1.1 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/stormwater flooding are the main flood types of concern for the entire planning area, with coastal and tidal surge impacting large portions of Skagit County. The Federal Emergency Management Agency considers the Skagit River "potentially the most damaging river in the state".

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).

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 (discussed below).
- 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. Within the National Flood Insurance Flood Maps (discussed below), coastal flood zones identify special flood hazard areas (SFHA) which are subject to waves with heights of between 1.5 and 3 feet during a 1-percent annual chance storm (100-year event). Figure 7-2 illustrates the various SFHA zones.

Tidal Flooding

Spring tides, the highest tides during any month, occur with each full and new moon. When these coincide with a northerly wind piling water, tidal flooding can occur. The tides can also enhance flooding in delta areas when rivers or creeks are at or near flood stage.

All coastal areas in Skagit County are at risk to tidal flooding. Such flooding is also a threat to low-lying farmlands in the area. Tidal impact is of most concern in delta areas when rivers are at flood stage and high tide exacerbates the situation. Concerns about tidal flooding are anticipated to increase due to the impacts of global climate change and sea level rise.

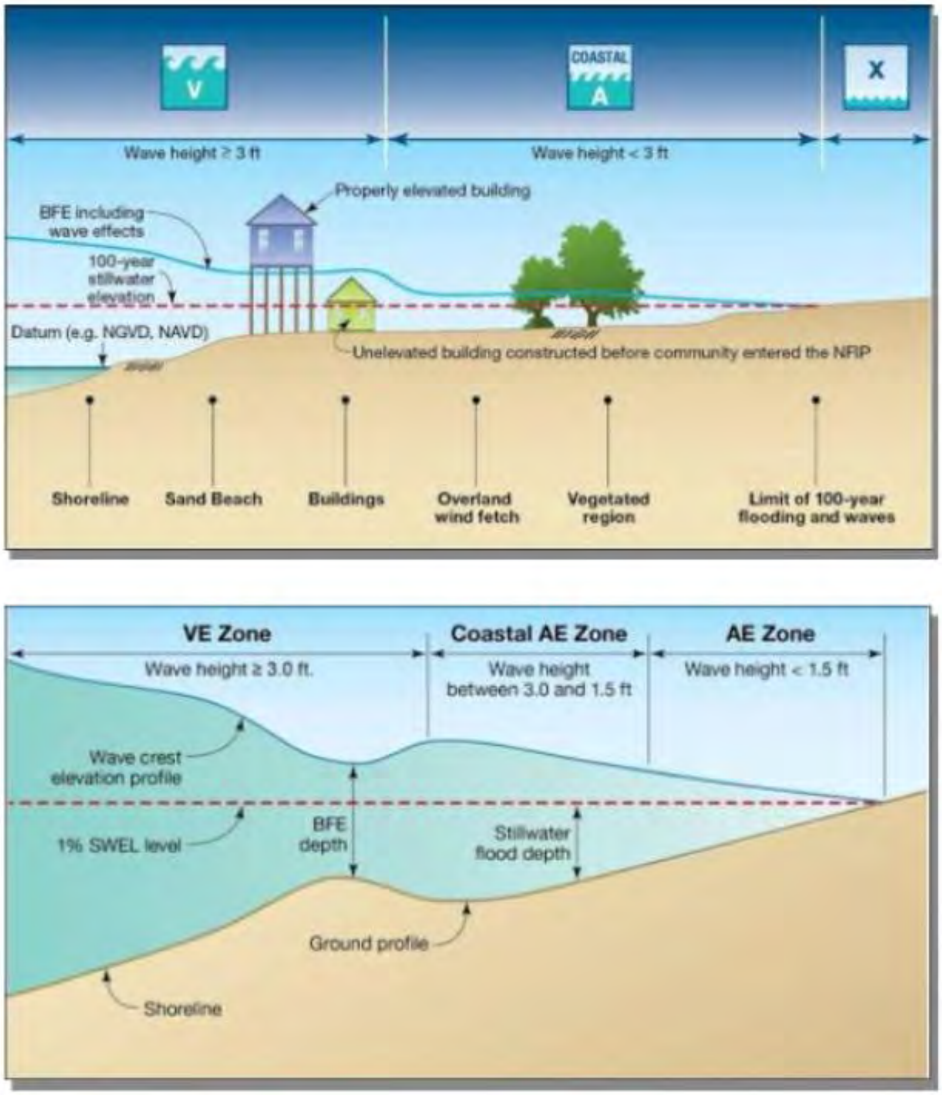


Figure 7-2 Schematic of Coastal Flood Zones within the National Flood Insurance Program

7.1.2 Dam Failure

Dam failures in the United States typically occur in one of four ways (Association of State Dam Safety Officials, 2012):

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

- 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 are earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage. The most likely disaster-related causes of dam failure in Skagit County are earthquakes.

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.

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 FEMA-monitored effort is to identify and mitigate the risk of dam failure so as to protect the lives and property of the public.

Washington Department of Ecology Dam Safety Program

The Dam Safety Office (DSO) of the Washington Department of Ecology regulates over 1,000 dams in the state that impound at least 10 acre-feet of water. The DSO has developed dam safety guidelines to provide dam owners, operators, and design engineers with information on activities, procedures, and requirements involved in the planning, design, construction, operation and maintenance of dams in Washington. The authority to regulate dams in Washington and to provide for public safety is contained in the following laws:

- State Water Code (1917)—RCW 90.03
- Flood Control Act (1935)—RCW 86.16
- Department of Ecology (1970)—RCW 43.21A .

Where water projects involve dams and reservoirs with a storage volume of 10 acre-feet or more, the laws provide for the Department of Ecology to conduct engineering review of the construction plans and specifications, to inspect the dams, and to require remedial action, as necessary, to ensure proper operation, maintenance, and safe performance. The DSO was established within Ecology's Water Resources Program to carry out these responsibilities.

The DSO provides reasonable assurance that impoundment facilities will not pose a threat to lives and property, but dam owners bear primary responsibility for the safety of their structures, through proper design, construction, operation, and maintenance. The DSO regulates dams with the sole purpose of reasonably securing public safety; environmental and natural resource issues are addressed by other state agencies. The DSO neither advocates nor opposes the construction and operation of dams.

U.S. Army Corps of Engineers Dam Safety Program

The U.S. Army Corps of Engineers is responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety

Act. The Corps has inventoried dams; surveyed each state and federal agency's capabilities, practices and regulations regarding design, construction, operation and maintenance of the dams; and developed guidelines for inspection and evaluation of dam safety (U.S. Army Corps of Engineers, 1997).

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) cooperates with a large number of federal and state agencies to ensure and promote dam safety. There are 3,036 dams that are part of regulated hydroelectric projects 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 engineer approved by the FERC must inspect and evaluate projects with dams higher than 32.8 feet (10 meters), or with a total storage capacity of more than 2,000 acre-feet.

FERC staff monitors and evaluates seismic research and applies it in investigating and performing structural analyses of hydroelectric projects. 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.

Skagit County does have DSO regulated water supply dams within its county boundaries owned and operated by Skagit PUD #1. The County also has FERC regulated hydro dams within its boundaries, which are owned and operated by Puget Sound Energy and Seattle City Light.

Hazard Ratings

The DSO classifies dams and reservoirs in a 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. The following codes are used as an index of the potential consequences in the downstream valley if the dam were to fail and release the reservoir water:

- 1A = Greater than 300 lives at risk (High hazard);
- 1B = From 31 to 300 lives at risk (High hazard);
- 1C = From 7 to 30 lives at risk (High hazard);
- 2 = From 1 to 6 lives at risk (Significant hazard);

- 3 = No lives at risk (Low hazard).

The Corps of Engineers developed the hazard classification system for dam failures shown in Table 7-1. The Washington and Corps of Engineers hazard rating systems are both based only on the potential consequences of a dam failure; neither system takes into account the probability of such failures.

Table 7-1
Corps of Engineers Hazard Potential Classification

Hazard Category[a]	Direct Loss of Life[b]	Lifeline Losses[c]	Property Losses[d]	Environmental Losses[e]
Low	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	Rural location, only transient or day-use facilities	Disruption of essential facilities and access	Major public and private facilities	Major mitigation required
High	Certain (one or more) extensive residential, commercial, or industrial development	Disruption of essential facilities and access	Extensive public and private facilities	Extensive mitigation cost or impossible to mitigate

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

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

Skagit County has 29 dams total within its boundaries identified by the Washington State Department of Ecology Dam Safety Program.[24] Based on review of the data, there are eight (8) high hazard dams within its boundary, two of which are owned by the Skagit County PUD. The City of Anacortes owns two high hazard dams; the City of Mount Vernon owns one high hazard dam; and the remaining high hazard dams are owned by private industry. Figure 7-3 identifies the major dams in the county.

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

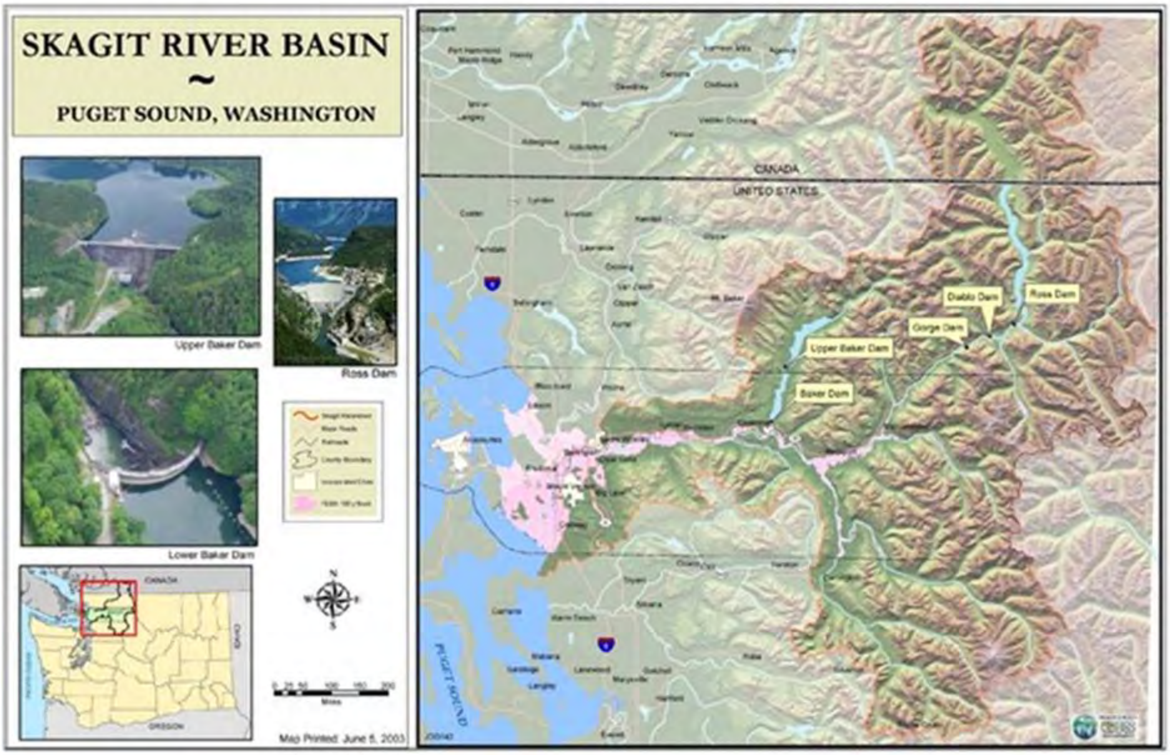


Figure 7-3 Skagit County River Basins and High-Hazard Dams

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 maps are available for public release for any of the dams in Skagit County as inundation maps are considered privileged information. Therefore, it is difficult to estimate the population living within the inundation zone beyond the information designated in the dam classification analysis. Without the ability to perform an inundation study, it is also not possible to estimate property losses from a dam failure which could ultimately affect the planning area.

Figure 7-4 2006 Flood Event - Skagit County

While no additional dam failure inundation studies are available, in some instances those inundation areas coincide with flood hazard areas. Review of the flood profile may provide a general concept of structures at risk, although, based on the size of the dams, 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 and its planning partners will continue to work to gain information for high-hazard dams.

7.1.3 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.

7.1.4 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 7-5). 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. Three primary areas make up the flood hazard area: the floodplains, floodways, and floodway fringes. Figure 7-6 depicts the relationship among the various designations, collectively referred to as the special flood hazard area.

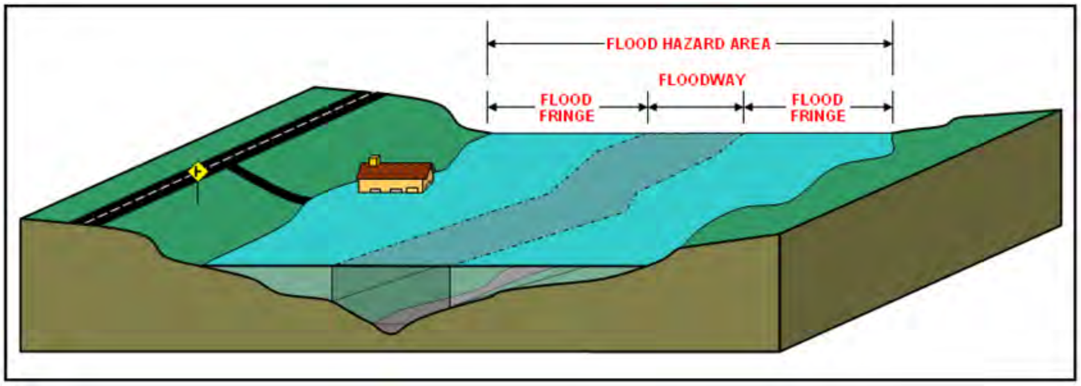


Figure 7-5 Flood Hazard Area Referred to as a Floodplain

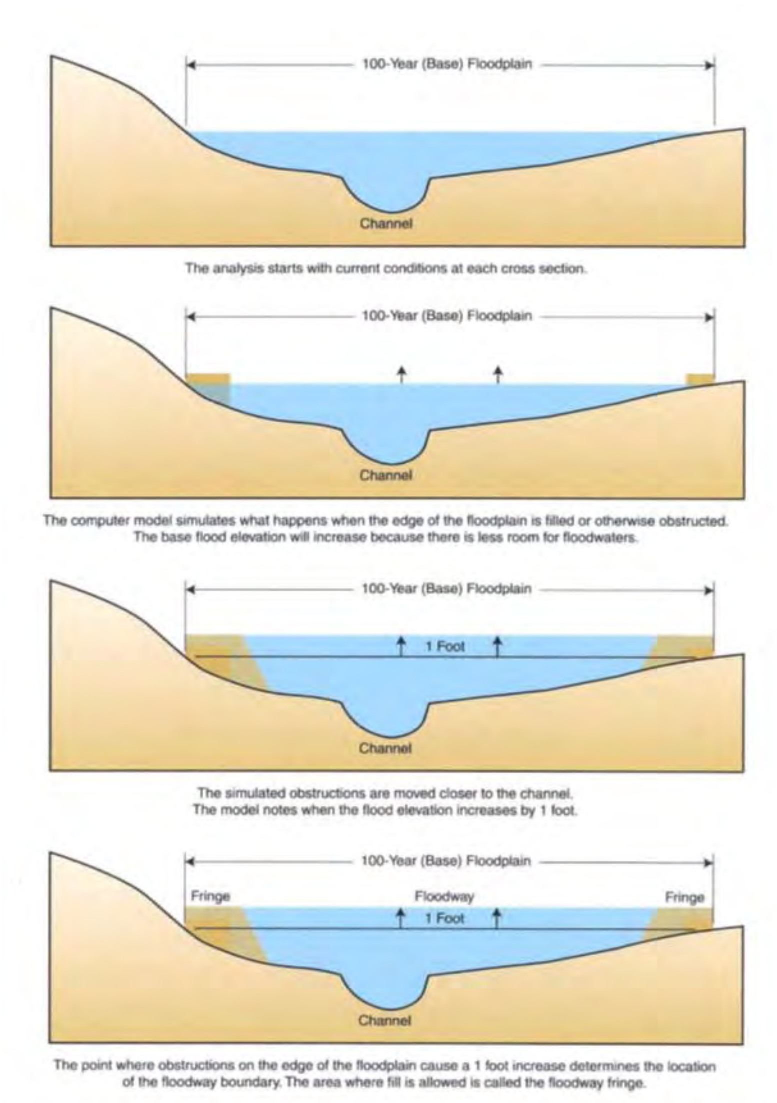


Figure 7-6 Special Flood Hazard Area

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 (SFHA) and the risk premium zones applicable to the community. 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—the 100-year and 500-year floodplain boundaries (FEMA, 2003; FEMA, 2005; FEMA, 2008). Table 7-2 identifies the various rate map zones.[25]

Table 7-2
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 (old map format)	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 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

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

Table 7-2 **Flood Insurance Rate Map Zones**	
	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 frontal 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.

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. The table below illustrates the estimated probability of flood events as utilized by the NFIP.

Table 7-3
Estimated Probability of Flood Event

EVENT	ANNUAL CHANCE OF OCCURRENCE
10-year flood	10%
25-year flood	4%
50-year flood	2%
100-year flood	1%
500-year flood	0.2%

7.1.5 National Flood Insurance Program (NFIP)

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

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

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

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

Local Perspective of the National Flood Insurance Program

Within Skagit County, each municipal planning team member that is a member of the National Flood Insurance Program administers their own program, discussed within their respective jurisdictional annex. Each municipality has their own floodplain ordinance, and is responsible for their own enforcement. The County does provide building and fire code services to Lyman, Hamilton, and La Conner.

For Skagit County, the Building Official also serves as the Floodplain Manager and Fire Code Official within the Planning and Development Services Department. Several teams/staff members in the Planning Department maintain a role with respect to oversight and enforcement of the NFIP, including:

- Natural Resources Division, which conducts reviews for compliance with habitat impacts in the floodplain;
- Permit technicians, which accept and process flood permits, answer flood questions, make flood determinations;
- Plans examiners, which verify that construction methods shown on plans are compliant with SCC14.34 and FEMA requirements;
- Building inspectors, which verify implementation on site;
- Stormwater Review Tech, which review for LID methods when in flood areas; and
- Certified Floodplain Manager, which has ultimate authority and oversight for all of the above functions.

Much of the flood hazard area identified on the NFIP maps has zoning restrictions that limit development, the majority being zoned as Agriculture Natural Resource Land. This zoning restricts the type of buildings that may be constructed and requires a minimum 40 acre lot size for construction of a dwelling. The ordinance regulating development in the NFIP is continually being updated to ensure compliance, with the next update occurring in 2020.

Flood risk throughout the County is identified using the NFIP maps and then using local, state, and federal regulations. Building designers, architects, and engineers are required to identify on the plans the Base Flood Elevation, flood-resistant materials, flood-resistant construction methods, and flood openings. Elevation Certificates are required both during construction and at final construction.

Enforcement of the program lies with the Floodplain Manager/Building Official, although

The following information expands on the existing NFIP program countywide.

NFIP Status and Severe Loss/Repetitive Loss Properties

Skagit County is a member in good standing in the NFIP, and does incorporate regulatory authority within its land use planning, as do all planning partners. Table 7-4 presents the NFIP policy status of the County planning partners.

Table 7-4
NFIP Insurance Policies in Force

Community Name	Policies In-Force	Insurance In-Force	Premiums In-Force
Anacortes, City of	42	14,565,000	21,057
Burlington, City of	992	255,886,000	1,012,662
Concrete, Town of	6	1,254,700	10,408

Table 7-4
NFIP Insurance Policies in Force

Community Name	Policies In-Force	Insurance In-Force	Premiums In-Force
Hamilton, Town of	15	1,943,900	22,040
La Conner, Town of	117	28,631,700	175,196
Lyman, Town of	1	350,000	373
Mount Vernon, City of	765	186,403,300	848,676
Sedro-Woolley, City of	54	19,157,400	60,536
Skagit County	2137	463,719,300	2,137,088

Source: https://bsa.nfipstat.fema.gov/reports/1040.htm#53

Statistics as of 9/30/18 – most recent update

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 provide 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 19, 2019, Skagit County is reported to have 21 Severe Repetitive Loss properties – 20 single family residences, and one 2-4 family residence, with total building and content loss payments being issued for $1,979,120.64.

The state has also reported that there are 24 repetitive flood claims within the Skagit County, representing 24 properties. 22 of those are single family residences, one 2-4 family residence, and one non-residential property, for total building and content loss payments being issued for $1,640,014.27.

Additional flood claim data is indicated in Table 7-5. All data represented there are for residential structures, with the exception of one severe repetitive loss property, which was identified as non-residential. Only one of the repetitive loss structures were within FEMA's designated FIRM map; the remainder were outside.

Washington State's 2018 Hazard Mitigation Plan identifies Skagit County as fifth highest statewide for the number of NFIP claims filed during the period 1978- 2018, with 711 claims filed, and a total claim amount during that period of $7,410,010.73.

Six ways to Protect Your Home

1. Elevate your home above possible flood levels on a new foundation. Alternatively, consider elevating or relocating furnaces/heat pumps, water heaters, appliances, and electrical panels higher above ground, out of harm's way.
2. Cut openings in foundation walls to allow water to flow freely through underneath the home. This helps to prevent the collapse of a wall(s).
3. Build and install flood shields for doors and other openings which will help prevent floodwaters from getting into your home or structure.
4. Install back-flow valves or plugs for drains, toilets, and other connections to prevent floodwaters from entering your home.
5. Install sump pumps with backup power in basements or crawl spaces to help pump out accumulating water.
6. Keep hazardous materials like fertilizers, pesticides, paint and household cleaners inside a plastic bucket or bin, off the floor to make sure floodwaters aren't contaminated. Make sure to take unwanted materials to an appropriate hazardous waste disposal site.
7. When building, renovating, or landscaping, remember that tree-cutting, grading, back-filling, concrete and asphalt work, retaining walls, and other land use development may increase flood waters and damage. When in doubt, check with the local building officials to make sure you won't be negatively impacting your or your neighbor's flood risk.

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.

Table 7-5 identifies the CRS Community Status in the County. Not all jurisdictions are CRS communities. As a result of the floodplain management activities implemented by Skagit County, the Department of Homeland Security, Federal Emergency Management Agency (FEMA), has determined that Skagit County will receive a Class 5 designation in the National Flood Insurance Program (NFIP) Community Rating System (CRS). This means that all NFIP flood insurance policies issued or renewed after October 1, 2019 in qualifying zones will receive an automatic 25% discount on premiums, an additional 5% reduction from the previous year. For the average policyholder, the discount equates to approximately $300 annually. With more than 22,000 communities participating in the National Flood Insurance Program, only 1,486 communities have committed to the voluntary Community Rating System program. Skagit County is one of only 113 CRS communities nationwide to achieve a Class 5 or better CRS rating.

TABLE 7-5
COMMUNITY RATING SYSTEM AND FLOOD INSURANCE CLAIMS

Community Name	CRS Community*	Total Losses	Flood Claims Closed	Total Flood Loss Payments
Anacortes, City of		1	1	$42,151.47
Burlington, City of	5	34	19	$165,594.82
Concrete, Town of		15	12	$93,078.44
Hamilton, Town of		228	201	$4,029,431.48
La Conner, Town of	7	5	2	$2,664.54
Lyman, Town of	10(R)	No data	0	$-
Mount Vernon, City of	6	103	65	$624,768.36
Sedro-Woolley, City of		35	29	$336,318.68
Skagit County Unincorporated	5**	715	576	$7,415,014.29

Source: Repetitive Loss and Severe Repetitive Loss Data from State and FEMA as of 9/19/19 -personal communication with State EMD Michael Levkowitz; NFIP Policies in Force Data from NFIP (6/6/19; data dated 9/30/18); *CRS Rating and Number of Policies in place captured from 2018 State Hazard Mitigation Plan and effective as of May 2017; for SRL data, requests through state agencies (to FEMA) were requested on three separate occasions, but were not provided; the County's CFM does not maintain such list. **County notified during October 2019 of increase CRS level.

7.2 HAZARD PROFILE

7.2.1 Extent and Location

Flooding is the most common hazard occurring in Skagit County, and is mostly due to coastal and riverine flooding, with urban flooding also occurring. Flooding in the County has been documented by gauge records, high water marks, damage surveys, and personal accounts.

The severity of flood damage is also dependent upon ground elevation, the surrounding topography, peak flow volumes, surface flow velocities, and proximity to the river or a levee break. Major channel changes are usually associated with high flow volumes, especially in areas characterized by flat, broad floodplains such as the lower Skagit Valley.

Riverine flooding is seen on all main rivers and tributaries in the rural portions of the county. The Skagit River, Samish River, Sauk River, Suiattle River, and Cascade River are all susceptible to river flooding. Urban flooding generally occurs within the boundaries of the cities. In addition, the County is also subject to coastal flooding, which is significantly impacted as a result of a strong tidal influence due to low gradients in the planning area.

Floods in the Skagit Basin can be classified as either spring snowmelt or winter rain on snow events. The threat of flooding in Skagit County is greatest in the months of November, December and January, with events occurring as early as October or as late as February. Winter flood events have the potential to produce the highest peak flows when significant low elevation snowfall is present, followed by rising freezing levels, heavy rain, and wind. In addition, high tides that occur during a flood event further increase the potential of flooding due to their restricting effect on river discharge flows.

Based on discharge flows of rivers that empty into salt-water, the Skagit River is the third largest river system on the West Coast of the contiguous United States with only the Columbia River and the Sacramento River being larger.

From its source in Canada, the Skagit River flows 135 miles and empties into Skagit Bay. The river drains an area of approximately 3,115 square miles. Three major tributaries empty into the Skagit River within Skagit County, thereby significantly increasing the Skagit's flow. These rivers are the Cascade River, the Sauk River, and the Baker River. Several small watersheds are also tributaries to the Skagit; these include Illabot Creek, Finney Creek, Day Creek, and Noockachamps Creek watersheds. In addition, many small feeder streams also discharge directly into the Skagit.

While the Skagit River poses a major flood threat in the lower valley, the Sauk River and Suiattle River (located in the upper valley) also pose a significant threat of their own. These streams do not have levee systems and have a history of changing their channels and eroding their banks during flood events. Because of the *Wild And Scenic River* designation, government entities and private property owners are not allowed to place rip-rap or any other type of material along these riverbanks to mitigate these channel changes and bank erosion (HMP, 2015). In areas where erosion is severe or drastic channel changes occur, homes and property are many times simply "lost" to the river.

Levee System

The levee system on the Skagit River has controlled much of the flood threat within the lower delta; however, these levees have also contributed to the vulnerability of the citizens and business of the county. Without the levees, minor flooding would occur on almost an annual basis, sometimes occurring more than once each year. The "inconvenience" of frequent minor flooding would have most likely encouraged residential and commercial development to be located on higher ground and out of flood hazard areas (Skagit County HMP, 2015).

FEMA 1981 Flood Maps (Updated 2017-Not Yet Adopted)

FEMA performed a Flood Insurance Study (FIS) for Skagit County in 1981. Since that time, additional studies have commenced, although no new maps have been adopted by the County or any of the planning partners. Identification of the data and maps within this plan does not constitute adoption by the County or any of its jurisdictions.

Skagit County's adopted 100- year flood area and special flood hazard zones are illustrated in the series of maps below, including variations of Skagit County's adopted 100- and 500-year adopted flood hazard and map projections with an increased flood depths. This data represents a series of maps prepared by County GIS, by consultant for this Flood Profile, and FEMA for the 2017 Risk Study, which has not been adopted by the County, but which maps provide assistance for emergency management planning purposes, including for illustration of potential impact to sea level rise.

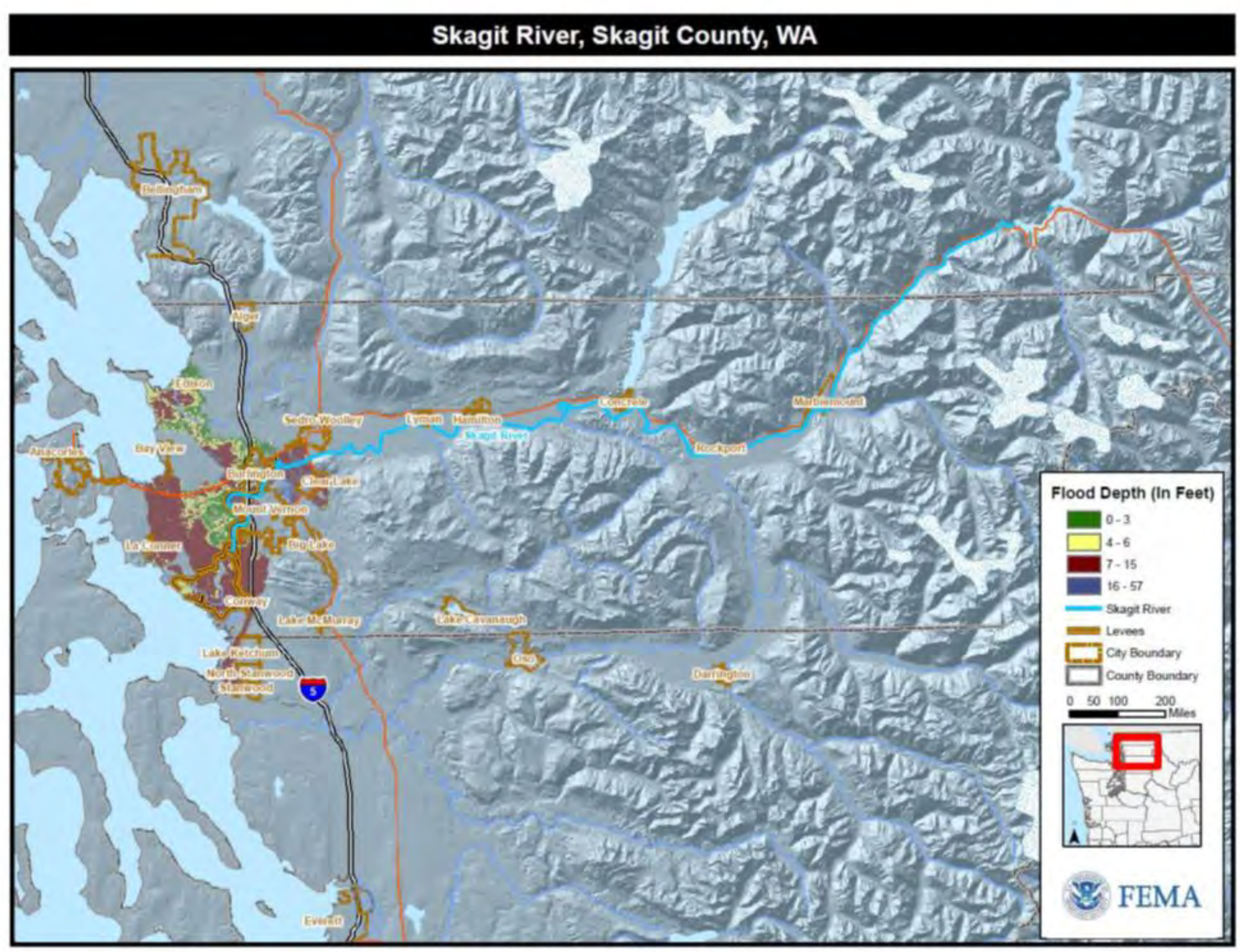


Figure 7-7 Skagit River 100-year Depth Grids

(Source: FEMA as contained in Skagit County COMP Plan, 2016)

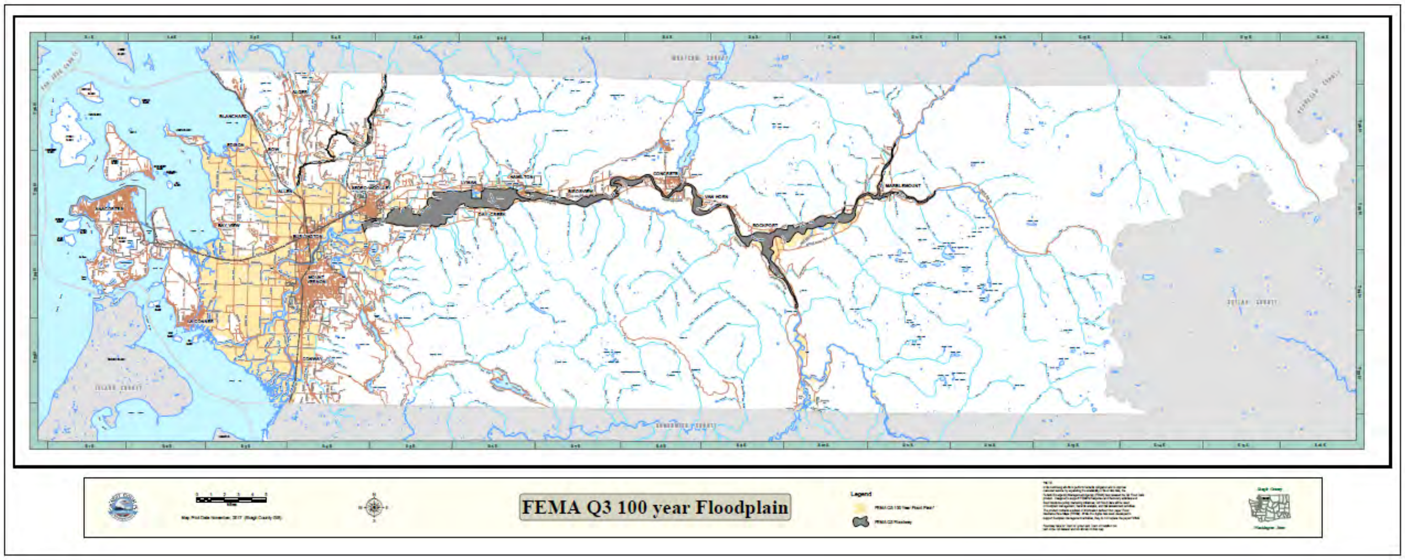


Figure 7-8 Skagit County 100-year and Special Flood Hazard Area (Skagit County GIS)

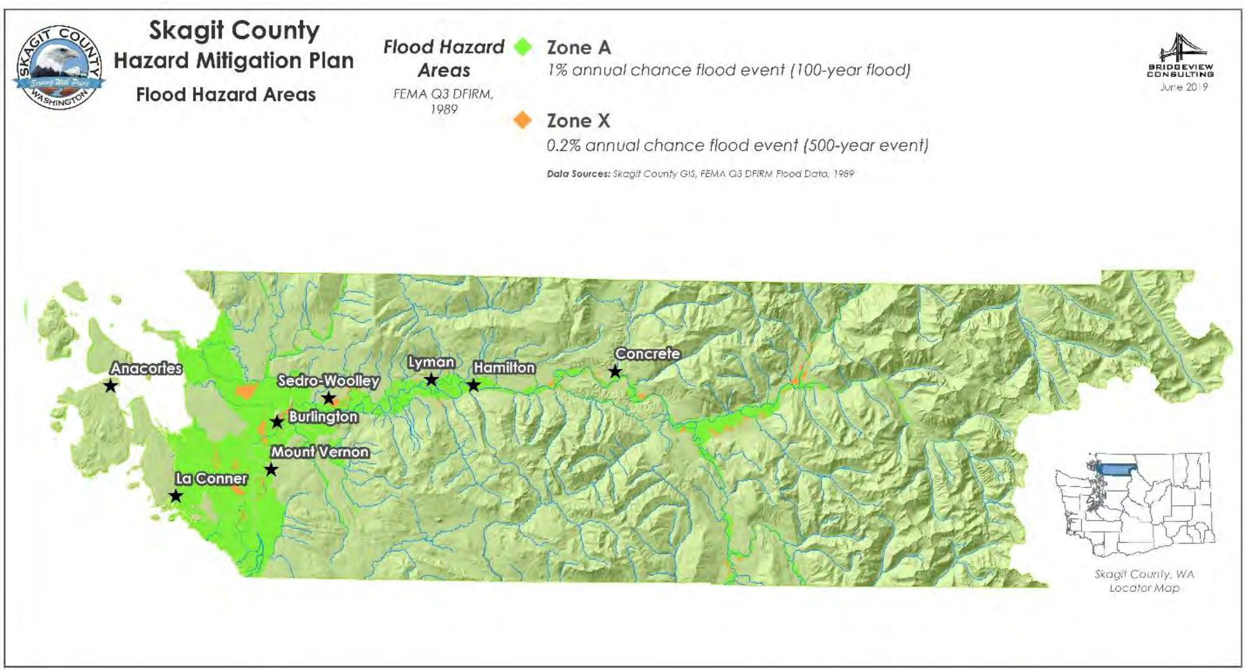


Figure 7-9 Skagit County 100- and 500-year Flood Hazard Zones

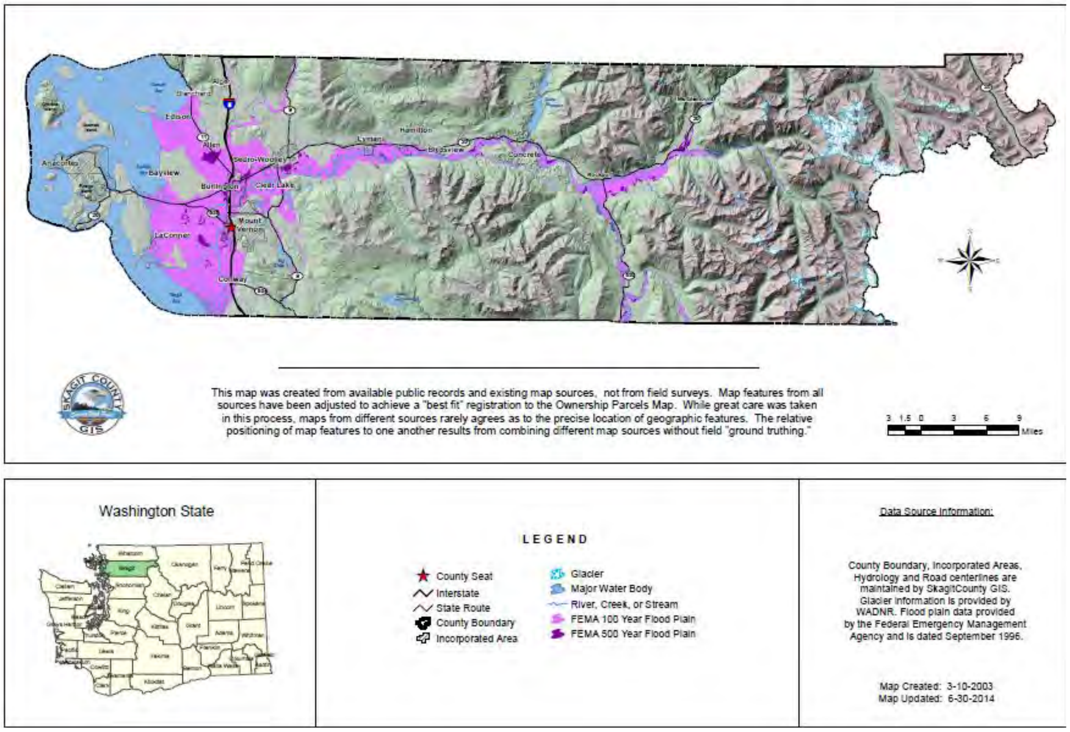


Figure 7-10 Skagit County Flood Hazard Areas (County GIS)

The flood depth grid map developed by FEMA for the coastal areas of the County is shown in Figure 7-11. In addition to the depth grid, a Base Flood Elevation (BFE)+ grid that was created shows increases of 1, 2, and 3 feet above the 1-percent-annual-chance BFE as illustrated in Figure 7-12 (FEMA, 2017). This elevation grid represents events above the 1-percent-annual-chance flood, which includes projected sea level rise. This product is meant to inform local communities about possible future risk and is not a substitute for detailed sea level rise modeling. Detailed information containing all data in the 2017 RiskMap Report is available for download from FEMA's website, or available for viewing from the County's Floodplain Manager. *The County has not adopted these maps as regulatory maps, and are projected within this document only for informational purposes to illustrate potential impact due to increased water depth at the levels indicated.*

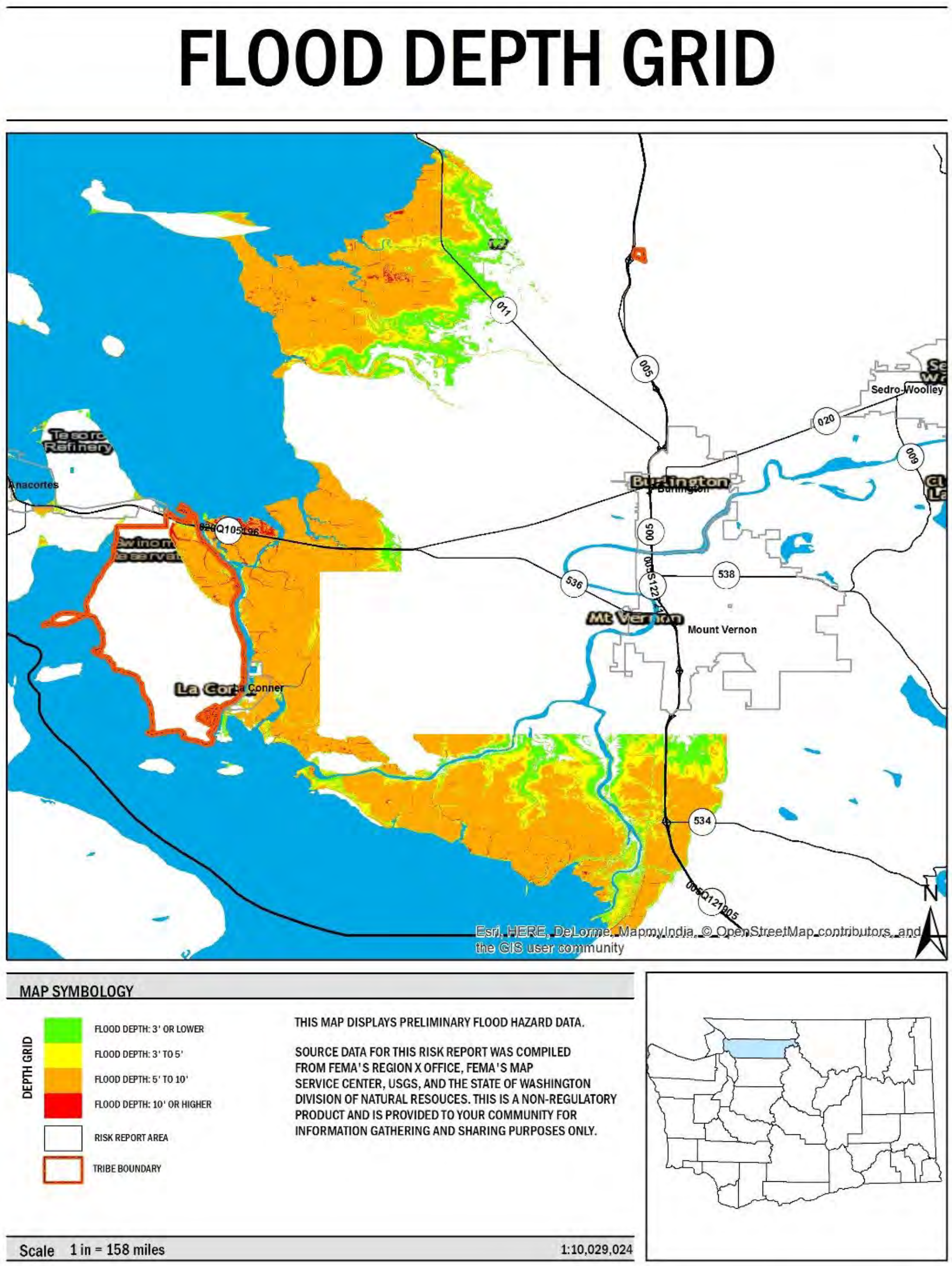


Figure 7-11 100-Year Flood Hazard Depth Grid for Coastal Areas

(Source: FEMA 2017 RiskMAP)

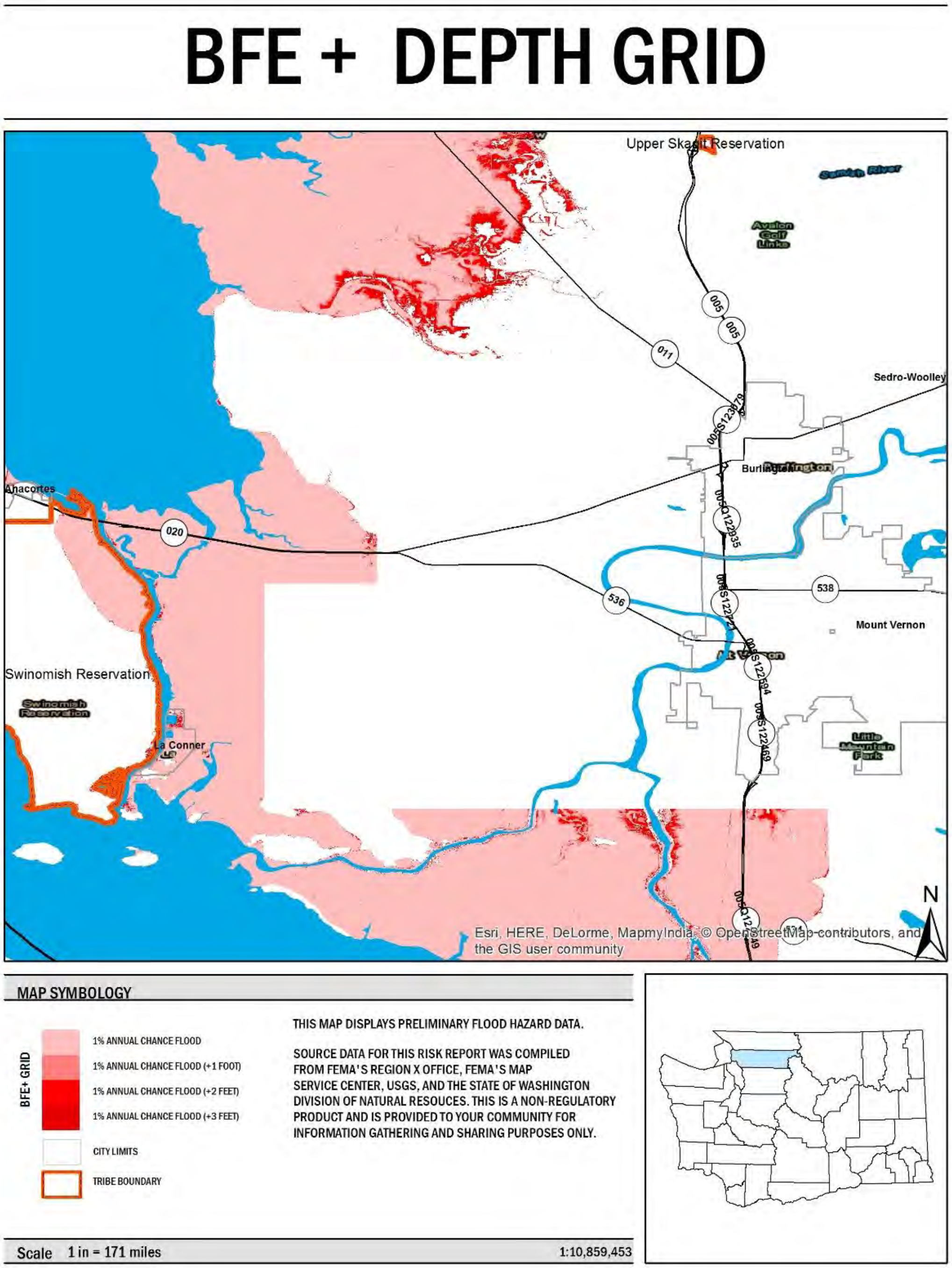


Figure 7-12 1% Flood Depth Grid (Base Flood Elevation) +1, 2, and 3 ft

(Source: FEMA RiskMap 2017)

The adjacent Pacific Ocean plays a significant role in influencing many hazards in the county by serving as a conduit for tsunamis, severe storms, coastal flooding, and hazardous material incidents. Along with coastal flooding, three major tributaries which empty into the Skagit River significantly increase the Skagit's flow. These rivers are the Cascade River, the Sauk River, and the Baker River. Several small watersheds are also tributaries to the Skagit; these include Illabot Creek, Finney Creek, Day Creek, and Noockachamps Creek watersheds. In addition, many small feeder streams also discharge directly into the Skagit.

Each type of flooding usually happens simultaneously. For example, rivers in flood stage flowing into the Skagit River may also experience tidal flooding as well. Both types of flooding can influence each other during natural disaster events. Smaller, more localized flood events in the county result from intense rainfall within a short period, saturated soils, high water tables and heavy surface run-off.

From Concrete to Sedro-Woolley, the river valley varies from 1 to 3 miles in width bordered by steeply rising timbered hills. Below Sedro-Woolley, the valley descends to nearly sea level and widens to a flat, fertile floodplain that joins the Samish Valley to the north and extends west through Mount Vernon to La Conner and south to the Stillaguamish River. During extremely large flood events, the Skagit River has overflowed the low divide between the Skagit River and the Samish River and has entered the Samish River Basin. At Fir Island, the Skagit divides into the North Fork (carrying about 60% of the discharge flow) and the South Fork (carrying about 40% of the discharge flow).

Tidal changes from the Pacific Ocean, combined with increased runoff have produced a history of frequent flooding in the planning area. Coastal land areas in the county tend to be flat, low areas with an abundance of floodplains, wetlands, marshes, and dunes along ocean beaches. Lower elevation coastal areas adjacent to rivers are subject to tidal fluctuations. Storm tides, combined with storm surge and high tides, will cause backwater flooding in rivers. Tidal fluctuations can influence river flooding for a significant number of miles upstream. Lowland water tables, especially in winter months, tend to produce standing water that often floods or impacts roads.

Flood Control Measures

Levee and dike building in Skagit Valley started in the late 1800's. Over the years there have been numerous floods and levee breaks followed by new levee construction projects to build the levees higher and wider thereby hoping to contain and control the mighty Skagit.

Currently, there are about 56 miles of river levees and 40 miles of salt-water dikes in Skagit County. These levees and dikes are managed by 12 separate Dike Districts with each district governed by a Board of Commissioners. The Districts have broad powers and responsibilities including the protection of lives and property located within their respective district.

The United States Army Corps of Engineers inspects the Skagit River levees on an annual basis to ensure they meet established standards. The Skagit River levee system is constructed to control an event that falls within the 25-year flood to 35-year flood range with a river gauge height of 38 feet and a flow of 140,000 to 155,000 cubic feet per second. In comparison, the Skagit River gauge height averages 10 feet to 14 feet in the summer months and 15 feet to 18 feet in the winter months. Flood Stage corresponds to a gauge height of 28 feet at both Concrete and Mount Vernon.

Dam construction of the five Skagit Basin dams began in 1924 with the Low Gorge Dam and continued until 1961. All of these dams were designed and built as hydropower generation structures. However, as the magnitude of Skagit Basin flooding problems became more evident, flood control storage was later required in the Ross and Upper Baker Reservoirs. No flood control storage is required in Diablo, Gorge, or Lower Baker Reservoirs. For the past several years, Skagit County has taken steps towards reaching an agreement with Puget Sound Energy to increase the flood control storage within the Baker River Project that would include both the Upper Baker Reservoir and the Lower Baker Reservoir. The General Investigation has recommended 74,000 acre feet at the Upper Baker Dam which can change seasonally. At the Lower Baker Dam 20,000 acre feet may be available.

During major flood events, the United States Army Corps of Engineers takes control of the Upper Baker Dam and the Ross Dam to maximize flood storage capacity and regulate the release of water in an attempt to minimize the impacts of the event to those areas located downstream. The United States Army Corps of Engineers typically takes control of the Upper Baker Dam and the Ross Dam under the following circumstances: 1) when there is a forecast of a natural flow of 90,000 cubic feet per second at Concrete, and 2) if either dam raises their pool elevation enough to encroach within the designated flood control storage space.

Flood Response

In the event of a predicted flood, the Corps takes control 8 hours prior to the forecasted time of peak flow arrival at Concrete and relinquishes control when the natural flow volume reaches 62,500 cubic feet per second. Depending upon other circumstances, the Corps may retain control of the dams as the situation dictates in order to accommodate response and/or recovery efforts that may be occurring downstream.

In the event the Corps takes control of the dams because of an elevated pool height, the Corps will retain control of the dam until the owner of the dam has evacuated all water above the flood control pool. (For additional information regarding this issue, please refer to the United States Army Corps of Engineers Water Control Manual, Skagit River Project, Skagit River, Washington.)

The actions taken by the United States Army Corps of Engineers to control the dams on the Baker River during the 1990 floods (two events) as well the 1995 floods (two events) and the 2003 flood significantly reduced peak flow rates and flood damage to government infrastructure and private property in the lower Skagit River Basin.

7.2.2 Previous Occurrences

Major floods in the planning area have resulted from intense rainstorms customarily between October and February, with the highest months for declared flood events occurring in January, October, November and December, with December being the highest. Table 7-6 highlights historical flood events. It should be noted that due to the disaster typing which occurs at the FEMA level, there are other types of events which also include flooding, but due to the typing, those are not referenced within this chapter. Specific examples of this include Severe Weather events which include flooding as a hazard of impact. Viewers should also review the Severe Weather hazard profile for additional information.

TABLE 7-6
FLOOD EVENTS IMPACTING PLANNING AREA

Disaster Number	Declaration Date	Disaster Type	Incident Type	Title	Incident Begin Date	Incident End Date	PA Dollars Obligated Or Losses (State)
1817	1/30/2009	DR	Flood	Severe Winter Storm, Landslides, Mudslides, & Flooding	1/6/2009	1/16/2009	
January 2009- Washington State was hit with severe winter storms that brought heavy rains and warmer temperatures, resulting in snow melting causing flooding, land- and mudslides. Virtually every river in the county was on flood watch. Melting snow saturated the soil, and drenching rain created risk of landslides making some roads impassable							
1734	12/8/2007	DR	Flood	Severe Storm, Landslides, Mudslides, & Flooding	12/1/2007	12/17/2007	Unknown
Statewide, numerous injuries occurred, as well as one death being reported by a falling tree which killed an Aberdeen man as he cleared downed trees. This event was identified as the worst storm since the Columbus Day storm of 1963 to hit the region with hurricane force winds gusting to 81 mph, heavy rain, and power outages virtually regionwide. Widespread flooding also caused a section of I-5 to close for three days, causing economic losses statewide.							
1671	12/12/2006	DR	Severe Storm	Severe Storms, Flooding, Landslides, Mudslides	11/02/2006	11/11/2006	$10,528,986
The Pineapple Express brought record-breaking rains to the state. Sustained coastal winds generated high coastal swells augmented by high tides. Wind and waves battered the area. Overbank flooding caused damage to both public and private properties, with channel avulsion and impact to levees in the area.							
1499	1/17/2003	DR	Severe Storm	Severe Storms and Flooding	10/15/2003	10/23/2003	$10,630,487
Severe storms caused flooding throughout the County.							
1100	2/9/1996	DR	Flood	High Winds, Severe Storms and Flooding	1/26/1996	2/23/1996	$1,167,783
Major flooding occurred along the Skagit and Samish Rivers. Overbank flooding caused damage to both public and private property. Damage to roads, dikes and levees occurred. One death was reported statewide (Snohomish County), as the result of a driver ignoring road closure signs.							
1079	November 1995	DR	Flood		11/7/1995	12/18/1995	$14,539,982
Major flooding occurred along the Skagit and Samish Rivers.							
896	3/8/1991	DR	Flood	Severe Storms and High Tides	12/20/1990	12/31/1990	Included below
One of two 1990 floods that were the larges to impact Skagit County since the completion of the hydropower dams on the upper Skagit and the Baker River. It involved an initial flood peak around Veterans Day, followed by a second flood peak near to Thanksgiving Day. The event is considered a 16-20-year flood event. Part of the severity of this flood was the conditions before the storm, that included saturation of soils and backwater areas from the flood event occurring two weeks earlier.							
883	11/26/1990	DR	Flood	Severe Storms & Flooding	11/9/1990	12/20/1990	$36,381,228 both events
Two deaths as a result of this incident statewide. November saw two major storms, one around Veteran's Day (discussed in #896 above), and the second over the Thanksgiving weekend.							

TABLE 7-6 FLOOD EVENTS IMPACTING PLANNING AREA							
612	12/31/1979	DR	Flood	Storms, High Tides, Mudslides & Flooding	12/31/1979	12/31/1979	$3,341,000
Heavy rains and snowmelt caused floods, mudslides, and road washouts.							
492	12/13/1975	DR	Flood	Severe Storms & Flooding	12/13/1975	12/13/1975	$365,808
A five-year record for precipitation resulted from this event. Record rainfall and snow caused widespread flooding. Strong winds occurring with the event caused additional damages throughout the county.							
300	2/9/1971	DR	Flood	Heavy Rains, Snowmelt, and Flooding	2/9/1971	2/9/1971	unknown
Snow followed by wind and rain caused widespread damages throughout the County.							

The 1975 flood event served as a "wake-up call" to all Skagit County residents and governmental agencies that the Skagit River posed a significant flood threat to the residents and businesses located within the floodplain and that we could not rely on a levee system to protect us from all flood events. This flood caused considerable damage to transportation systems, river levee systems and wastewater disposal and drainage systems as well as damage to homes, businesses and the local agricultural community. Following the flood, there was a concerted effort by local dike districts and other government agencies to raise and reinforce existing levees as well as increase flood awareness and public education regarding the flood risk in Skagit County.

The two 1990 floods and the two 1995 floods were the largest floods to impact Skagit County since the completion of the hydropower dams on the upper Skagit and the Baker River. Both involved an initial flood peak occurring on or near Veterans Day followed by a second flood peak occurring on or near Thanksgiving Day. Both floods events are considered 16-20 year flood events.

The 1990 floods caused major flooding in the Town of Hamilton as well as many other low-lying areas of Skagit County. In addition, a failure of the levee on Fir Island forced an emergency evacuation of all residents of Fir Island as well as more than 1,200 head of cattle. Fir Island was inundated with water up to 8 feet in depth, flooding almost all of the homes on the island and damaging agricultural land and crops. Before the water receded, unusually cold temperatures caused the floodwaters to freeze for almost two weeks causing further damage to many homes. Approximately 8,000 acres of farmland was damaged due to floodwaters and flood debris. In some areas, farmland was covered with up to 3 feet of sand and silt.

While the 1995 floods had almost the same peak flows as the 1990 floods, there was less damage from these floods because of the extensive work done to the levee system following the 1990 floods as well as the aggressive and sustained flood-fight efforts on the part of the dike districts and other governmental agencies to prevent a levee failure like the one on Fir Island in 1990.

Figure 7-13 Fir Island during 1990 Flood.

Photo courtesy of Skagit County Public Works

7.2.3 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).

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. The tables below identify various stream characteristics as have occurred. The USGS maintains current stream gauge data, and is available real-time for viewing. Tables 7-7 through 7-9 illustrate various data derived from the gauge data during events. Readers may elect to obtain data on stream gauges directly from the USGS at: https://waterdata.usgs.gov/wa/nwis/rt

Early flood management were local efforts such as the construction of dike and levee systems. As problems increased, the United State Army Corps of Engineers (USACE) began to play an important role in supporting the county with flood management activities.

Flooding has increased over the decades. According to records, 13 major flood events from 1960 to present in Skagit County were included in Federal Disaster Declarations (some of these events were typed as severe storm rather than just flood). However, there are also incidents involving flooding issues which did not rise to the level of a disaster declaration. As damages have grown in frequency and in size, flood management efforts have accelerated throughout the County. Except for severe storms, floods are the most common of natural disasters that occur in Skagit County; the Federal Emergency Management Agency (FEMA) considers the Skagit River "potentially the most damaging river in the state" (SCHMP, 2015).

Table 7-7
Summary of Historical Floods (CFS)
(Flows from USGS Records Except as Noted)

STATION	Skagit River near Concrete		Skagit River near Mt Vernon	
PERIOD OF RECORD	October 1924-Present		October 1940-Present	
	2,737 square miles		3,093 square miles	
	Peak Discharge		Peak Discharge	
Date	cfs	cfs / sq. mi.	cfs	cfs / sq. mi.
1815	510,000	186.3	--	--
1856	340,000	124.2	--	--
16 Nov 1896	--	--	--	--
18-19 Nov 1897	265,000	96.8	--	--
16 Nov 1906	--	--	180,000	58.2
18 Nov 1908	--	--	--	--
29-30 Nov 1909	245,000	89.5	--	--
21 Nov 1910	--	--	--	--
29-30 Dec 1917	210,000	76.7	--	--
12-13 Dec 1921	228,000	83.3	--	--

Table 7-7
Summary of Historical Floods (CFS)
(Flows from USGS Records Except as Noted)

STATION	Skagit River near Concrete		Skagit River near Mt Vernon	
PERIOD OF RECORD	October 1924-Present		October 1940-Present	
	2,737 square miles		3,093 square miles	
	Peak Discharge		Peak Discharge	
Date	cfs	cfs / sq. mi.	cfs	cfs / sq. mi.
27 Feb 1932	147,000	53.7	--	--
13 Nov 1932	116,000	43.4	--	--
22 Dec 1933	101,000	36.9	--	--
25 Jan 1935	131,000	47.9	--	--
27 Nov 1949 1	154,000	56.3	114,000	36.9
10 Feb 1951 1	139,000	50.8	144,000	46.6
3 Nov 1955 2	106,000	38.7	107,000	34.6
23 Nov 1959 2/3	89,300	32.6	91,600	29.6
20 Nov 1962 2/3	114,000	41.7	83,200	26.9
13 Jul 1972 2/3	91,900	33.6	80,600	26.1
4 Dec 1975 2/3	122,000	44.6	130,000	42.0
27, 28 Dec 1980 2/3	148,700	54.3	114,000	36.9
9-12 Nov 1990 2/3	148,800	54.4	142,000	45.9
22-26 Nov 1990 2/3	146,000	53.3	152,000	49.1
28-30 Nov 1995 2/3	160,000	58.5	141,000	45.6
17-21 Oct 2003 2/3	166,000	60.7	129,000	41.7
6-7 Nov 2006 2/3	145,000	53.0	125,000	40.4

Table 7-8
Flood Conditions Related to Flood Gauge
Skagit River Near Mount Vernon, Washington

Stage (Ft)	Discharge (cfs)	Phase	Character of Flooding
25.0	53,200	1	Beginning of backwater in Nookachamps Creek area with flooding of low-lying farmlands --no damage
28.0	67,850	1	Zero damage
30.3	82,260	1	Beginning of flooding in town of Hamilton
		2	South End of Francis Road is overtopped and closed to traffic which is the road to Sedro-Woolley via Clear Lake. Those living in this lower area on Francis Road no longer have an escape route.
		3	Beginning of overland flow to levee east of Burlington on Fairhaven Street, on north side of river between Sedro-Woolley and Burlington.
32.7	100,300	1	Major damage discharge in the vicinity of Mount Vernon
33.8	110,000	1	Levee freeboard as follows: Levee east of Burlington on Fairhaven Street -3 to 4 feet.

Table 7-8 Flood Conditions Related to Flood Gauge Skagit River Near Mount Vernon, Washington			
Stage (Ft)	**Discharge (cfs)**	**Phase**	**Character of Flooding**
		2	Levee failures may occur when river remains above this stage more than 24 hours, with flood conditions varying as levees fail or are overtopped throughout the valley
		3	In view of the inadequate cross-section of practically all Skagit River dikes, the following action should be taken by the Corps at this time if a 2-foot rise is indicated in the next 24 hours: **Be prepared to evacuate flood fighting crews from areas below Mount Vernon.**
36.60	141,500	1	Flooding expected in many districts. Dikes on either right or left bank from Hwy. 99 bridge downstream to Mt. Vernon may be breached
38.1	160,000	1	Emergency raising of Burlington and Mount Vernon levees necessary to prevent flooding

(Engineers, 2013)

Table 7-9 Samples of Skagit and Samish River Flood Events Resulting in Disaster Declaration				
Incident Date	**Disaster Number**	**Gauge Stage In Feet**	**Maximum Flow (cubic feet/second)**	**Estimated Damage**
Dec. 1975	492	35.7 Feet (mv)	129,000 cf/s	$365,808
Dec. 1979	612	34.0 Feet (mv)	112,000 cf/s	$3,341,000
Nov. 1990	883	40.2 Feet (c)	142,000 cf/s	$36,381,228 (for both events)
Nov. 1990	883	37.37 Feet (mv)	152,000 cf/s	
Nov. 1995	1079	37.34 Feet (mv)	92,000 cf/s	$14,539,982 (for both events)
Nov. 1995	1079	41.57 Feet (c)	151,000 cf/s	
Feb. 1996	1100	32.11 Feet (c)	94,000 cf/s	$1,167,783
Oct. 2003	1499	42.2 Feet (c)	129,000 cf/s	$10,630,487
Nov. 2006	1672	39.8 Feet (c)	122,000 cf/s	$10,528,986

7.2.4 Frequency

Floods are commonly described as having a 10-, 50-, 100-, and 500-year recurrence interval, meaning that floods of these magnitudes have (respectively) a 10-, 2-, 1-, or 0.2-percent chance of occurring in any given year. These measurements reflect statistical averages only; it is possible for two or more rare floods (with a 100-year or higher recurrence interval) to occur within a short time period. Assigning recurrence intervals to historical floods on different rivers can help indicate the intensity of a storm over a large area.

The Skagit River has a long, well-documented history of flooding, with several of those flood events resulting in Presidential Disaster Declarations. While there were many large flood events during the late 1800's and early 1900's with peak flow rates varying between 180,000 cubic feet per second and 210,000 cubic feet per second, recent events have been notably smaller with peak flow rates of 152,000 cubic feet per second in 1990, 151,000 cubic feet per second in 1995 and 129,000 cubic feet per second in 2003. The differences in peak flow rates between these time periods is most likely attributable to the flood storage provided by the Ross Reservoir and the Upper Baker Reservoir as well as the regulating of water released from these reservoirs by the United States Army Corps of Engineers during flood events.

Large floods that can cause property damage have occurred 13 times during the time period 1960 through 2017. Frequency for this calculation was based on the period covering 1960 to 2018, and the number of events averaged based on years and number of floods. Based on this method of assessment, the return interval for a flood event (not inclusive of FEMA's severe storm designation) is approximately 4.5 years, or a 22 percent chance of some level of a flood event occurring every year. Such calculations do not reflect the scientific recurrence interval, as that calculation is specific on varying factors, such as the incident type, discharge rate, etc. These measurements reflect statistical averages only; it is possible for two or more floods within a 100-year or higher recurrence interval to occur in a short period of time. Urbanized portions of the planning area also annually experience nuisance flooding related to drainage issues.

7.3 VULNERABILITY ASSESSMENT

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For this planning purpose, the flood hazard areas identified include the 1-percent (100-year) and 0.2 % (500-year) floodplains. These events are generally those considered by planners and evaluated under federal programs such as the NFIP. The following text evaluates and estimates the potential impact of flooding in Skagit County.

7.3.1 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.

As a result of the flooding occurring in the planning area, the County and its planning partners have initiated buy-outs from citizens in several frequently flooded areas including, but not limited to: Lyman, Hamilton, and the unincorporated areas of the County. In addition, new dikes and levees have been built to help reduce the impact of flood events.

Methodology

As indicated, the County's effective FIRMs are paper copy which have been digitized. The maps are dated 1985. A building exposure analysis could not be performed for this assessment due to lack of available digital parcel data for the planning area, which also prohibited the identification of the number of individuals at risk as no residential building count could be identified. As better data and technology become available, this degree of analysis is recommended to determine flood risk in greater detail in the planning area. Utilizing the critical facilities list developed during this update, a GIS analysis was performed outside of Hazus on the critical facilities only.

As of this update, pursuant to the 2017 Risk Study, FEMA has also begun the process of updating portions of the county flood maps and completing an overall risk assessment; however, those updated maps have not yet been adopted. As a result of the lack of data with respect to building information, to the greatest extent possible, FEMA's data for impact have been used. The data sources utilized are referenced.

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. Dam inundation due to dam failure can occur within mere minutes of a dam breach or failure.

The potential warning time a community has to respond to a flooding threat is a function of the time between the first measurable rainfall and the first occurrence of flooding. The time it takes to recognize a flooding threat reduces the potential warning time to the time that a community has to take actions to protect lives and property. Another element that characterizes a community's flood threat is the length of time floodwaters remain above flood stage. The County's flood threat system consists of a network of precipitation gauges throughout the watershed and stream gauges at strategic locations in the county that constantly monitor and report stream levels. This information is fed into a U.S. Geological Survey forecasting program, which assesses the flood threat based on the amount of flow in the stream (measured in cubic feet per second). In addition to this program, data and flood warning information is provided by the National Weather Service (NWS). All of this information is analyzed to evaluate the flood threat and possible evacuation needs.

Each watershed has unique qualities that affect its response to rainfall. A hydrograph, which is a graph or chart illustrating stream flow in relation to time (see Figure 7-14)[26], is a useful tool for examining a stream's response to rainfall. Once rainfall starts falling over a watershed, runoff begins and the stream begins to rise. Water depth in the stream channel (stage of flow) will continue to rise in response to runoff even after rainfall ends. Eventually, the runoff will reach a peak and the stage of flow will crest. It is at this point that the stream stage will remain the most stable, exhibiting little change over time until it begins to fall and eventually subside to a level below flooding stage.

The NWS issues watches and warnings when forecasts indicate rivers may approach bank-full levels. When a watch is issued, the public should prepare for the possibility of a flood. When a warning is issued, the public is advised to stay tuned to a local radio station for further information and be prepared to take quick action if needed. A warning means a flood is imminent, generally within 12 hours, or is occurring. Local media broadcast NWS warnings. The County utilizes its webpage and various social media to distribute this data to its citizens.

Skagit County maintains a webpage specifically related to the flood hazard in the county, providing both historical and real-time data with respect to watches and warnings issued. That site is regularly updated as events occur, and is available at: https://www.skagitcounty.net/Departments/Flood/main.htm

[26] The County provides a link on their Emergency Management Website to the various River Gauges maintained by USGS: http://water.weather.gov/ahps2/index.php?wfo=sew

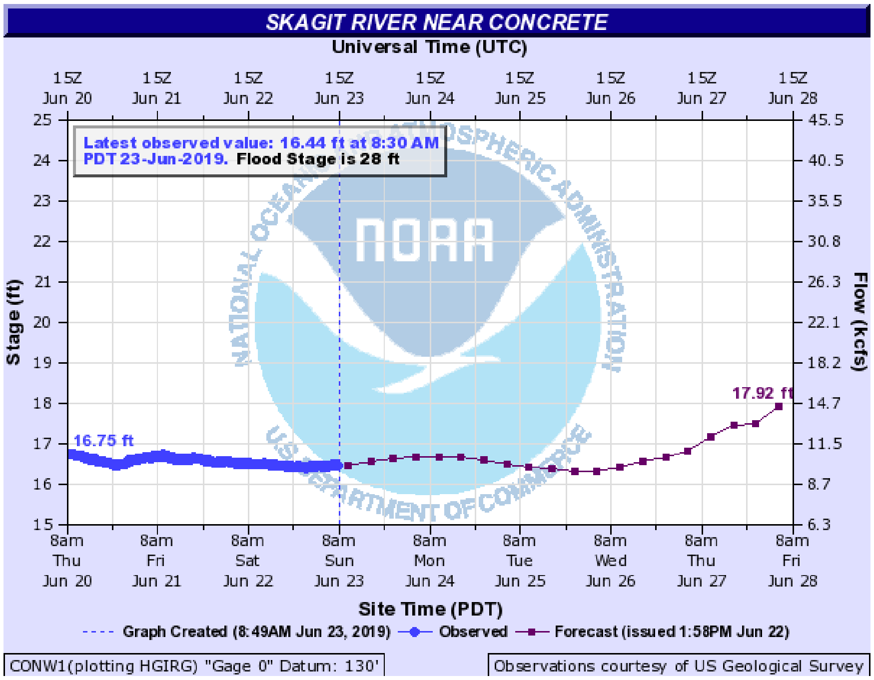


Figure 7-14 Skagit River Hydrograph

7.3.2 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. However, of significant concern within the planning area is the number of tourists who can be impacted during periods of flooding. Tourism is a very large economic base within the planning area, with many tourists traveling through the area at all times of the year for skiing, festivals, and summer-time excursions.

There are also residential structures in the path of potential waterflow with respect to the various dams throughout the County. While existing available data identifies some residential structures, there are also businesses in the area. Therefore, consideration should also be given to employees working in those potential inundation areas who would also be at potential risk. 2017 Census data identifies in excess of 53,000 residential structures in the County; however, due to the absence of a valid digital dataset of the structures within the County, analysis could not be conducted with respect to the placement of residential structures within either the 100- or 500-year floodplain.

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.

Evacuation efforts throughout the floodplain would require special considerations due to the fact that large numbers of dairy cattle will need to be evacuated from numerous farms in addition to the approximately 30,000 people that live in the floodplain. In 1990, over 1,200 dairy cows were transported off of Fir Island and relocated to various dairies in Skagit and Snohomish counties as a result of floods.

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.

7.3.3 Impact on Property

Table 7-10 identifies the area of the county in the 100- and 500-year flood hazard area based on the QFIRM. During its preliminary risk assessment to complete the updated Risk Report, FEMA also projected building impact data for coastal and riverine flooding. That data, while not adopted or confirmed, provides information which can be utilized for planning purposes, although it is noted that building count varies. Tables 7-11 through Table 7-13 illustrate impact to the planning partners. Detailed information on FEMA's methodology utilized for this process may be gained by review of the 2017 Risk Map Report, which is pending review.

As indicated, several buy-outs from citizens in several frequently flooded areas have occurred to date in the County, including structures within the areas of Lyman, Hamilton, and the unincorporated areas of the County.

7.3.4 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. Estimates to critical facilities exposed to the 100- and 500-year flood risk was performed outside of Hazus and FEMA's Risk Map process as part of the HMP development utilizing the critical facilities database and GIS. Table 7-14 through Table 7-17 identify critical facilities and infrastructure exposed in the FEMA 100- and 500-year flood hazard areas (adopted QFIRMS). Figure 7-15 illustrates the location of the critical facilities impacted by the adopted QFIRMS. It should be noted that all facilities identified are listed based on geographic location, not on ownership.

In addition to those items listed in the tables, portions of Interstate 5, State Route 9, State Route 11, State Route 20, State Route 536 and possibly portions of State Route 530 would be inundated and impassable to traffic (Skagit County 2015 HMP).

Table 7-10
Area in the 100- and 500-Year Flood Hazard Areas

Jurisdiction	Total Land Area (in acres)	Area in 100-Year Floodplain (in acres)	Area in 500-Year Floodplain (in acres)	Total Area in Floodplain (in acres)	Total Area Outside of Floodplain (in acres)
Unincorporated Skagit County	1,090,875.6	98,627.9	5,337.50	103,965.40	986,910.20
Anacortes, City of	10,039.6	106.1	0	106.10	9,933.50
Burlington, City of	2,839.5	2,189.6	306.2	2,495.80	343.70
Concrete Town of	765.4	107.0	16	123.00	642.40
Hamilton, Town of	714.2	335.8	12.9	348.70	365.50

Table 7-10
Area in the 100- and 500-Year Flood Hazard Areas

Jurisdiction	Total Land Area (in acres)	Area in 100-Year Floodplain (in acres)	Area in 500-Year Floodplain (in acres)	Total Area in Floodplain (in acres)	Total Area Outside of Floodplain (in acres)
LaConner, Town of	313.9	202.9	0	202.90	111.00
Lyman, Town of	488.5	197.6	4.4	202.00	286.50
Mount Vernon, City of	8,051.3	2,051.4	60.2	2,111.60	5,939.70
Sedro-Woolley, City of	2,742.8	165.5	255.7	421.20	2,321.60
Swinomish Indian Tribal Community	7,550.7	111.1	8.8	119.90	7,430.80
Sauk-Suiattle Tribe	356.7	125.6	65.3	190.90	165.80
Upper Skagit Indian Tribe	748.1	0.0	0	0.00	748.10
Total	**1,125,486.2**	**104,220.5**	**6,067.00**	**110,287.50**	**1,015,198.9**

Table 7-11
Coastal Special Flood Hazard Area Assessment
(Based on FEMA 2017 Risk Map Project)

Community	Total Estimated Building Value	Total Number of Buildings	Number of Buildings within the VE Zone (Coastal)	Number of Buildings within the AE/AO Zone	Number of Buildings within the SFHA	Percent of Buildings within the SFHA
Anacortes	$1.3B	6,348	27	59	86	1.4%
Burlington	$547.2M	1,447	--	1,385	1,385	95.7%
Concrete	$29.3M	144	--	3	3	2.1%
Hamilton	$3.2M	36		13	13	36.1%
La Conner	$26.1M	140		111	111	79.3%
Lyman	$12.3M	151		6	6	4.0%
Mount Vernon	$1.5B	7,896		1,812	1812	22.9%
Sedro-Woolley	$244.4M	1,593		43	43	2.7%
Sauk-Suiattle Tribe	--	--		Unknown	Unknown	
Swinomish Indian Tribal Community	$155.4M	965	21	22	43	4.5%

Table 7-11
Coastal Special Flood Hazard Area Assessment
(Based on FEMA 2017 Risk Map Project)

Community	Total Estimated Building Value	Total Number of Buildings	Number of Buildings within the VE Zone (Coastal)	Number of Buildings within the AE/AO Zone	Number of Buildings within the SFHA	Percent of Buildings within the SFHA
Upper Skagit Indian Tribe	$4.8M	53				--
Unincorporated Skagit County	$3.2B	17,736	32	4,830	4,862	27.4%
Total	**$5.5B**	**36,509**	**80**	**8,284**	**8,278**	**22.7%**

Note: This table summarized properties that are in the floodplain and differentiates between VE and AE/AO zones. The VE zone represents a greater risk since these areas are at risk to velocity wave damage on the coast. The percent of buildings within the SFHA was calculated by taking the total number of buildings within the SFHA/total number of buildings in the community. Structure data were not available for the Sauk-Suiattle Tribe, so no losses are shown in this report.

Table 7-12
Special Flood Hazard Area Assessments from Coastal Flooding

Community	Total Estimated Building Value	Total Number of Buildings	Building Dollar Loss for a 1% Annual Chance Flood Event	Loss Ratio (Dollar Losses/Total Building Value)
Anacortes	$1.3B	6,348	$2.1M	<1%
La Conner	$26.1M	140	$6.2K	<1%
Swinomish Indian Tribal Community	$155.4M	965	$490.8K	<1%
Unincorporated Skagit County	$3.2B	17,736	$71.2M	2.2%
Total	**$4.7B**	**25,189**	**$73.8M**	**<1%**

Note: Dollar loss information is included for those communities where coastal flood depth grids are available. Dollar losses are only reported for structures that intersect the available coastal depth grid. This table summarizes impacts from coastal flooding only, so only the coastal communities are shown in this table.

Table 7-13
Special Flood Hazard Area Assessments from Riverine Flooding
(Based on FEMA's 2017 Risk Map Project)

Community	Total Estimated Building Value	Total Number of Buildings	Number of Building within the SFHA	Building Dollar Loss for a 2%-Annual-Chance Flood Event	Loss Ratio (Dollar Losses/ Total Building Value)	Building Dollar Loss for A 1%-Annual-Chance Flood Event	Loss Ratio (Dollar Losses/ Total Building Value)	Building Dollar Loss for A 0.2%-Annual-Chance Flood Event	Loss Ratio (Dollar Losses/ Total Building Value)
Anacortes*	$1.3B	6,348	-	-	-	-	-	-	-
Burlington	$547.2M	1,447	851	$81.4M	14.9%	$95.0M	17.4%	$123.9M	22.6%
Concrete**	$29.3M	144	--	--	--	--	--	--	--
Hamilton**	$3.2M	36	--	--	--	--	--	--	--
La Conner*	$26.1M	140		$2.8M	10.7%	$2.9M	11.1%	$3.1M	11.9%
Lyman**	$12.3M	151	--	--	--	--	--	--	--
Mount Vernon	$1.5B	7,896	1,043	$91.5M	6.1%	$100.0M	6.7%	$114.2M	7.6%
Sedro-Woolley	$244.4M	1,593	10	$14.7K	6.0%	$27.8K	11.4%	$463.2K	0.2%
Sauk-Suiattle Tribe**	--	--	--	--	--	--	--	--	--
Swinomish Indian Tribe*	$155.4M	965	--	--	--	--	--	--	--
Upper Skagit Indian Tribe**	$4.8M	53	--	--	--	--	--	--	--
Unincorporated Skagit County	$3.2B	17,736	1,500	$82.7M	2.6%	$92.7M	2.9%	$124.1M	3.9%
Total	**$7.0B**	**36,509**	**3,404**	**273.1M**	**3.9%**	**$318.4M**	**4.5%**	**$365.7M**	**5.2%**

Note: Dollar loss information is included for those communities where riverine flood depth grids were available, which are downstream of Sedro-Woolley. Dollar losses are only reported for structures that intersect the available depth grids, which include the 2% event (50 year), 1% event (100 year), and the 0.2% event (500 year). For those properties with damages, a loss value and a loss ratio are calculated. *These communities do not have riverine damages, but do have coastal damage which is shown in the previous table. **These communities were not assessed for riverine floodplain loss since flood depth grids were not available, but the number of structures within the floodplain are reported.

Table 7-14
Critical Facilities Exposed in the 100-Year Flood Hazard Area

Jurisdiction	Medical and Health Services	Government Function	Protective	Schools	Hazardous Materials	Other	Total
Unincorporated Skagit County	0	1	50	2	18	0	**71**
Anacortes, City of	0	0	0	0	0	1	**1**
Burlington, City of	1	12	5	5	18	0	**41**
Concrete Town of	0	0	0	0	1	0	**1**
Hamilton, Town of	0	3	2	0	1	0	**6**
La Conner, Town of	0	1	0	3	2	0	**6**
Lyman, Town of	0	0	0	0	0	0	**0**
Mount Vernon, City of	2	12	14	2	14	0	**44**
Sedro-Woolley, City of	1	1	1	0	1	0	**4**
Swinomish Indian Community	0	0	0	0	0	0	**0**
Sauk-Suiattle Tribe	0	0	0	0	0	0	**0**
Upper Skagit Indian Tribe	0	0	0	0	0	0	**0**
Total	**4**	**30**	**72**	**12**	**55**	**1**	**174**

Table 7-15
Critical Infrastructure in the 100-Year Flood Hazard Area

Jurisdiction	Bridges	Water Supply	Waste-water	Power	Communications	Other	Total
Unincorporated	48	1	0	2	0	0	**51**
Anacortes, City of	0	0	0	0	0	1	**1**
Burlington, City of	0	0	1	0	0	3	**4**
Concrete Town of	0	0	2	0	0	0	**2**
Hamilton, Town of	1	0	0	0	1	0	**2**
La Conner, Town of	0	0	1	0	0	0	**1**
Lyman, Town of	0	0	0	0	0	0	**0**
Mount Vernon, City of	0	0	6	0	0	1	**7**
Sedro-Woolley, City of	0	0	5	0	0	0	**5**
Swinomish Indian Tribal Community	0	0	0	0	0	0	**0**
Sauk-Suiattle Tribe	0	0	0	0	0	0	**0**
Upper Skagit Indian Tribe	0	0	0	0	0	0	**0**
Total	**49**	**1**	**15**	**2**	**1**	**5**	**73**

Table 7-16
Critical Facilities Exposed in the 500-Year Flood Hazard Area

Jurisdiction	Medical and Health Services	Government Function	Protective	Schools	Hazardous Materials	Other	**Total**
Unincorporated Skagit County	0	0	0	0	5	0	**5**
Anacortes, City of	0	0	0	0	0	0	**0**
Burlington, City of	0	0	0	0	0	0	**0**
Concrete Town of	0	0	0	0	0	0	**0**
Hamilton, Town of	0	0	2	0	0	0	**2**
La Conner, Town of	0	0	0	0	0	0	**0**
Lyman, Town of	0	0	0	0	0	0	**0**
Mount Vernon, City of	0	0	0	0	1	0	**1**
Sedro-Woolley, City of	0	2	0	1	1	0	**4**
Swinomish Indian Tribal Community	0	0	0	0	0	0	**0** **4**
Sauk-Suiattle Tribe	1	1		1	0	1	**0**
Upper Skagit Indian Tribe	0	0	0	0	0	0	**16**
Total	**1**	**3**	**2**	**2**	**7**	**1**	

Table 7-17
Critical Infrastructure in the 500-Year Flood Hazard Area

Jurisdiction	Bridges	Water Supply	Waste-water	Power	Communications	Other	**Total**
Unincorporated	2	0	0	0	0	0	**2**
Anacortes, City of	0	0	0	0	0	0	**0**
Burlington, City of	0	0	0	1	0	0	**1**
Concrete Town of	0	0	3	1	0	0	**4**
Hamilton, Town of	0	0	0	0	0	0	**0**
La Conner, Town of	0	0	0	0	0	0	**0**
Lyman, Town of	0	0	0	0	0	0	**0**
Mount Vernon, City of	0	0	0	0	0	0	**0**
Sedro-Woolley, City of	0	0	0	0	0	0	**0**
Swinomish Indian Tribal Community	0	0	0	0	0	0	**0**
Sauk-Suiattle Tribe	0	0	0	0	0	0	**0**
Upper Skagit Indian Tribe	0	0	0	0	0	0	**0**
Total	**2**	**0**	**3**	**2**	**0**	**0**	**7**

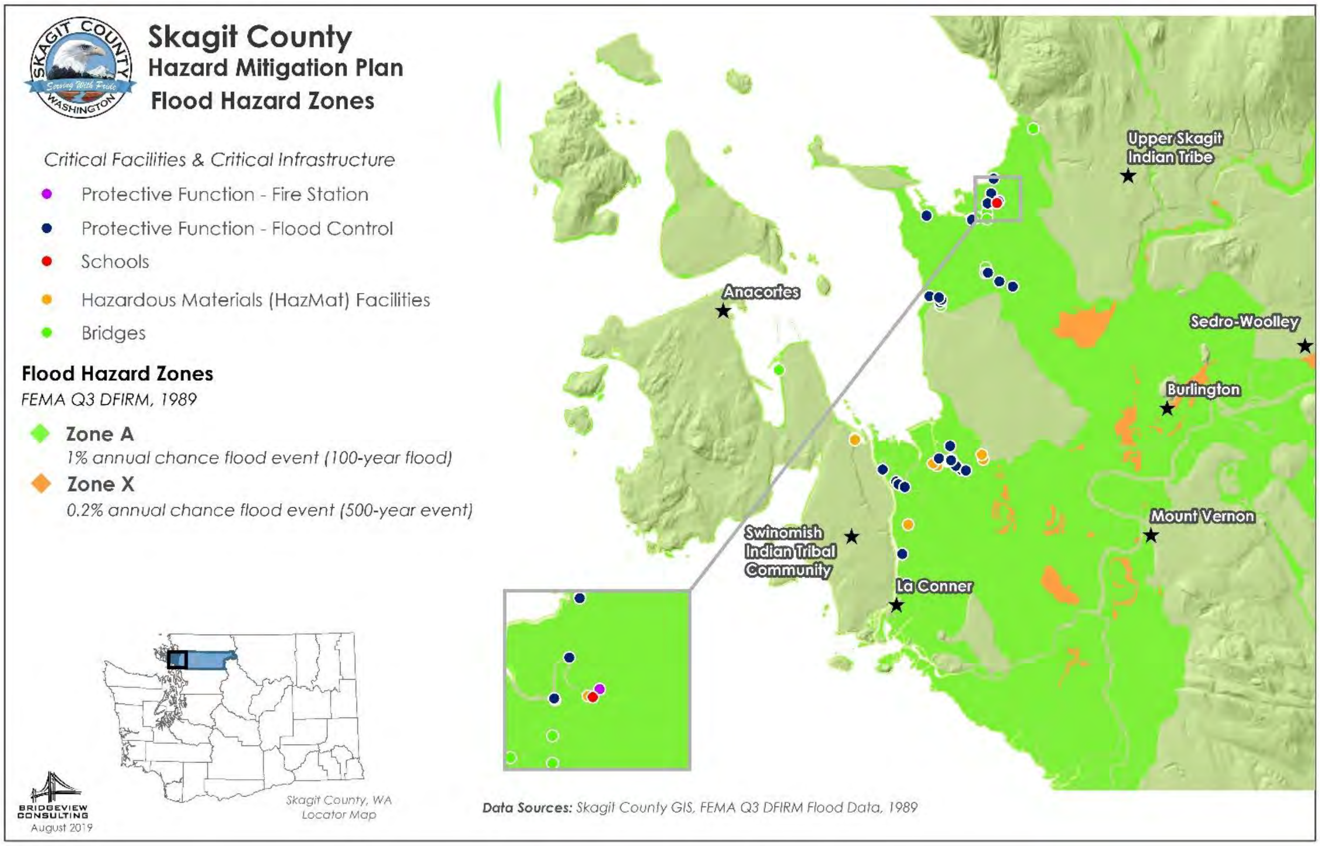


Figure 7-15 Critical Facilities Impacted in the 100- and 500-year Flood Hazard Areas

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.

7.3.5 Impact on Economy

Impact on the economy related to a flood event in Skagit County would include loss of property and associated tax revenue, as well as potential loss of businesses, including tourism. 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. Flooding has impacts on agricultural and forestland. Agricultural land in the County are subject to flooding. Likewise, inundation frequently affects croplands, something on which the County relies as a source of income. Forestland is also vulnerable to floods due to erosion when river and stream banks fail and overflow.

Due to the large amount of commercial and industrial development that is located in the lower valley floodplain, the majority of the County's transportation and communication infrastructure has also been located in the floodplain in order to serve the needs of the community. A major Skagit River flood event that causes large portions of the valley to be inundated with water has the potential to severely impact the overall economy of Skagit County as well as other communities within the North Puget Sound region (Skagit County HMP, 2015).

A U.S. Army Corps of Engineers (USACE) Feasibility Study (date unknown) on the Skagit River illustrated that as a result of a significant flood event, the economy of the entire county could be devastated. According to United States Army Corps of Engineers' estimates, damages could exceed $1 billion dollars locally per 100-year flood event.

Road, railroad and pipeline transportation to the refineries would be in jeopardy forcing shutdowns for an industry employing more than 800 workers with annual payrolls exceeding $57 million and thousands of people would possibly be unable to commute from their homes to work.

USACE also identified the fact that the Anacortes Water Treatment Plant could be inoperable for up to 45 days or perhaps longer. The facility serves the City of Anacortes, the Town of La Conner, portions of Fidalgo Island, as well as the Shell and Marathon refineries in addition to the City of Oak Harbor and Naval Air Station Whidbey Island located in Island County.

7.3.6 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. 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.

7.3.7 Impact from Climate Change

According to University of Washington scientists, global climate changes resulting in warmer, wetter winters are projected to increase flooding frequency in most Western Washington river basins. Future floods are expected to exceed the capacity and protective abilities of existing flood protection facilities, threatening lives, property, major transportation corridors, communities, and regional economic centers.

Changes in Hydrology

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 events (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, bypass channels and levees, as well as the design of local sewers and storm drains.

Sea Level Rise

Sea level and temperature are interrelated (U.S. EPA, 2013e). Warmer temperatures result in the melting of glaciers and ice sheets. This melting means that less water is stored on land and, thus, there is a greater volume of water in the oceans. Water also expands as it warms, and the heat content of the world's oceans has been increasing over the last several decades. According to the EPA, there is likely to be 13 inches of sea level rise in the Puget Sound basin by 2100. According to the Washington State Department of Ecology the impacts of sea level rise could include the following: increased coastal community flooding, coastal erosion and landslides, seawater well intrusion, acidification of waters, and lost wetlands and estuaries.

7.4 FUTURE DEVELOPMENT TRENDS

Skagit County and its planning partners are subject to the provisions of the Washington State Growth Management Act (GMA), which regulates identified critical areas. The County Code identifies critical areas which are regulated by the County.

Further, the Critical Areas Protection Ordinance, which was updated in 2017, includes regulatory authority concerning frequently flooded areas, which are 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. These plans exclude areas designated as "critical areas" from consideration as buildable lands due to the scope of regulations affecting them. Some floodplains in the planning area can be developed, but are subject to regulatory provisions in the codes of the County and/or its partner cities. The analysis assumes that these regulations will discourage development from these areas. Section 3 of this plan discusses the County's land use designations, including identification of critical areas.

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. As NFIP map updates occur, those updates will be utilized to further expand, modify and enhance planning efforts occurring within the County.

7.5 ISSUES

A large portion of the planning area has the potential to flood, generally in response to a succession of winter rainstorms, or tidal surge. Storm patterns of warm, moist air are normal events, usually occurring between October and April, and can cause severe flooding in the planning area, although flooding can occur at any time.

Development has affected these natural features over time as the County developed from a wilderness to the present day. Along with development came land alternations that have been a factor in increasing the magnitude and frequency of floods in the County. Encroachment on floodplains by structures and fill material reduces carrying capacity and increases flood heights and velocities. Dams alter the hydrology of a watershed and stormwater runoff from impervious surfaces contributes to the volume and velocity of floodwater.

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, especially when occurring simultaneous with a high-tide event. These types of events have occurred in Skagit County, and have overwhelmed response capabilities within the County.

The results of such an event could again block major roads as has previously occurred, preventing critical access for residents and critical functions in portions of the planning region. High in-channel flows would cause watercourses to scour, possibly washing out roads or impacting bridges, causing levee structures to be impacted, and potentially creating more isolation problems, and further exacerbating erosion along the coast- and shore-lines. 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:

- Several of the rivers in the area have strong tidal influences due to the low gradients and proximity to the Pacific Ocean.
- The lack of current flood hazard mapping is a difficult obstacle to overcome when attempting to develop a strategy for hazard prone areas in land use planning (although the county has actively and successfully made the decision to pursue CRS), and for development of this

mitigation plan. Many of the jurisdictions have updated ordinances to address flood-prone issues, but additional, reliable NFIP maps are needed.

- The risk associated with the flood hazard overlaps the risk associated with other hazards such as erosion, severe storm events, earthquake, 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. Once a building exposure analysis can be completed with improved Assessor's data, such data will increase the outputs available through the risk assessment process.
- 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. Such information could be maintained in a GIS layer, which would further support planning and identification of areas at risk.
- Ongoing flood hazard mitigation will require funding from multiple sources.
- There needs to be a coordinated hazard mitigation effort between the county, cities, tribes, 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 during storm/flooding events.
- Floodplain residents need to continue to be educated about flood preparedness, including insurance, and the resources available during and after floods. This should occur on an annual basis, which the County has actively pursued on an annual basis, such as with the annual Flood Awareness Week and the County's flood portion of its website. Such activities should be continued and supported countywide.
- The promotion of flood insurance as a means of protecting property from the economic impacts of frequent flood events should continue. Future outreach efforts should include the insurance industry in attendance to assist in determining the types of insurance available, and associated costs at the individual homeowner level, again, such as occurs during the Flood Awareness Week.
- Existing floodplain-compatible uses such as agricultural and open space need to be maintained. The County has an extensive levee system which supports open space while helping to reduce the flood hazard.

7.6 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 highly likely. The area experiences some level of flood annually, albeit not necessarily to the level of a disaster declaration. The City of Burlington and the Town of La Conner and the Unincorporated Areas of Skagit County have the largest percentage of buildings located in the SFHA based on FEMA's Risk Map Report, and the identification of the critical facilities list utilized for this assessment. In addition, these areas also have the highest projected dollar losses associated with a flood event. While structural damage may vary due to flood depths and existing floodplain management regulations, there is a fairly high rate of property ownership that does not have flood insurance. Based on the potential impact, the Planning Team determined the CPRI score to be 3.05 with overall vulnerability determined to be a high level.

CHAPTER 8.
LANDSLIDE

8.1 GENERAL BACKGROUND

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. They can be initiated by storms, earthquakes, fires, volcanic eruptions or human modification of the land.

> **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.

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.

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 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. 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.

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.

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:

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

Flows and slides are commonly categorized by the form of initial ground failure. Common types of slides are shown on Figure 8-1 through Figure 8-4 (Washington State Department of Ecology, 2014). 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.

Deep-seated landslides are much larger than shallow landslides and can occur at any time of the year. Soil degradation can happen over years, decades, and centuries with little to no warning to people above ground. The most notable and deadliest deep-seated landslide event in the United States was SR 530 (also known as the Oso Landslide) that took the lives of 43 people in Oso, Washington, in 2014.

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.

The primary types of landslides that occur in Skagit County are debris flows and earth flows. While small slides and debris flows occur on a somewhat regular basis, there have been several slides and/or debris flows that have resulted in loss of life and/or property damage.

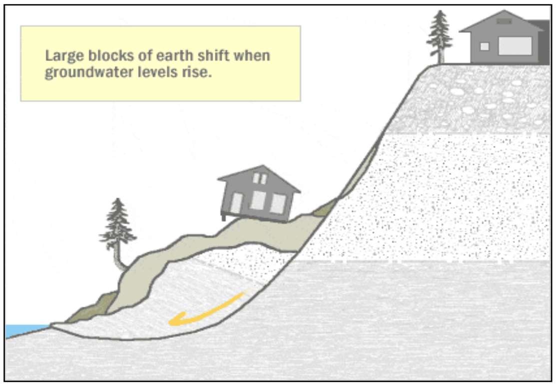


Figure 8-1 Deep Seated Slide

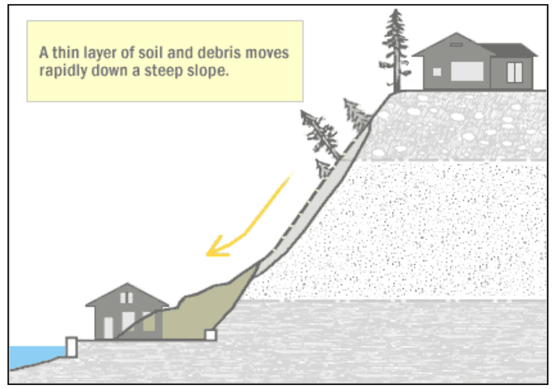


Figure 8-2 Shallow Colluvial Slide

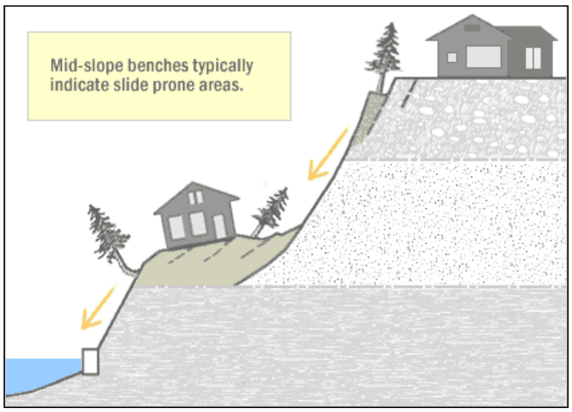


Figure 8-3 Bench Slide

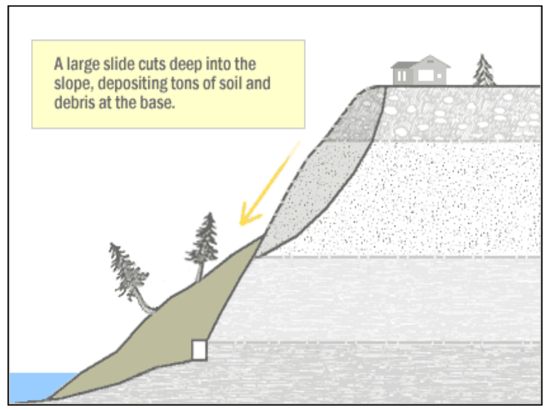


Figure 8-4 Large Slide

Coastal Erosion

Coastal erosion is a natural process that is common along the shoreline interface of a water body and the land. Along sedimentary coasts, a beach is commonly found at this interface, with sediments moving and changing the shape of the beach in response to hydrodynamic forces. As such, the beach typically serves as a buffer zone between the water's edge and the more stable back beach dune or upland margin. While a net loss of sediment from a beach may be noticeable and affect human uses and the environment, often much greater concern and impact occurs when there is dune or upland erosion, particularly where this land has been considered to be stable and suitable for development.

Coastal erosion is defined as the wearing of coastal land by natural forces, such as by water waves, wind, and tidal currents. Beach sediments are routinely mobilized by these forces, which can change the shape and size of a beach over a range of time scales from hours to years. These changes are often only recognized as erosion when there is a significant net loss of material that causes an impact or instability to the adjacent upland. Coastal erosion can occur during an episodic event, such as a large storm, or as a chronic condition with the gradual loss of the beach or coastal land.

Washington's coastlines are subject to high energy waves that can cause rapid coastal erosion during typical winter storms that coincide with high tides and elevated water levels.

Localized coastal erosion such as adjacent to shoreline armoring or along a river mouth can result from the interactions of forces that locally change the transport and distribution of sediments. Large-scale coastal erosion can occur during the infrequent, yet periodic, Cascadia subduction zone earthquakes, associated with coastal subsidence and large tsunamis.

Much of Skagit County's shorelines are composed of fine sand derived from the various rivers that are readily mobilized by wind and wave action. Seasonal fluctuations in waves and water levels typically cause beach erosion in the winter and beach accretion (or build up) in the summer. Where the beaches are backed by bluffs composed of older sedimentary deposits, bluff erosion constitutes a permanent loss of the upland.

In addition to rock composition, the geology may control the elevation and slope of the nearshore area, which in turn can determine how wave energy is dissipated before reaching the shoreline. A shallow and mild-sloped shoreface will cause waves to break offshore and greatly reduce their ability to erode coastal uplands. In contrast, a deep and steep shoreface will enable high waves to break directly onto the beach and dissipate as run-up onto the upper beach or bluff. In general, a deep and steep shoreface will manifest as a steep and rocky beach composed of larger particles, such as cobbles or boulders, because smaller particles, such as sand and gravel, are readily transported away and deposited in areas having a lower energy regime.

On a seasonal scale, coastal erosion typically occurs during the winter, when distant and local storms produce large waves, high winds, and elevated water levels. Winter storms typically approach the shoreline from the southwest, resulting in northerly and offshore sediment transport that erodes beaches, whereas fair-weather summer conditions generally produce smaller waves approaching from the northwest that result in southerly and onshore sediment transport that builds up the beaches. During strong El Niño events, sustained elevated water levels can accentuate seasonal coastal erosion.

Coastal erosion is dependent on a combination of site-specific conditions and influencing factors. Most commonly, the factors that contribute to erosion fall into three broad categories:

- Hydraulic energy regime (waves, water levels, currents, winds, storm climatology).
- Geomorphic setting (sediment supply and grain size, geologically inherited substrate, landform and composition, e.g., coastal barrier, bluff, geology, vegetation, streams, rivers).
- Human activity (e.g. dams, jetties, coastal structures that affect sediment transport and sediment budget).

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 slope 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.

The primary types of landslides that occur in Skagit County are debris flows and earth flows.

8.2 HAZARD PROFILE

8.2.1 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 2007 USGS Landslide Hazard area which occurred for the Seattle, Washington area further confirms that "when slopes are dry, steepness and strength control potential instability. However, where ground water perches on lower permeability clay layers, extended wet winter conditions can increase the water table near the bluff face. Elevated ground-water pressures can lower slope stability" (USGS, 2007).

Generally, landslides in Skagit County will develop at the base or top of a steep cut slope; on developed hillsides or coastal bluffs; from activities that disturb slopes such as construction, road building and logging; and on old existing landslides. Other factors inducing landslides can be poorly located septic systems that contribute to slope unsuitability, areas where surface water is channeled along roads and below culverts, water leakage from utilities, vegetation removal and paths or trails down a bluff leading to beach access.

As indicated, the primary types of landslides that occur in the County are debris flows and earth flows. Debris flows are also called mudslides, mudflows, or debris avalanches. They are rivers of a combination of loose soil, rock, organic matter, water, and air that flow downhill. As they continue downhill they tend to grow in volume with the addition of water, soil, boulders and other materials. When the flow reaches flatter ground, it can spread over a large area. Earth flows usually occur in fine-grained materials or clay bearing rocks on moderate slopes. The slope's material liquefies and forms a bowl shape depression at the source area. Table 8-1 identifies the types and acres impacted by each landslide type in Skagit County as identified by WA DNR. Figure 8-5 illustrates the same information countywide by location.

TABLE 8-1
TYPES AND NUMBER OF LANDSLIDES AND IMPACTED AREA

Landslide Type	Number Of Recorded Landslides By Type in Skagit County	Total Area Impacted by Slides (in Acres)
Block Fall or Topple	28	6.39
Debris Flow	614	564.94
Debris slide and avalanches	403	201.16
Deep-seated	210	5,413.63
Deep-seated earthflow	50	2,954.01
Hyper-concentrated Flows	18	4.92
Shallow undifferentiated	1,340	1,351.13
Unknown	2,118	4,491.08

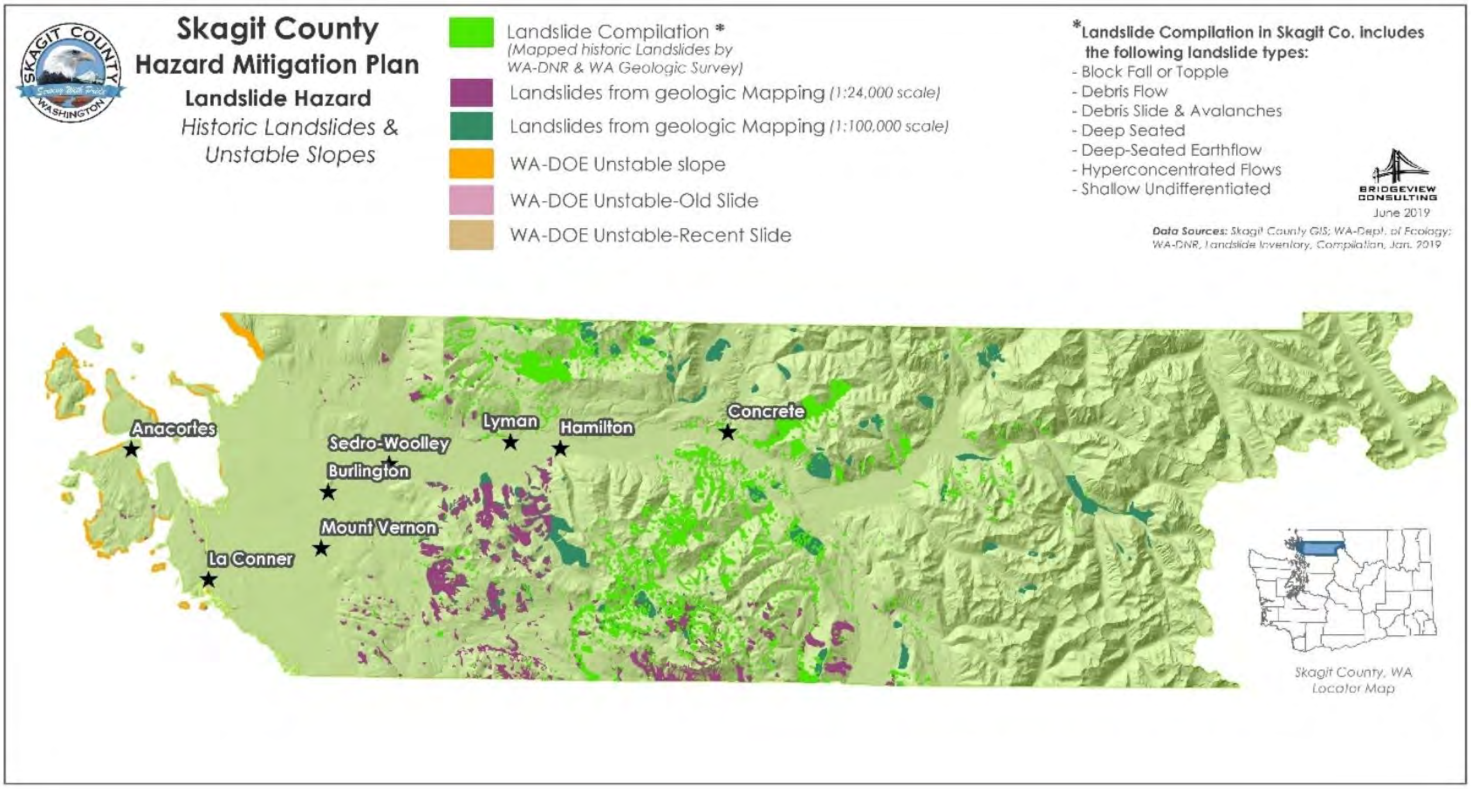


Figure 8-5 Landslide Types as Established by Washington State Department of Natural Resources

Skagit County has experienced significant slides in the past, and does address the landslide hazard within their Comprehensive Land Use Plan. Skagit County identifies the Landslide Susceptibility areas within Chapter 14.24 Critical Areas Ordinance.[27] Skagit County GIS also maintains a series of landslide maps available on the Skagit County Website at: https://www.skagitcounty.net/Departments/GIS/main.htm

Erosion

The best predictor of where coastal erosion might occur is along shorelines that have eroded in the past. A range of geological, historical, and contemporary approaches can be used to identify coastal erosion hazard areas and their associated time and space scales. One way to reveal if either chronic or episodic erosion has occurred is through the mapping of historical shorelines. Coastal erosion can also be recognized in surface topography by steep scarps and slumps along dunes and bluffs that are generally unstable and unvegetated. Eroded beaches are typically narrower, steeper, and composed of coarser sediment than adjacent stable beaches. Sandy beaches may have higher concentrations of heavy minerals and surface lag deposits that are more resistant to transport relative to other local sediments. Past erosion events may also be detected by ground-penetrating radar and recorded as subsurface lag deposits that were subsequently buried during an accretion phase.

[27] https://www.codepublishing.com/WA/SkagitCounty/html/SkagitCounty14/SkagitCounty1424.html

8.2.2 Previous Occurrences

Landslides within the planning area are common. Since 1963, a total of seven (7) weather events have included impact from landslides or mudslides. However, the County has never received a disaster declaration specifically typed *Landslide* by FEMA. Reviewers should examine the Disaster Event tables in Section 3, as well as both the Severe Weather and Flood Chapters to identify disaster-related landslide occurrences included with other hazards of concern.

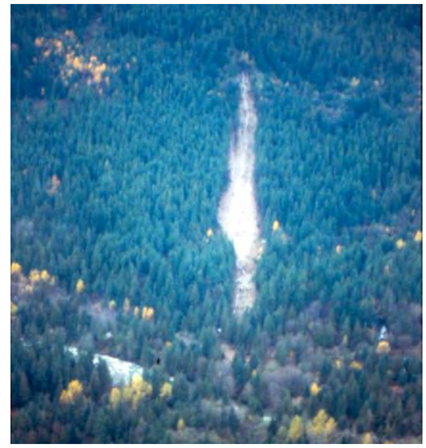


Figure 8-6 Marblemount 1985 Slide Resulting in Four (4) Deaths

Landslide history in Skagit County does include incidents involving death and significant property damage. Some of the larger events include the following.

- A debris flow occurring in the area of Marblemount on November 2, 1985, which caused four deaths. That landslide swept into a mobile home park (see Figure 8-6).
- In January 2009, a typical atmospheric river (Pineapple Express) storm rolled through the state, bringing with it warm rains that rapidly melted lowland snow. The Washington Geological Survey reported that the storm caused more than 1,500 landslides greater than 5,000 ft2 in size. Approximately 300 to 500 landslides occurred in Skagit and Whatcom Counties.
- In October 2003 heavy rainfall caused severe flooding and landslides in 15 counties. Landslides or ground failure caused temporary closures on nine state highways. Landslides closed SR 20 between Skagit and Okanogan Counties.
- In the late 1960's, a large landslide that occurred east of Marblemount on the south side of the Cascade River in the isolated recreational community of Cascade River Park. While limited data is available on the slide and total impact, this slide did destroy several recreational cabins and covered a large number of vacant lots with debris; the County has been unable to determine if persons were injured or killed as a result of this slide. The slide was serious enough that a large portion of the development was permanently abandoned.

Figure 8-7 January 2009 Landslide which destroyed structure

Figure 8-8 April 2013 Rockslide on Rosario Beach

Photo courtesy of Skagit County Emergency Management

Additional information on landslides occurring in the planning area are identified in the Table 8-2. It should be noted that this list is not all inclusive, and that additional landslides in the area have occurred.

Table 8-2
Historic Landslide Movement Events in Skagit County

Date	Location	Description of Event
November 23, 1939	Concrete	Three homes destroyed in the center of town, by a land slide that released in three stages, no one was injured.
May 18, 1965	Lower Baker Dam Powerhouse – near Town of Concrete	A large landslide that occurred just east of the Town of Concrete that partially buried the Lower Baker Powerhouse owned and operated by Puget Sound Energy. This slide was so large that the powerhouse was abandoned and a new powerhouse was constructed approximately 200 feet east of the original powerhouse.

Table 8-2
Historic Landslide Movement Events in Skagit County

Date	Location	Description of Event
January 24, 1982	Various locations throughout Skagit County	Excessive rainfall caused six (6) mudslides in various areas of Skagit County including: Del Mar Drive on Fidalgo Island; along the South Skagit Highway; Burpee Hill near Concrete; Cascade River Road; Concrete-Sauk Valley Road; State Route 530 south of Rockport.
January 10, 1983	Near Cruse Road north of Sedro-Woolley	A very large debris flow occurred killing one person and 300 veal calves; a large barn and a mobile home were completely destroyed.
November 2, 1985	Cascade River Park	A large debris flow occurred on the North side of the Cascade River within the Cascade River Park development killing two persons and destroying two mobile homes.
January 18, 1990	Burpee Hill – north of Concrete	Additional mudslides occurred in various areas on Burpee Hill.
February 10, 1990	Mill Addition – Town of Concrete	A mudslide occurred on a steep slope above the Mill Addition Plat within the Town of Concrete that potentially threatened seven families.
November, 1990	Biz Point area – Fidalgo Island	Heavy rains caused excessive runoff from storm water drainage systems and bank erosion in the Biz Point area
November 10, 1990	Grandy Creek	Heavy rains caused severe flooding throughout Skagit County and numerous mudslides occurred in the Grandy Creek area causing the Grandy Creek Campground to be evacuated.
November 25, 1990	Burpee Hill – north of Concrete	Numerous mudslides occurred in various areas on Burpee Hill causing property damage and damage to two homes; damage to a portion of Burpee Hill Road; and damage to Puget Sound Energy's facility.
December 28, 1990	Salmon Beach – Gibralter Road	A slump of a mid-slope bench area near the shoreline of Similk Bay cause damage to several homes and resulted in the temporary evacuation of a total of 28 homes; two homes were severely damaged and officially posted as uninhabitable by the Skagit County Building Official.
July 10, 1991	Big Lake	A debris flow caused by a beaver dam break damaged a portion of West Big Lake Boulevard and a Washington State Fishing Access and boat launch and blocking access to two homes.
May 5, 1994	Highway 20 east of Anacortes	A large rockslide occurred just east of the City of Anacortes blocking traffic for several days.
May 3, 1995	Big Lake	A debris flow caused by a beaver dam break damaged a portion of West Big Lake Boulevard and a Washington State Fishing Access and boat launch and blocking access to two homes.

Table 8-2 **Historic Landslide Movement Events in Skagit County**		
Date	**Location**	**Description of Event**
February 8, 1996	Turner Ranch – 5502 East Sauk Prairie Road	A debris flow damaged a barn and adjacent feed shed and killed 1 bull, 20 cows, and 30 calves.
January 10, 1997	Lonestar Property - East Concrete	Area residents are concerned that the hill above their homes will slide – occupants of 15 homes in the immediate area were advised to leave. Several residents claim that a slide occurred at this same location in the late 1950's or early 1960's and destroyed three or four homes.
February 8, 1997	Lonestar Property - East Concrete	A small side occurred knocking a garage from its foundation.
October 16, 1997	Jura Way – Similk Bay	A small slide occurred affecting one home.
December 13 -14, 2001	Frank's Place – Town of Concrete	A slide occurred affecting three homes.
February 22, 2002	Cascade River Park	A mud slide occurred along East Cascade Drive washing out a portion of road and requiring the evacuation of six cabins.
March 20, 2002	North Beach Area Samish Island	A slide occurred blocking access to three homes.
January 14, 2003	Hill Ditch and Johnson Road area	A debris flow caused by a beaver dam break damaged a portion of the Hill Ditch Levee and blocked access to three homes
February 22, 2003	Colony Creek	A large debris flow caused by a beaver dam break damaged a portion of Wood Road and also damaged the access and utilities serving two residences, and a footbridge. This same debris flow also damaged a private well, pond, and fish ladder along Deer Trails Lane further upstream on Colony Creek.
January 6-13, 2009	Town of Concrete and State Route 20	A slide destroyed a home in the Town of Concrete, trapping an occupant inside who was later rescued. A slide blocked State Route #20 for 8 days and caused loss of electricity for 7 days to approximately 960 households in the communities of Rockport and Marblemount. Minor slides also reported on Burpee Hill. (See Figure 8-7 above.)
April 8, 2013	Rosario Beach	Rock fall near shoreline. No damage to homes or private property. (See Figure 8-8 above.)
January 2016	State Route 20 closure from Concrete Sauk Valley Road to Highway 530	SR 20 was closed for several days due to slope on north side of highway becoming unstable.

Property Protection Activities

Various strategies are available to help mitigate the impact of natural hazards. Historically, Skagit County and its planning partners have been forward-thinking in their application of those mitigation activities to help reduce the risk and impact from the hazards of concern. FEMA historically has provided various funding streams to allow communities to better prepare, and Skagit County has taken advantage of those opportunities. The table below illustrates the cost associated with previous disaster incidents which include landslides, as well as identification of some of the mitigation efforts completed.

Table 8-3
Assistance Cost Data for Skagit County
Presidential Disaster Declarations Including Landslides

Disaster Number	Declaration Date	Incident Type/ Title	Total Public Assistance Grants-Dollars Obligated	HMGP Funding			
				Project Title	Sub Grantee	Project Amount	Cost Share
1963	3/25/2011	Severe Storms/ Severe Winter Storm, Flooding, Landslides, and Mudslides	$11,357,180.63	State Management Costs (Salaries)	Statewide	$71,550.00	100%
1817	1/30/2009	Flood/ Severe Winter Storm, Landslides, Mudslides, and Flooding	$51,055,701.79	State Management Costs (Salaries)	Statewide	$568,640.00	100%
				Acquisition Of Private Real Estate	Concrete	$594,706.00	75%
				Relocation Of Private Structures	Skagit (County)	$6,410.00	75%
				Washington State Facilities Inventory System Initiated	WA State Office Of Financial Mgmt.	$177,288.00	75%
1734	12/8/2007	Severe Storms/ Severe Storms, Flooding, Landslides, and Mudslides	$60,627,680.14	State Management Costs (Salaries)	Statewide	$567,545.00	100%
				Hazus Risk Assessments Produced	WA State Military Dept.	$92,272.00	75%
1682	2/14/2007	Severe Storms/ Severe Winter Storm, Landslides, and Mudslides	$30,374,675.17	State Management Costs (Salaries)	Statewide	$400,635.00	75%
1671	12/12/2006	Severe Storms/ Severe Storms, Flooding, Landslides, and Mudslides	$31,624,958.61	State Management Costs (Salaries)	Statewide	$401,598.00	75%
				Structural Retrofitting/ Rehabilitating Of Public Structures	Skagit County Fire District #2	$75,591.00	75%
				Acquisition Of Private Real Estate	Skagit (County)	$436,600.00	75%

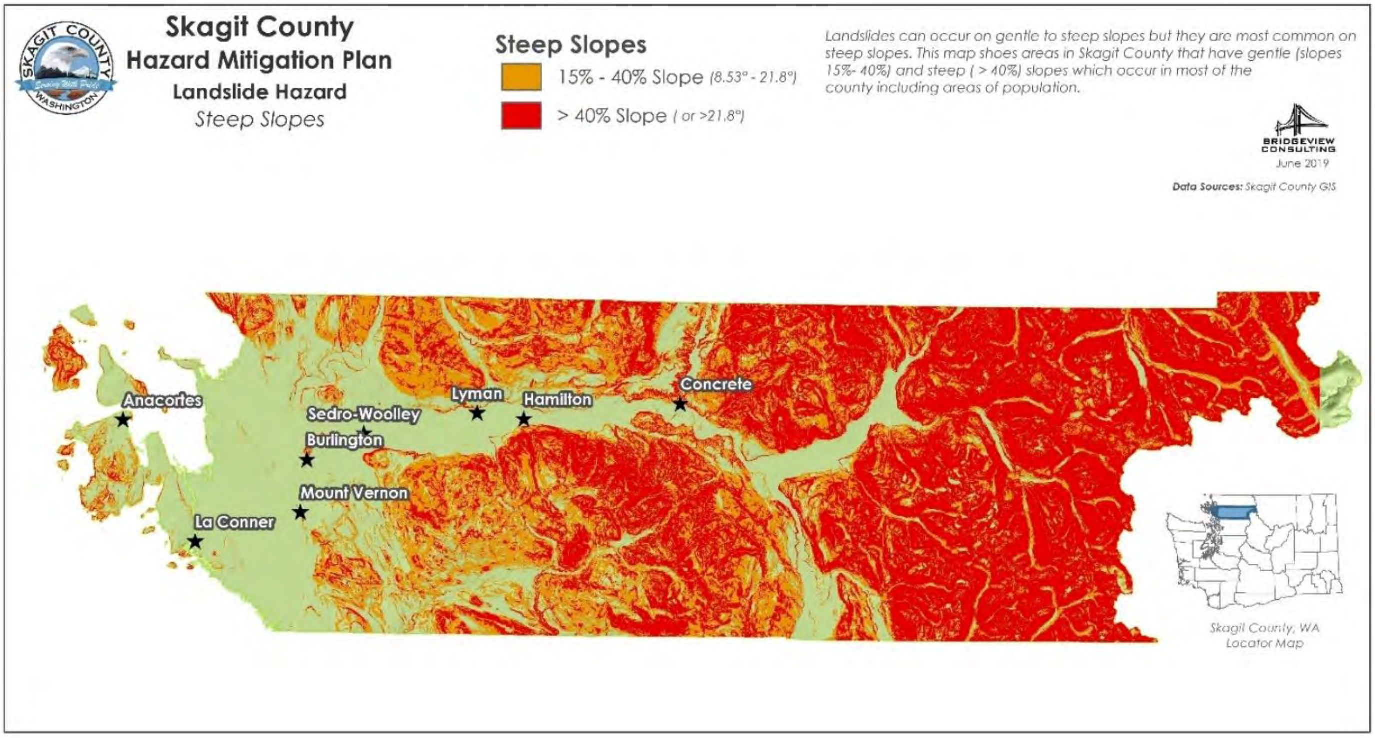


Figure 8-9 Landslide Hazard Areas

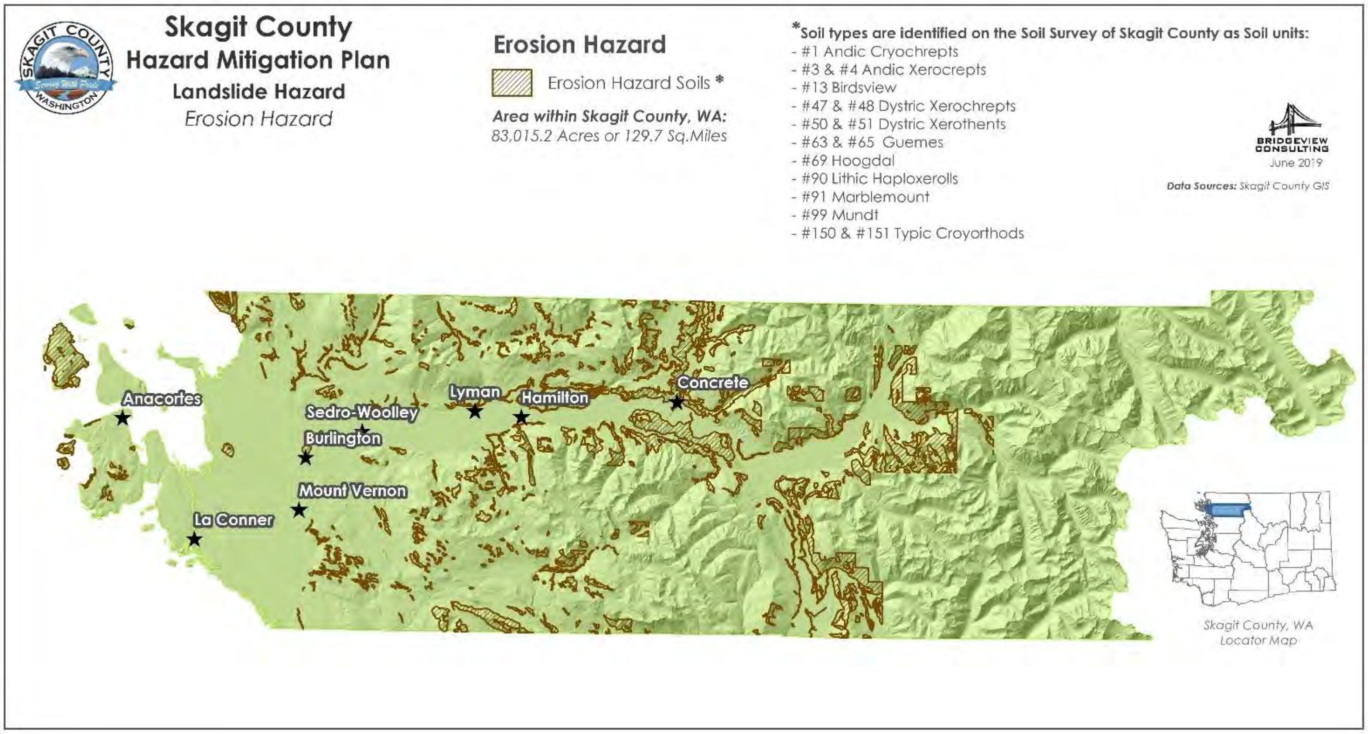


Figure 8-10 Erosion Hazard Area

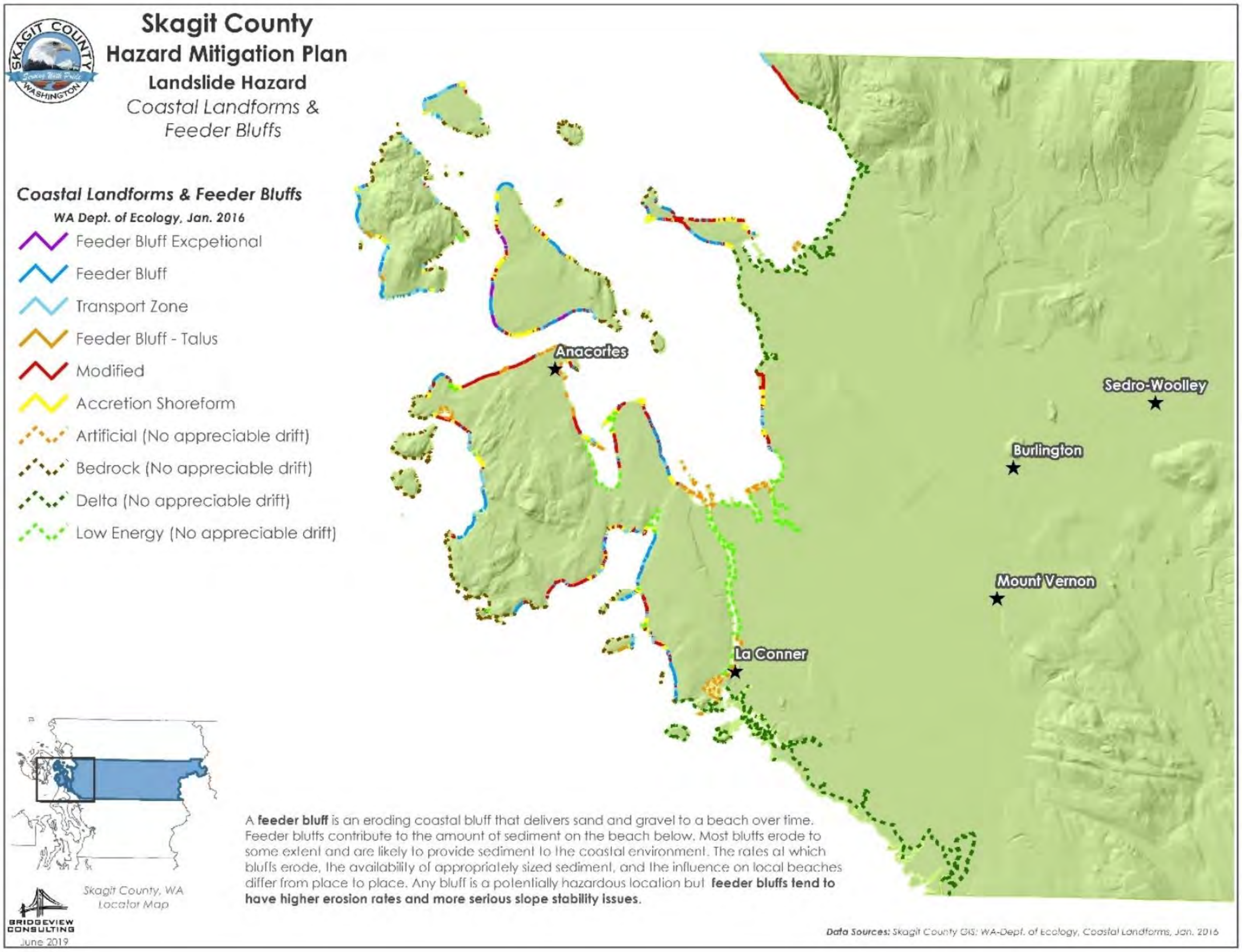


Figure 8-11 Landslide Hazard Areas- Coastal Landforms and Feeder Bluffs

8.2.3 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).

Washington is one of seven states listed by the Federal Emergency Management Agency as being especially vulnerable to severe land stability problems. Topographic and geologic factors cause certain areas of Skagit County to be highly susceptible to landslides. Ground saturation and variability in rainfall patterns are also important factors affecting slope stability in area susceptible to landslides. Strong earthquake shaking can cause landslides on slopes that are otherwise stable.

Figure 8-9 illustrates the Steep Slopes in Skagit County identified with 40 percent or greater slopes – areas identified by WA DNR as being more susceptible to landslide areas. The 40 percent slope designation is also the same identification utilized by the County. This equates to ~482,617.2 acres of steep slopes.

8.2.4 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.

While the County has not received a disaster declaration specifically for a landslide, there have been seven (7) disaster declarations which have included mud- or land-slides which occurred in conjunction with severe storm (or flood) events since 1963. 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 most likely occur during periods of higher than average rainfall as the ground is already saturated prior to the onset of a major storm, which increases the likelihood of significant landslides to occur. Precipitation influences the timing of landslides on three scales: total annual rainfall, monthly rainfall, and single precipitation events. In general, landslides likely occur during periods of higher than average rainfall.

The ground must be saturated prior to the onset of a major storm for significant landsliding to occur. Studies conducted by the USGS have identified two precipitation thresholds to help identify when landslides are likely (USGS, 2007)[28]:

- Cumulative Precipitation Threshold (Figure 9-11—A measure of precipitation over the last 18 days, indicating when the ground is wet enough to be susceptible to landslides. Rainfall of 3.5 to 5.3 inches is required to exceed this threshold, depending on how much rain falls in the last 3 days.
- Intensity Duration Threshold (Figure 9-12)—A measure of rainfall during a storm, indicating when it is raining hard enough to cause multiple landslides if the ground is already wet.

These thresholds are most likely to be crossed during the rainy season. The 2007 USGS study indicates that by comparing recent and forecast rainfall amounts to the thresholds, meteorologists, geologists and city officials can help people know when to be prepared for landslides. The thresholds as developed and tested are accurate, but imperfect indicators of when landslides may occur. During the study, statistical analysis of landslides that occurred between 1978 and 2003 showed that 85% occurred when the Cumulative Precipitation Threshold was exceeded (USGS, 2007).

Review of existing disaster-related data illustrates that slide events in the planning area most commonly occur from November through January, after water tables have risen. Review of historic disasters illustrates that the month of December experienced the greatest number of slides, followed by January and November.

[28] USGS Landslide Hazards in the Seattle, Washington, Area. Accessed 20 June 2019. Available at: https://pubs.usgs.gov/fs/2007/3005/pdf/FS07-3005_508.pdf

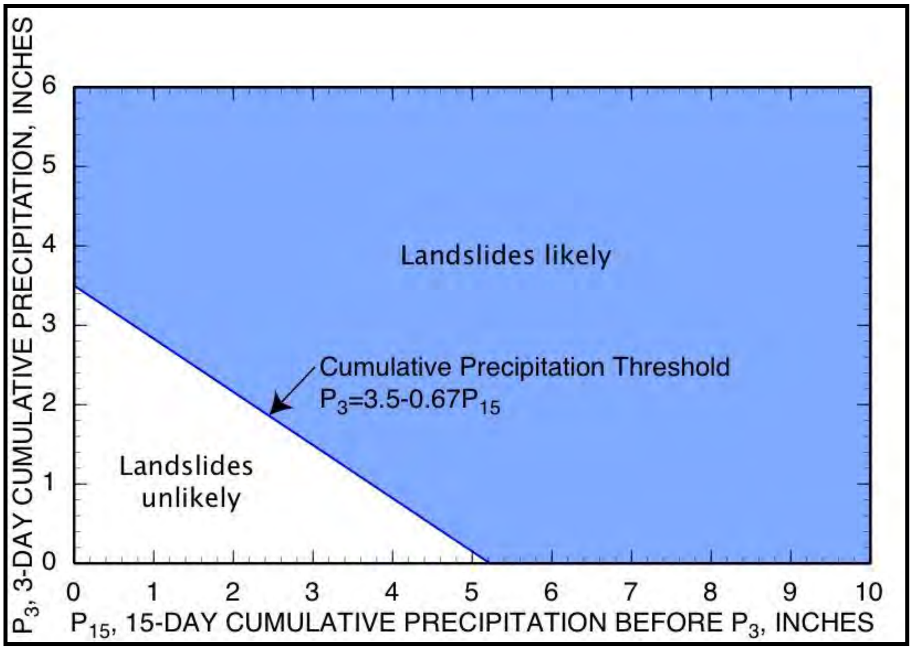


Figure 8-12 Cumulative Precipitation Threshold

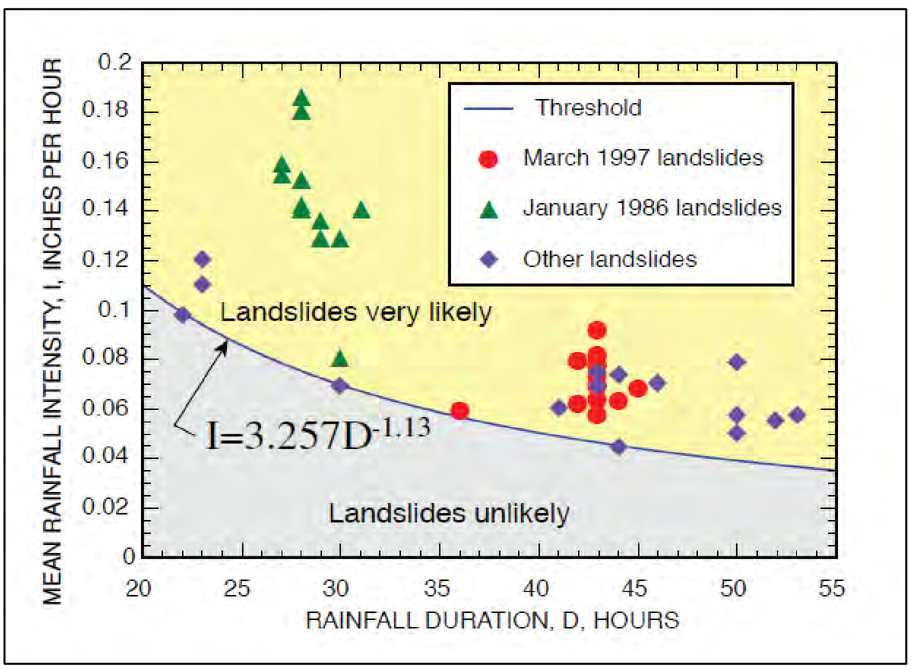


Figure 8-13 Landslide Intensity Duration Threshold

8.3 VULNERABILITY ASSESSMENT

8.3.1 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 Skagit County's very steep slopes in certain areas, its soil type, and its historical patterns of previous slide occurrences, the landslide hazard is a significant concern for the planning partners.

Review of the DNR data illustrates areas of high vulnerability based on slope are disbursed throughout the entire county, with higher areas concentrated in those less-populated mountainous regions in the eastern portion of the county. Areas along coastal bluffs, particularly after prolonged periods of rain, as well as within the river valleys (particularly near the coastline) are highly susceptible to coastal erosion. The Coastal Zone Atlas for the county shows approximately 17.7 miles of unstable bluffs, or about 8.3 percent of the total marine shoreline.

It should also be noted that the Shannon and Wilson study in Seattle found that 88% of the slides that occurred within the City of Seattle occurred within a potential slide area or along steep slopes. This study also found that only about 1% of the land area of the region is actually vulnerable to slides, 84% of the slides recorded had human-related causes; thus indicating the willingness of people to ignore signs of potential danger in order to possess the most desirable view property (SCHMP, 2015).

Methodology

Historical occurrences, combined with analysis of the slope and the type of soil, are the most effective indicator of areas at risk to landslide. The Washington Department of Natural Resources collects data to use in determining historical events and landslide danger; however, no damage figures are developed as a result of that process.

Landslide hazard areas are those identified by Washington State DNR as having previous landslide events, and includes areas of slopes with a slope greater than or equal to 40 percent (or 21.8 degrees). 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. Additional landslide data is available at: http://www.dnr.wa.gov/programs-and-services/geology/geologic-hazards/landslides

For purposes of this landslide analysis to determine potential building count or dollar loss estimates, two sources were utilized:

- Exposure analysis using the 2020 critical facilities data captured during this update as it intersects with slopes greater than or equal to 40 percent (WA DNR's definition of landslide hazard area).
- FEMA's analysis conducted during its 2017 Risk Map project. The project team produced the landslide susceptibility map by synthesizing semi-qualitative experts' opinions that were based on scoring landslide risk factors such as geology, slope angle, topographic aspect, distance to road, distance to river, and land cover in combination with a multi-criteria decision-making method called Analytic Hierarchy Process (AHP), originally developed by Saaty (1987). The AHP modeling incorporated Remote Sensing Data (i.e., Light Detection and Ranging [LiDAR]) used to generate slope angle and aspect gridded layers, as well as other available GIS data (i.e., cover, geology, distances to roads and streams). (See FEMA 2017 Risk Report for Skagit County available from Skagit County Emergency Management for detailed information on the methodology or risk assessment provided.)

Warning Time

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

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

- Springs, seeps, or saturated ground in areas that have not typically been wet before;
- New cracks or unusual bulges in the ground, street pavements or sidewalks;
- Soil moving away from foundations;
- Ancillary structures such as decks and patios tilting and/or moving relative to the main house;
- Tilting or cracking of concrete floors and foundations;
- Broken water lines and other underground utilities;
- Leaning telephone poles, trees, retaining walls or fences;
- Offset fence lines;
- Sunken or down-dropped roadbeds;
- 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.

Within Washington State, in a partnership with the National Oceanic and Atmospheric Administration (NOAA) and the National Weather Service, Washington State Department of Natural Resources monitors conditions that could produce shallow landslides. Landslide warning information can be viewed at https://fortress.wa.gov/dnr/protection/landslidewarning/.

8.3.2 Impact on Life, Health, and Safety

A population estimate could not be performed for this assessment due to the lack of available digital parcel data for the planning parcel area as parcel designation and building location is currently not available for use. Once data is improved, a more accurate inventory will assist in identifying the number of individuals potentially at risk.

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.

Also to be taken into account when determining affected population are the area-wide impacts 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 areas along major highways, which have a high transient population of tourists, especially during summertime months. In addition, Skagit 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. The increased level of population resulting from tourists in the area must also be considered for planning purposes by first responders. This is particularly true within Skagit County due to its high level of tourism that exists for not only individuals visiting Skagit County as its destination, but also traveling through the County to other areas, including Canada, the San Juan Islands, and the various ski resorts in the area.

Landslides can be fast moving, or slow creeping, with the fast moving obviously increasing the potential for injury or death from such an event. Landslides can also damage water treatment facilities, potentially harming water quality. Skagit County does have several large public water distribution and treatment facilities, but also relies heavily on well water to serve its communities.

Erosion is generally a slow moving, chronic stressor on a community. However, during storm events, high rates of shoreline retreat can occur, also causing damage from associated flooding and the transport of drift logs and other debris. Wave overtopping of coastal structures, dune blowouts, and infra-gravity "sneaker" waves can cause high velocity flows over inland areas thought to be safe by unsuspecting observers. The wave climate of the Pacific Northwest is one of the most severe in the world and the mobility of the fine sand that make up most of the beaches in Washington result in relatively large seasonal morphology changes and long-term regional changes from sediment imbalances that may not be realized until the shoreline is within close proximity to human use areas that have been commonly viewed as stable and secure from the coastal hazards. While both chronic and episodic erosion have severe consequences associated to loss of private assets and critical public infrastructure, the direct impacts on life, health and safety is typically low compared to other shoreline natural hazards. Erosion from co-seismic subsidence and large tsunamis can have a high impact on life, health, and safety, but the frequency of these events are relatively low.

8.3.3 Impact on Property

Landslides and erosion affect both 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 businesses in the area as well as large commercial industries and government facilities. Development in landslide hazard area is guided by building code and the critical area ordinance as discussed above, which help to prevent the acceleration of manmade and natural geological hazards, and to neutralize or reduce the risk to the property owner or adjacent properties from development activities.

For mitigation planning purposes only (not specific to the County's ordinance), the Washington State Department of Natural Resources Landslide Dataset was utilized to identify areas of historic events. In addition, slopes identified as being forty (40) percent or steeper were included in this analysis. The area and percent of the total planning area exposed to the landslide hazard in the planning area are summarized below. Data presented in these maps and tables are not a substitute for site-specific investigations by qualified practitioners.

Table 8-4 identifies the percent of area within the landslide risk, as well as the percent of the total planning area. Table 8-5 identifies the number of buildings exposed based on FEMA's 2017 study. It should be noted that the Planning Team has not been able to validate the FEMA data, and as such, should be used for planning purposes only. Table 8-6 identifies the percent of area within the erosion area.

Table 8-4
Percent of Land Area in Landslide Risk Areas

Jurisdiction	Land Area in Landslide Risk (in Acres)	Percent of Total Planning Area
Unincorporated Skagit County	481,689.9	42.9%
Anacortes, City of	418.1	0.372%
Burlington, City of	63.2	0.0056%
Concrete Town of	113.6	0.0101%
Hamilton, Town of	18.1	0.0016%
La Conner, Town of	4.3	0.0004%
Lyman, Town of	3.2	0.0003%
Mount Vernon, City of	150.2	0.0134%
Sedro-Woolley, City of	3.3	0.0003%
Sauk-Suiattle	5.8	0.005%
Swinomish Indian Tribal Community	130.9	0.0117%
Upper Skagit Indian Tribe	16.6	0.0015%
Total	**482,617.2**	**42.98%**

For these planning purposes, risk area is defined as slopes 40% (21.8°) and above, and areas identified within WADNR mapped historic landslides.

Table 8-5
Skagit County Buildings Exposed to Landslides

Community	Total Number of Buildings	Number of Buildings Exposed to Deep-Seated Landslide Zone *	Number of Buildings Exposed to Shallow Landslide Zone**	Percent of Buildings in Deep-Seated Landslide Zone	Percent of Buildings in Shallow Landslide Zone
Anacortes	6,348	38	2	0.6%	--
Mount Vernon	7,896	297	--	3.8%	--
Sauk-Suiattle Tribe	-	Unknown	--	--	--
Swinomish Indian Tribal Community	965	1	12	0.1%	1.2%
Unincorporated Skagit County	17,736	1,395	80	7.9%	<1%
Total	32,945	1,731	94	5.3%	<1%

*Deep-Seated Landslide Susceptibility (landslides susceptibilities greater than and equal to category VI)
**Shallow Landslide Susceptibility (landslide susceptibilities greater than and equal to category VI)
There is a deep-seated landslide risk for the Sauk-Suiattle Tribe; however, it is unknown how many structures are impacted. Therefore, the table lists this as "Unknown."
(Source: FEMA 2017 Risk Assessment Report)

Table 8-6
Percent of Land Area in Coastal Erosion Zone

Jurisdiction	Shoreline in Landslide Risk (in miles)	Percent of Total Planning Area Shoreline
Unincorporated Skagit County	14.59	6.85%
Anacortes, City of	1.09	0.51%
Burlington, City of	0	0
Concrete Town of	0	0
Hamilton, Town of	0	0
La Conner, Town of	0	0
Lyman, Town of	0	0
Mount Vernon, City of	0	0
Sedro-Woolley, City of	0	0
Sauk-Suiattle	0	0
Swinomish Indian Tribal Community	2.03	0.95%
Upper Skagit Indian Tribe	0	0
Total	17.71	8.31%

Note: Total miles of shoreline for Skagit County was calculated as 213.00727, but 2313 was used to determine percent for purposes of rounding

Based on FEMA analysis, over 90 buildings are located in the defined shallow landslide zone and 1,731 buildings are in the deep-seated landslide zone. The resulting values of landslide susceptibility include approximately $99.4 million in shallow landslide zones and $192.1 million in the deep-seated landslide zones. The majority of the deep-seated buildings are located in the unincorporated areas of the county, but buildings in the shallow landslide zone total approximately $81 million for the Swinomish Indian Tribal Community. Figure 8-12 identifies the Landslide Susceptibility Zones defined by FEMA (2017).

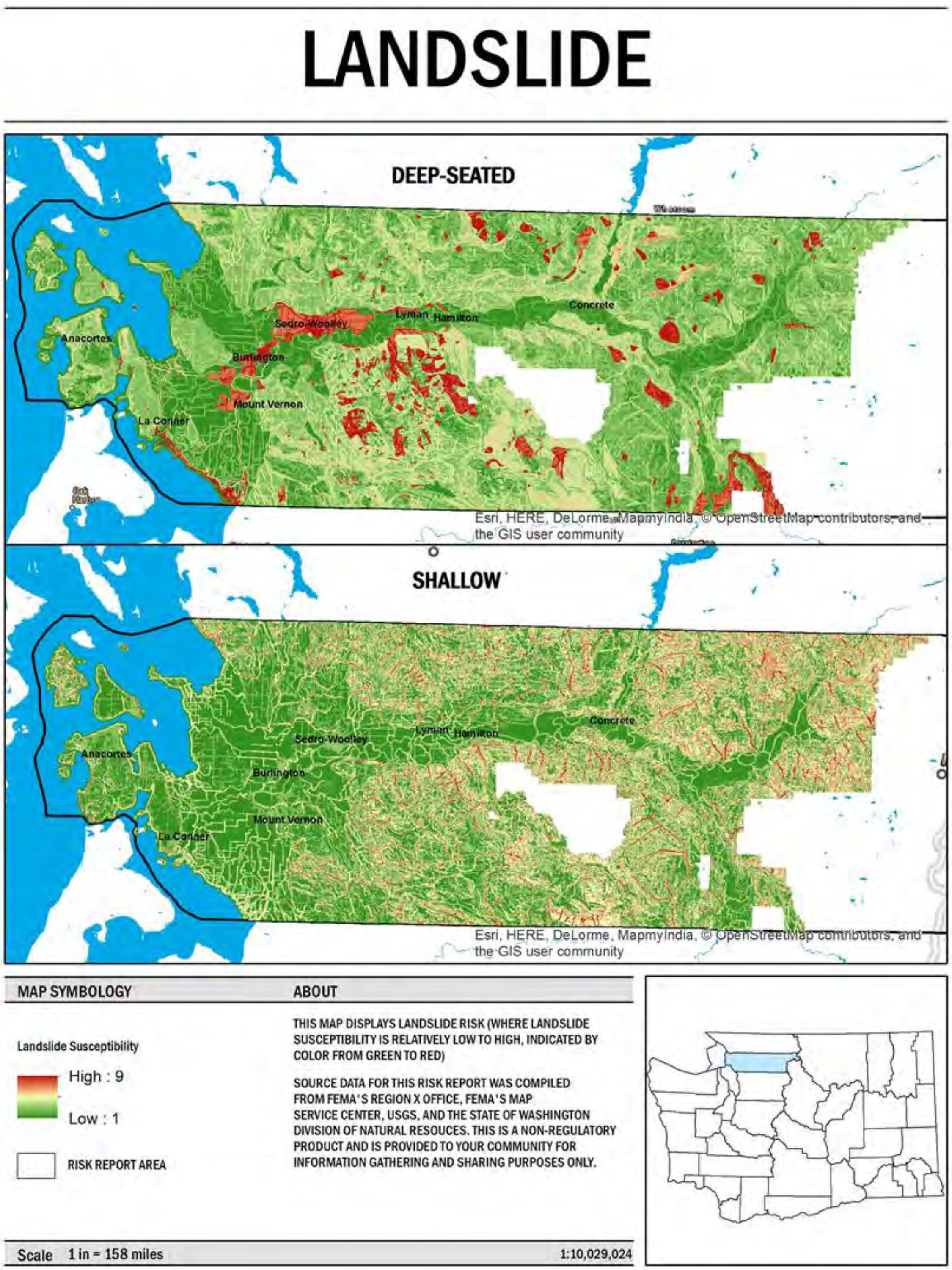


Figure 8-14 Landslide Susceptibility Zones (FEMA, 2017)

8.3.4 Impact on Critical Facilities and Infrastructure

Table 8-7 through Table 8-9 identify the number of critical facilities and infrastructure exposed to the landslide areas based on the 100 foot buffer intersecting with the potential landslide hazard area.

Table 8-7
Potential Dollar Losses to Critical Facilities Exposed Landslide Hazard Area (100' Buffer)

Jurisdiction	Number of Critical Facilities and Infrastructure	Replacement Value	Content (50% Replacement unless otherwise specified)	Total	Percent of Total Value CIKR*
Unincorporated Skagit County	44	$21,692,338	$10,846,169	$32,538,507	1.39%
Anacortes, City of	9	$9,240,600	$4,620,300	$13,860,900	0.59%
Burlington, City of	0	$0	$0	$0	0.00%
Concrete Town of	5	$1,568,989	$784,495	$2,353,484	0.10%
Hamilton, Town of	0	$0	$0	$0	0.00%
LaConner, Town of	2	$1,572,300	$786,150	$2,358,450	0.10%
Lyman, Town of	0	$0	$0	$0	0.00%
Mount Vernon, City of	1	$3,000,000	$1,500,000	$4,500,000	0.19%
Sedro-Woolley, City of	0	$0	$0	$0	0.00%
Swinomish Indian Tribal Community	2	$2,681,162	$1,340,581	$4,021,743	0.17%
Sauk-Suiattle Tribe	0	$0	$0	$0	0.00%
Upper Skagit Indian Tribe	0	$0	$0	$0	0.00%
Total	**63**	**$39,755,389**	**$19,877,695**	**$59,633,084**	**2.56%**

Table 8-8 Critical Facilities in the Skagit County Landslide Hazard Area (100' buffer)						
Jurisdiction	Medical and Health Services	Government Function	Protective	Hazardous Materials	Other Facility	**Total**
Unincorporated Skagit County	0	0	14	1	0	**15**
Anacortes, City of	0	0	0	2	2	**4**
Burlington, City of	0	0	0	0	0	**0**
Concrete Town of	0	1	0	1	0	**2**
Hamilton, Town of	0	0	0	0	0	**0**
La Conner, Town of	0	0	0	1	0	**1**
Lyman, Town of	0	0	0	0	0	**0**
Mount Vernon, City of	0	0	0	0	0	**0**
Sedro-Woolley, City of	0	0	0	0	0	**0**
Swinomish Indian Tribal Community	0	0	0	1	0	**1**
Sauk-Suiattle Tribe	0	0	0	0	0	**0**
Upper Skagit Indian Tribe	0	0	0	0	0	**0**
Total	**0**	**1**	**14**	**6**	**2**	**23**

Table 8-9 Critical Infrastructure in Skagit County Landslide Hazard Area (100' buffer)							
Jurisdiction	Bridges	Water Supply	Wastewater	Power	Communications	Other Infrastructure	**Total**
Unincorporated Skagit Co.	21	8	0	0	0	0	**29**
Anacortes, City of	0	0	0	0	0	5	**5**
Burlington, City of	0	0	0	0	0	0	**0**
Concrete Town of	0	2	1	0	0	0	**3**
Hamilton, Town of	0	0	0	0	0	0	**0**
La Conner, Town of	0	1	0	0	0	0	**1**
Lyman, Town of	0	0	0	0	0	0	**0**
Mount Vernon, City of	0	1	0	0	0	0	**1**
Sedro-Woolley, City of	0	0	0	0	0	0	**0**
Swinomish Indian Tribal Community	1	0	0	0	0	0	**1**
Sauk-Suiattle Tribe	0	0	0	0	0	0	**0**
Upper Skagit Indian Tribe	0	0	0	0	0	0	**0**
Total	**22**	**12**	**1**	**0**	**0**	**5**	**40**

Critical facilities and infrastructure at risk from erosion along the coastal zone of Skagit County depends on the location of the facility or infrastructure relative to an erosion hazard area. Several types of infrastructure may be exposed to the erosion hazard and associated flooding, particularly along coastal roads and transportation infrastructure. Table 8-10 through 8-11 identify critical facilities exposed within a 100 foot buffer.

Table 8-10
Critical Facilities in the Landslide Hazard Area (Coastal Zones Only, 100' buffer)

Jurisdiction	Medical & Health Services	Government Function	Protective	Hazardous Materials	Other Facilities	Total
Unincorporated Skagit County	0	0	11	1	0	**12**
Anacortes, City of	0	0	0	0	2	**2**
Burlington, City of	0	0	0	0	0	**0**
Concrete Town of	0	0	0	1	0	**1**
Hamilton, Town of	0	0	0	0	0	**0**
La Conner, Town of	0	0	0	1	0	**1**
Lyman, Town of	0	0	0	0	0	**0**
Mount Vernon, City of	0	0	0	0	0	**0**
Sedro-Woolley, City of	0	0	0	0	0	**0**
Swinomish Indian Tribal Community	0	0	0	1	0	**1**
Sauk-Suiattle Tribe	0	0	0	0	0	**0**
Upper Skagit Indian Tribe	0	0	0	0	0	**0**
Total	**0**	**0**	**11**	**4**	**2**	**17**

Table 8-11
Critical Infrastructure in the Landslide Hazard Area (Coastal Zones Only, 100'buffer)

Jurisdiction	Bridges	Water Supply	Wastewater	Power	Communications	Other Infrastructure	Total
Unincorporated	14	0	0	0	0	0	**14**
Anacortes, City of	0	0	0	0	0	5	**5**
Burlington, City of	0	0	0	0	0	0	**0**
Concrete Town of	0	0	0	0	0	0	**0**
Hamilton, Town of	0	0	0	0	0	0	**0**
LaConner, Town of	0	0	0	0	0	0	**0**
Lyman, Town of	0	0	0	0	0	0	**0**
Mount Vernon, City of	0	0	0	0	0	0	**0**
Sedro-Woolley, City of	0	0	0	0	0	0	**0**
Swinomish Indian Tribal Community	0	0	0	0	0	0	**0**
Sauk-Suiattle Tribe	0	0	0	0	0	0	**0**
Upper Skagit Indian Tribe	0	0	0	0	0	0	**0**
Total	**14**	**0**	**0**	**0**	**0**	**5**	**19**

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. 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, Marinas, and Boat/Ferry Docks**—Landslides can significantly impact road bridges, marinas, and boat/ 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.

Skagit County and its planning partners have a significant number of bridges, marinas, and boat/ferry docks that would be at risk from a landslide hazard. In many instances, the docks represent the only access to/from the various islands. Countywide, there are also more above-ground power lines than below ground, increasing the risk of power outages due to landslides.

8.3.5 Impact on Economy

A landslide or erosion event could 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, marinas, boat docks, municipal airports all can have a significant impact on the economy. Damages in this capacity could have a significant economic impact on not only Skagit County, but also other areas of the state.

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 in the area. Debris could impact cargo staging areas and lands needed for business operations. With primary transportation routes in the hazard areas impacted, the use of primary roadways reduces travel time, and in some cases, restricts ingress and egress. In some cases, travel time increases to much greater distances. Impacts would also significantly reduce the tourism industry within the County. Beach-area access becoming limited may further reduce local tourism, impacting the local community and economy.

Loss of access to businesses, ferry access and beaches may result in decreased tax revenues to the areas, including those coastal municipalities, school districts, and the County overall. While these impacts will be temporary, more severe and chronic landslide or erosion event may result in loss of private property, causing permanent decreases in property tax revenue.

8.3.6 Impact on Environment

Environmental problems as a result of mass movements can be numerous. Landslides or erosion 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 or an erosion event. With impact already occurring due to increased sediment loads in the floodplain, landslides could cause additional impact within the Skagit River watersheds.

8.3.7 Impact from Climate Change

Climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Increase in global temperature could affect the snowpack and its ability to hold and store water. 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. All of these factors would increase the probability for landslide occurrences. Likewise, although erosion on beaches and bluffs is a naturally occurring, on-going process, major episodes of erosion often occur during storm events, particularly when storms coincide with high tides. Such events will exacerbate episodic erosion events, accelerating bluff and beach erosion.

8.4 FUTURE DEVELOPMENT TRENDS

Under the Growth Management Act, the County is required to address geologic hazards within its Critical Areas Ordinance, which is detailed above. 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.

Skagit County has experienced continued growth over the past 10 years, and anticipates such growth to continue. The region continues to attempt to expand its business base, which will increase economic vitality by providing businesses that stimulate retail sales and services and increased tourism. As a higher-than-average 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 or erosion. 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.

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.

8.5 ISSUES

Landslides and erosion throughout the County occur as a result of soil conditions that have been affected by severe storms, groundwater, wave action, or human development. The worst-case scenario for landslide hazards in the planning area would generally correspond to a severe storm with a strong storm surge that had heavy rain and caused flooding and erosion. Landslides are most likely during late fall or early spring—months when the water tables are high. After heavy rains during 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. 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 or the undercutting of bluffs 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; landslides and erosion may block ingress and egress to areas of the County, especially for areas with limited roadways.

Coastal erosion is both a chronic and episodic problem that affects coastal communities. The severity of coastal erosion changes seasonally, interannually, and over decadal time scales in response to climate variability, sediment budgets, and human activities such as dredged material management and erosion mitigation methods that can either compound or reduce the impact. Previous studies and ongoing coastal change monitoring provide a solid scientific baseline for anticipating future erosion hazards. However, coastal conditions are changing over time, sea level and wave heights are increasing, strong El Niño events are predicted to increase, and the probability of a Cascadia subduction zone earthquake and tsunami increase with time since the previous event.

Important issues associated with landslides and erosion throughout Skagit County include the following:

- There are existing homes in landslide and erosion 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 and erosion risk areas.
- Portions of the County are surrounded by fairly steep banks and cliffs. Coastal erosion causes landslides as the ground washes away.
- Mapping and assessment of landslide hazards and areas of erosion are constantly evolving. As new data and science become available, assessments of landslide risk and areas of erosion should be re-evaluated. While some exists, additional LiDAR data would greatly enhance the ability to determine landslide hazard areas, areas of increased erosion, 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 and erosion hazards overlap the risk associated with other hazards such as severe storms, earthquake, flood and wildfire. This provides an opportunity to seek mitigation goals with multiple objectives that can reduce risk for multiple hazards.

8.6 RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from a landslide or continued erosion 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 erosion and landslides. Areas within the unincorporated areas of the County, the cities and towns all 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.

Construction in critical areas, which includes geologically and environmentally sensitive areas are regulated; however, beyond the structural impact, secondary impact to infrastructure and roadways causing isolation or commodity shortages also has the potential to impact the region. Erosion-related impacts to existing commercial and residential structures and associated infrastructure (utilities, roadways, etc.), when coupled with the economic impact to tourism and potential negative impact on real estate taxes, have the potential to harm the entire region. Landslides and erosion debris entering the area rivers would also have significant impact, potentially causing back-flooding or diversion of the waterway, changing the floodplain.

Based on the potential impact, the Planning Team determined the CPRI score to be 3.10, with overall vulnerability determined to be a high level.

CHAPTER 9.
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 and erosion associated with severe weather are discussed in their respective hazard chapters. Snow historically does not accumulate in great amounts in the area, although even small amounts can impact the area through traffic-related issues and safety for citizens walking in areas of snow accumulation or ice. Excessive heat and cold, while they have occurred, are rare and the County has never received a disaster declaration for either type of event.

> **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 hail storm. 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.

9.1 GENERAL BACKGROUND

Skagit County has a predominantly maritime climate, influenced by the Pacific Ocean and the Olympic Mountain Range. The County can experience all types of severe weather (except hurricanes).

9.1.1 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 hail storms 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.

Within Skagit County, severe storms hit the coastlines during the winter, bringing heavy rains, winds, and high waves. Windstorms with sustained winds of 50 miles per hour or greater occur with some regularity and are powerful enough to cause significant damage. On occasion, winter storms have exceeded hurricane force winds. While the entire county is vulnerable to windstorms, high winds are more commonplace along the coastline. Most of these storms cause transportation-related problems and damage to utilities. On occasion, homes and other structures are damaged either by high winds or falling trees. With its geographic position between the waters of Puget Sound and the Cascade Range, and the Olympic Mountains and the Vancouver Island Range, the local hills and valleys can generate variable wind patterns which are locally accelerated. Likewise, the eastern portion of Skagit County can also experience locally accelerated winds due to the narrowing of the river valley and the close proximity to mountain passes. The Cascade Range, located to the east, forms a natural barrier to moisture-laden marine air masses resulting in regular rainfall events as these air masses rise in elevation and pass over the mountains.

9.1.2 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 9-1):

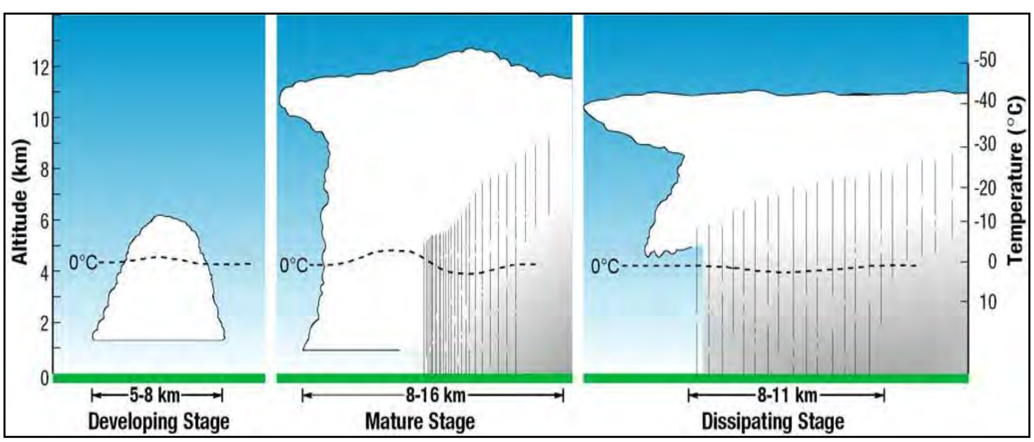


Figure 9-1 The Thunderstorm Life Cycle

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, is a long line of storms with a continuous well-developed gust front at the leading edge. The storms can be solid, or have 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.

As Figure 9-2 illustrates, Washington ranks 50th nationwide in deaths associated with lightning strikes, having five deaths during the time period 1959-2016. No deaths were reported in 2017 or 2018 as a result of lightning strikes. Washington ranks 49th with respect to cloud-to-ground flash densities during the time period 2007-2016.[29] Annually, 30 percent of all power outages nationwide are lightning related, with total

[29] NOAA Lightning Safety. Accessed 2 July 2019. http://www.lightningsafety.noaa.gov/stats/59-16_State_Ltg_Fatality+Fatality_Rate_Maps.pdf

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 9-3).

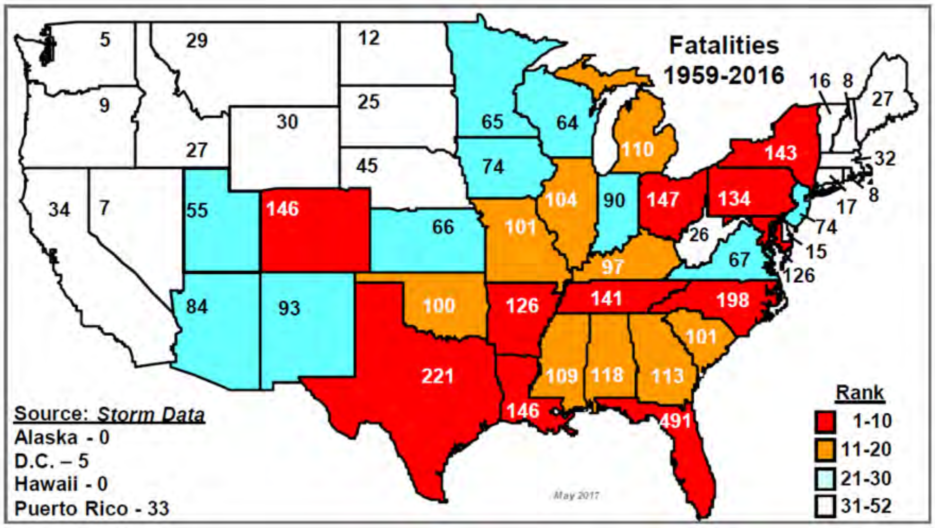


Figure 9-2 Lightning Fatalities by State 1959-2016

Source: Vaisala, 2017

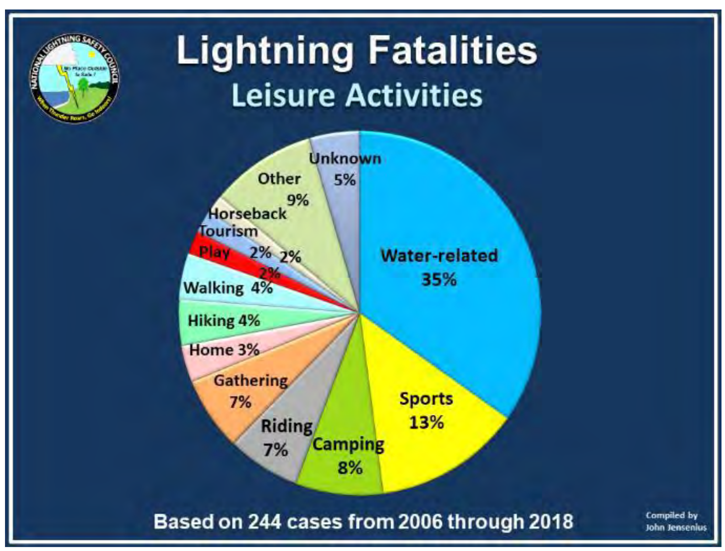


Figure 9-3 Lightning Fatalities by Leisure Activities

9.1.3 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.

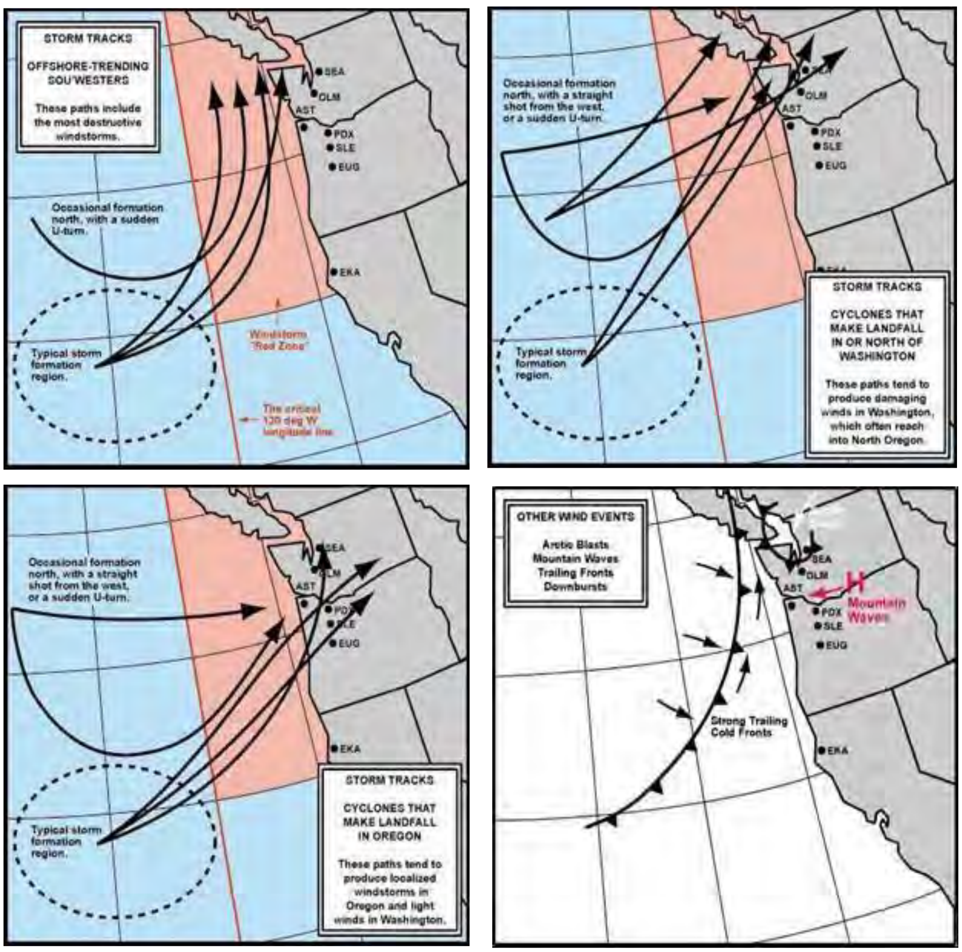
There are four main types of windstorm tracks that impact the Pacific Northwest as identified in Figure 9-4. These four tracks are distinguished by two basic windstorm patterns that have emerged in the Puget Sound Region: the South Wind Event and the East Wind Event. South wind events are generally large-scale events that affect large portions of Western Washington and possibly Western Oregon. On occasional cases, they have reached as far south as Northern California.

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.

National Wind Zones are featured in Figure 9-5. These zones are utilized to guide structure development (2006 International Building Code). These exposure zones further identify areas that are at higher risk from impacts of high winds. The closer development is to open waters and on top of steep cliffs, the higher the design criteria that is required through building code.

For each wind direction considered, an exposure category that adequately reflects the characteristics of ground surface irregularities are determined for the site at which the building or structure is to be constructed. Account shall be taken of variations in ground surface roughness that arise from natural topography and vegetation as well as from constructed features. Based on the International Building Code, the zones are further broken down into surface roughness categories and are defined as follows:

- Surface Roughness B. Urban and suburban areas, wooded areas or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger.
- Surface Roughness C. Open terrain with scattered obstructions having heights generally less than 30 feet (9144 mm). This category includes flat open country, grasslands, and all water surfaces in hurricane-prone regions.
- Surface Roughness D. Flat, unobstructed areas and water surfaces outside hurricane-prone regions. This category includes smooth mud flats, salt flats and unbroken ice.



Source: Oregon Climate Service, 2015

Figure 9-4 Windstorm Tracks Impacting the Pacific Northwest

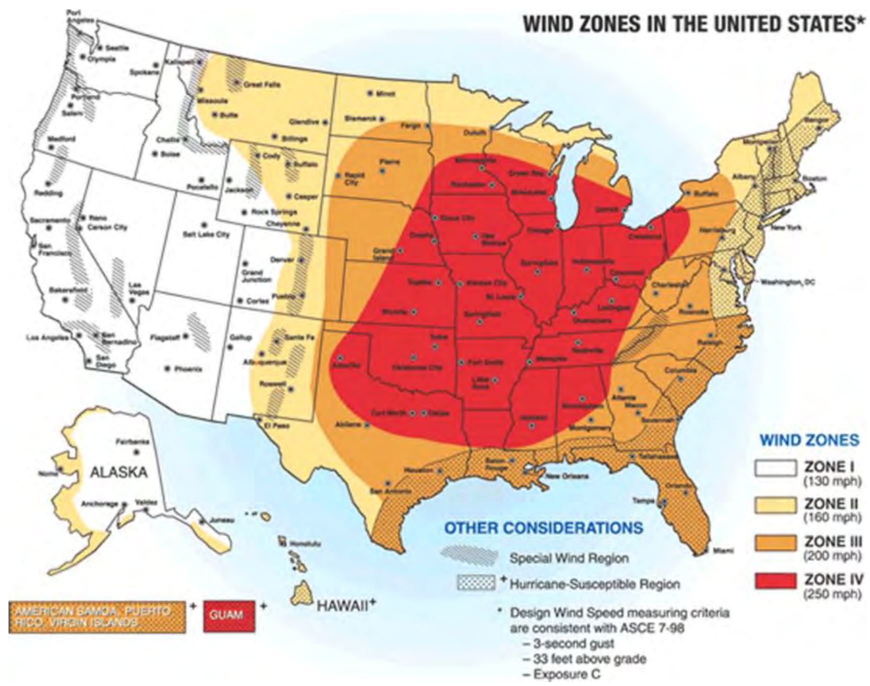


Figure 9-5 United State Wind Zones

Skagit County has identified 85 mph as the wind-strength to which construction must occur. Additional hazard-specific building code requirements such as those identified in the graphic below are identified on the County's iMap application, available at:
https://www.skagitcounty.net/Maps/iMap/?mapid=8fe801e1318643c9bfef288efb64c85f

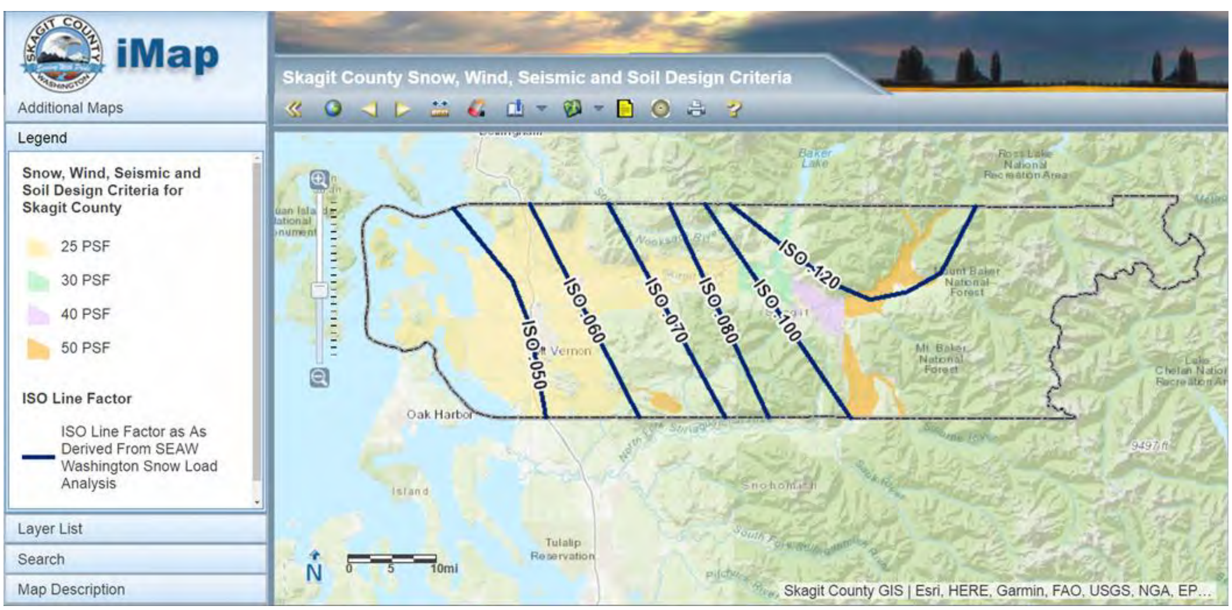


Figure 9-6 County GIS iMap Information

9.1.4 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.

9.1.5 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 9-7).

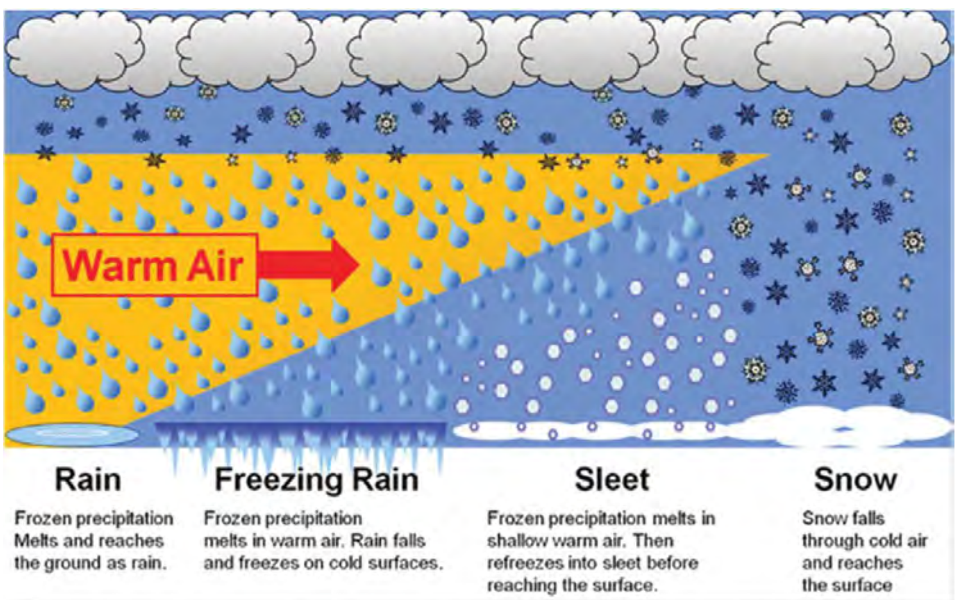


Figure 9-7 Types of Precipitation

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.

Figure 9-8 Ice skating on Skagit River at Conway (1916)[30]

As illustrated in Figure 9-8, portions of Skagit County do experience a significant amount of snow and ice on a regular basis, particularly in those areas abutting the mountainous regions. As a result of the snow and ice accumulations, the County has established Roof Snow Load Zones illustrated in Figure 9-9. Additional information is available on the County's website at: https://www.skagitcounty.net/Departments/GIS/Gallery/main.htm#snow

30 Photo courtesy of Skagit County Historical Museum.

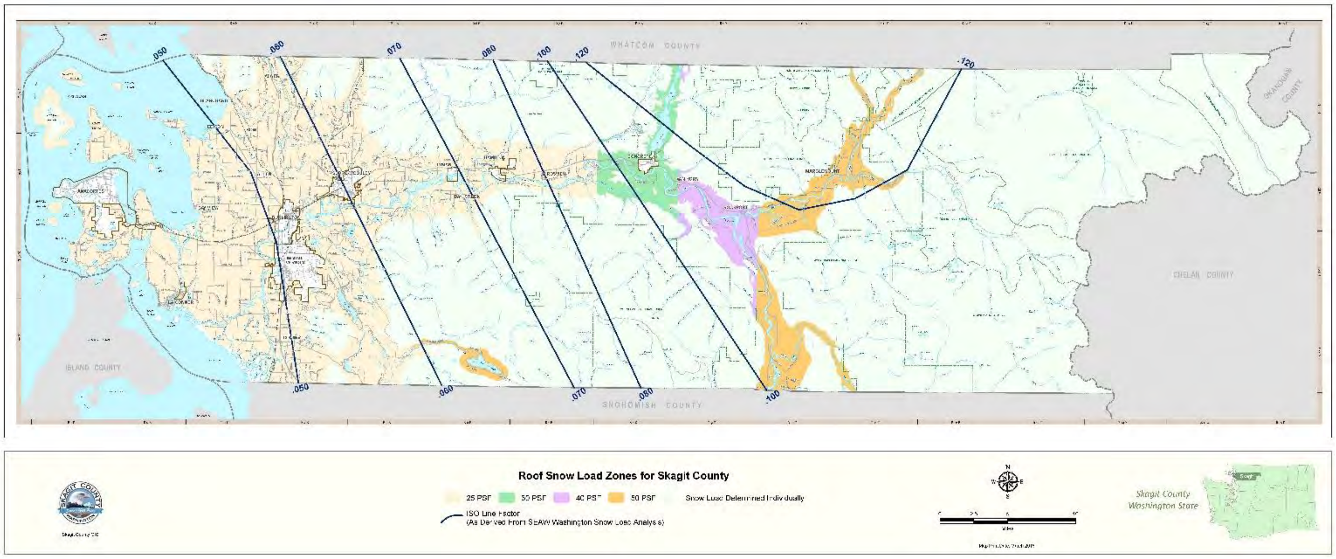


Figure 9-9 Skagit County Snow Load Zones

9.1.6 Extreme Temperatures

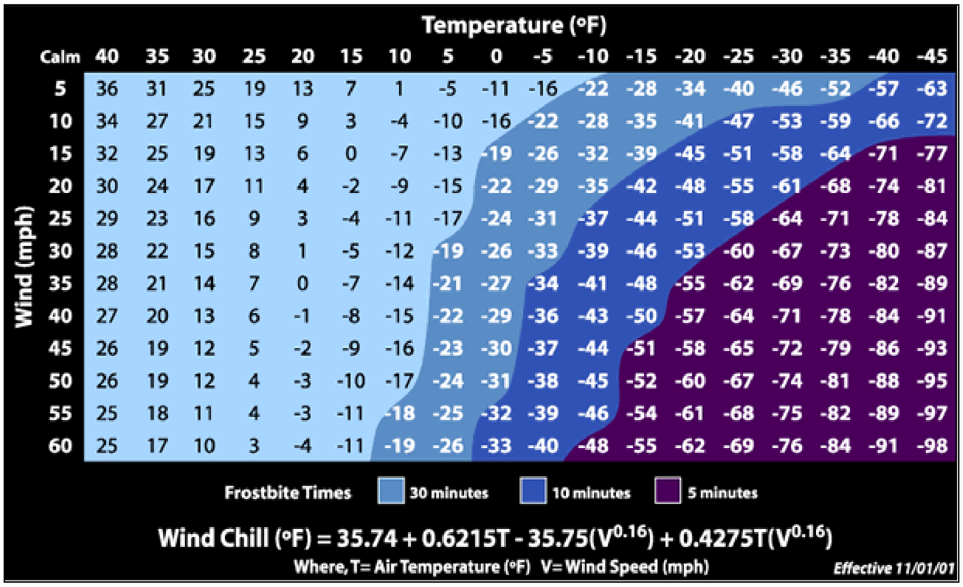
Extreme temperature includes both heat and cold events, which can have a significant impact on human health, commercial/agricultural businesses and primary and secondary effects on infrastructure (e.g., burst pipes and power failure). What constitutes "extreme cold" or "extreme heat" can vary across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

Extreme Cold

Extreme cold events are when temperatures drop well below normal in an area. In regions relatively unaccustomed to winter weather, near freezing temperatures are considered "extreme cold." Extreme cold can often accompany severe winter storms, with winds exacerbating the effects of cold temperatures by carrying away body heat more quickly, making it feel colder than is indicated by the actual temperature (known as wind chill). Figure 9-10 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. 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.



Temperature (°F)

Wind (mph)	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 9-10 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 days or weeks are defined as extreme heat (FEMA, 2006; CDC, 2006). An extended period of extreme heat of three or more consecutive days is typically called a heat wave and is often accompanied by high humidity (Ready America, Date Unknown; NWS, 2005). There is no universal definition of a heat wave because the term is relative to the usual weather in a particular area. The term heat wave is applied both to routine weather variations and to extraordinary spells of heat which may occur only once a century (Meehl and Tebaldi, 2004). A basic definition of a heat wave implies that it is an extended period of unusually high atmosphere-related heat stress, which causes temporary modifications in lifestyle and which may have adverse health consequences for the affected population (Robinson, 2000). Figure 9-11 identifies some of those consequences and associated temperatures. [31]

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 (see Figure 9-12), pregnant woman, the homeless or poor, the overweight, and people with mental illnesses, disabilities and chronic diseases (NYS HMP, 2008).

[31] NCDC, 2000

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										

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 9-11 Heat Stress Index

Wind-Chill Factor Chart (in Fahrenheit)

Wind Speed in mph

Air Temperature	Calm	5	10	15	20	25	30	35	40
40	40	36	34	32	30	29	28	28	27
30	30	25	21	19	17	16	15	14	13
20	20	13	9	6	4	3	1	0	-1
10	10	1	-4	-7	-9	-11	-12	-14	-15
0	0	-11	-16	-19	-22	-24	-26	-27	-29
-10	-10	-22	-28	-32	-35	-37	-39	-41	-43

Comfortable for out door play Caution Danger

Heat Index Chart (in Fahrenheit %)

Relative Humidity (Percent)

Air Temperature (F)	40	45	50	55	60	65	70	75	80	85	90	95	100
80	80	80	81	81	82	82	83	84	84	85	86	86	87
84	83	84	85	86	88	89	90	92	94	96	98	100	103
90	91	93	95	97	100	103	105	109	113	117	122	127	132
94	97	100	103	106	110	114	119	124	129	135			
100	109	114	118	124	129	130							
104	119	124	131	137									

Figure 9-12 Temperature Index for Children

Figure 9-13 identifies the number of weather fatalities based on 10-year and 30-year averages.[32] Extreme heat is the number one weather-related cause of death in the U.S. over the 30-year average. On average, more than 1,500 people die each year from excessive heat. Heat again ranked highest in causes of weather related deaths for the 30-year average, followed by flood.

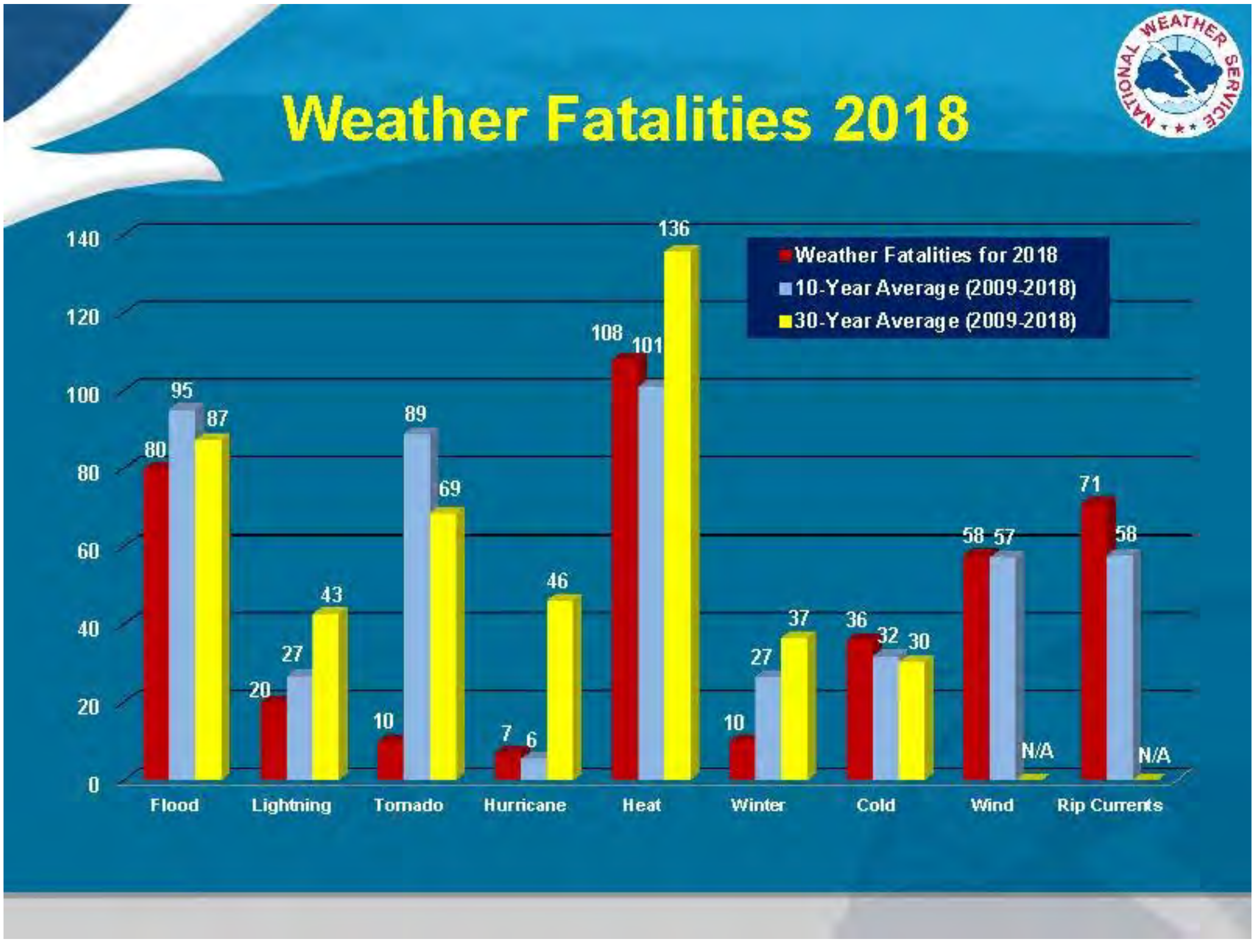


Figure 9-13 Average Number of Weather Related Fatalities in the U.S.

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

[32] NOAA, 2018. Accessed 2 July 2019. Available online at https://www.nws.noaa.gov/om/hazstats.shtml

9.2 HAZARD PROFILE

9.2.1 Extent and Location[33]

The entire planning area is susceptible to the impacts of severe weather. Severe weather events customarily occur during the months of October to April, although they have occurred year round. The County has been impacted by strong winds (including storm surge), rain, snow (although limited), or other precipitation, and have experienced thunder or lightning storms, although rare. Considerable snowfall does not customarily occur throughout the entire region, but does occur more regularly and significantly in the foothills of the mountains.

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 the County. Winds coming off of the Pacific Ocean 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, although customarily not for long extended periods. Due to the geologic makeup of the county, winds can be accelerated in small areas.

Severe storms and weather also affect transportation. Access across certain parts of the County is unpredictable as roads are vulnerable to damage from severe storms, storm surges, flooding, and landslide/erosion. Severe storms and storm surges also cause flooding and channel migration.

Average snowfall in the area is 12 inches per year (see Figure 9-14), higher than the state-wide average, with precipitation falling approximately 168 days per year. Annual average temperature is 51 degrees, with the average daily high in July is ~74 degrees, with the January lows at approximately 25 degrees. On average, the county experiences only one or two days when the temperature is over 90 degrees, which is cooler than many places in Washington. Annually, the County experiences slightly over 40 days per year when nighttime low temperatures fall below freezing. Seldom does the County experience zero or negative temperatures.

[33] The temperature, snow fall, and precipitation information on this page were calculated from the historical data of 18,000+ U.S weather stations for the period of time from 1980 to 2010. Source: various – consolidate at: http://www.usa.com/skagit-county-wa-weather.htm

Figure 9-14 Snow Accumulation Levels in Skagit County

November is the wettest month in Skagit County with 7.7 inches of rain, and the driest month is July with 1.3 inches. The wettest season is Spring with 34 percent of yearly precipitation (~43 inches) and 11percent occurs in Autumn, which is the driest season. The annual rainfall of ~49 inches in Skagit County means that it is wetter than most places in Washington, which average ~39 inches. Windspeeds vary by month, with January and October customarily gaining highest speeds, and August lowest speeds (see Figure 9-15). The County has experienced no tornado events on record.

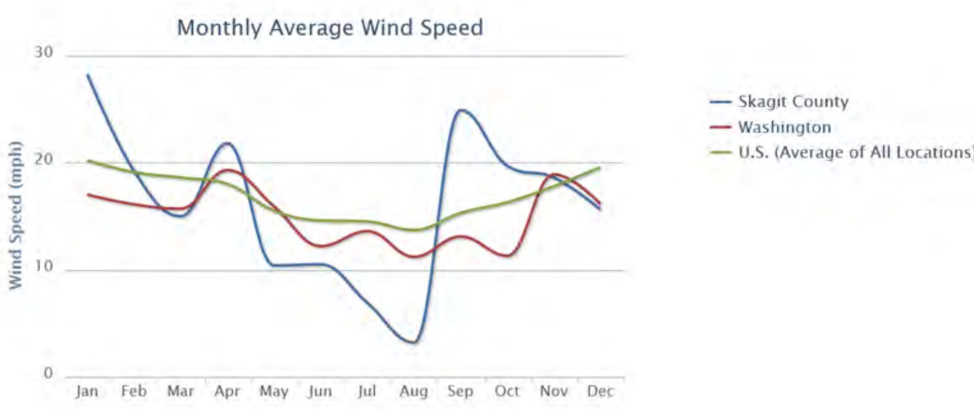


Figure 9-15 Skagit County Monthly Average Wind Speed

Source: USA.com

9.2.2 Previous Occurrences

In addition to the federally declared events identified in Table 9-1, Skagit 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 incidents associated only with floods in most instances. Since 1960, of the incidents impacting the region which have been declared declarations eight (8) have been FEMA "typed" as Severe Storms; however, others which included severe storms were typed as Flooding, so readers should also review the flood chapter to identify impact from other such severe weather events. When combined, the county has been impacted 13 times since 1960 with a "severe weather" event which has risen to the level of a federal disaster declaration. The following provides a brief synopsis of additional severe weather events occurring in the County which did not rise to the level of a disaster declaration.

- February 1916 – Snow: Heavy accumulations of snow fell throughout western Washington with accumulations of approximately 4 feet in the western portion of Skagit County. This snow event was followed by very cold temperatures causing many lakes and even the Skagit River to freeze over (see Figure 9-8 above).
- January 1950 – Snow: Heavy accumulations of snow fell throughout western Washington with accumulations of 3 to 4 feet in the western portion of Skagit County with deeper drifts.
- October 1962 – Wind: Columbus Day Windstorm (discussed in detail below) affected areas from northern California to British Columbia and is the windstorm all others since are compared to. Recorded wind gusts between 88 and 150 miles per hour were recorded in Washington State; damage in Skagit County ranged from downed trees, broken windows to collapsed barns.
- February 1979 – Wind: A series of windstorms caused damage throughout western Washington including Skagit County and in some areas caused more damage than the Columbus Day windstorm due to sustained winds of 25 to 30 miles per hour over a long period of time.
- January 1993 – Wind: Inauguration Day Windstorm caused damage throughout western Washington including Skagit County. While Skagit County received less damage than other areas, large areas of the county were without electrical power for several days.
- December 2000 – Wind: A series of windstorms with gusts between 60 and 90 miles per hour in the western portion of the county downing trees and power lines and damaging numerous agricultural buildings and barns.
- November 2006 – Wind: A sustained windstorm with high peak gusts caused significant blow-down of large trees on southeast Fidalgo Island, in the vicinity of the Swinomish Reservation, blocking roads and access within the Reservation for 2-3 days and downing power lines. The combination of loss of power and blocked roads for an extended period forced some temporary relocation of residents to emergency shelters.

Table 9-1
Severe Weather Events Impacting Planning Area Since 1960

Date	Type	Deaths or Injuries	Property Damage
November 1990 (Disaster 896)	Flooding (severe storm and high tides)	1 death – falling tree	$12,013,257 (Skagit)
Description: A series of arctic-air windstorms caused damage throughout western Washington including $12,013,257 in public and private damage in Skagit County. Thousands of trees were downed in the western portion of Skagit County, mostly on Samish Island, Guemes Island, and in the Anacortes/Fidalgo Island area and large areas of the county were without electrical power for several days. Several homes and vehicles were damaged due to downed trees and 1 person was killed when a tree hit the vehicle the victim was driving.			
November 1995 (Disaster 1079)	Flooding, severe storm, and high winds	Unknown	Unknown
Description: Heavy rains lead to flooding throughout the region.			
Dec. 1996—Jan. 1997 (Disaster 1159)	Severe winter storm, flooding, landslides and mudslides.	24 deaths statewide	Skagit: $6,245,145 Statewide 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. Heavy accumulations of snow fell throughout Skagit County over several days with depths of 2-3 feet in the western portion and depths of 4-5 feet in the eastern portions of the county. This snow event was followed several days later by high winds and rain. Many roads were impassable and road crews worked 24-hour days to plow snow. Damage to barns, agricultural buildings, and commercial greenhouses exceeded 3 million dollars and many residential carports, unattached garages, and storage buildings were destroyed. Marinas in Skagit County received over 1.7 million dollars in damage to docks and roofs and 30 private boats were damaged due to collapsed marina roof structures. The total amount of public and private damage in Skagit County was $6,245,145 as a result of these events.			
October 2003 (Disaster 1499)	Severe Storm and Flooding	Unknown	Statewide losses PA >$9 million; IA >$5.5 million
Description: Heavy rains, severe storms.			
December 2006 (Disaster 1671)	Severe winter storm, flood, landslide, mudslide, tidal surge	Unknown	Statewide PA >$29 million; IA >$5M
Description: Heavy rains from November 2 – 11, 2006 along with high tidal surge caused flooding in several Western Washington counties.			
December 2006 (DR 1682)	Severe winter storm, wind, landslides and mudslides	One fatality in McCleary	Unknown
Description: A severe low pressure weather event accompanied by high winds and coinciding with high tide created a 100-year tidal surge event within the Town of La Conner and the Swinomish Indian Tribal Community. This event caused damage to homes and other structures adjacent to shorelines on Fidalgo Island and caused a break in the dike along Sullivan Slough in La Conner. The severe winter storm caused landslides and mudslides throughout region. Areas of the state experienced hurricane-force winds and heavy rains with over one million people without power in the State. The "Hanukkah Eve Wind Storm of 2006" downed power lines, trees, and building debris which caused many road closures and left the county in a state of emergency. A McCleary man was killed when the top of a tree snapped off in the wind and crashed into his home crushing him in his bed. A woman was injured when a gust blew a light pole down on the Chehalis River Bridge, sending it crashing onto her windshield and trapping her inside her vehicle. Injuries were reported statewide.			
December 2007 (Disaster 1734)	Severe storm, flooding, landslides, and mudslides	Unknown	Unknown

Table 9-1
Severe Weather Events Impacting Planning Area Since 1960

Date	Type	Deaths or Injuries	Property Damage
Description: Severe winter storm, including record and near record snowfall and heavy rains and winds. The 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. Impact from the series of windstorms in the western portion of the county caused damage to the Skagit County dock at Sinclair Island. Warming temperatures caused an avalanche in eastern Skagit County damaging a Skagit County bridge on the Cascade River Road. The region between Newport, OR and Hoquiam, WA received the strongest gale since the great Columbus Day Storm of 1962. Figure 9-16 below compares winds speeds of the 1962 Columbus Day Storm to the 2007 event.[34]			
December 2008 (Disaster 1825)	Severe winter storm, record and near record snow	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.			
January 2011 (Disaster 1963)	Severe Winter Storm, Flooding, Landslides and Mudslides	Unknown	PA >$870,000
Description: : A weather system deposited snow and rain over much of Western Washington. Water and slides impacted roadways in the eastern portion of Skagit County as well as the Samish Flood Plain. Total damage to public assets $879,183.			
IA= FEMA Individual Assistance funds paid as a result of the disaster (loss impact paid to individuals);			
PA=FEMA Public Assistance funds paid as a result of the disaster (loss impact paid to governmental entities)			

Windstorms impact all of Skagit 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. The 1962 Columbus Day Storm has been identified as the strongest non-tropical windstorm to hit the lower 48 states. It traveled ~40 mph from Northern California to the Canadian border and east as far as Montana. The storm killed 46 people, destroyed more than 50,000 homes, left another 469,000 without power, caused $235 million in property damage and flattened 15 billion board feet of timber worth an estimated $750 million

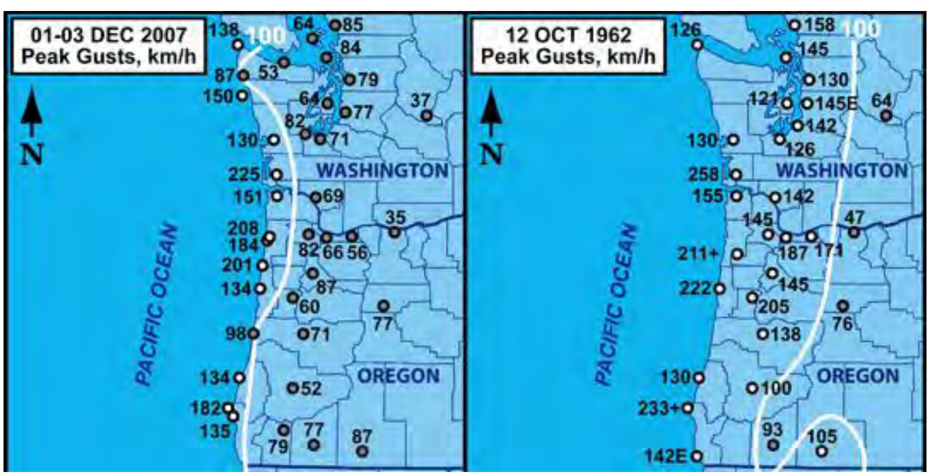


Figure 9-16 Peak Gust Comparison- 2007 Great Coastal Gale and 1962 Columbus Day Storm

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

For wind events like the Hanukkah Eve Windstorm of 2006 (see Figure 9-18), the impact on the public can be severe, and such was the case in Skagit County when one of the strongest windstorms to impact the region occurred.

Figure 9-18 Hanukkah Eve Peak Wind Gusts

Severe winds also occurred during the Inauguration Day storm of 1993 (see Figure 9-17) . Five people were killed (statewide), state government was shut down, and at the height of the storm more than 750,000 residential and commercial customers were without power. Due to damages from the storm in the county, Skagit was included in federal disaster declaration, #981 specified for this storm.

9.2.3 Severity

The most common problems associated with severe storms are immobility and loss of utilities. Fatalities are uncommon, but have occurred. Roads become impassable due to flooding, downed trees, ice or snow, or a landslide. Power lines may be downed due to high winds, and services such as water or phone may not be able to operate without power. Lightning can cause severe damage and injury, although no such injuries have been reported within Skagit County. Physical damage to homes and facilities caused by wind do occur, although unless it is a significant wind storm, the impact is usually limited in nature. Due to the amount of snow customarily received in the 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.

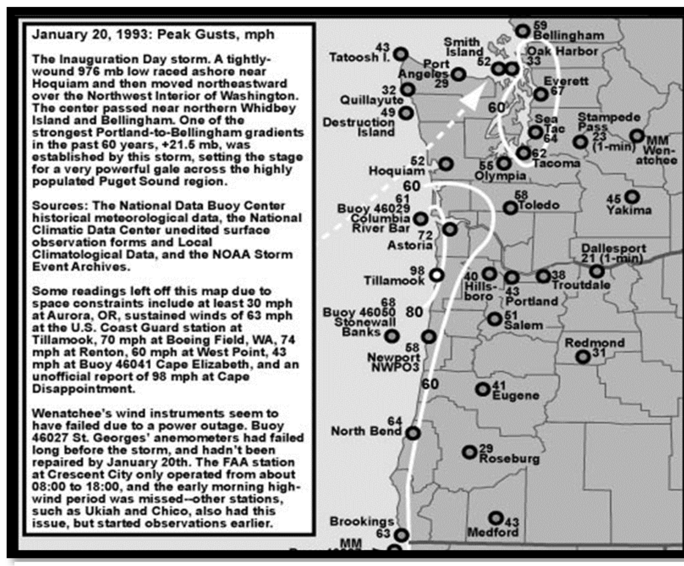


Figure 9-17 Inauguration Day Storm Peak Wind Gusts

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, and also its impact on the densely wooded areas. 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. The County has received no disaster declarations for an ice storm event.

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. The coastal portions of Skagit County do not experience as much snowfall as the inland or more eastern portions of the county due to their proximity to the more mountainous region and the higher, cooler elevations. As indicated, within Skagit County, snowfall averages approximately 12 inches per year – higher than the state average. Snowfall followed by wind and rain did cause the January 1971 (DR 300) incident.

Historical records in Western Washington are as follows:

- January 1950 – One day record for snow accumulation – 21 inches
- January 1950 – One month record for snow accumulation – 57 inches
- 1968-1969 – Winter season record for snow accumulation – 67 inches

Windstorms are common in the planning area, occurring many times throughout the year. The predicted wind speed given for wind warnings issued by the National Weather Service is for a one-minute average, during which gusts may be 25 to 30 percent higher. Windstorms are one of the greatest threats within the planning area, with several significant events identified. 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. Businesses could be forced to close for an extended period, impacting commodities available for citizens. As a result of the heavily forested areas, debris accumulations would be high, causing additional difficulties with access along major arterials connecting the area to other parts of the state, further impacting logistical support and commodities.

The extent (severity or magnitude) of extreme cold temperatures are generally measured through the wind chill temperature index. Wind Chill Temperature is the temperature that people and animals feel when outside and it is based on the rate of heat loss from exposed skin by the effects of wind and cold. As the wind increases, the body is cooled at a faster rate causing the skin's temperature to drop (NWS, 2009).

On November 1, 2001, the NWS implemented a new wind chill temperature index. It was designed to more accurately calculate how cold air feels on human skin. Figure 9-10 (above) shows the new wind chill temperature index[35]. The Index includes a frostbite indicator, showing points where temperature, wind speed and exposure time will produce frostbite to humans. The chart shows three shaded areas of frostbite danger. Each shaded area shows how long a person can be exposed before frostbite develops (NWS, 2009).

The extent of extreme temperatures is generally measured through the heat index (shown above). Created by the NWS, the Heat Index accurately measures apparent temperature of the air as it increases with the relative humidity. The Heat Index can be used to determine what effects the temperature and humidity can have on the population (NCDC, 2000).

9.2.4 Frequency

The severe weather events for Skagit County shown in Table 9-1 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. The State's Hazard Mitigation Plan (2013) identifies Skagit County as being highly vulnerable to Meteorological conditions with a 58% chance of occurrence at least once every two years. (State HMP, 2013). As such, the planning area can expect to experience exposure to some type of severe weather event at least annually.

[35] NWS, 2008

Washington State Department of Ecology has estimated frequency intervals for wind speed as follows:

WIND SPEEDS EXCEED	FREQUENCY
55 MPH	Annually
76 MPH	~ 5 years
83 MPH	~10 years
92 MPH	~25 years
100 MPH	~50 years
108 MPH	~100 years

9.3 VULNERABILITY ASSESSMENT

9.3.1 Overview

Severe weather incidents can and regularly do occur throughout the entire planning area. Similar events impact areas within the planning region differently, even though they are part of the same system. While in some instances some type of advanced warning is possible, as a result of climatic differences, topographic and relative distance to the coastline, the same system can be much more severe in certain areas of the County. Therefore, preparedness plays a significant contributor in the resilience of the citizens to withstand such events.

Methodology

A lack of data separating severe weather damage from flooding, windstorms, and landslide damage prevented a detailed analysis for exposure and vulnerability. For planning purposes, it is assumed that the entire planning area is exposed to some extent to severe weather. Certain areas are more exposed due to geographic location and local weather patterns, as well as the response capabilities of local first responders.

Warning Time

Meteorologists can often predict the likelihood of some severe storms. In some cases, this can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm, and the rapid changes which can also occur significantly increasing the impact of a weather event.

9.3.2 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.

The National Severe Storms Laboratory states that of injuries related to ice and snow[36]:

  - About 70% occur in automobiles.
  - About 25% are people caught out in the storm.
  - Majority are males over 40 years old.
- Of injuries related to exposure to cold:
  - 50% are people over 60 years old.
  - Over 75% are males.
  - About 20% occur in the home.

With areas of the county accessible by only one primary transportation route, even minor incidents have the potential to impact ingress and egress. Such issues are of concern as a result of limited access for evacuation purposes by first responders 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.

The fairly large population of retirees (higher than other areas of the state) and the high rate of disabled individuals are of significant concern to the planning partners throughout the region when severe weather events occur due to the higher levels of vulnerable populations.

In addition, events causing storm surge, or a storm event during a high-tide make certain low-lying areas more vulnerable. The low-lying shoreline areas listed below are especially vulnerable to tidal flooding:

- Portions of the City of Anacortes and other low-lying areas adjoining and adjacent to Burrows Bay, Rosario Strait, Guemes Channel and Fidalgo Bay.
- Portions of the Town of La Conner adjoining and adjacent to Swinomish Channel.
- Portions of the community of Bay View, Samish Island, the community of Edison, and other low-lying areas adjoining and adjacent to Padilla Bay and Bellingham Bay.
- Portions of Fir Island and other low-lying areas adjoining and adjacent to Skagit Bay.

9.3.3 Impact on Property

Loss estimations for severe weather hazards are not based on modeling utilizing damage functions, as no such functions have been generated. A building exposure analysis could not be performed for this assessment due to the lack of available digital parcel data for the planning area. As better data becomes available, this degree of analysis is recommended to determine vulnerability in the planning area.

For planning purposes, all properties and 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, or low-lying coastal areas) may be at risk for the most damage. While an accurate and detailed building count is not available, in general terms, the U.S. Census identifies that the highest percentage of Skagit County's buildings were built before 1959, with the median year built as 1981. Most

[36] http://www.nssl.noaa.gov/education/svrwx101/winter/

of these buildings are identified as residential, with approximately 53,000 residential structures identified. (See Chapter 3 for additional information on building stock age.)

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.

9.3.4 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. In an effort to assign a loss dollar value to the hazard for planning purposes, emergency managers can utilize damages based on a 10/30/50 percent potential impact as identified in Table 9-2.

Table 9-2
Potential Dollar Losses to Critical Facilities Due to Severe Weather Hazard

Jurisdiction	Facilities & Infrastructure Count**	Exposed Value* (Structure only)	10% Damage	30% Damage	50% Damage
Anacortes	53	$224,306,610	$22,430,661	$67,291,983	$112,153,305
Burlington	49	$246,345,790	$24,634,579	$73,903,737	$123,172,895
Concrete	32	$178,405,475	$17,840,548	$53,521,643	$89,202,738
Hamilton	14	$2,573,153	$257,315	$771,946	$1,286,577
La Conner	10	$83,617,662	$8,361,766	$25,085,299	$41,808,831
Lyman	8	$5,038,905	$503,891	$1,511,672	$2,519,453
Mount Vernon	83	$573,729,347	$57,372,935	$172,118,804	$286,864,674
Sedro-Woolley	57	$166,937,018	$16,693,702	$50,081,105	$83,468,509
Sauk-Suiattle Indian Tribe***	5	$5	$1	$2	$3
Swinomish Indian Tribal Community	9	$77,241,163	$7,724,116	$23,172,349	$38,620,582
Upper Skagit Indian Tribe***	2	$1	$0.10	$0.30	$0.50
Unincorporated Skagit Co.	326	$774,848,209	$77,484,821	$232,454,463	$387,424,104
Total	**648**	**$2,333,043,338**	**$233,304,334**	**$699,913,001**	**$1,166,521,669**

** Values were not provided for any HazMat facilities included in the critical infrastructure list provided by the County*

*** Total count includes HazMat facilities for which values were not provided*

****A value of $1 was put into place for facilities or infrastructure for which a value was not provided.*

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.

Within the planning region, hydroelectric energy from dams located on the Skagit River and Baker River produce a significant amount of power to areas well outside of the planning area. Major power lines travel from the dam through a large swath of the County. As such, wind events occurring in Skagit County also have the potential to impact power supplies in large metropolitan areas well outside of the county.

In addition to potential impact to power, phone, water, and sewer systems may also not function properly during severe weather events. Ferry transportation may be disrupted due to high winds. Such incidents would cause isolation to portions of the County (Guemes Island). Ferry transportation would also impact transportation lifelines for residents of San Juan Island, as well as a large transient population into Canada. Roads may become impassable due to ice or snow or from secondary hazards such as landslides. Incapacity and loss of roads are the primary transportation failures, most of which are associated with secondary hazards. Landslides that block roads are caused by heavy prolonged rains. High winds can cause significant damage to trees and power lines, with obstructing debris blocking roads, incapacitating transportation, isolating population, and disrupting ingress and egress. Snowstorms at higher elevations can impact the transportation system, impacting not only commodity flow, but also the availability of public safety services into impacted areas. 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.

9.3.5 Impact on Economy

Prolonged obstruction of major routes due to severe weather can disrupt the shipment of goods and other commerce. 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/manufacturing, 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.

Accommodation and food services account for 7.18 percent of the County's economy, while arts, entertainment and recreation account for 2.08 percent of the economy; transportation and warehousing accounts for 2.53 percent; manufacturing composes 9.13 percent of the economy, with construction at 7.83; agriculture, forestry, fishing and hunting account for 5.31 percent; health care and social assistance 8.66 percent, while wholesale and retail trade accounts for 14.63 percent (OFM).[37] Combined, these occupation categories account for approximately 60 percent of the County's economy. Each of these occupation classes are highly vulnerable to impacts from severe weather events, and as such, would have a significant impact on the County's economy, particularly if an event lasted for several days, or the resulting impacts (e.g., power outage) continued for significant periods of time.

[37] https://washington.reaproject.org/analysis/industry-structure/industries_by_region/employment/tools/530057/

9.3.6 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.

9.3.7 Impact from Climate Change

Climate change presents a 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. According to the EPA, "Since 1901, the average surface temperature across the contiguous 48 states has risen at an average rate of 0.14°F per decade. Average temperatures have risen more quickly since the late 1970s (0.36 to 0.55°F per decade). Seven of the top 10 warmest years on record for the contiguous 48 states have occurred since 1998, and 2012 was the warmest year on record (U.S. EPA, 2013)." This increase in average surface temperatures can also lead to more intense heat waves that can be exacerbated in urbanized areas by what is known as urban heat island effect. Additionally, the changing hydrograph caused by climate change could have a significant impact on the intensity, duration, and frequency of storm events. All of these impacts could have significant economic consequences.

With the increase in average ambient temperatures, since the 1980s, unusually cold temperatures have become less common in the contiguous 48 states (U.S. EPA, 2013). This trend is expected to continue and the frequency of winter cold spells will likely decrease. As ambient temperatures increase, more water evaporates from land and water sources. The timing, frequency, duration, and type of precipitation events will be affected by these changes. In general, more precipitation will fall as rain rather than snow.

9.4 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.

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; however, 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 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.

9.5 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 across the entire planning-region in order to understand and mitigate the vulnerabilities more fully.
- The capacity for backup power generation is limited and should be enhanced, especially in areas of potential isolation due to impact on major thoroughfares, evacuation routes, or ferry transportation.
- 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 the coastline enhances flooding potential through storm surges, erosion, and severe storms in general.

9.6 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 Skagit County, 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 allows 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 in the region, causing not only power outages, but also impacting the ability of ferries (and other vessels) to transport citizens and goods. While the utilities maintain excellent records for low incidents of long-term outages, the possibility does exist. Historically, severe weather events that occur 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 10.
TSUNAMI

A tsunami is a series of high-energy waves radiating outward from a disturbance. Earthquakes may produce displacements of the sea floor that can set the overlying column of water in motion, initiating a tsunami.

Tsunamis are classified as local or distant. Distant tsunamis may travel for hours before striking a coastline, giving a community a chance to implement evacuation plans. Local tsunamis have minimal warning times, leaving few options except to run to high ground. They may be accompanied by damage resulting from the triggering earthquake due to ground shaking, surface faulting, liquefaction or landslides. As a result of the high probability of a Cascadia Subduction Zone-type earthquake, occupants of many parts of Washington's coastlines have minimal time to reach high ground, in some areas only 20-30 minutes.

DEFINITIONS

Tsunami—A series of traveling ocean waves of extremely long wavelength usually caused by displacement of the ocean floor and typically generated by seismic or volcanic activity or by underwater landslides.

Tidal bore – A tidal phenomenon in which the leading edge of the incoming tide forms a wave (or waves) of water that travel up a river or narrow bay against the direction of the river or bay's current.

Tsunami Advisory - The purpose of a Tsunami Advisory is to keep people away from rivers, beaches, and harbors for their own personal safety. Tsunami waves during a Tsunami Advisory can also appear as "sneaker waves."

Sneaker wave – A term used to describe disproportionately large coastal waves that can sometimes appear in a wave train without warning.

10.1 GENERAL BACKGROUND

10.1.1 Physical Characteristics of Tsunamis

All waves, including tsunamis, are defined by the following characteristics (see Figure 10-1; Earth Science, 2012, Tulane University[38]):

- **Wavelength** is defined as the distance between two identical points on a wave (i.e., between wave crests or wave troughs). Normal ocean waves have wavelengths of about 300 feet. Tsunamis have much longer wavelengths, up to 300 miles.
- **Wave height** is the distance between the trough of a wave and its crest or peak.
- **Wave amplitude** is the height of the wave above the still water line; usually this is equal to 1/2 the wave height. Tsunamis can have variable wave height and amplitude that depends on water depth.
- **Wave frequency or period** is the amount of time it takes for one full wavelength to pass a stationary point.
- **Wave velocity** is the speed of a wave. It is equal to the wavelength divided by the wave period. Velocities of normal ocean waves are about 55 mph while tsunamis have velocities up to 600 mph (about as fast as jet airplanes).

Tsunamis are different from the waves most of us have observed on the beach, which are caused by the wind blowing across the ocean's surface. Wind-generated waves usually have periods of 5 to 20 seconds and a wavelength of 300 to 600 feet. A tsunami can have a period in the range of 10 minutes to 2 hours and

[38] http://www.tulane.edu/~sanelson/Natural_Disasters/tsunami.htm

wavelengths greater than 300 miles. Tsunamis are shallow-water waves, which are waves with very small ratios of water depth to wavelength.

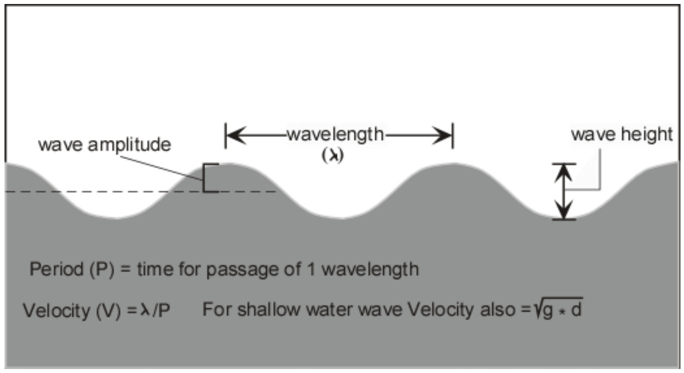


Figure 10-1 Physical Characteristics of Waves

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 10-2; 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.

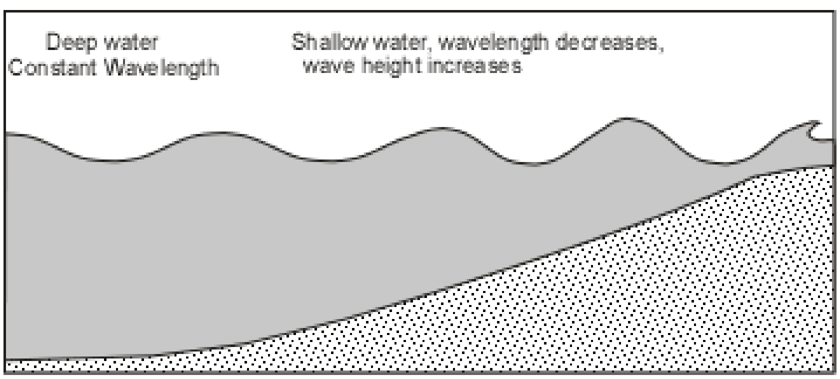


Figure 10-2 Change in Wave Behavior with Reduced Water Depth

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 of 100 feet above sea level.

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.

10.2 HAZARD PROFILE

10.2.1 Extent and Location

Tsunamis affecting Washington may be induced by local geologic events or earthquakes at a considerable distance, such as in Alaska or South America. Approximately 80 percent of tsunamis originate in the Pacific

Ocean and can strike distant coastal areas in a matter of hours, such as the 2011 earthquake and ensuing tsunami occurring in Japan which impacted Washington's coastlines, including within the planning area.

Most recorded tsunamis affecting the Pacific Northwest originated in the Gulf of Alaska. The landslide-generated tsunami in Lituya Bay, Alaska in 1958 produced a 200-foot-high wave. There is also geological evidence of significant impacts from tsunamis originating along the Cascadia subduction zone, which extends from Cape Mendocino, California to the Queen Charlotte Islands in British Columbia.

There is no written historical record of a damaging tsunami occurring in or affecting Skagit County (Skagit County, 2015). Geologic evidence of tsunamis has been found at Cultus Bay on Whidbey Island and at West Point in Seattle. Researchers believe these tsunami deposits are evidence of earthquake activity along the Seattle Fault or other shallow crustal faults located in the Puget Sound area.

Although there is no written record of a tsunami affecting Skagit County, scientific studies conclude that tsunami inundation resulting from a large-magnitude Cascadia Subduction Zone earthquake does pose a hazard to some areas of Skagit County.

Studies indicate that about a dozen very large earthquakes with magnitudes of 8 (Richter) or more have previously occurred in the Cascadia Subduction Zone off the coast of Washington. Computer models indicate that tsunami waves from such an event could be up to 30 feet in height and could affect the entire coast of Washington at varying degrees and depths. Such a tsunami would most likely impact the Pacific coastal areas of Washington, but inlets like the Strait of Juan de Fuca, could also be impacted. In addition to the direct impact of the tsunami, such an event could produce extensive seiche action of nearby waters resulting in additional damage to nearby shoreline areas not directly impacted by the tsunami (SCHMP, 2015).

If a tsunami were to strike the coast of Washington and Vancouver Island in such a way that a portion of the tsunami directly enters the Strait of Juan de Fuca, a large tsunami wave could travel easterly thereby directly striking the west shore of Whidbey Island (Island County) and would most likely also impact the west shore of Fidalgo Island portions of the City of Anacortes, and other low-lying shoreline areas within Skagit County.

2016 NOAA and Joint Institute for the Study of Ocean and Atmosphere (JISAO) Study

The State of Washington has partnered with University of Washington/Joint Institute for the Study of Atmosphere and Ocean/NOAA Center for Tsunami Research/Pacific Marine Environmental Laboratory in conducting a study to determine, using a local earthquake scenario, the level of tsunami energy and impact of tsunami waves as they propagate along the Strait of Juan de Fuca and into Puget Sound. Those studies focused on various coastal areas, including on-going efforts in Skagit, Island and Whatcom Counties. Information from that study, referenced as *2016 Study*, will be utilized to supplement information within this hazard profile. It is noted that the study is on-going, with additional data scheduled for release after completion of this update. That information, once released, should be reviewed, and the Tsunami Profile updated to include best available data.

The Tsunami Source used in the 2016 Study is based on that of Witter *et al*. (2011). The rupture scenario (referred to as L1), occurs along the Cascadia subduction zone at a Magnitude 9.0. The study was specifically selected from 15 rupture scenarios because it generates the highest moment magnitude, due to a higher maximum and average slip values.

It is noted that the study was not re-created for these planning purposes, but rather existing data utilized, as such modeling far exceeds the intent and capabilities of these planning purposes based on the level of expertise required. Reviewers wishing greater detail on this and other reports may access the information on Washington State Department of Natural Resources' webpage at: https://www.dnr.wa.gov/programs-and-services/geology/publications-and-data/publications-and-maps#wgs-publication-catalog.

Based on the 2016 Study, it is anticipated that within Anacortes, significant inundation occurs on the southwest side, particularly in the community of Flounder Bay. The shores of Cannery Lake and the western portion of Ship Harbor Interpretive Preserve are also inundated. Based on the 2016 simulation, the flow depth around Flounder Bay ranges from 0.30 m to as high as 5 m. A flow depth of at least 2 m and at least 3.5 m could occur at Cannery Lake and west of Ship Harbor Interpretive Preserve, respectively. The northern coast is also inundated, especially at the pier area from Georgia Avenue to Dakota Avenue and from Guemes Island Ferry Terminal eastward beyond R Avenue. The extent of inundation covers several blocks inland, with a flow depth ranging from 0.01 m to as high as 2 m. Cap Sante Marina and an area to its south are also inundated. The parking lots south of Fidalgo Marina and near Weavering Spit and the coast along the southeast end of Fidalgo Bay are also affected.

From the simulated results, the tsunami wave front first hits the southwest coast of Anacortes, specifically along the coast of Flounder Bay. In Anacortes, the community of Flounder Bay is the hardest hit, in terms of inundation extent and flow depth. The tsunami wave amplitude drops as it proceeds along the northern coast through Guemes Channel and moves into Fidalgo Bay.

The maximum current is high offshore Flounder Bay and slowly declines as it rounds the northern shore of Anacortes. It picks up speed along the Guemes Channel, dropping again as it passes Cap Sante Marina and enters Fidalgo Bay. In terms of inundation, the pier/port and marina area of Anacortes is flooded. At Flounder Bay, the flooding extends into the residential area. Mapped results are illustrated in Figure 10-3, completed by the Washington State Geological Survey (2018).

It should be noted that the data referenced in this document is for planning purposes only as much of the data will be refined and will undoubtedly change, as well as expanded as additional geographic areas are studied. Readers should use this information as intended, for planning purposes only, and not life safety measures prior to verifying the information as the study continues. There are also significant variations in the data, as well as unknown factors which may lead to different outcomes, including:

- The Digital Elevation Model used in the 2016 Study is based on Mean High Water;
- The study does not take into account the effects of tides, particularly at the time of tsunami arrival, which has the potential to greatly impact the inundation area;
- While some models show no co-seismic deformation, such does not suggest nor imply that no such deformation will actually occur. The 2016 Study is based on best available science at the time completed, and variations will occur based on the actual placement of the epicenter, and the size of the earthquake;

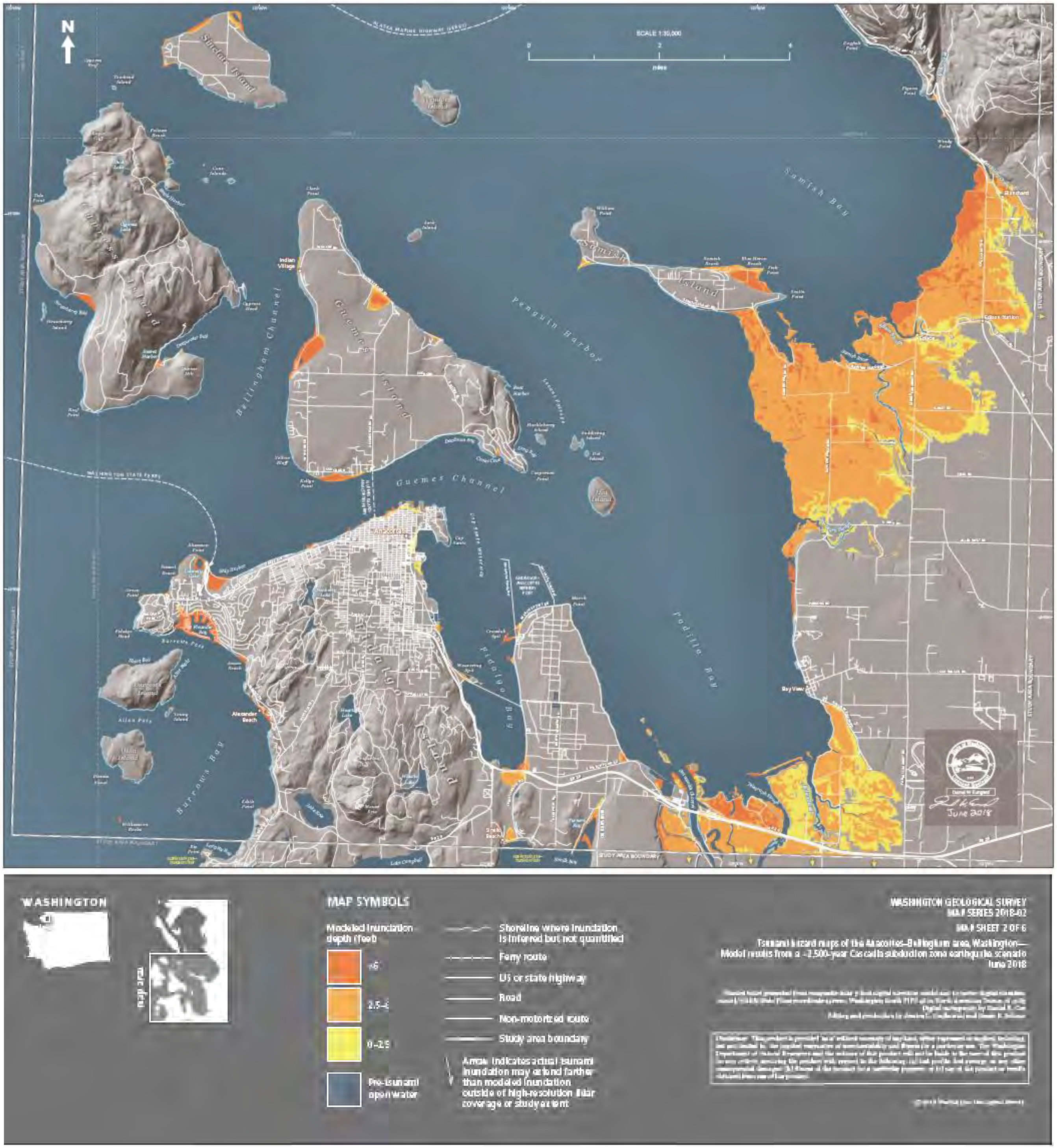


Figure 10-3 Inundation Area Based on Washington Geological Survey Map Series (2018)

The County's 2015 Hazard Mitigation Plan also utilized previous data to identify areas of potential impact, which the Planning Team also determined to be relevant. That study includes the *Tsunami Hazard Map of the Anacortes-Whidbey Island Area, Washington,* which was produced in January 2005 by the Washington State Department of Natural Resources (DNR), Division of Geology and Earth Resources in cooperation with the Washington State Military Department, Emergency Management Division. That map was the result of an extensive computer modeling study conducted by the Center for the Tsunami Inundation Mapping Efforts (TIME) at the National Oceanic and Atmospheric Administration (NOAA) Pacific Marine Environmental Laboratory in Seattle, Washington, and was considered a benchmark document. Due to its size, the map is available for viewing online at: http://www.dnr.wa.gov/Publications/ger_ofr2005-1_tsunami_hazard_anacortes_whidbey.pdf.

Review of the results from the studies referenced above indicate that a tsunami induced by a Cascadia Subduction Zone earthquake could generate waves of sufficient height to inundate shorelines and adjacent low-lying areas of Skagit County with water up to 2 meters in depth. Certain isolated shoreline areas could receive water greater than 2 meters in depth. Based on the 2005 study, those areas are identified in Table 10-1 and Table 10-2.

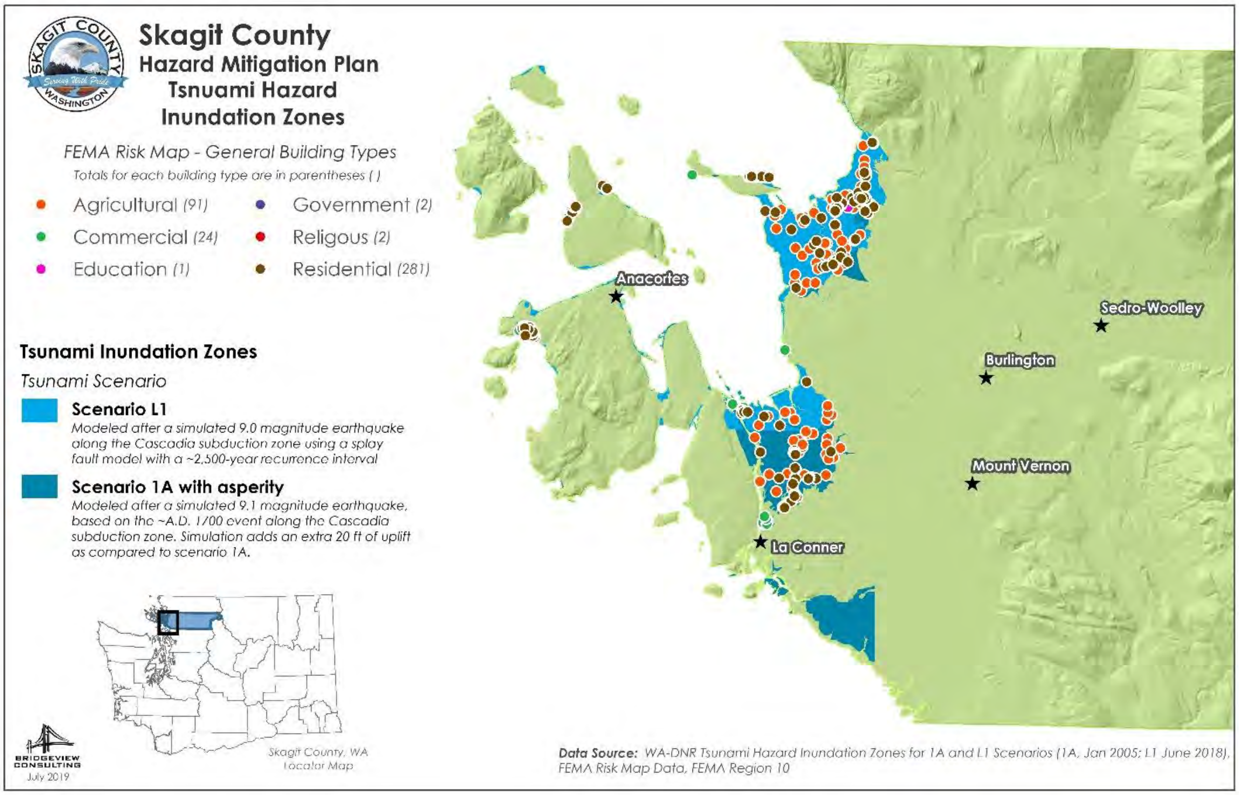
Table 10-1
Areas with Possible Inundation Depths of 2 Meters or Less

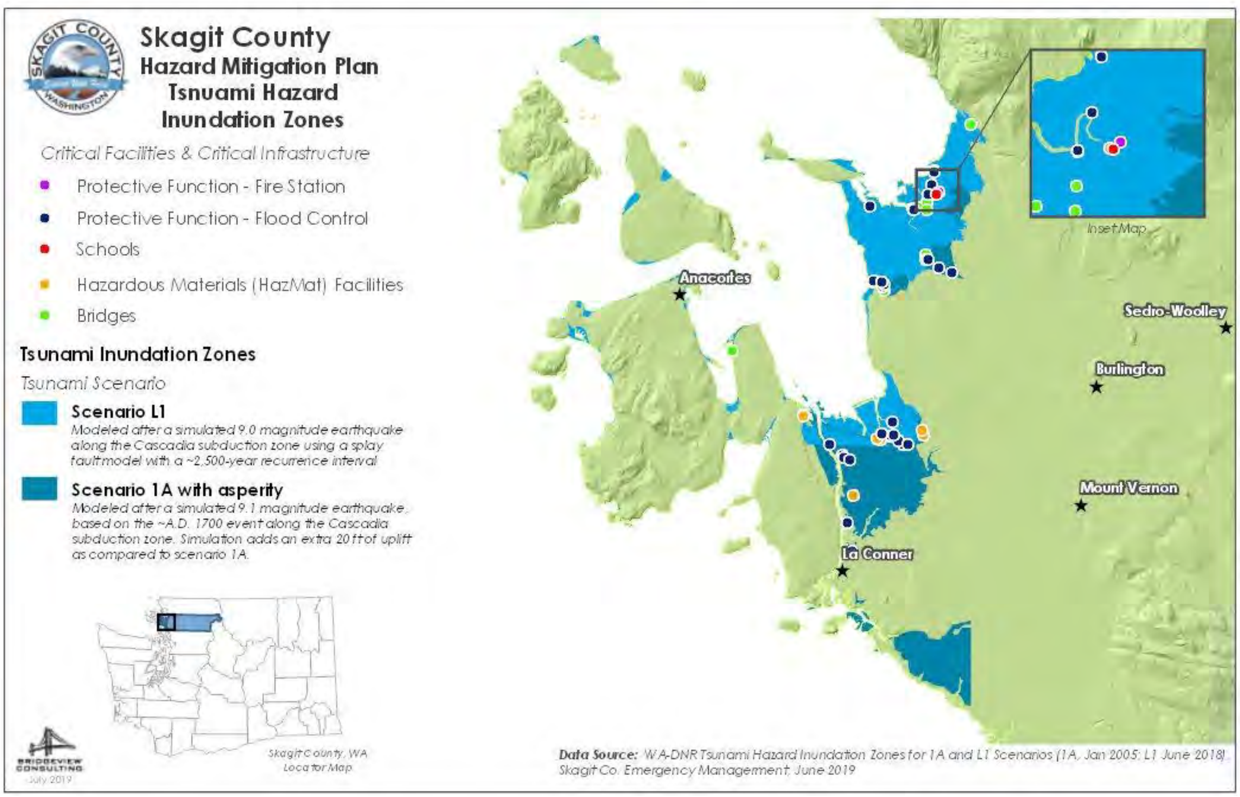
Bay View	March Point
Cypress Island - Strawberry Bay and Secret Harbor	Padilla Bay
Dewey Beach	Samish Bay
Easterly shoreline of Guemes Island	Samish Flats north of Joe Leary Slough
Edison	Samish Island – Camp Kirby and Blue Heron Beach
Fidalgo Bay	Similk Bay
Fir Island	Snee-oosh Beach
Guemes Channel	Swinomish Channel
	Western Shoreline of Fidalgo Island

Table 10-2
Areas with Possible Inundation Depths of Greater than 2 Meters

Alexander Beach	Fidalgo Head and Washington Park
Allen Island	Rosario Beach
Biz Point	Skyline
Bowman's Bay	Southern shoreline of Padilla Bay
Burrows Island	West Beach, Guemes Island
Eastern shoreline of Fidalgo Bay near Anacortes Marina	

The studies also identify deficiencies with respect to the fact that several of the potential inundation areas "protected by salt-water dikes… were not resolved in the grid used for the modeling [in the study], but the height of the dikes suggest they would be overtopped by the model tsunami" (Tsunami Hazard Map of the Anacortes–Whidbey Island Area, Washington: Modeled Tsunami Inundation from a Cascadia Subduction Zone Earthquake, 2005) (SCHMP, 2015). As such, viewers should take such findings into consideration. The County, realizing this potential issue, has identified future studies as a potential mitigation strategy for future consideration.


Skagit County
Hazard Mitigation Plan
Tsnuami Hazard
Inundation Zones
FEMA Risk Map - General Building Types
Totals for each building type are in parentheses ( )
Agricultural (91)
Government (2)
Commercial (24)
Religous (2)
Education (1)
Residential (281)
Tsunami Inundation Zones
Tsunami Scenario
Scenario L1
Modeled after a simulated 9.0 magnitude earthquake along the Cascadia subduction zone using a splay fault model with a ~2,500-year recurrence interval
Scenario 1A with asperity
Modeled after a simulated 9.1 magnitude earthquake, based on the ~A.D. 1700 event along the Cascadia subduction zone. Simulation adds an extra 20 ft of uplift as compared to scenario 1A.
Anacortes
Sedro-Woolley
Burlington
Mount Vernon
La Conner
Skagit County, WA Locator Map
BRIDGEVIEW CONSULTING
July 2019
Data Source: WA-DNR Tsunami Hazard Inundation Zones for 1A and L1 Scenarios (1A, Jan 2005; L1 June 2018). FEMA Risk Map Data, FEMA Region 10


Skagit County
Hazard Mitigation Plan
Tsnuami Hazard
Inundation Zones
Critical Facilities & Critical Infrastructure
Protective Function - Fire Station
Protective Function - Flood Control
Schools
Hazardous Materials (HazMat) Facilities
Bridges
Tsunami Inundation Zones
Tsunami Scenario
Scenario L1
Modeled after a simulated 9.0 magnitude earthquake along the Cascadia subduction zone using a splay fault model with a ~2,500-year recurrence interval
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Inset Map
Anacortes
Sedro-Woolley
Burlington
Mount Vernon
La Conner
Skagit County, WA Locator Map
BRIDGEVIEW CONSULTING
July 2019
Data Source: WA-DNR Tsunami Hazard Inundation Zones for 1A and L1 Scenarios (1A, Jan 2005; L1 June 2018). Skagit Co. Emergency Management, June 2019

10.2.2 Previous Occurrences

According to data captured from NOAA, SHELDUS and historical records, there is no record that Skagit County has ever been impacted by tsunami wave events. However, geologic evidence of tsunamis has been found at Cultus Bay on Whidbey Island and at West Point in Seattle. Researchers believe these tsunami deposits are evidence of earthquake activity along the Seattle Fault or other shallow crustal faults located in the Puget Sound area. Other historic incidents that have impacted areas of Washington State as a whole include:

- On May 22, 1960, the biggest earthquake ever recorded at the time occurred just off the coast of Chile, South America. The earthquake measured 9.5 (Richter) with swarms of aftershock earthquakes that measured as large 8.0 (Richter). The earthquakes triggered the creation of a tsunami, which was responsible for most of the ensuing devastation and death. The tsunami, together with the coastal subsidence and flooding, caused tremendous damage along the Chile coast, where about 2,000 people died. The waves spread outwards across the Pacific and fifteen (15) hours after the earthquake, tsunami waves flooded Hilo, on the island of Hawaii, where they built up to thirty (30) feet in height and caused 61 deaths along the waterfront. Seven hours later, the waves flooded the coastline of Japan where waves at least ten (10) feet in height caused 200 deaths. Tsunami waves also caused damage in the Marquesas, Samoa, and New Zealand.
- The 1964 Magnitude-9.2 earthquake in Prince William Sound, Alaska which caused a tsunami that struck Washington, Oregon and California, killing 139 people, mostly in Alaska. There were no reported deaths in Washington, but there were reports of damaged roads, bridges, boats and houses along the coastline in the more southwestern portions of the state.[39]
- On July 17, 1998, an earthquake measuring 7.1 (Richter) occurred about 15 miles off the coast of New Guinea in the southwestern Pacific Ocean. While the magnitude of the quake was not large enough to create the tsunami directly, it is believed the earthquake generated an undersea landslide, which in turn caused the tsunami that generated waves reaching 40 feet killing an estimated 2,200 people.
- On December 26, 2004, a massive earthquake measuring over 9.0 (Richter) occurred under the Indian Ocean floor just of the coast of the Indonesian island of Sumatra. Violent movement of the Earth's tectonic plates in this area displaced an enormous amount of water, sending powerful tsunami waves in every direction. Within hours, tsunami waves radiating from the earthquake’s epicenter slammed into the coastline of 12 Indian Ocean countries with wave heights reaching up to 50 feet. As many at 250,000 persons were either killed or listed as missing and presumed dead. As many as 1,125,000 people were displaced by the earthquake and subsequent tsunami. The economic losses exceed $10 billion.
- 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

[39] USC Tsunami Research Group http://cwis.usc.edu/dept/tsunamis/alaska/1964/webpages/index.html

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.

- As a result of the Queen Charlotte Island M7.7 Earthquake which occurred on October 28, 2012 Toke Point and Westport experienced a tsunami, with maximum water height at Toke Point .04m and Westport .08m.[40]

10.2.3 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.[41] From 1950 to 2007 alone, 478 tsunamis were recorded globally. Fifty-one events caused fatalities, to a total of over 308,000 coastal residents. The overwhelming majority of these events occurred in the Pacific basin. Recent tsunamis have struck Nicaragua, Indonesia, Thailand, and Japan, killing several hundred thousand people. Property damage due to these waves was nearly $1 billion. Historically, tsunamis originating in the northern Pacific and along the west coast of South America have caused more damage on the west coast of the United States than tsunamis originating in Japan and the Southwest Pacific.

The Cascadia subduction zone will produce the state's largest tsunami. The Cascadia subduction zone is similar to the Alaska-Aleutian trench that generated the Magnitude-9.2 1964 Alaska earthquake and the Sunda trench in Indonesia that produced the Magnitude-9.3 December 2004 Sumatra earthquake. Native American accounts of past Cascadia earthquakes suggest tsunami wave heights on the order of 60 feet, comparable to water levels in Aceh Province Indonesia during the December 2004 tsunami there. The Cascadia subduction zone last ruptured on January 26, 1700, creating a tsunami that left markers in the geologic record from Humboldt County, California, to Vancouver Island in Canada and is noted in written records in Japan. Water heights in Japan produced by the 1700 Cascadia earthquake were over 15 feet, comparable to tsunami heights on the African coast after the Sumatra earthquake. At least seven ruptures of the Cascadia subduction zone have been observed in the geologic record.

A Cascadia Subduction Zone earthquake is expected to lower the ground surface along much of the coast of Washington. Maximum flooding depth, velocity, and extent will depend greatly on the tide height at the time of the tsunami arrival.

Although there is no record of a tsunami affecting Skagit County, scientific studies conclude that tsunami inundation resulting from a large-magnitude Cascadia Subduction Zone earthquake does pose a hazard to some areas of Skagit County. Such a tsunami would most likely impact the Pacific coastal areas of Washington and also inlets like the Strait of Juan de Fuca.

If a tsunami were to strike the coast of Washington and Vancouver Island in such a way that a portion of the tsunami directly enters the Strait of Juan de Fuca, a large tsunami wave could travel easterly thereby directly striking the west shore of Whidbey Island (Island County) and would also impact not only the west shore of Fidalgo Island, but additional areas of the City of Anacortes and other low-lying shoreline areas within Skagit County.

[40] NOAA National Centers for Environmental Information Accessed 25 July 2019. Available online at: https://www.ngdc.noaa.gov/nndc/struts/form?t=101650&s=167&d=166
[41] https://www.ncei.noaa.gov/news/november-5-world-tsunami-awareness-day

10.2.4 Frequency

Unlike many natural hazards, the number of tsunamis is low. In the last 100 years, slightly over 100 fatal tsunamis struck coastlines around the globe.[42] Generally four or five tsunamis occur every year in the Pacific Basin, and those that are most damaging are generated off South America rather than in the northern Pacific. Pacific-wide tsunamis are rare, occurring every 10 to 12 years on average. Most of these tsunamis are generated by earthquakes that cause displacement of the seafloor, but a tsunami can also be generated by volcanic eruptions, landslides, underwater explosions, and meteorite impacts (Nelson, undated). The frequency of tsunamis is related to the frequency of the event that causes them, which would include seismic, volcanic, or landslide events.

10.3 VULNERABILITY ASSESSMENT

10.3.1 Overview

Results from several studies conducted over the course of the last several years vary in some degree to impact; however, most reports are consistent in several factors. Due to the close proximity to the earthquake source, subsidence may occur, which will result in long-term inundation (Gica, 2014). Short-term inundation is expected to be caused by the generated tsunami waves. While the 2016 Study indicates that the long-term inundation generated by co-seismic displacement may not occur based on the L1 scenario, the epicenter and size of the earthquake source may in fact generate co-seismic displacement, thereby causing long-term inundation. There are additional factors which would also influence the potential co-seismic displacement.

Studies based on scenarios developed by PMEL and NOAA have illustrated inundation in the planning area. Extensive flooding is primarily caused by the initial tsunami waves that hit the coasts, with later waves also deemed to be damaging, with some area's amplitudes almost matching the initial waves occurring hours after the earthquake.

As a result of the offshore continental shelf margin and wave refractions and reflections along the coast, tsunami time series models indicate that it will take several hours before the generated tsunami waves begin to die out (Gica, 2014). Wave height also varies by study (Gica, 2014).

Aside from the tremendous hydraulic force of the tsunami waves themselves, floating debris carried by a tsunami can endanger human lives and destroy inland structures. Ships moored at piers and in harbors often are swamped and sunk or are left battered and stranded high on the shore. Breakwaters and piers collapse, sometimes because of scouring actions that sweep away their foundation material and sometimes because of the sheer impact of the waves. Railroad yards and oil tanks situated near the waterfront are particularly vulnerable. Oil fires frequently result and are spread by the waves.

Methodology

The majority of data utilized within this process is the result of FEMA's on-going RiskMap project and Washington State Department of Natural Resources (and others)Tsunami inundation modeling and studies as they remain the subject matter experts in the field.

For FEMA's RiskMap project, the tsunami model for Skagit County is based on a Cascadia M9.0 earthquake, and was developed by Priest and others (1997) and designated Scenario 1A (also see Myers

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

and others, 1999). The various sources utilized are referenced. It should be noted that discrepancies in data results will exist due to the variations in the methods used (different Hazus models), as well as different data sources, such as topography, tidal state, and the use of the various water tables (e.g., Mean High Water, wave height, source of the tsunami, etc.).

Exposure analysis was also conducted during this update process outside of Hazus utilizing the critical facilities identified by the HMP Planning Team during this update process, and is also based on the same Cascadia M9.0 earthquake event as utilized by FEMA.

As the County's building layer data is refined, increased accuracy with respect to the number of structures at risk will be modified. Readers requiring additional data on the methodology utilized in the various studies referenced should obtain such information from FEMA Region X, or from Washington State Department of Natural Resources for a full copy of the findings. Information presented is for hazard mitigation planning purposes only, and should not be considered for life-safety measures.

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 10-4 shows typical time for a tsunami to travel across the Pacific Ocean, based on the 1964 Alaska and 1960 Chile earthquakes and resulting tsunamis.

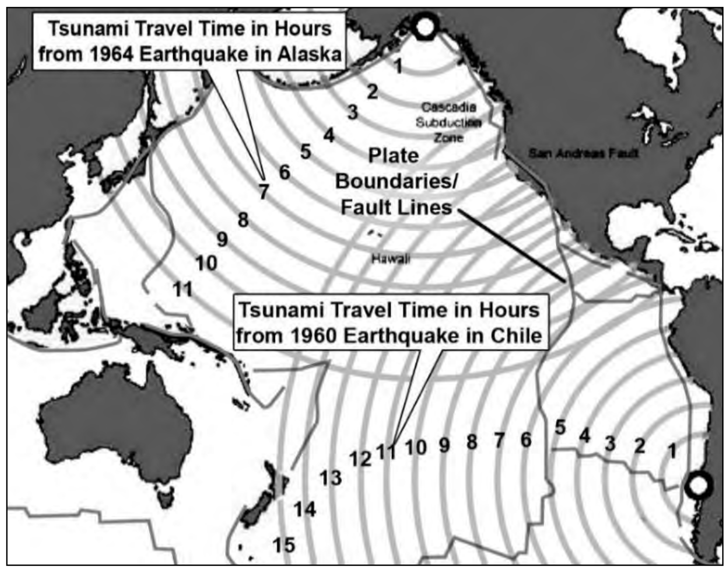


Figure 10-4 Tsunami Travel Times in the Pacific Ocean

According to Washington State's Hazard Mitigation Plan (2013) at least thirteen (13) of Washington State's Pacific Ocean coastal communities and tribal reservations lack natural high ground that is of sufficient elevation to escape a 30+ foot tsunami triggered by a Cascadia Subduction Zone earthquake.

The lack of natural high ground coupled with preceding earthquake damage, close proximity to the fault (~50-100 miles), and limited time for evacuation (15-30 minutes) preclude the use of traditional horizontal or vehicular evacuation strategies. These limiting factors make the 13 outer coastal communities in Washington extremely vulnerable to significant loss of life from such an incident. However, this situation is not unique to Washington State, as many low-lying coastal areas within U.S. states, commonwealths, and territories are also constrained by similar geographic factors.

To address this unique challenge, the concept of vertical evacuation was established. This evacuation strategy allows residents and visitors to move upwards to safety in man-made structures (buildings, towers, or berms) and is particularly important on peninsulas where traditional evacuation measures are not viable options for life safety. In 2008, FEMA collaborated with the National Oceanic and Atmospheric Association and published engineering guidance entitled "*Guidelines for Design of Structures for Vertical*

Evacuation from Tsunamis" to promote the planning and development of life safety refuges in the United States (FEMA P646). In 2011, the vertical evacuation concept was tested to its fullest extent and successfully saved thousands of lives in Japan during the March 11, 2011 tsunami. Within Washington State, Grays Harbor County was successful in constructing our nation's first vertical evacuation at the Ocosta School – Project Safe Haven.

The arrival time and duration of flooding are key factors to be considered in evacuation strategies. For some locations on Washington's outer coast, the first wave crest is generally predicted to arrive between 25 and 40 minutes after the earthquake (Gica, 2014). However, significant flooding can occur before the first crest arrives because a Cascadia Subduction Zone earthquake is expected to lower the ground surface along the coastlines. This will effectively render evacuation times short not only for people on the beach, but also along coastal roadways, including major transportation corridors traversing the coastline.

Washington State Department of Natural Resources recently completed a study within several different areas of the state to determine the timelines within which waves are expected to begin reaching the shorelines, as well as the anticipated walking time required to evacuate those areas. The study is intended to last for several more months, well beyond the time associated with the update of this plan; however, some maps for the planning area have been completed. Figure 10-5 illustrates travel times out of hazards zones along the areas of the planning region. Additional and updated data (as it is developed) is available online at https://www.dnr.wa.gov/programs-and-services/geology/geologic-hazards/Tsunamis#.6 Readers should continue to check the site to view new data as it becomes available. The next phase of the study is anticipated to be released during the springtime of 2020.

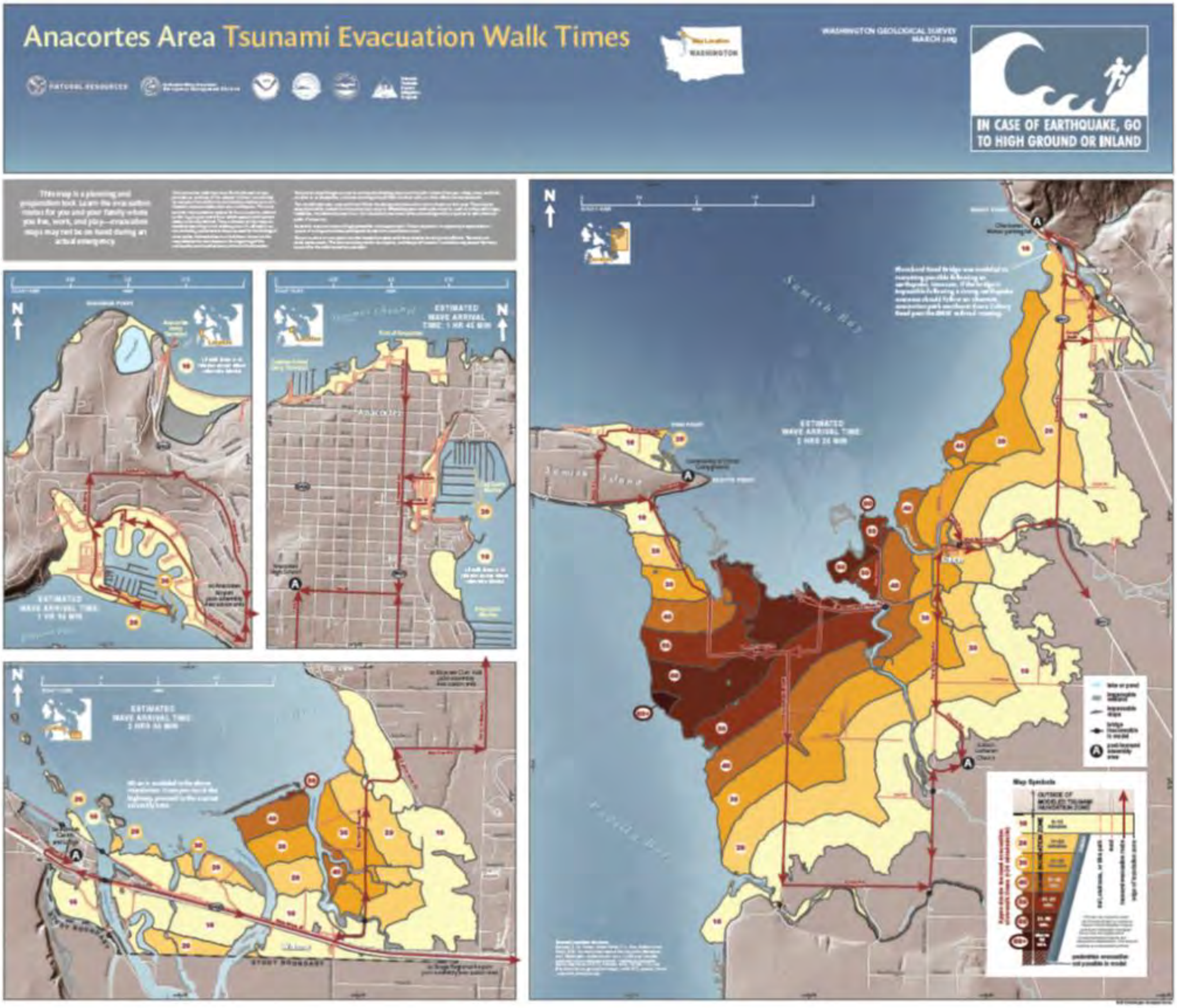
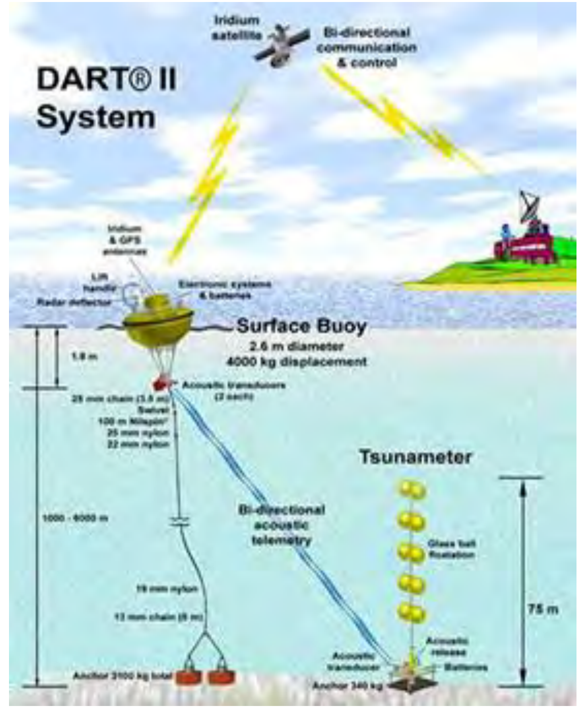


Figure 10-5 Travel Time out of Tsunami Hazard Zone in Minutes

Deep-Ocean Assessment and Reporting of Tsunamis

NOAA's Deep-ocean Assessment and Reporting of Tsunamis system (see Figure 10-6) 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 10-6 Deep-Ocean Assessment and Reporting of Tsunamis System (DART)



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 gauges. 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.

All-Hazard Alert Broadcasting Network

Currently, the County is in the process of installing All-Hazard Alert Broadcast sirens in the area. It is anticipated that installation of those sirens will occur during the life cycle of this plan, as the County is in the process of working with Washington State Department of Emergency Management to for installation of those sirens. Once installed, those sirens will provide warnings of tsunamis to outdoor populations. The system will provide rapid alert to citizens and visitors who are in the hazard zone, giving advanced warning for evacuation.

10.3.2 Impact on Life, Health, and Safety

Several factors are considered when determining the impact to the population from the Tsunami hazard. The arrival time and duration of flooding are key factors to be considered in evacuation strategies. For a Cascadia Subduction Zone tsunami, the first wave crest is generally predicted to arrive at the City of Anacortes approximately 90 minutes after the earthquake; however, a Seattle fault-generated tsunami would begin arriving in Skagit County within 60 minutes (FEMA 2017 Risk Report). Maximum flooding depth, velocity, and extent will depend on tide height at the time of tsunami arrival, but it is important for readers to evacuate to higher ground immediately after the ground stops shaking.

The populations most vulnerable to the tsunami hazard are the elderly, disabled and very young who reside near beaches, low-lying coastal areas, tidal flats and river deltas that empty into ocean-going waters. In the event of a local tsunami generated in or near the planning area, there would be limited warning time, so more of the population would be vulnerable.

The degree of vulnerability of the population exposed to the tsunami hazard event is based on a number of factors:

- Is there a warning system?
- What is the lead time of the warning?
- What is the method of warning dissemination?
- Will the people evacuate when warned?

Also for consideration within Skagit County is the high population of tourists, which not only traverse the area en route for other destinations, but also who stay in local hotel and motels and other types of temporary lodging in areas along the coastline. Those population numbers should also be factored into the potential population impacted.

10.3.3 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. The County has several ports, business, and structures which store or use chemicals. This could also render property unusable based on the type of chemical, while also increasing the level of damage. Based on the 2017 Risk Report, FEMA identified 478 structures at risk, representing approximately 1.9 percent of the buildings in the region (see Table 10-3). Figure 10-7 identifies structure by general use type based on the scenarios utilized.

TABLE 10-3
POTENTIAL BUILDING EXPOSURE AND DOLLAR LOSSES
CASCADIA M9.0 EARTHQUAKE-INDUCED TSUNAMI

Community	Total Estimated Building Value	Building Value in Tsunami Zone	Total Number of Buildings	Number 0f Buildings in Tsunami Hazard Zone	Percent of Buildings in Tsunami Hazard Zone
Anacortes	$1.3B	$24.9M	6,348	119	1.9%

TABLE 10-3 POTENTIAL BUILDING EXPOSURE AND DOLLAR LOSSES CASCADIA M9.0 EARTHQUAKE-INDUCED TSUNAMI					
La Conner	$26.1M	$6.4M	140	8	5.7%
Swinomish Indian Tribal Community	$155.4M	--	965	--	--
Unincorporated Skagit County	$3.2B	$99.5M	17,736	351	2.0%
Total	**$4.7B**	**$130.8M**	**25,189**	**478**	**1.9%**

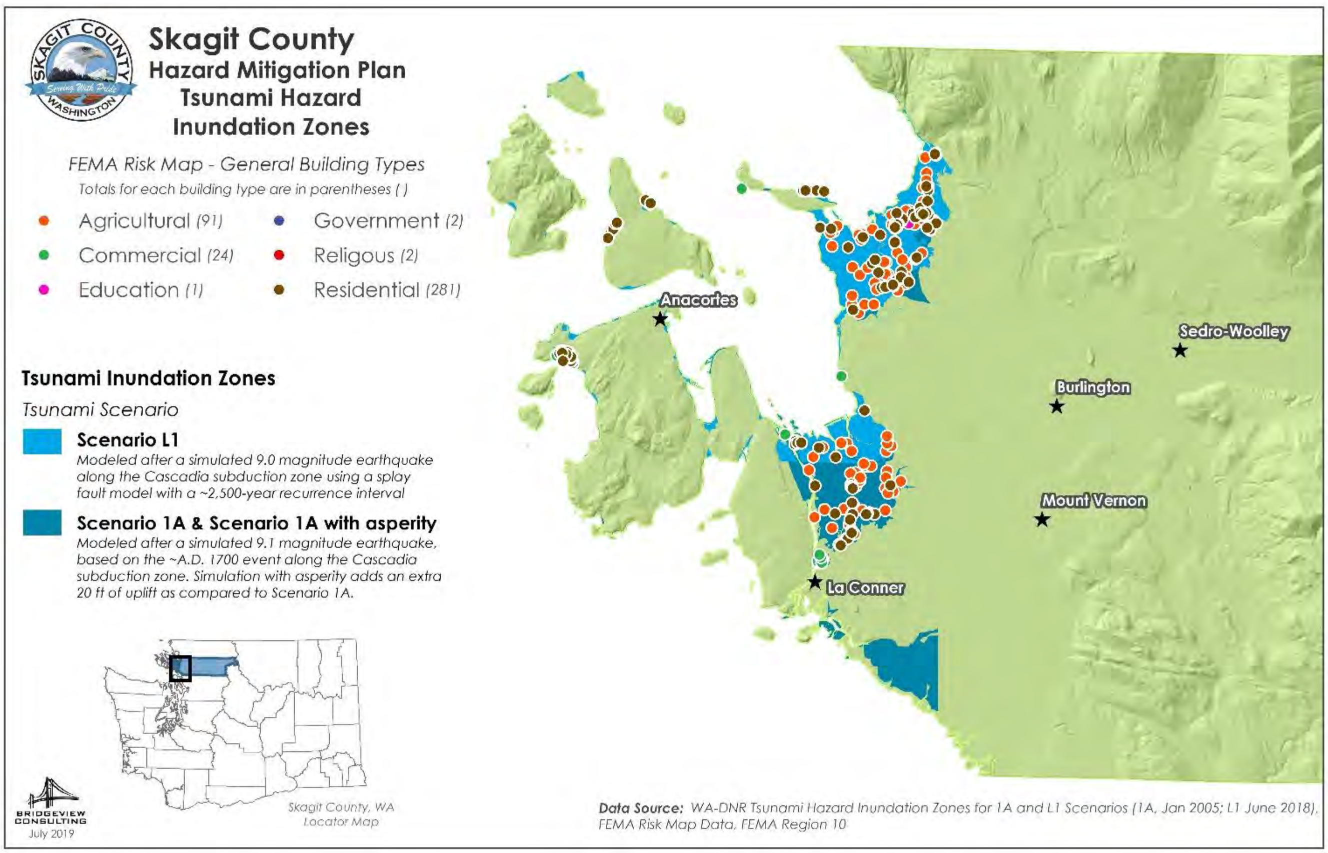


Figure 10-7 Tsunami Inundation Zones and General Building Types Impact

10.3.4 Impact on Critical Facilities and Infrastructure

Roads or railroads that are blocked or damaged can prevent access and can isolate residents and emergency service providers needing to get to vulnerable populations or to make repairs. Bridges washed out or blocked by tsunami inundation or debris from flood flows also can cause isolation. Water and sewer systems can be flooded or backed up, causing further health problems. Underground utilities can also be damaged during flood events.

Figure 10-8 illustrates the location of the critical infrastructure. Table 10-4 through Table 10-6 provide an estimate of the number and types of critical facilities exposed to the tsunami hazard, as well as potential dollar losses.

Within Skagit County, government-owned infrastructure owned by the Port of Anacortes and the Port of Skagit County as well as the Washington State Department of Transportation Anacortes Ferry Terminal may be vulnerable to tsunami. In addition, the numerous marina facilities as well as the downtown commercial and industrial/manufacturing areas of the City of Anacortes and the Town of La Conner could be vulnerable to tsunami or severe seiche action. A tsunami would most likely cause damage to agricultural crops and washing or erosion of farm ground located near shoreline areas throughout the Skagit Delta, especially in those areas near Samish Bay, Padilla Bay, and Skagit Bay.

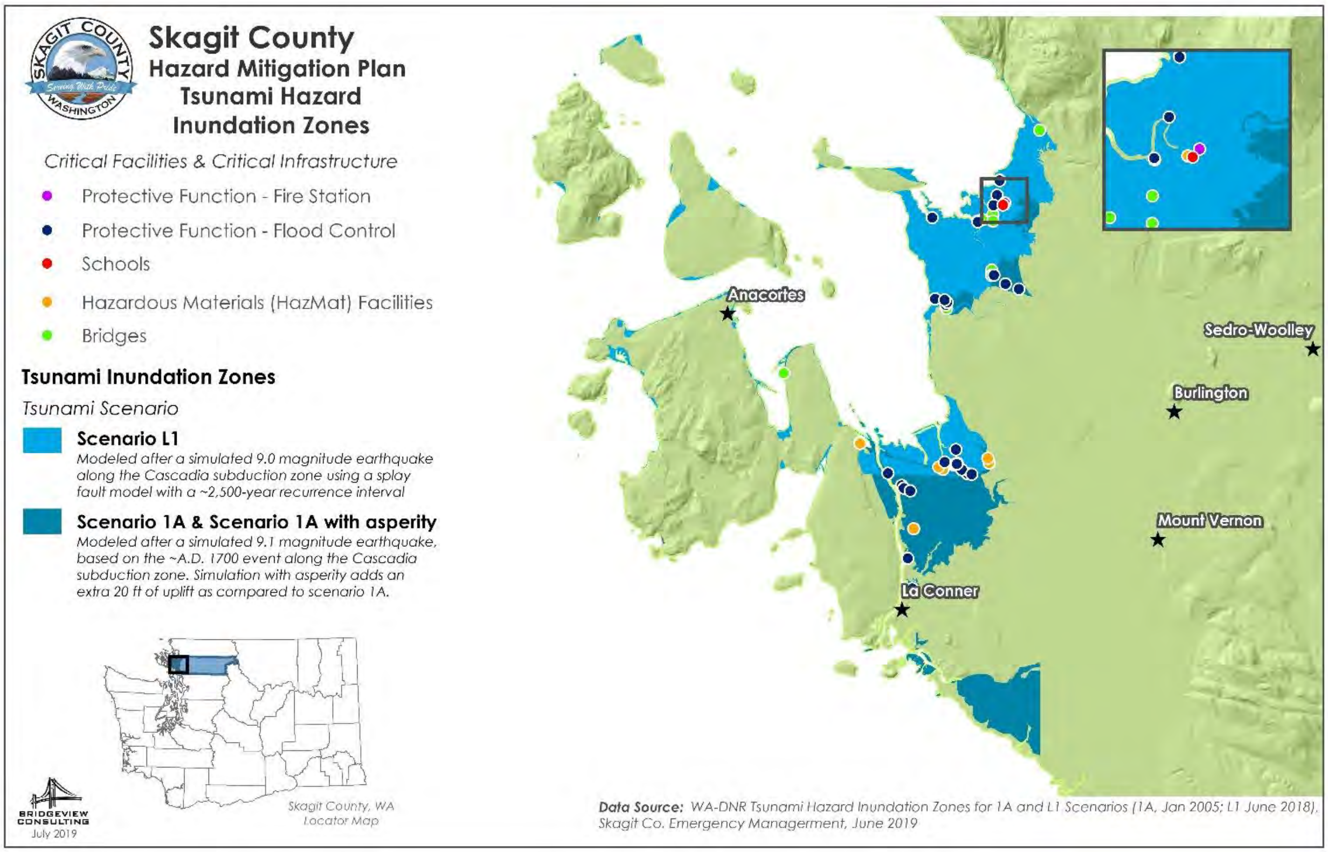


Figure 10-8 Tsunami Inundation Zones and Impact to Critical Facilities (M9.0 Cascadia Event)

Table 10-4
Critical Facilities Exposed in the Tsunami Inundation Zone*

Jurisdiction	Medical & Health Services	Government Function	Protective	Schools	Hazardous Materials	Other Facilities	**Total**
Unincorporated Skagit Co.	0	0	33	1	6	0	**40**
Anacortes, City of	0	0	0	0	0	0	**0**
Burlington, City of	0	0	0	0	0	0	**0**
Concrete Town of	0	0	0	0	0	0	**0**
Hamilton, Town of	0	0	0	0	0	0	**0**
La Conner, Town of	0	0	0	0	0	0	**0**
Lyman, Town of	0	0	0	0	0	0	**0**
Mount Vernon, City of	0	0	0	0	0	0	**0**
Sedro-Woolley, City of	0	0	0	0	0	0	**0**
Swinomish Indian Tribal Community	0	0	0	0	2	0	**2**
Sauk-Suiattle Tribe	0	0	0	0	0	0	**0**
Upper Skagit Indian Tribe	0	0	0	0	0	0	**0**
Total	**0**	**0**	**33**	**1**	**8**	**0**	**42**

* The most current tsunami inundation zone for which geospatial data was available was used for this analysis, WA-DNR Tsunami Hazard Inundation Zones for 1A and L1 Scenarios (1A, Jan 2005; L1 June 2018)

Table 10-5
Critical Infrastructure Exposed in the Tsunami Inundation Zone*

Jurisdiction	Bridges	Water Supply	Wastewater	Power	Communications	Other Infrastructure	**Total**
Unincorporated Skagit Co.	10	0	0	0	0	0	**10**
Anacortes, City of	0	0	0	0	0	0	**0**
Burlington, City of	0	0	0	0	0	0	**0**
Concrete Town of	0	0	0	0	0	0	**0**
Hamilton, Town of	0	0	0	0	0	0	**0**
LaConner, Town of	0	0	0	0	0	0	**0**
Lyman, Town of	0	0	0	0	0	0	**0**
Mount Vernon, City of	0	0	0	0	0	0	**0**
Sedro-Woolley, City of	0	0	0	0	0	0	**0**
Swinomish Indian Tribal Community	0	0	0	0	0	0	**0**
Sauk-Suiattle Tribe	0	0	0	0	0	0	**0**
Upper Skagit Indian Tribe	0	0	0	0	0	0	**0**
Total	**10**	**0**	**0**	**0**	**0**	**0**	**10**

* The most current tsunami inundation zone for which geospatial data was available was used for this analysis, WA-DNR Tsunami Hazard Inundation Zones for 1A and L1 Scenarios (1A, Jan 2005; L1 June 2018).

Table 10-6
Dollar Loss Estimations for Critical Facilities and Infrastructure in Tsunami Zone ***

Jurisdiction	Number of Critical Facilities & Infrastructure	Replacement Value	Content *(50% Replacement unless otherwise specified)*	Total	**Percent of Total Value CIKR***
Unincorporated Skagit County**	**50**	**$18,333,308**	**$9,166,654**	**$27,499,962**	**1.18%**
Anacortes, City of	0	$0	$0	$0	**0.00%**
Burlington, City of	0	$0	$0	$0	**0.00%**
Concrete Town of	0	$0	$0	$0	**0.00%**
Hamilton, Town of	0	$0	$0	$0	**0.00%**
La Conner, Town of	0	$0	$0	$0	**0.00%**
Lyman, Town of	0	$0	$0	$0	**0.00%**
Mount Vernon, City of	0	$0	$0	$0	**0.00%**
Sedro-Woolley, City of	0	$0	$0	$0	**0.00%**
Swinomish Indian Tribal Community**	**2**	Not Provided	Not Provided	$0	**0.00%**
Sauk-Suiattle Tribe	0	$0	$0	$0	**0.00%**
Upper Skagit Indian Tribe	0	$0	$0	$0	**0.00%**
Total	**52**	**$18,333,308**	**$9,166,654**	**$27,499,962**	**1.18%**

* Total value for CIKR is equal to $2,333,543,338 which includes all facilities and infrastructure for which a replacement value was provided;
** Analysis includes 8 HazMat facilities for which replacement values were not provided (6 in Unincorporated Skagit Co. and 2 in Swinomish Indian Tribal Community);
***The most current tsunami inundation zone for which geospatial data was available was used for this analysis, WA-DNR Tsunami Hazard Inundation Zones for 1A and L1 Scenarios (1A, Jan 2005; L1 June 2018).

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. Several major transportation corridors will be impacted by tsunami events, due to its proximity to the coastline along much of the County. Likewise, bridges will also be impacted. These factors are of significant concern for evacuation purposes as these are the only thoroughfares out of the area and to higher ground.

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. The Port of Skagit County, Washington State Ferry System and private businesses operate marine terminals, marinas, airports and business parks in various areas throughout the County, all of which would sustain some impact from a Tsunami event.

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. This would also impact facilities that are outside of the actual tsunami inundation area.

10.3.5 Impact on Economy

Port facilities, marinas, ferry terminals (both County and state), 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 other economic hubs 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. With the major fuel pipelines in the area, economies outside of the planning area would also be impacted.

Many businesses in the County and impacted areas are related to tourism, and are highly dependent on the millions of visitors to the area annually. Depending on the season, large numbers of visitors and tourists may be in the area, increasing response requirements. Those visitors and tourists will require some type of educational outreach with respect to what to do and where to go if an earthquake and tsunami occur. A tsunami would also damage economically important natural resources, such as crab, clams, salmon and other fish, and outdoor recreation areas.

When considering the total area of the County, the inundation zone for the planning region is limited, but the impact nonetheless would have a significant impact on the planning region's economy. Ingress and egress to the island communities would be impacted, restricting access to and from the areas, as well as first-responder response and access to medical facilities. Loss of tax base, destruction of government facilities, destruction of private businesses, loss of land-base, loss of marine vessels for the fishing industry, among other items, all would be significant impacts to overcome to allow the economy to sustain itself. In addition to the County impact, all of Washington would be impacted as a result of the loss of connectivity with Canada to Washington, as well as the impact on major highways, the Port system, ferry systems (both the County's and Washington State's systems), and the travel time associated with loss of the transportation infrastructure.

10.3.6 Impact on Environment

The vulnerability of agricultural and 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.

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.

10.3.7 Impact from Climate Change Tsunami

The impacts of climate change on the frequency and severity of tsunami events could be significant in regions with vulnerable coastline. Global sea-level rise will affect all coastal societies, especially densely populated low-lying coastal areas. Sea level 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.

10.4 FUTURE DEVELOPMENT TRENDS

The County does address velocity with respect to wave force in their Comprehensive Land Use Plan and Floodplain ordinance based on storm surge, although standard floodplain development regulation may not provide adequate risk protection for new development. As the tsunami inundation study has not yet been completed, once the data and science can be applied to official mapping with assigned probabilities of occurrence countywide, the County may at that point in time wish to review the regulatory provisions in place for new development in high-risk tsunami inundation areas.

Of additional concern is the potential for erosion and bluff washout as a result of Tsunami waves. The planning area does have 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.

10.5 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). Portions of County residents can expect waves to reach their boundaries within approximately 1.5-2.5 hours depending on the type of earthquake triggering the tsunami. This could result in loss of life due to residents' inability to evacuate quickly enough. This can also cause severe economic and environmental impacts.

The planning team has identified the following issues related to the tsunami hazard for the planning area:

- To measure and evaluate the probable impacts of tsunamis, new hazard mapping needs to be created based on probabilistic scenarios likely to occur for the County. The science and technology in this field are emerging. For tsunami hazard mitigation programs to be effective, probabilistic tsunami mapping will need to be a key component, with updates occurring as new data emerges. While portions of the County have just recently completed such a study, additional areas are still in progress. That data will continue to be enhanced using Hazus (and other) analysis as time progresses. Regular updates should continue to occur.
- Limitations associated with assessor's data relating to building location and 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 pending installation of the All Hazards Alert Broadcast (AHAB) system. Funding for weather radios, additional sirens, or notification systems which will be strategically located will allow for advanced warning in areas of concern.
- Additional elevated tsunami evacuation points throughout the area of inundation need to be constructed, which will require additional funding sources.

- 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.

10.6 RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from Tsunami throughout the area is limited in nature with respect to geographic extent, but the risk to lives does increase its severity. There have been no recorded events within Skagit County. However, due to the fact that we are well over-due for a Cascadia type earthquake event, which undoubtedly will generate a tsunami within the region (from Canada to California), the probability of occurrence is possible (medium). Economic impact as a result of the tsunami would reach well beyond that of the inundation zone, and would have impact statewide. A tsunami would also be a more sudden-impact event, with evacuation times varying depending on where the earthquake occurred. Implementation of mitigation strategies for vertical evacuation sites will help protect some lives, but not all. Based on the potential impact, the Planning Team determined the CPRI score to be 2.55, with overall vulnerability determined to be a medium-high level.

CHAPTER 11.
VOLCANO

The Cascade Range of Washington, Oregon and California has volcanoes in close proximity to Skagit County. The primary effect of the Cascade volcanic eruptions countywide would be ash fall, with additional disruption of service due to impact on surrounding counties. Skagit County's Eastern boundary follows the crest of the Cascade Range. While there are no volcanic peaks within Skagit County, Mount Baker lies just to the North in Whatcom County and Glacier Peak lies just to the South in Snohomish County. Due to the topography of the region and the location of drainage basins and river systems, eruption events on either Mount Baker or Glacier Peak resulting in lahars, pyroclastic flows, tephra or ash fall, and lava flows could significantly impact portions of Skagit County.

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.

11.1 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 11-1). 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 Skagit County), 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 will occur 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. While Mount St. Helens has continued to emit steam on occasion since its last eruption, scientists feel that advanced warning of a significant magnitude would provide some level of advanced notice.

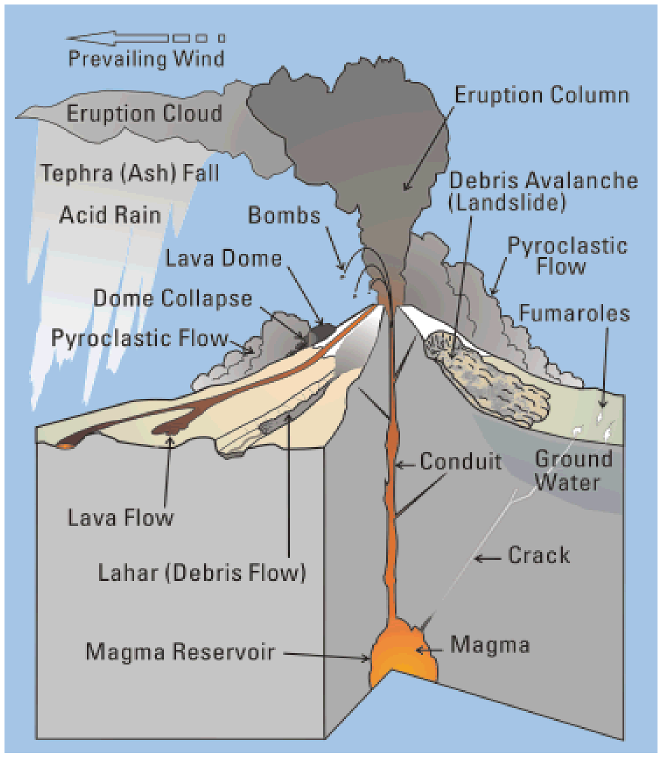


Figure 11-1 Volcano Hazard

The most recent eruption in Washington State, the eruption of Mount 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.

11.2 HAZARD PROFILE

11.2.1 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 11-2 shows the location of the Cascade Range volcanoes, most of which have the potential to produce a significant eruption.

Mt. Baker is 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, although in previous times, it produced some of the largest and most explosive eruptions in the state.

Skagit County's Eastern boundary follows the crest of the Cascade Range. While there are no volcanic peaks within Skagit County, Mount Baker lies just to the North in Whatcom County and Glacier Peak lies just to the South in Snohomish County.

Geologic evidence indicates that both Mount Baker and Glacier Peak have erupted in the past and will no doubt erupt again in the foreseeable future. Due to the topography of the region and the location of drainage basins and river systems, eruption events on either Mount Baker or Glacier Peak resulting in lahars, pyroclastic flows, tephra or ash fall, and lava flows could severely impact portions of Skagit County.

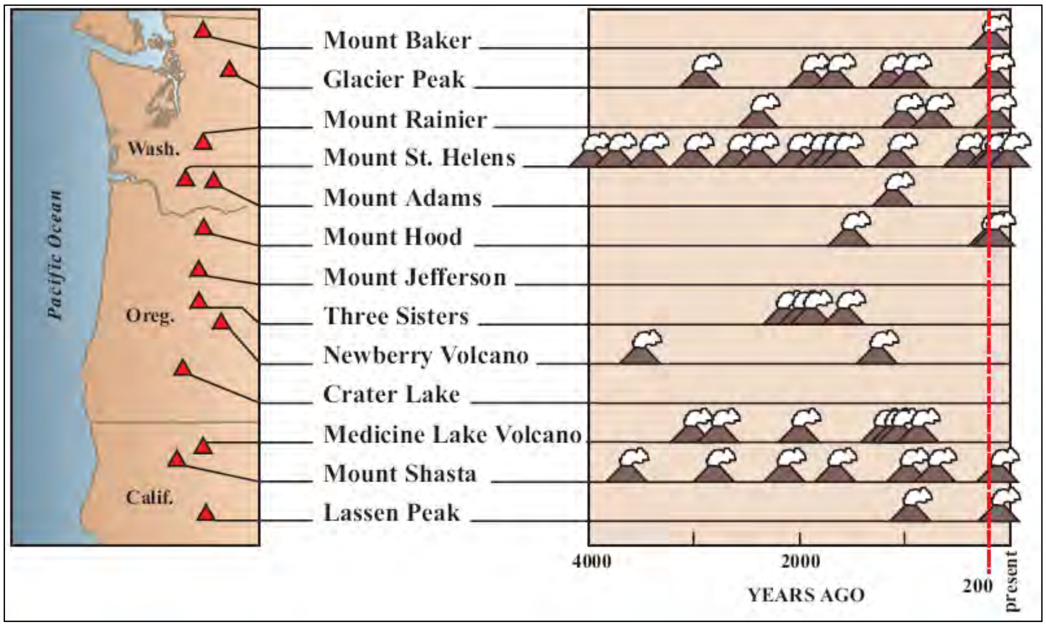


Figure 11-2 Past Eruptions of Cascade Volcanoes

Mount Baker

Figure 11-3 Mount Baker

(Source: Schurlock, 2002-2014)

Mount Baker is an ice-clad stratovolcano located just North of Skagit County in the North Cascades. USGS research in the last decade shows Mount Baker to be one of the youngest volcanoes in the Cascade Range. At 10,781 feet it is the third highest volcano in Washington State. (Volcano Hazards Program, Mt Baker, 2013) After Mount Rainier, Mount Baker is the most heavily glaciated of the Cascade volcanoes: the volume of snow and ice on Mount Baker (about 0.43 cubic miles) is greater than that of all the other Cascades volcanoes (except Rainier) combined. Isolated ridges of lava and hydrothermally altered rock, especially in the area of Sherman Crater, are exposed between glaciers on the upper flanks of the volcano; the lower flanks are steep and heavily vegetated. The volcano rests on a foundation of non-volcanic rocks in a region that is largely non-volcanic in origin.

Historical activity at Mount Baker includes several explosions during the mid-19th century, which were witnessed from the Bellingham area. Sherman Crater (located just South of the summit) probably originated with a large hydrovolcanic explosion. In 1843, explorers reported a widespread layer of newly fallen rock fragments and several rivers south of the volcano were clogged with ash. A short time later, two collapses of the East side of Sherman Crater produced two lahars, the first and larger of which flowed into the natural Baker Lake, raising its water level at least 10 feet.

In 1975, increased fumarolic activity in the Sherman Crater area caused concern that an eruption might be imminent. Additional monitoring equipment was installed and several geophysical surveys were conducted to try to detect the movement of magma. The level of the present day Baker Lake reservoir (located to the East and south of the mountain) was lowered and people were restricted from the area due to concerns that an eruption-induced debris avalanche or debris flow might enter Baker Lake and displace enough water to either cause a wave to overtop the Upper Baker Dam or cause complete failure of the dam. However, few anomalies other than the increased heat flow were recorded during the surveys nor were any other precursory activities observed to indicate that magma was moving up into the volcano. This volcanic activity gradually declined over the next two years but stabilized at a higher level than before 1975. Several small lahars formed from material ejected onto the surrounding glaciers and acidic water was discharged into Baker Lake for many months.

Glacier Peak

Figure 11-4 Glacier Peak from the Northeast

Source: Schurlock, Glacier Peak, 2007

Glacier Peak is a small stratovolcano and is the most remote of the five active volcanoes in Washington State. At 10,541 feet elevation, it is, next to Mount St Helens, the shortest of the major Washington volcanoes. Glacier Peak is not prominently visible from any major population center, and so its hazards tend to be over-looked. Erupting more than 6 times, this volcano has produced some of the largest and most explosive eruptions in the continuous United States since the last ice age. (Volcano Hazards Program, Glacier Peak, 2013)

Glacier Peak and Mount St. Helens are the only volcanoes in Washington State that have generated large, explosive eruptions in the past 15,000 years. Their violent behavior results from the type of magma they produce which is too viscous to flow easily out of the eruptive vent and must be pushed out under high pressure. As the magma approaches the surface, expanding gas bubbles within the magma burst and break into countless fragments of tephra and ash. The largest of these eruptions occurred about 13,000 years ago and ejected more than five times as much tephra as the May 18, 1980, eruption of Mount St. Helens.

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

There is definite evidence that pyroclastic flows have mixed with melted snow and glacial ice to form lahars that have severely affected river valleys that head on Glacier Peak. Approximately 13,000 years ago, dozens of eruption-generated lahars descended down the White Chuck, Suiattle, and Sauk Rivers, inundating valley floors.

Geologic evidence indicates that lahars flowed down both the North Fork Stillaguamish (then an outlet of the upper Sauk River) and the Skagit River to Puget Sound. These lahars deposited more than seven feet of material as far away as 60 miles from Glacier Peak. The Sauk River's course via the Stillaguamish was abandoned and the Sauk River began to drain only into the Skagit River as it still does today.

11.2.2 Previous Occurrences

Table 11-1 summarizes past eruptions in the Cascades. During the 1980 Mount St. Helens eruption, 23 square miles of volcanic material buried the North Fork of the Toutle River and there were 57 human fatalities. During the last 4,000 years, Mount St. Helens (see Figure 11-2) has erupted more frequently than any other volcano in the Cascade Range.

Geologic evidence indicates that both Mount Baker and Glacier Peak have erupted in the past and will no doubt erupt again in the foreseeable future. Due to the topography of the region and the location of drainage basins and river systems, eruption events on either Mount Baker or Glacier Peak resulting in lahars, pyroclastic flows, tephra or ash fall, and lava flows could severely impact portions of Skagit County.

Table 11-1
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 9,000 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

11.2.3 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 11-5 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 Mount St. Helens or Mt. Rainier customarily would be far more likely on the east side of the volcano. Glacier Peak, due to its location, would impact a portion of Skagit County if the winds maintained their westerly direction. Even a relatively small amount of ash in Skagit County could have a significant impact with respect to individuals with health or breathing issues, mechanical or motorized devices, fish and other natural wildlife, and the forest and plant life, particularly in light of the high agricultural areas within the County. Based on USGS analysis, Skagit County has a 0.1 to 0.02 percent probability of ash or tephra collection in any given year (see Figure 11-5). Figure 11-6 shows areas of the U.S. that have been covered by volcanic ash.

The degree of volcanic hazard from the volcanoes of the Cascade Range depends on the type, size, and origin of the eruption. While the possibility of a large volcanic eruption exists, these types of events are typically separated by several hundred to a few thousand years and it is unlikely that we will see such an event in our lifetimes. Clearly, persons, property, and infrastructure closest to the volcano at the time of the eruption are most vulnerable.

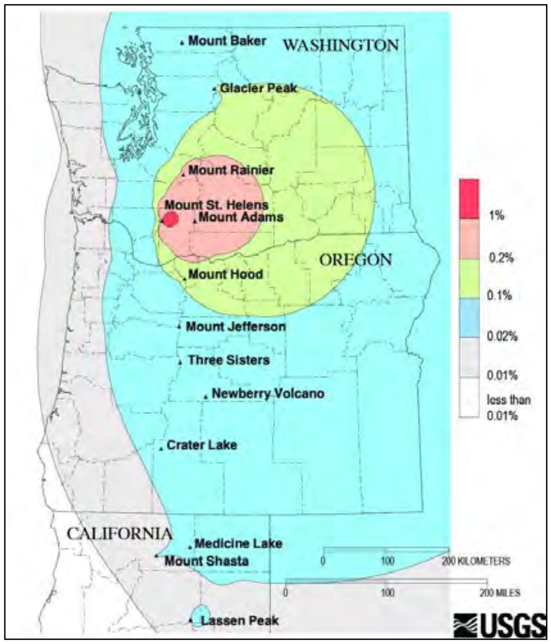


Figure 11-5 Probability of Tephra Accumulation in Pacific Northwest

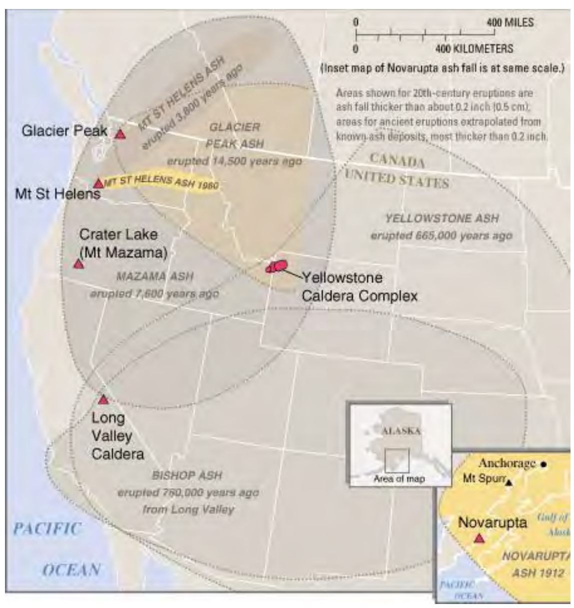


Figure 11-6 Defined Tephra Layers Associated with Historical Eruptions

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

While ash is of some concern, a lahar is also a significant probability within the planning area. Geologic evidence indicates that both Mount Baker and Glacier Peak have erupted in the past and will no doubt erupt again in the foreseeable future. Due to the topography of the region and the location of drainage basins and river systems, eruption events on either Mount Baker or Glacier Peak resulting in lahars, pyroclastic flows, tephra or ash fall, and lava flows could severely impact portions of Skagit County. Figure 11-7 through Figure 11-10 illustrate the volcano hazard zones as identified by the USGS.

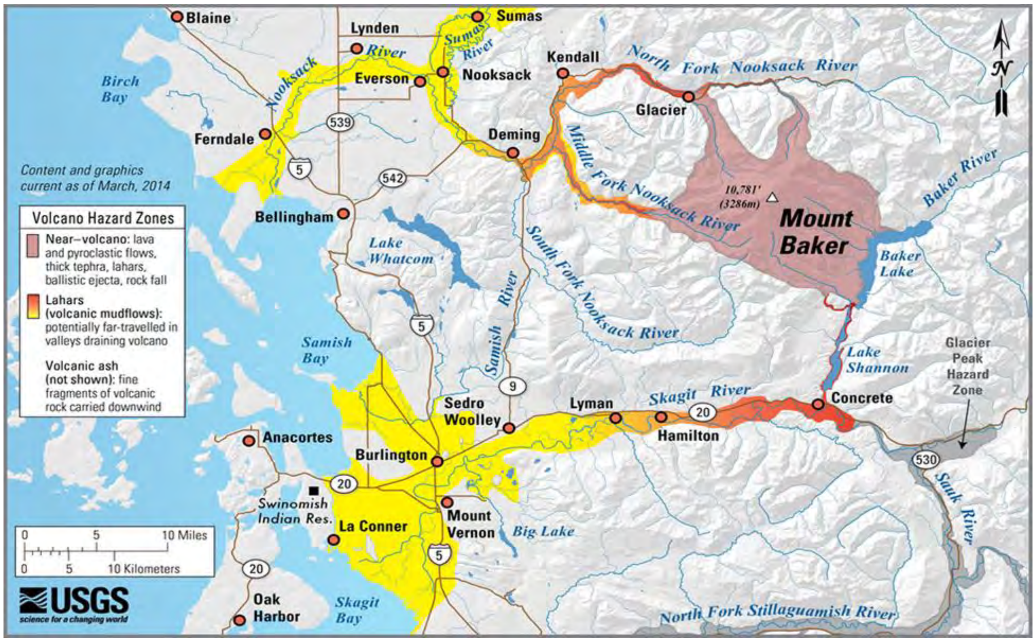


Figure 11-7 Volcano Hazard Zones From Mount Baker

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

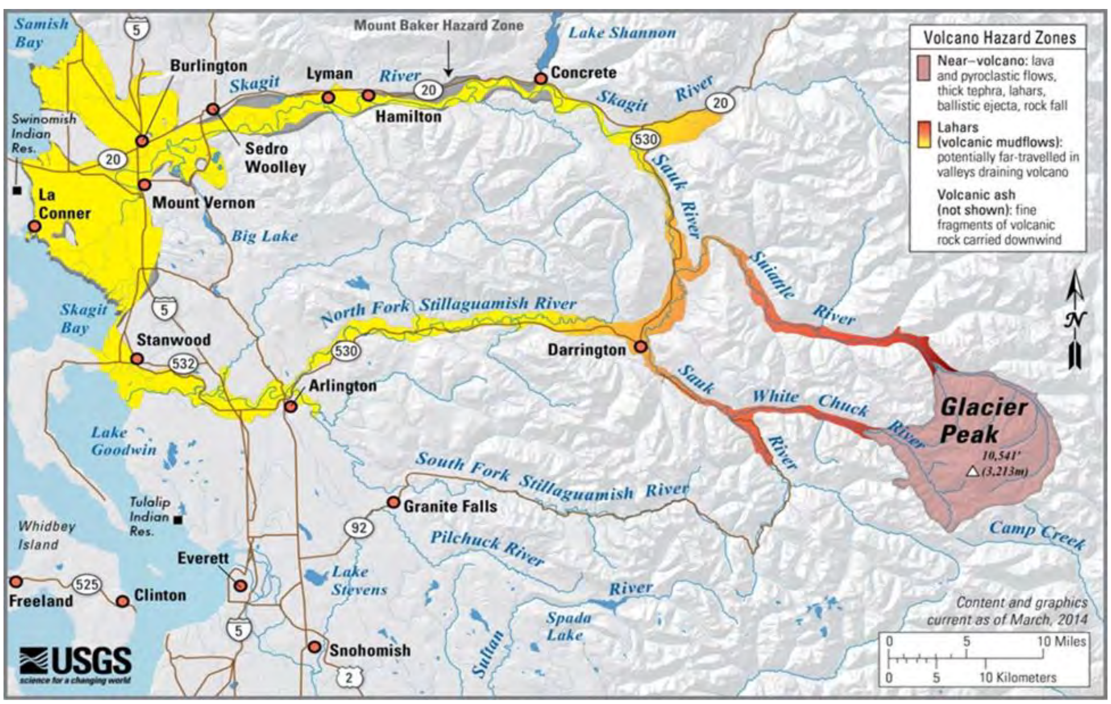


Figure 11-8 Volcano Hazard Zones from Glacier Peak

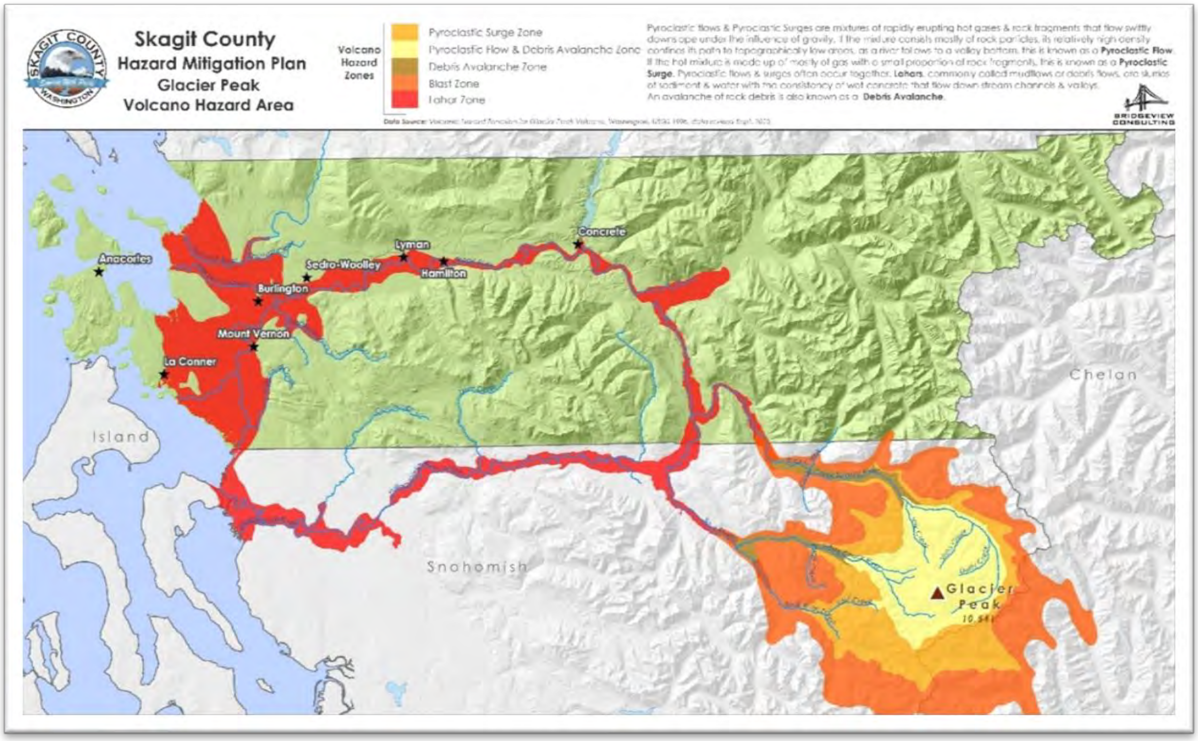


Figure 11-9 Glacier Peak Volcano Hazard Areas

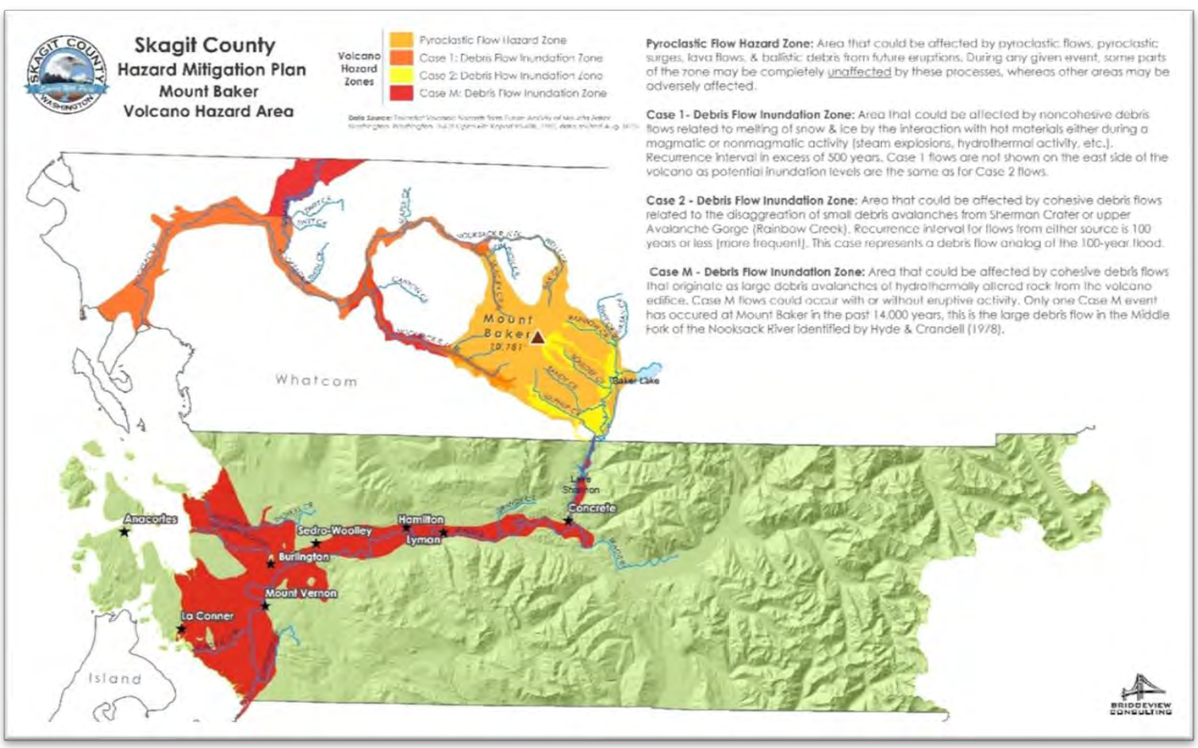


Figure 11-10 Mount Baker Volcano Hazard Areas

11.2.4 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.

11.3 VULNERABILITY ASSESSMENT

11.3.1 Overview

The closest Cascade volcanoes to the planning area are Mount Baker and Glacier Peak. Because of the location of Mount Baker and Glacier Peak and the flow direction of prevailing winds, the majority of airborne ash would most likely be carried to the northeast or east and away from population centers in Skagit County should an ash eruption occur. According to the USGS analysis, westerly winds dominate in the Pacific Northwest sending volcanic ash east and north–eastward about 80–90 percent of the time, though ash can blow in any direction. However, even 10 percent of ash reaching Skagit County could have a negative impact on the natural resources and the agricultural economy. In addition, regardless of wind direction, there would still be considerable amount of ash fall in the immediate vicinity of the volcano during and immediately flowing an explosive tephra and ash eruption. In addition, large amounts of ash would be carried by moving vehicles traveling into the area as well. The potential for fire danger also increases as a result of static charge contained within the ash.

The 1980 eruption of Mount St. Helens produced enough ash fall to reduce the maximum flow capacity of the Cowlitz River from 76,000 cubic feet per second to less than 15,000 cubic feet per second and also reduced the channel depth of portions of the Columbia River from 40 feet to 14 feet. Should a St. Helens-type event occur from either Mount Baker or Glacier Peak, large portions of the Skagit River floodplain could be severely impacted by flooding in addition to the direct effects of the ash eruption.

Ash and chemical products in any of the rivers in the area could contaminate water supply to the County. Transportation for ships, boats, 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 to high impact on the Skagit County region, as commodity flows would decrease, as well as interruptions to power transmission, telecommunications outages, and potentially medical services. Residents with health issues, especially those with breathing difficulties, would also be impacted, even by small amounts of ash.

Methodology

Several parts of the county are within the Lahar Zone; however, due to the lack of structure data, no updated structure analysis could be conducted during this update process. However, during FEMA's 2017 RiskMap process, FEMA did identify the structures at risk, and that data is utilized herein. Critical facilities exposed within the Lahar Zone are also identified below based on the 2019 development of the Critical Facilities list by the planning team members.

No historical data was available specifically for Skagit 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.

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. The USGS Cascade Volcano Observatory works in conjunction with PNSN to provide constant monitoring and notification when activities increase. Figure 11-11 depicts one of the sensors used by USGS and PNSN for monitoring purposes. Figure 11-12 identifies the various types of remote sensing devises available.

Based on past events and especially the 1980 eruption of Mount St. Helens, future eruptions from either Mount Baker or Glacier Peak will almost certainly be preceded by an increase in seismic (earthquake) activity, and possibly by measured swelling of the volcano and emission of volcanic gases. The University of Washington Geophysics Program, in cooperation with the USGS, monitors seismic activity at Mount Baker and other Cascade Range volcanoes that could signal a possible future eruption. In addition, the USGS monitors gas emissions from Sherman Crater on Mount Baker to detect possible changes in the volcano that may be a warning of impending magma activity or an increase in hydro-volcanic activity in an effort to predict the likelihood of an eruption event. This ability to monitor seismic and other types of activity at Mount Baker and Glacier Peak provides a warning system of sorts for volcanic eruptions that could impact Skagit County.

Furthermore, the 1980 Mount St. Helens eruption made it clear that preparing for and responding to a large-scale volcanic eruption must involve a wide variety of agencies and jurisdictions. For this reason, emergency managers from Skagit, Snohomish, and Whatcom Counties, the State of Washington, and the Province of British Columbia, as well as personnel from the United States Forest Service developed the Mount Baker-Glacier Peak Coordination Plan. The plan was adopted in April 2001, and updated in 2011 and the plan provides a tool to coordinate the actions that various agencies must take to minimize loss of life and damage to property before, during, and after a hazardous geologic event occurring at either volcano. The plan also includes the necessary legal authorities in addition to statements of responsibilities of County, State, and Federal agencies in the United States as well as Provincial and Federal agencies in Canada.

Figure 11-11 Monitoring Equipment

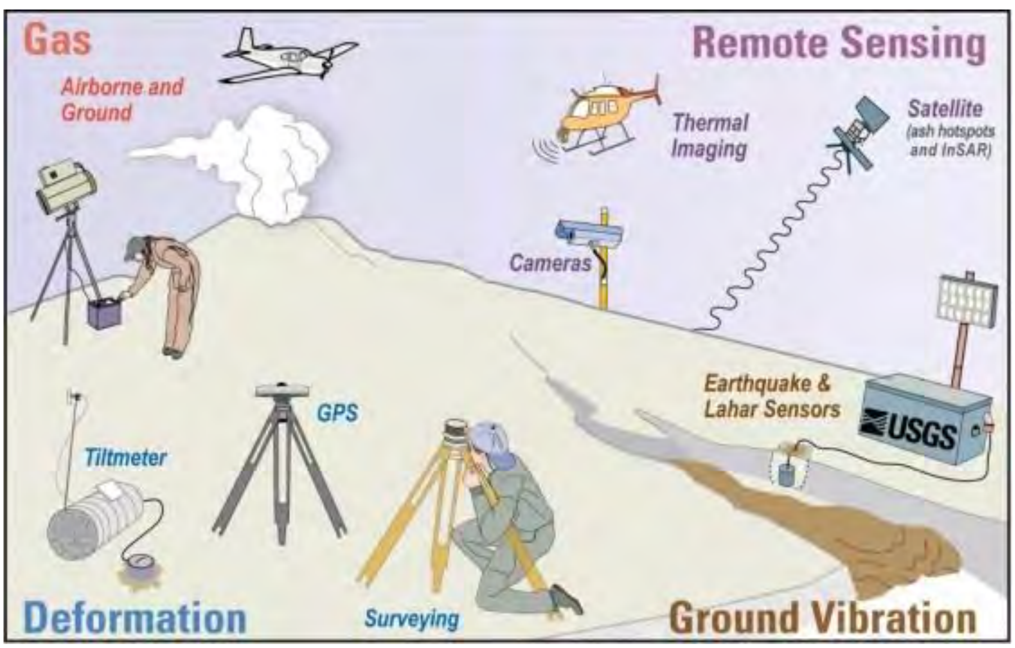


Figure 11-12 Remote Sensing Devices

11.3.2 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. As a result of the river drainage basins and the topography of the planning area, an ensuing lahar would also be of significant, if not catastrophic impact.

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 mist occurring from 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, the high number of tourists who annually visit the area would potentially increase the number of people to which the region would have to provide emergency services, housing, and associated support.

11.3.3 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 much of the current building stock does not lend itself to be able to withstand large amounts of accumulation of ash on rooftops, as a one-inch deep layer of ash weighs an average of 10 pounds per square foot. This added weight to the aged buildings would increase the danger of structural collapse. However, the County does have increased snow- and wind-load capacities, which does increase the ability to withstand the weight of ash for more recently constructed buildings.

Ash itself 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.

The 1980 eruption of Mount St. Helens produced enough ash fall to reduce the maximum flow capacity of the Cowlitz River from 76,000 cubic feet per second to less than 15,000 cubic feet per second and also reduced the channel depth of portions of the Columbia River from 40 feet to 14 feet. Should a St. Helens-type event occur from either Mount Baker or Glacier Peak, large portions of the Skagit River floodplain could be severely impacted by flooding in addition to the direct effects of the ash eruption.

The river valleys and associated floodplains of the Baker River, Skagit River, Sauk River, and Suiattle River (along with their associated tributaries) are all especially vulnerable to the effects of large-scale lahars and associated flooding that will no doubt result from a large lahar.

Lahars traveling down the Baker River drainage could rapidly raise the level of Baker Lake leading to overtopping and/or damaging the Upper Baker Dam thereby leading to possible overtopping and/or damage to the Lower Baker Dam resulting in severe flooding of portions of the Town of Concrete and surrounding upriver areas of the Skagit River floodplain.

Pursuant to the 2017 FEMA Risk Report, a small area in northern Skagit County, encompassing the Town of Concrete, would be at risk from a lateral blast from Mount Baker similar to the 1980 Mount St Helens lateral blast (Gardner and others, 1995). Glacier Peak was most recently active around the 18th century (Waitt and others, 1995). Dome-building eruptions at Glacier Peak generated lahars about 5,900 years ago and 1,800 years ago. These lahars extended to the sea along the Skagit River (Mastin and Waitt, 2000). The cities of Burlington and Mount Vernon and the towns of Concrete, Hamilton, La Conner, and Lyman are most at risk from a lahar event in Skagit County. The project team assessment projects that the City of Burlington and the towns of La Conner and Lyman would be completely inundated by a lahar, impacting over 11,000 buildings in the lahar hazard zone (see Table 11-2).

Table 11-2 Building Exposure To Volcano (Lahar) Hazard			
Community	**Total Number Of Buildings**	**Number of Buildings in Lahar Volcano Hazard Zone**	**Percent of Buildings in Lahar Volcano Hazard Zone**
Anacortes	6,348	--	--
Burlington	1,447	1,402	96.9%
Concrete	144	80	55.6%
Hamilton	36	14	38.9%
La Conner	140	140	100.0%
Lyman	151	149	98.7%
Mount Vernon	7,896	2,216	28.1%
Sedro-Woolley	1,593	238	14.9%
Sauk-Suiattle Tribe	--	Unknown	--
Swinomish Indian Tribal Community	965	--	--
Upper Skagit Indian Tribe	53	--	--
Unincorporated Skagit County	17,736	7,011	39.5%
Total	**36,509**	**11,250**	**30.8%**
Source: FEMA 2017 Report			

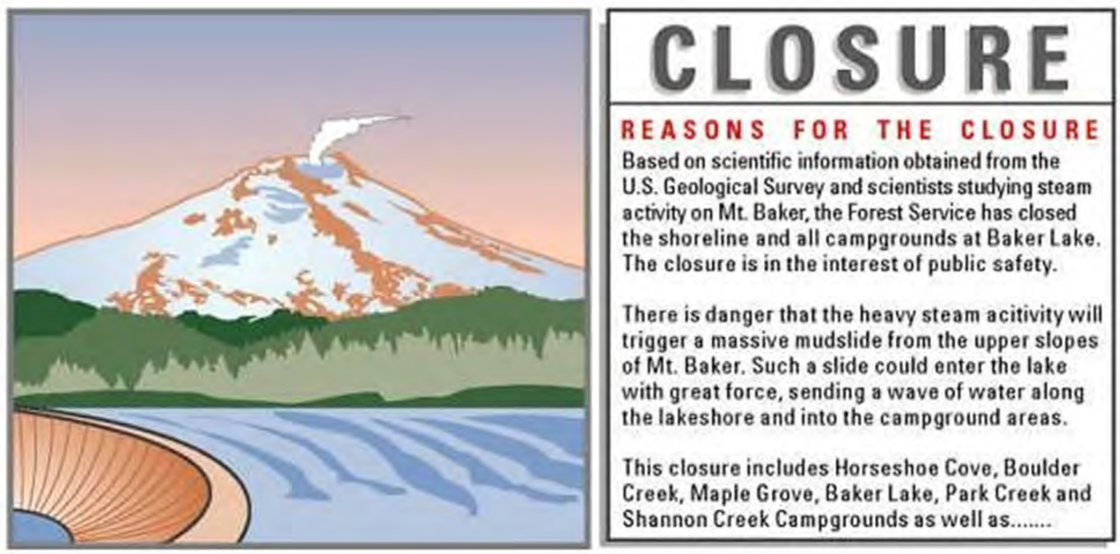


Figure 11-13 Closure signs for Baker Lake campgrounds circa 1975.

Source: Mt Baker - Living with an Active Volcano (2005)

As demonstrated during the 1980 Mount St. Helens eruption, the hydraulic power of fast-moving lahars and debris flows is astonishing. Sandbags and other “normal” flood fight measures will not be effective to provide any type of protection for such an event.

Furthermore, problems related to lahar debris could last for years and even decades because of the tremendous volume of loose rock and ash that could have potentially been added to the ground surface near the volcano. This debris could provide a source of material that would no doubt flow downstream during flood events for many years following the eruption event.

Due to the topography and river drainage basins within Skagit County, the impacts of a major eruption from either Mount Baker or Glacier Peak to property and infrastructure could be catastrophic when viewed in this respect.

Specific loss estimations for the volcano hazard could not be based on modeling utilizing damage functions, as no such functions have been generated. Due to the lack of parcel-based information in a GIS format for the planning area, a detailed exposure analysis of the building stock was also not possible beyond the identification of the breakdown of structures by age contained in Chapter 3, Section 3.9.2. As better data and technology becomes available, this degree of analysis is recommended to help determine vulnerability in the planning area.

11.3.4 Impact on Critical Facilities and Infrastructure

All critical facilities and infrastructure identified would be at risk from ash. Exposure to those facilities in the lahar inundation zones are identified in Table 11-3 through Table 11-6.

Table 11-3
Critical Facilities in the Skagit County within Mt. Baker Lahar Zone

Jurisdiction	Medical & Health Services	Government Function	Protective	Schools	Hazardous Materials	Other Facilities	Total
Unincorporated Skagit County	0	8	73	4	29	0	**114**
Anacortes, City of	0	0	0	0	0	0	**0**
Burlington, City of	1	12	5	5	18	0	**41**
Concrete Town of	0	2	1	7	2	2	**14**
Hamilton, Town of	0	3	5		3	0	**11**
La Conner, Town of	0	2	1	3	2	0	**8**
Lyman, Town of	0	4	1	1	1	0	**7**
Mount Vernon, City of	2	10	13	4	17	0	**46**
Sedro-Woolley, City of	0	4	3	4	1	0	**12**
Swinomish Indian Tribal Community	0	0	0	0	0	0	**0**
Sauk-Suiattle Tribe	0	0	0	0	0	0	**0**
Upper Skagit Indian Tribe	0	0	0	0	0	0	**0**
Total	**3**	**45**	**102**	**28**	**73**	**2**	**253**

Table 11-4
Critical Infrastructure in Skagit County within Mt. Baker Lahar Zone

Jurisdiction	Bridges	Water Supply	Wastewater	Power	Communications	Other Infrastructure	**Total**
Unincorporated Skagit Co.	46	4	0	2	0	0	**52**
Anacortes, City of	0	0	0	0	0	0	**0**
Burlington, City of	0	1	1	1	0	5	**8**
Concrete Town of	0	0	6	1	0	2	**9**
Hamilton, Town of	1	0	0	0	1	0	**2**
La Conner, Town of	0	1	1	0	0	0	**2**
Lyman, Town of	0	1	0	0	0	0	**1**
Mount Vernon, City of	0	0	6	0	0	1	**7**
Sedro-Woolley, City of	0	0	4	0	0	0	**4**
Swinomish Indian Tribal Community	0	0	0	0	0	0	**0**
Sauk-Suiattle Tribe	0	0	0	0	0	0	**0**
Upper Skagit Indian Tribe	0	0	0	0	0	0	**0**
Total	**47**	**7**	**18**	**4**	**1**	**8**	**85**

Table 11-5
Critical Facilities in Skagit County within the Glacier Peak Lahar Zone

Jurisdiction	Medical & Health Services	Government Function	Protective	Schools	Hazardous Materials	Other Facilities	**Total**
Unincorporated Skagit County	0	3	80	5	28	0	**116**
Anacortes, City of	0	0	0	0	0	0	**0**
Burlington, City of	1	12	5	5	18	0	**41**
Concrete Town of	0	0	0	0	1	0	**1**
Hamilton, Town of	0	2	1	0	1	0	**4**
La Conner, Town of	0	2	1	3	2	0	**8**
Lyman, Town of	0	4	1	1	1	0	**7**
Mount Vernon, City of	3	12	16	16	19	0	**66**
Sedro-Woolley, City of	0	3	1	0	1	0	**5**
Swinomish Indian Tribal Community	0	0	0	0	0	0	**0**
Sauk-Suiattle Tribe	1	1	1	1	0	1	**5**
Upper Skagit Indian Tribe	0	0	0	0	0	0	**0**
Total	**5**	**39**	**106**	**31**	**71**	**1**	**253**

Table 11-6
Critical Infrastructure in Skagit County within the Glacier Peak Lahar Zone

Jurisdiction	Bridges	Water Supply	Wastewater	Power	Communications	Other Infrastructure	**Total**
Unincorporated	57	20	0	3	1	0	**81**
Anacortes, City of	0	0	0	0	0	0	**0**
Burlington, City of	0	1	1	1	0	5	**8**
Concrete Town of	0	0	5	1	0	0	**6**
Hamilton, Town of	0	0	0	0	1	0	**1**
LaConner, Town of	0	1	1	0	0	0	**2**
Lyman, Town of	0	1	0	0	0	0	**1**
Mount Vernon, City of	0	5	9	0	2	1	**17**
Sedro-Woolley, City of	0	0	4	0	0	0	**4**
Swinomish Indian Tribal Community	0	0	0	0	0	0	**0**
Sauk-Suiattle Tribe	0	0	0	0	0	0	**0**
Upper Skagit Indian Tribe	0	0	0	0	0	0	**0**
Total	**57**	**28**	**20**	**5**	**4**	**6**	**120**

While exposure analysis was conducted on the critical facilities, the ability of the structure to withstand impacts cannot be determined as specific building data was not available. As better data and technology becomes available, this degree of analysis is recommended to help determine vulnerability in the planning area.

In addition to the lahar inundation, all critical facilities and infrastructure would also 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.

11.3.5 Impact on Economy

A severe lahar event from either Mount Baker or Glacier Peak could cover most of the Skagit River Floodplain resulting in a catastrophic disaster and long-term economic impacts throughout the entire county and possibly the region.

Dollar losses of critical facilities and infrastructure in the area include 338 structures, valued at over $1.8 billion (structure and content) for the Mount Baker Lahar Zone, and 373 structures valued at over $2.5 billion (structure and content) for the Glacier Peak Lahar Zone. There are also 67 hazardous materials facilities in the area which potentially could be impacted, for which no dollar values are associated.

In addition to the economic losses associated with the critical facilities and infrastructure on which the County and its planning partners rely, economic impact could result from many sources, including the potential aqua- and agri-cultural losses, the loss of tourism due to suspended travel and visitors to the area, structural losses, including businesses and governmental offices/buildings. Structures containing hazardous materials within the lahar inundation zone would also cause significant economic loss, including the potential clean-up costs if a point source location cannot be identified. The impact to the agricultural component of the economy would also be significant, depending on the lahar zone, and the ash accumulation. Lost tax revenues from businesses disrupted by structural damage or as a result of fewer patrons would impact the area's economy. The tourism industry could also be impacted for a substantial amount of time if ash impacts the agricultural industry.

11.3.6 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. The potential release from any of the hazardous materials sites countywide would be a significant environmental impact. The lahar itself would also cause significant impact to the river drainage basins, and influence the topography of the area as the lahar continues out to sea. Glaciers could melt resulting in mudflows and flooding of the Baker River, Sauk River, and Skagit River.

11.3.7 Impact from Climate Change

Climate change is not likely to affect the risk associated with volcanoes; however, volcanic activity can affect climate change. Volcanic clouds absorb terrestrial radiation and scatter a significant amount of incoming solar radiation. By reducing the amount of solar radiation reaching the Earth's surface, large-scale volcanic eruptions can lower temperatures in the lower atmosphere and change atmospheric circulation patterns. Such effects can last from two to three years following a volcanic eruption. The massive outpouring of gases and ash can influence climate patterns for years following a volcanic eruption as sulfuric gases convert to sub-micron droplets containing about 75 percent sulfuric acid. These particles can linger three to four years in the stratosphere.

11.4 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. Building codes with respect to load capacity does influence the ability to withstand impact. Skagit County and its planning partners have adopted current IBC standards, which address the load capacity. The County's Comprehensive Plan also addresses the geologically hazardous areas to which the County is subject. That document gets updated on a regular basis.

11.5 ISSUES

In the event of a volcanic eruption, there would be enough advanced warning that there would be no 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 by 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.

The following list is a compilation of comments and suggestions made by various stakeholders and the public during public outreach sessions regarding possible problems that could result from a volcanic event:

- An event on the southeast slopes of Mount Baker could cause a large debris flow that may enter Baker Lake and cause damage to or overtopping of the Upper Baker Dam. Damage to or overtopping of the Upper Baker Dam could result in damage to or overtopping of the Lower Baker Dam thereby causing severe damage and possible loss of life in the Town of Concrete and nearby low-lying areas.
- A severe lahar event from either Mount Baker of Glacier Peak could cover most of the Skagit River Floodplain resulting in a catastrophic disaster and long-term economic impacts throughout the entire county and possibly the region.
- Glaciers could melt resulting in mudflows and flooding of the Baker River, Sauk River, and Skagit River.
- An ash fall event could cause numerous transportation-related problems and delay first response agencies in responding to emergency situations.

11.6 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 in Skagit County would most likely be from lahars or debris avalanches originating from either Mount Baker or Glacier Peak.

Based on past events and especially the 1980 eruption of Mount St. Helens, future eruptions from either Mount Baker or Glacier Peak will almost certainly be preceded by an increase in seismic (earthquake) activity, and possibly by measured swelling of the volcano and emission of volcanic gases.

The river valleys and associated floodplains of the Baker River, Skagit River, Sauk River, and Suiattle River (along with their associated tributaries) are all especially vulnerable to the effects of large-scale lahars and associated flooding that will no doubt result from a large lahar.

Lahars traveling down the Baker River drainage could rapidly raise the level of Baker Lake leading to overtopping and/or damaging the Upper Baker Dam thereby leading to possible overtopping and/or damage to the Lower Baker Dam resulting in severe flooding of portions of the Town of Concrete and surrounding upriver areas of the Skagit River floodplain.

Furthermore, problems related to lahar debris could last for years and even decades because of the tremendous volume of loose rock and ash that has could potentially have been added to the ground surface near the volcano. This debris could provide a source of material that would no doubt flow downstream during flood events for many years following the eruption event.

Based on review and analysis of the data, the Planning Team has determined that the probability for a future event is low; however, the impact at some level could be significant based on the lahar inundation zone, the topography of the area, and the impact to the river drainage basins in Skagit County.

Implementation of mitigation strategies which help increase load capacities on roofs could potentially help reduce the number of structures at risk, but the environmental and economic impact cannot be so easily mitigated. Based on the potential impact, the Planning Team determined the CPRI score to be 2.35, with overall vulnerability determined to be a medium to high level.

CHAPTER 12.
HAZARD RANKING

12.1 CALCULATED PRIORITY RISK INDEX

In ranking the hazards, the Planning Team completed a Calculated Priority Risk Index worksheet for each hazard identified below. The index examines five criteria for each hazard as discussed in Chapter 4 (probability, magnitude/severity, extent/location, warning time, and duration), defines a risk index for each according to four levels, then applies a weighting factor. The result is a score that has been used to rank the hazards at the County level. All planning partners also completed their own hazard rankings, using the same process. Table 12-1 presents the results of the Calculated Priority Risk Index scoring for all hazards impacting the County. Table 12-2 is a summary of the hazard ranking results for the planning partners. Each planning partner's completed CPRI Excel Spreadsheet identifying probability, magnitude/severity, extent and location, warning time, duration and the resulting score are included at the end of this chapter. A summary of each planning partner's CPRI score is contained within their respective annex template.

Utilizing a process such as this is beneficial when discussing risk with the public, as it provides a means to identify risk throughout the entire planning area, and then more narrowly focus the risk to the specific municipality. When comparing the risk assessment data to that contained within the public outreach surveys, this then provides another mechanism of determining how citizens view risk at their geographic area of impact to help validate the risk assessment as identified by the citizens.

Table 12-1
County Calculated Priority Risk Index Ranking Scores

Hazard	Probability	Magnitude and/or Severity	Extent and Location	Warning Time	Duration	Calculated Priority Risk Index Score
Drought	3	2	3	1	4	2.55
Earthquake	4	4	4	4	1	3.85
Flood	4	3	3	1	2	3.05
Landslide/Erosion	4	2	2	4	2	3.10
Severe Weather	4	3	4	1	2	3.25
Tsunami	2	3	2	4	3	2.55
Volcano	1	4	4	1	4	2.35
Wildfire	4	2	2	4	1	3.05

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.

Table 12-2
Countywide Combined Risk Ranking Summary

City or Town	Drought	Earth-quake	Flood	Landslide	Severe Weather	Tsunami	Volcano	Wildfire
County	6	1	4	3	2	5	5	4
Anacortes*	6	1	6	3	5	4		2
Burlington	8	1	2	4	3	5	6	7
Concrete*	5	2	3	2	1	6	3	4
Hamilton	5	3	1	6	4	7	2	4
Mount Vernon	6	1	3	9	5	8	2	4
Sedro-Woolley	4	1	3	4	2	NR	5	6
Swinomish Indian Tribal Community*	5	1	9	10	2	7	8	6
Upper Skagit Indian Tribe*	5	3	2	6	1	12	9	4
Sauk Suiattle	2	1	4	5	3	NR	6	4
Concrete School District	7	1	6	3	5	NR	4	2
Skagit County PUD 1*	7	1	2	3	5	6	8	4
Dike and Drainage Districts								
Dike #1	5	1	2	7	3	4	6	8
Dike #3	5	1	2	7	3	4	5	8
Dike #12	6	1	2	8	3	4	6	5
Dike #17	4	1	2	7	3	6	4	8
Drainage Districts								
Drain #14	5	1	2	7	3	4	6	8
Drain #15	5	1	2	7	3	4	6	8
Drain #16	5	1	2	7	3	4	6	8
Drain #17	5	1	2	7	3	4	6	8
Drain #18	5	1	2	7	3	4	6	8
Drain #19	5	1	2	7	3	4	6	8
Drain #22	5	1	2	7	3	4	6	8
Consolidated Dike and Drainage Districts								
CDD #5	5	1	2	7	3	4	6	8
CDD #22	5	1	2	7	3	4	6	8
CDD #25	5	1	2	7	3	4	6	8

*Anacortes Ranked Storm Surge #6 / Concrete – Dam Failure #3 / Mount Vernon – Climate Change – 7 / PUD-1 Chlorine Release #9 / Swinomish Indian Tribal Community Sea Level Risk – 3, Erosion – 4 / USIT – Severe Weather Inclusive of High Winds – 1, Snow Storm – 7, Severe Heat - 8; Wildfire Small Brush Fire - 10; Dam Failure – 11 /

12.1.1 Calculated Priority Rate Index

CPRI Category	Degree of Risk			Assigned Weighting Factor
	Impact/ Level ID	Description	Impact 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	

12.1.2 Results and Discussion

Once the risk ranking was determined, the Planning Team conducted a qualitative assessment combining the value of the CPRI and summarizing the potential impact based on past occurrences, spatial extent, and subjective damage and casualty potential. The intent to this process was to have a means of easily discussing the hazards of concern with the citizens based on a high/medium/low ranking, while also allowing a comparative analysis with the survey results conducted as part of the public outreach strategy. The levels of risk were categorized as follows, with the end results identified in Table 12-3:

- 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.
- Very High—Very widespread with catastrophic impact.

Table 12-3
Countywide Vulnerability Rating

Jurisdiction	Drought	Earthquake	Flood	Landslide	Severe Weather	Tsunami	Volcano	Wildfire
County	Low	Very High	High	High	High	Med-High	Med-High	Medium
Anacortes*	Low	Very High	Low	High	Med-High	High	Low	High
Burlington	Ex. Low	Very High	Very High	Low	Very High	Very Low	Low	Medium
Concrete	Low	High	Med-High	High	Very High	Low	Med-High	Medium
Hamilton	Medium	High	High	Low	High	NR	High	High
Mount Vernon*	Low	High	Medium	Low	Medium	Low	High	Medium
Sedro-Woolley	Low	Very High	Medium	Low	High	NR	High	Medium
Swinomish Indian Tribal Community*	High	Very High	Low	Low	High	Medium	Medium	Medium
Upper Skagit Indian Tribe*	High	High	High	High	High	Medium	Medium	High
Sauk Suiattle	High	High	Medium	Low	High	NR	Medium	Medium
Concrete School District	Low	High	High	Medium	High	NR	High	Medium
Skagit County PUD 1*	Medium	Very High	High	Med-High	Med-Low	Medium	Med-High	Med-Low

Table 12-3
Countywide Vulnerability Rating

Jurisdiction	Drought	Earthquake	Flood	Landslide	Severe Weather	Tsunami	Volcano	Wildfire
Dike and Drainage Districts								
Dike #1	Low	Very High	High	Low	High	High	Medium	Medium
Dike #3	Low	Very High	High	Low	High	High	Medium	Medium
Dike #12	Low	Very High	High	Low	High	High	Medium	Medium
Dike #17	Low	Very High	High	Low	High	High	Medium	Medium
Drain #14	Low	Very High	High	Low	High	High	Medium	Medium
Drain #15	Low	Very High	High	Low	High	High	Medium	Medium
Drain #16	Low	Very High	High	Low	High	High	Medium	Medium
Drain #17	Low	Very High	High	Low	High	High	Medium	Medium
Drain #18	Low	Very High	High	Low	High	High	Medium	Medium
Drain #19	Low	Very High	High	Low	High	High	Medium	Medium
Drain #22	Low	Very High	High	Low	High	High	Medium	Medium
CDD #5	Low	Very High	High	Low	High	High	Medium	Medium
CDD #22	Low	Very High	High	Low	High	High	Medium	Medium
CDD #25	Low	Very High	High	Low	High	High	Medium	Medium

*Anacortes – Storm Surge - Medium / Concrete – Dam Failure - Med-High / Mt. Vernon – Climate Change – Low / PUD1 – Chlorine Release – Med-Low / Swinomish Indian Tribal Community Sea Level – High, Erosion – High; / USIT – High Winds - High; Wildfire Scenario Small Brush Fire - Medium; Dam Failure –Medium; Snow Storm -High; Severe Heat - High

12.2 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.

12.2.1 Municipal Planning Partners

City of Anacortes																		
	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration				CPRI Score	Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event					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
Drought			3			2				2						1				4	2.35	Low
Earthquake				4				4				4	4				1				3.85	Extremely High
Flood		2				2				2						1		2			1.85	Low
Landslides				4			3			2			4						3		3.35	High
Severe Weather				4			3				3					1		2			3.05	Medium - High
Tsunami				4			3			2			4						3		3.35	High
Volcano	1				1				1							1			3		1.10	Low
Wildfire				4			3				3		4						3		3.55	High
Strom Surge				4		2				2						1		2			2.65	Medium

City of Burlington

Hazard	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration				CPRI Score	Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event					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
Drought	1				1							4				1				4	1.75	Low
Earthquake			3				3				3		4				1				3.05	High
Flooding			3			2			1						2				3		2.25	Medium - High
Landslides			3				3			2			4					2			2.90	High
Severe Weather				4		2						4				1			3		3.10	Extremely High
Tsunami	1				1				1					3				2			1.35	Low
Volcano	1							4				4	4							4	2.80	Medium - High
Wildfire		2				2				2			4					2			2.30	Medium
Dam Failure	1							4				4	4							4	2.80	Medium - High

City of Mount Vernon

Hazard	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration				CPRI Score	Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event					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
Drought	1					2				2						1				4	1.55	Low
Earthquake			3				3					4	4							4	3.40	High
Erosion		2			1				1							1				4	1.55	Low
Flood			3			2				2					2			2			2.40	Medium
Landslides	1				1				1							1			3		1.10	Low
Severe Weather		2				2				2						1		2			1.85	Medium
Tsunami		2					3			2			4						3		2.55	Low
Volcano	1							4				4	4							4	2.80	High
Wildfire		2				2				2			4						3		2.35	Medium
Climate Change	1					2				2						1				4	1.55	Low

City of Sedro-Wollley

Hazard	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration				CPRI Score	Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event					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
Drought			3			2					3					1				4	2.55	Low
Earthquake				4			3					4	4				1				3.65	Extremely High
Flood				4		2				2						1		2			2.65	Medium
Landslides			3			2			1				4				1				2.45	Low
Severe Weather			3				3					4	4					2			3.30	High
Tsunami - NR																					0.00	Not Rated
Volcano	1							4				4				1				4	2.35	High
Wildfire		2				2				2			4				1				2.25	Medium

Town of Concrete

Hazard	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration				CPRI Score	Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event					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
Drought	1				1							4				1				4	1.75	Low
Earthquake			3				3				3		4				1				3.05	High
Flood			3			2			1						2				3		2.25	Medium - High
Landslides			3				3			2			4					2			2.90	High
Severe Weather				4		2						4				1			3		3.10	Extremely High
Tsunami	1				1				1					3				2			1.35	Low
Volcano	1							4				4	4							4	2.80	Medium - High
Wildfire		2				2				2			4					2			2.30	Medium
Dam Failure	1							4				4	4							4	2.80	Medium - High

Town of Hamilton																						
	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration					Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event				CPRI Score	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
Drought		2				2					3					1				4	2.15	Medium
Earthquake			3			2						4	4						3		3.15	High
Flood				4				4				4	4							4	4.00	High
Landslides	1				1					2			4					2			1.70	Low
Severe Weather		2					3					4			2			2			2.60	High
Tsunami - NR	1				1				1							1	1				1.00	Not Rated
Volcano				4				4				4	4							4	4.00	High
Wildfire			3				3			2				3					3		2.80	High

12.2.2 Special Purpose Districts

Concrete School District																						
	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration					Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event				CPRI Score	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
Drought		2				2			1							1				4	1.75	Low
Earthquake				4				4				4	4				1				3.85	High
Flood	1						3				3					1		2			1.85	High
Landslides		2					3				3		4				1				2.65	Medium
Severe Weather		2				2					3					1			3		2.10	High
Tsunami - NR																					0.00	Not Rated
Volcano	1							4				4				1				4	2.35	High
Wildfire			3					4				4			2		1				3.15	Medium

Public Utility District 1

Hazard	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration				CPRI Score	Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event					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
Drought			3			2					3					1				4	2.55	Medium
Earthquake				4				4				4	4				1				3.85	Extremely High
Flood			3					4			3		4						3		3.35	High
Landslides				4		2				2			4					2			3.10	Medium - High
Severe Weather				4		2				2						1		2			2.65	Medium - Low
Tsunami		2					3			2			4						3		2.55	Medium
Volcano	1							4				4				1				4	2.35	Medium - High
Wildfire			3			2				2			4					2			2.70	Medium - Low
Chlorine Release	1					2				2			4					2			1.90	Medium - Low

Skagit County Dike District 1

Hazard	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration				CPRI Score	Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event					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
Drought			3		1						3					1				4	2.35	Low
Earthquake				4			3					4	4				1				3.65	Extremely High
Flood				4			3				3					1			2		3.05	High
Landslides	1				1					2			4					2			1.70	Low
Severe Weather				4		2						4				1		2			3.05	High
Tsunami		2						4			3		4						3		2.95	High
Volcano	1							4				4				1				4	2.35	Medium
Wildfire	1								1					3			1				1.10	Medium

Skagit County Dike District 3

Hazard	Probability: Likelihood of occurrence				Magnitude / Severity: Physical losses and damages				Geographic Extent and Location: Extent (degree) and area impacted				Warning Time: Sudden impact or amount of advanced notice				Duration: Time span/ length of event				CPRI Score	Level: 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
Drought			3		1						3					1				4	2.35	Low
Earthquake				4			3					4	4				1				3.65	Extremely High
Flood				4			3				3					1			2		3.05	High
Landslides	1				1					2			4					2			1.70	Low
Severe Weather				4		2						4				1		2			3.05	High
Tsunami		2						4			3		4						3		2.95	High
Volcano	1							4				4				1				4	2.35	Medium
Wildfire	1				1				1							1	1				1.00	Medium

Skagit County Dike, Drainage, and Irrigation District 12

Hazard	Probability: Likelihood of occurrence				Magnitude / Severity: Physical losses and damages				Geographic Extent and Location: Extent (degree) and area impacted				Warning Time: Sudden impact or amount of advanced notice				Duration: Time span/ length of event				CPRI Score	Level: 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
Drought			3		1						3					1				4	2.35	Low
Earthquake				4			3					4	4				1				3.65	Extremely High
Flood				4			3				3					1			2		3.05	High
Landslides	1				1					2			4					2			1.70	Low
Severe Weather				4		2						4				1		2			3.05	High
Tsunami		2						4			3		4						3		2.95	High
Volcano	1							4				4				1				4	2.35	Medium
Wildfire				4	1				1				4				1				2.65	Medium

Skagit County Dike District 17																		
	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration				CPRI Score	Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event					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
Drought			3		1						3					1				4	2.35	Low
Earthquake				4			3					4	4				1				3.65	Extremely High
Flood				4			3				3					1			2		3.05	High
Landslides	1				1					2			4					2			1.70	Low
Severe Weather				4		2						4				1		2			3.05	High
Tsunami	1					2					3		4						3		2.15	High
Volcano	1							4				4				1				4	2.35	Medium
Wildfire	1				1				1					3			1				1.30	Medium

Skagit County Dike, Drainage, and Irrigation District 5																		
	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration				CPRI Score	Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event					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
Drought			3		1						3					1				4	2.35	Low
Earthquake				4			3					4	4				1				3.65	Extremely High
Flood				4			3				3					1			2		3.05	High
Landslides	1				1					2			4					2			1.70	Low
Severe Weather				4		2						4				1		2			3.05	High
Tsunami		2						4			3		4						3		2.95	High
Volcano	1							4				4				1				4	2.35	Medium
Wildfire	1				1				1					3			1				1.30	Medium

Skagit County Consolidated Dike, Drainage, and Irrigation District 22

	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration					Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event				CPRI Score	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
Drought			3		1						3					1				4	2.35	Low
Earthquake				4			3					4	4				1				3.65	Extremely High
Flood				4			3				3					1			2		3.05	High
Landslides	1				1					2			4					2			1.70	Low
Severe Weather				4		2						4				1		2			3.05	High
Tsunami		2						4			3		4						3		2.95	High
Volcano	1							4				4				1				4	2.35	Medium
Wildfire	1				1				1					3			1				1.30	Medium

Skagit County Dike, Drainage, and Irrigation District 25

	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration					Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event				CPRI Score	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
Drought			3		1						3					1				4	2.35	Low
Earthquake				4			3					4	4				1				3.65	Extremely High
Flood				4			3				3					1			2		3.05	High
Landslides	1				1					2			4					2			1.70	Low
Severe Weather				4		2						4				1		2			3.05	High
Tsunami		2						4			3		4						3		2.95	High
Volcano	1							4				4				1				4	2.35	Medium
Wildfire	1				1				1					3			1				1.30	Medium

Skagit County Drainage and Irrigation District 14

Hazard	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration				CPRI Score	Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event					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
Drought			3		1						3					1				4	2.35	Low
Earthquake				4			3					4	4				1				3.65	Extremely High
Flood				4			3				3					1			2		3.05	High
Landslides	1				1					2			4					2			1.70	Low
Severe Weather				4		2						4				1		2			3.05	High
Tsunami		2						4			3		4						3		2.95	High
Volcano	1							4				4				1				4	2.35	Medium
Wildfire	1				1				1					3			1				1.30	Medium

Skagit County Drainage and Irrigation District 15

Hazard	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration				CPRI Score	Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event					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
Drought			3		1						3					1				4	2.35	Low
Earthquake				4			3					4	4				1				3.65	Extremely High
Flood				4			3				3					1			2		3.05	High
Landslides	1				1					2			4					2			1.70	Low
Severe Weather				4		2						4				1		2			3.05	High
Tsunami		2						4			3		4						3		2.95	High
Volcano	1							4				4				1				4	2.35	Medium
Wildfire	1				1				1					3			1				1.30	Medium

Skagit County Drainage and Irrigation District 16																						
	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration					Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event				CPRI Score	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
Drought			3		1						3					1				4	2.35	Low
Earthquake				4			3					4	4				1				3.65	Extremely High
Flood				4			3				3					1			2		3.05	High
Landslides	1				1					2			4					2			1.70	Low
Severe Weather				4		2						4				1		2			3.05	High
Tsunami		2						4			3		4						3		2.95	High
Volcano	1							4				4				1				4	2.35	Medium
Wildfire	1				1				1					3			1				1.30	Medium

Skagit County Drainage and Irrigation District 17																						
	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration					Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event				CPRI Score	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
Drought			3		1						3					1				4	2.35	Low
Earthquake				4			3					4	4				1				3.65	Extremely High
Flood				4			3				3					1			2		3.05	High
Landslides	1				1					2			4					2			1.70	Low
Severe Weather				4		2						4				1		2			3.05	High
Tsunami		2						4			3		4						3		2.95	High
Volcano	1							4				4				1				4	2.35	Medium
Wildfire	1				1				1					3			1				1.30	Medium

Skagit County Drainage and Irrigation District 18																						
	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration				CPRI Score	Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event					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
Drought			3		1						3					1				4	2.35	Low
Earthquake				4			3					4	4				1				3.65	Extremely High
Flood				4			3				3					1			2		3.05	High
Landslides	1				1					2			4					2			1.70	Low
Severe Weather				4		2						4				1		2			3.05	High
Tsunami		2						4			3		4						3		2.95	High
Volcano	1							4				4				1				4	2.35	Medium
Wildfire	1				1				1					3			1				1.30	Medium

Skagit County Drainage and Irrigation District 19																						
	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration				CPRI Score	Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event					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
Drought			3		1						3					1				4	2.35	Low
Earthquake				4			3					4	4				1				3.65	Extremely High
Flood				4			3				3					1			2		3.05	High
Landslides	1				1					2			4					2			1.70	Low
Severe Weather				4		2						4				1		2			3.05	High
Tsunami		2						4			3		4						3		2.95	High
Volcano	1							4				4				1				4	2.35	Medium
Wildfire	1				1				1					3			1				1.30	Medium

Skagit County Drainage and Irrigation District 22																						
	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration					Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event				CPRI Score	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
Drought			3		1						3					1				4	2.35	Low
Earthquake				4			3					4	4				1				3.65	Extremely High
Flood				4			3				3					1			2		3.05	High
Landslides	1				1					2			4					2			1.70	Low
Severe Weather				4		2						4				1		2			3.05	High
Tsunami		2						4			3		4						3		2.95	High
Volcano	1							4				4				1				4	2.35	Medium
Wildfire	1				1				1					3			1				1.30	Medium

12.2.3 Tribal Planning Partners

Sauk Suiattle Indian Tribe																						
	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration					Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event				CPRI Score	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
Drought				4		2						4				1				4	3.15	High
Earthquake				4			3					4	4				1				3.65	High
Flooding			3			2				2						1		2			2.25	Medium
Landslides		2			1					2			4				1				2.05	Low
Severe Weather				4			3				3					1		2			3.05	High
Tsunami - NR																					0.00	Not Rated
Volcano	1						3			2						1				4	1.75	Medium
Wildfire			3			2				2			4				1				2.65	Medium

Swinomish Indian Tribal Community

Hazard	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration				CPRI Score	Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event					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
Drought			3			2						4				1				4	2.75	High
Earthquake				4				4				4	4						3		3.95	Extremely High
Flooding			3			2				2						1			3		2.30	Low
Landslides		2				2				2			4				1				2.25	Low
Severe Weather				4			3					4	4					2			3.70	High
Tsunami		2					3			2				3				2			2.35	Medium
Volcano	1							4				4				1				4	2.35	Medium
Wildfire			3			2				2				3				2			2.55	Medium
Sea Level Rise			3				3				3					1				4	2.75	High
Erosion				4		2				2						1				4	2.75	High

Upper Skagit Indian Tribe																						
	Probability				Magnitude / Severity				Geographic Extent and Location				Warning Time				Duration				CPRI Score	Level
	Likelihood of occurrence.				Physical losses and damages				Extent (degree) and area impacted				Sudden impact or amount of advanced notice				Time span/ length of event					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
Flooding - Dam Failure	1						3					4		3					3		**2.40**	Medium
Drought				4			3					4				1				4	**3.35**	High
Earthquake			3					4				4	4				1				**3.45**	High
High Winds				4			3					4		3					3		**3.60**	High
Tsunami	1						3				3		4				1				**2.25**	Medium
Flooding				4			3				3			3						4	**3.45**	High
Landslides			3				3				3		4							4	**3.20**	High
Snow Storm			3				3					4		3					3		**3.20**	High
Severe Heat			3				3					4				1			3		**2.90**	High
Wildfire Scenario A - Small Brush Fire			3				3		1				4				1				**2.65**	Medium
Wildfire Scenario B - Large Wildfire			3					4				4	4				1				**3.45**	High
Volcano		2					3				3		4							4	**2.80**	Medium

CHAPTER 13.
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 Skagit 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.

The CRS program grants points to NFIP communities for setting goals which help reduce the impact of flooding and other known natural hazards; identifying mitigation projects that include activities for prevention, property protection, natural resource protection, emergency services, structural control projects, and public information. Establishing goals in such a manner was a primary focus of the Planning Team.

13.1 HAZARD MITIGATION GOALS AND OBJECTIVES

During the kick-off meeting, the Planning Team reviewed the 2015 existing goals and objectives, confirming the same for use in the 2020 update. The goals and associated objectives for this plan are as follows:

Goal 1: Protect Life and Property

Objective 1: Implement mitigation activities that will assist in protecting lives and property by making homes, businesses, infrastructure, and critical facilities more resistant to natural hazards.

Objective 2: Continue the Skagit Community Emergency Response Team (C.E.R.T.) Program to provide for and promote individual and family disaster preparedness.

Objective 3: Encourage homeowners and businesses to purchase insurance coverage for damages caused by natural hazards.

Objective 4: Encourage homeowners and businesses to take preventative actions in areas that are especially vulnerable to natural hazards.

Goal 2: Increase Public Awareness

Objective 5: Develop and implement additional education and outreach programs to increase public awareness of the risks associated with natural hazards.

Objective 6: Continue the current flood awareness programs conducted by various jurisdictions as part of the National Flood Insurance Program Community Rating System.

Goal 3: Encourage Partnerships

Objective 7: Strengthen inter-jurisdiction and inter-agency communication and coordination and partnering of jurisdictions and agencies to foster the establishment and implementation of natural hazard mitigation strategies and/or projects designed to benefit multiple jurisdictions.

Goal 4: Provide for Emergency Services

Objective 8: Encourage the establishment of policies to help ensure the prioritizing and implementation of mitigation strategies and/or projects designed to benefit critical/essential facilities, services, and infrastructure.

Objective 9: Where appropriate, coordinate and integrate natural hazard mitigation activities with existing local emergency operations plans.

13.2 HAZARD MITIGATION ALTERNATIVES

After the goals and objectives were established, the Planning Team developed specific action items to further increase resilience. FEMA's 2013 catalog of *Mitigation Ideas* was presented to the Steering Committee and Planning Team to provide ideas and concepts of possible action items. 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.

13.3 SELECTED 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 13-1 lists the identified 2020 Hazard Mitigation Initiatives for Skagit County, inclusive of some strategies which will be implemented countywide. As such, several of these initiatives are also identified by other planning partners who support the effort. Initiatives carried forward from the 2015 plan have been identified as such.

13.4 ANALYSIS 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.

13.5 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.

Table 13-1
County Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency*	Estimated Cost	Funding Sources	Timeline	In Previous Plan?	Initiative Type	Who Benefits?
C-1 Continue data gathering for facility information to continue to improve the risk assessment and identification of infrastructure countywide.									
New/ Existing	All	1, 5, 6, 7, 8, 9	EM, All planning partners	Low	HLS/EMPG, PDM, HMGP, HUD, General Funds	Ongoing	No	Structural Projects, Property Protection	Regional
C-2 Work with County and state agencies to establish a protocol and advance permitting for transporting of hazardous materials for identification during an incident. Establish a countywide hazardous materials incident response team.									
New	Hazardous Materials	1, 3, 4, 5, 6, 7, 8, 9	EM, PH, Fire, EM, PW, WSDOT, WDOE	High	General Funds, HLS (EMPG), CDC grants	Long-Term	Partial	Prevention, Public Information and Education, Natural Resource Protection, Emergency Services/ Response	Regional

Table 13-1
County Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency*	Estimated Cost	Funding Sources	Timeline	In Previous Plan?	Initiative Type	Who Benefits?
C-3 Develop Drought Contingency Plan to address public education and water conservation practices (as necessary), particularly when needed for firefighting.									
New	All	1, 3, 4, 5, 6, 7, 8, 9	SK PUD, Local PW, Water purveyors, Local EMs	Low	EMPG, HUD	Short-Term	No	Public Information and Education, Emergency Services / Response, Recovery	Regional
C-4 Coordinating with Assessor's Office, Permitting and other County offices, update Assessor's parcel data to include more building-specific information which may be utilized within the GIS and Hazus programs for enhanced risk assessments to provide a detailed loss estimation.									
New and Existing	All	2, 3, 4, 5, 6, 7	Assessor's Office; GIS; PW, CD	Medium	General Fund, HMGP	Short-Term	No	Structural Projects, Property Protection, Recovery	County and Local
C-5 Coordinate among all jurisdictions to seek out and apply for grants for site hardening of facilities. This includes back-up power at county/city facilities, among others.									
New/ Existing	E, EQ, F, LS, SW, V, WF	1, 2, 3, 4, 5, 6, 7, 8, 9	EMs, PW	Medium	Earthquake and Tsunami Program, HMGP, PDM, HUD, DOT, EPA	Long-Term	Partial	Structural Projects, Property Protection, Natural Resource Protection	Facility Specific
C-6 Continue implementation of coordinated public information program within Skagit County to inform citizens about the hazards faced and the appropriate preparedness and response measures, including, but not limited to, NFIP, Earthquake, Tsunami (based on 2018 data) and landslide information; specific types of insurance information, and structural projects which homeowners can undertake, such as affixing chimneys, foundations, fire-proof roofing materials, etc.									
New/ Existing	All	All	EM and Local EM, Local and County Land Use Planning, private industry.	Low	EMPG, General Fund	Ongoing	Yes	Prevention, Public Information and Education	County and Community

Table 13-1
County Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency*	Estimated Cost	Funding Sources	Timeline	In Previous Plan?	Initiative Type	Who Benefits?
C-7 Continue to expand CERT training, involving local teams in exercises and training with first responders.									
New/ Existing	All	All	EM, Local EM, County Citizen Corps Groups,	Low	EMPG	Ongoing	Yes	Prevention, Public Information and Education, Emergency Services, Response, Recovery	County and Community
C-8 Identify and designate emergency shelter structural and utility readiness for occupancy after a significant incident.									
New/ Existing	All	1, 2, 4, 5, 6, 7, 8, 9	EM	Medium	PDM, HMGP, General Funds	Short-Term	Yes	Prevention, Public Information Emergency Services/ Response	Regional
C-9 Provide erosion control information and steep slope stability recommendations to citizens and homeowners. Inform owners concerning structures above steep bluffs or below steep bluffs. Increase monitoring of countywide erosion issues and bluffs.									
New/ Existing	E, EQ, F, LS, SW	1, 2, 3, 4, 5, 6, 7, 8, 9	EM, County and Local PW, WDNR	Medium	PDM, HMGP, General Funds	Long-Term	No	Structural Projects, Property Protection	County and Local
C-10 In conjunction with the Diking and Irrigation Districts, assist in conducting a needs assessment to determine logistical requirements for equipment and parts for dike and drainage equipment, wells and water distribution sources to ensure a surplus allowing for management of floodwaters, and continued supply of potable water in case commodity flow is impacted by a major event.									
New/ Existing	All	2, 3, 4, 5, 6, 9	PH, EM PW, WDOE	Medium	Earthquake and Tsunami Program Grant Funds, EPA, EMPG	Ongoing	Partial	Response, Recovery	County and Local
C-11 In coordination with the Skagit County Conservation District and local fire agencies, continue to promote a "FireWise" program in County to increase fire safety zones around businesses and residences. Encourage owners to reduce woodland fuel loads on their property, as well as other strategies identified in the 2019 CWPP									
New/ Existing	D, WF	2, 3, 4, 5, 6, 7, 8, 9	EM, Local EM, Fire	Low	Fire Grants, PDM, HMGP	Ongoing	No	Property Protection, Natural Resource Protection, Prevention	Local

Table 13-1
County Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency*	Estimated Cost	Funding Sources	Timeline	In Previous Plan?	Initiative Type	Who Benefits?
C-12 Work with local jurisdiction and planning partners to develop various emergency planning efforts to help ensure continuity of business and resiliency, and to develop mechanisms to ensure recovery efforts exist.									
New/ Existing	All	1, 2, 3, 4, 5, 6, 7, 8	EM, Local EM, ED, Chamber	Medium	EMPG Funds, General Funds	Long-Term	Partial	Recovery	County, Local
C-13 Partner with Washington State Department of Transportation, surrounding counties and local municipalities to expand earthquake assessment of roadways and bridges to reduce hazard impact and transportation-related issues and potential isolation.									
New/ Existing	All	2, 5, 6, 7, 8	EM, Local EM, PW, Roads, WSDOT	Medium	US DOT and WA DOT Grants, HLS	Long-Term	No	Emergency Services/ Response, Recovery	Regional
C-14 Continue to promote and establish a countywide emergency management actions, projects, and programs, working with the cities and special purpose districts, to enhance resiliency and maintain consistency in mitigation activities, emergency management programs, and capabilities. This includes seeking grant funding to support such initiatives.									
New/ Existing	All	All	EM, Local EM, Fire, Hospitals	Medium	General Funds, Grant Opportunities as they arise	Long-Term	No	Prevention, Public Information and Education, Emergency Services/ Response, Recovery	County and Local
C-15 Strive to capture time-sensitive, perishable data such as high water marks, extent and location of hazard, and loss information following hazard events to support future updates to the risk assessment and in support of future grant applications to demonstrate impact.									
New/ Existing	All	1, 2, 3, 4, 5, 6, 7, 8, 9	EM and Local EMs	Medium	General Funds	Long-Term	No	Emergency Services/ Response, Recovery	County and Local
C-16 Continue to enhance local emergency planning committee (LEPC) involvement with private industry and local jurisdictions throughout the County with the goal of quarterly meetings.									
Existing	WF	5, 7, 8	EM, Local EM, Fire, Private Industry	Low	General Funds	Ongoing	No	Prevention, Emergency Services/ Response, Recovery	County and Local

Table 13-1
County Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency*	Estimated Cost	Funding Sources	Timeline	In Previous Plan?	Initiative Type	Who Benefits?
C-17 Continue to integrate mitigation planning data into ongoing land-use planning to assist in providing information necessary to enforce existing building codes, floodplain and critical areas ordinances, and shoreline protection.									
New and Existing	All	All	EM, PW, CD	Low	FEMA	Short-Term	Yes	Prevention, Emergency Services, Planning, Response, Recovery	Local and County
C-18 Maintain countywide mutual aid agreements with both public and private agencies in support of preparedness and response activities.									
New	All	4, 5, 6	EM	Medium	General Funds	Ongoing	No	Emergency Services/ Response, Recovery	County and Local
C-19 Update the flood profile once Assessor's data is updated, and the Flood Insurance Study and RiskMAP products are finalized. Review existing ordinances in place to ensure continued protection and compliance. This may include the County seeking grant funding to develop a comprehensive update, including public outreach to ensure information is disseminated countywide.									
New/ Existing	All	All	DEM	High	Ecology, HMGP or PDM Grant Funds	Ongoing	Partial	Emergency Services/ Response, Recovery	County and Local
C-20 Work with local school districts to study and retrofit school facilities to better withstand damage from earthquake, tsunami, flood, severe weather, erosion and landslide events.									
New/ Existing	All	All	DEM, Local DEM, School Districts	High	HLS/EMPG, PDM, HMGP, HUD, Dept. of Education, State Earthquake/ Tsunami Program	Ongoing	No	Structural Projects, Property Projection, Emergency Services/ Response, Recovery	Facility, County, and Local

Table 13-1
County Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency*	Estimated Cost	Funding Sources	Timeline	In Previous Plan?	Initiative Type	Who Benefits?
C-21 Study, retrofit or move county owned facilities to better withstand damage from earthquake, flood, severe weather, and tsunami.									
Existing	All		EM, Facilities	High	HLS/EMPG, PDM, HMGP, HUD, General Funds	Ongoing	Yes	Structural Projects, Property Protection	Facility
C-22 Evaluate and enhance the current capital improvements program for county roads. Working with corresponding special purpose districts, include/review as necessary, drainage projects such as culverts; elevate roadways as necessary where areas are frequently flooded, blocking ingress and egress; replace small-diameter flood control devices in known flood problem areas; enhance drainage system maintenance plans and sediment and debris clearance to ensure unobstructed flow of floodwaters.									
New/ Existing	E, F, LS, SW, T		PW, US DOT	High	General Funds, HLS (EMPG), CDC grants	Long-Term	Partial	Property Protection, Structural Projects, Natural Resource Protection	County and Local
C-23. Seek grant funding for acquisition of properties in high-hazard areas, with special attention to repetitive or severe loss properties.									
Existing	All	1, 3, 4, 5, 6, 7, 8, 9	Commis-sioners, CFM, EM	High	PDM, HMGP, FMA	Long-Term	Yes	Property Protection, Structural Projects,	Facility and County
C-24 Continue participation in the NFIP; continuing implementation of the various steps to increase CRS scores to help lower insurance premiums.									
New/ Existing	F, SW	1, 2, 3, 4, 5, 6, 7, 8, 9	EM, Planning	Medium	General Fund	Long-Term	Yes	Prevention, Mitigation	County
C-25Continue to design and build facilities to meet or exceed seismic and code standards, including redundant essential equipment. Apply current seismic and wind load standards to all renovation or replacement of existing facilities, and/or equipment.									
New/ Existing	EQ, LS, SW, T	1, 2, 3, 4, 5, 6, 7, 8, 9	Planning, PW	High	PDM, HMGP	Ongoing	Partial	Structural Projects, Property Protection	County

Table 13-1
County Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency*	Estimated Cost	Funding Sources	Timeline	In Previous Plan?	Initiative Type	Who Benefits?
C-26 Conduct activities that support mitigation efforts to reduce the negative influence of natural hazards impacting Skagit County, such as appropriate hazard identification, warning, dissemination of relevant information and data, and public outreach.									
New	All	All	Planning, PH, EM	Low	General Fund, various grants.	Ongoing	Yes	Structural Projects, Public Information and Education, Natural Resource Protection	County, Facility, Local
C-27 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 (e.g., dams, high-hazard facilities, etc.).									
Existing	All	2, 4, 5, 6, 7,	EM, PUDs, IT, Sheriff	Low	General Funds	Short-Term	No	Prevention, Property Protection, Emergency Services	Regional
C-28 Implement cost-effective measures to address vulnerability of facilities at risk to sea level rise, extreme high tides and storm surges as they relate to potential inflow of saltwater. This includes working with local private water purveyors.									
New/ Existing	CC, EQ, F, LS, SW, T	1, 2, 3, 4, 5, 6, 7, 8, 9	EM, P&D, PH, PW, WDNR, WDOH, WDOE	Medium	PDM, HMGP, General Funds, Ecology, DOH, HLS	Long-Term	No	Structural Projects, Property Protection, Natural Resource Protection	County
C-29 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/ Existing	All	All	EM, PW, P&D, FEMA, WDNR	Medium	Earthquake and Tsunami Program Grant Funds, General Funds, PDM, HMGP	Short-Term	No	Structural Projects, Property Protection, Recovery	Facility, County

Table 13-1
County Hazard Mitigation Initiatives

New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency*	Estimated Cost	Funding Sources	Timeline	In Previous Plan?	Initiative Type	Who Benefits?
C-30 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/ Existing	EQ, F, LS, T, WF		EM, PW	High	Earthquake and Tsunami Grant Program, PDM, HMGP	Ongoing	No	Property Protection, Structural Projects	Facility, County
C-31 Implement a recovery system to ensure maximum FEMA reimbursement for disaster response, repair, mitigation and recovery, which will capture and track emergency activities, associated expenses (mileage, supplies, expendables, outside vendors, etc.), employee time and dedicated resources.									
New/ Existing	All		EM, Risk, Finance	Medium	EMPG Funds, General Funds	Long-Term	No	Recovery	County
C-32 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/ Existing	All	2, 5, 6, 8	IT, Assessor's Office, Risk Mgmt., P&D EM	Medium	General Funds, HLS, HMGP	Short-Term	No	Recovery	County
C-33 Develop public outreach which supports community participation in incentive-based programs, such as the Community Rating System, FireWise, and StormReady.									
New/ Existing	All		EM, P&D, FD, Conservation District	Low	General Funds	Ongoing	No	Public Information and Education, Emergency Services/ Response	County
C-34 Seek out and apply for grant funding, or seek technical assistance from FEMA to identify tsunami-resistant structures in inundation zones to allow for the installation of flashing lights to serve as potential tsunami shelters or evacuation sites. This may lead to retrofits of most suitable structures in the inundation areas to allow such structures to serve as vertical evacuation or tsunami-resistant structures.									
New/ Existing	T, SW (storm surge)		EM	Medium	Grants	Ongoing	Yes	Emergency Services, Response, Public Information	Local and County

* CD=Community Development; ED=Economic Development; EM= Emergency Management; Fire=Districts and Depts.; HS=Human Services; LE=Law Enforcement; PH=Public Health; PW=Public Works; WSDOT=Washington State Dept. of Transportation; WDOH=Washington State Dept. of Health; WDNR=Washington State Dept. of Natural Resources; WDOE=Washington Dept. of Ecology

13.6 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.

13.7 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 13-2 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 13-2
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	4	H	L	Y	Y	Y	H
2	5	H	H	Y	Y	Y	H
3	3	H	L	Y	Y	Y	H
4	6	H	M	Y	N	Y	M
5	9	H	M	Y	N	Y	M
6	9	H	L	Y	Y	Y	H
7	4	H	L	Y	Y	Y	H
8	8	H	M	Y	Y	Y	H
9	9	H	M	Y	Y	Y	H
10	6	M	M	Y	Y	N	M
11	8	M	L	Y	Y	N	L
12	8	M	M	Y	Y	Y	M
13	5	M	M	Y	Y	N	M
14	9	H	M	Y	N	N	M
15	3	H	L	Y	Y	N	H
16	3	M	L	Y	N	Y	M

Table 13-2
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)
17	8	L	M	N	Y	N	L
18	3	H	M	Y	N	Y	M
19	9	H	M	Y	Y	Y	H
20	9	H	H	Y	Y	N	H
21	8	H	H	Y	Y	N	H
22	9	M	H	N	Y	N	M
23	3	M	H	Y	Y	Y	M
24	9	H	L	Y	N	Y	H
25	9	H	H	Y	N	N	L
26	9	H	L	Y	Y	N	H
27	5	H	L	Y	Y	Y	H
28	9	M	M	Y	Y	N	M
29	9	M	M	Y	N	N	L
30	7	H	H	Y	Y	N	H
31	4	H	M	Y	N	Y	M
32	4	H	M	Y	Y	Y	H
33	5	H	L	Y	Y	Y	H
34	5	H	M	Y	Y	N	H

13.8 2015 ACTION PLAN STATUS

A comprehensive review of the 2014/2015 action plan was performed to determine which countywide actions were completed, which should carry over to the updated plan, and which were no longer feasible and should be removed from the plan. The following identifies the results of this review for the County. Each Planning Team member's respective annex update contains information concerning their previous strategies.

2014 Multiple-Hazard Action Item #1: Continue and/or enhance existing education programs aimed at mitigating natural hazards, and reducing the risk to citizens, public agencies, properties at risk, businesses, and schools.

- Continue to make the **Skagit County Natural Hazard Mitigation Plan** available to the public by providing a link to the plan on local jurisdictional websites.
- Continue to support the Skagit Community Emergency Response Team (C.E.R.T.) Program.
- Continue participation in the National Flood Insurance Program Community Rating System Program to inform citizens in participating jurisdictions about the flood risk in Skagit County.
- Continue to make public awareness materials and programs available from various sources available to the public to help inform the citizens of all communities within Skagit County as to the risks associated with various natural hazards.

<u>LEAD AGENCY</u>:	Skagit County Emergency Management and Community Rating System Coordinators
<u>FUNDING SOURCE</u>:	Jurisdiction Budget; various grant monies such as Washington State Department of Ecology Flood Control Assistance Account Program (FCAAP) funds
<u>TIME-LINE</u>:	All programs are currently active and on-going

<u>2020 Status:</u>

The County continued to make great strides in this area. A few examples of activities completed since the 2015 plan in response to Action Item #1 include:

Development of new Flood Hazard Awareness Week activities, hazard specific workshops and information exchange with citizens, public officials, and within the schools to students, faculty, and staff.

Through this Hazard Mitigation Plan Update process, new maps and hazard information has been made available in poster displays located in the Commissioners' Chambers and on the County's website, as well as maps and hazard information being presented at LEPC meetings, the Emergency Management Group meetings, as well as the preparedness fair held at Skagit Valley College; DEM visit and Natural Hazard Awareness presentation to Middle School earth science class; Safety day at Skagit County Fair, and National Night Out, among others.

The County's Community Wildfire Protection Plan (CWPP) is in the process of being updated. Once completed, the CWPP will serve as the County's wildfire hazard chapter. The CWPP is being completed by the Whatcom County Conservation District and retired Forester Al Craney volunteering countless hours to help develop the risk assessment portion of the plan, identify the WUI areas, and present the information at various public forums.

The County was part of a multi-county study to identify the tsunami hazard more accurately in the planning area. The project resulted in tsunami evacuation maps being developed, and a coordinated outreach effort to provide the information to the impacted communities. The County also established a 5K "Run for the Hills" event to promote both Tsunami and Flood awareness.

The County has continued to expand involvement in the NFIP CRS program by enhancing outreach activities (such as the Flood Hazard Awareness Week), increasing flood awareness, and working on structural projects, such as the completion of the levee in Burlington, a Q&A event during Flood Awareness Week held at the library to engage citizens that may have questions. The event was hosted by various subject matter experts in the specific hazard field, who not only presented information, but were also available to answer citizens' questions.

This project is on-going in nature and is carried over to the 2020 plan.

<u>2014 Multiple-Hazard Action Item #2:</u> Where appropriate, each jurisdiction and Indian tribe participating in this plan will strive to continue efforts to incorporate the goals and action items identified in this section of the Skagit County Natural Hazard Mitigation Plan into other planning mechanisms such as:

- Jurisdictional/Tribal Codes and Ordinances
- Jurisdictional/Tribal Comprehensive Plans and Critical Areas Ordinance(s)
- Jurisdictional/Tribal Capital Facilities and/or Improvement Plans

- Skagit County Comprehensive Economic Development Strategy
- Growth Management Act
- Coordinated Water System Plan
- Skagit County Comprehensive Emergency Management Plan
- County-wide and Jurisdictional Flood Plan(s)
- Jurisdictional National Flood Insurance Program
- Jurisdictional Community Rating System Programs

LEAD AGENCY: Jurisdiction/Tribal Planning Department or Public Works Department
FUNDING SOURCE: Jurisdiction/Tribal Budget and/or available grant funding
TIME-LINE: These efforts are currently active and on-going

2020 Status:

Each planning partner continues to utilize information from the mitigation plan as well as other sources to ensure consistency of information and application of identified hazard areas. This includes incorporating the data into updates for Comprehensive Land Use Plans developed under the Growth Management Act, as well as identifying mitigation strategies such as enhanced levees to help reduce the impacts of flooding. Several planning partners, including the county itself, have applied for and received various grant funds to support mitigation projects.

The County has also continued to work with FEMA under the RiskMap project to update its NFIP maps. In response to the on-going drought situation, the county planning partnership has developed implementation measures to help manage the impact of drought both on the agricultural community, as well as ensuring potable water for the citizens of the county.

This project is on-going in nature, and will be carried forward into the 2020 plan.

2014 Multiple-Hazard Action Item #3: Continue to develop partnerships with various jurisdictions and agencies as well as business and industry to identify and pursue funding opportunities to implement local mitigation activities and to foster coordination and collaboration of natural hazard mitigation goals, strategies, and projects within Skagit County. Possible actions include:

- Identify and encourage partnering with various agencies and organizations within Skagit County that have an interest in or have established natural hazard mitigation programs.
- Identify/encourage partnering with various state/federal agencies that have programs that support natural hazard mitigation programs such as the Flood Control Assistance Account Program administered by the Washington State Department of Ecology.

LEAD AGENCY: Local elected officials; jurisdiction/Indian tribe department/agency directors; Skagit County Department of Emergency Management
FUNDING SOURCE: Local Jurisdictional/Private Business Funding via Budget Process
TIME-LINE: Short term (less than 3 years from funding)

2020 Status:
The 2020 update to the County's Hazard Mitigation Plan is demonstrative of the activities associated with the partnering of the local municipalities, special purpose districts, and tribal entities countywide. The County has significantly increased the number of planning partners in this update process, enabling the

distribution of hazard information countywide through a robust public outreach strategy developed at the onset of the project by the Steering Committee.

This project is continuing in nature, and has been integrated into the 2020 action plan.

2014 Multiple-Hazard Action Item #4: Continue to strengthen emergency services preparedness and response by linking emergency services with natural hazard mitigation programs. Possible ideas include:

- Promote inter-agency response planning and training among various first response agencies within Skagit County.
- Continue involvement at the county level with the Northwest Region Fire Defense Board and the Northwest Region Fire Mobilization Plan.
- Encourage local fire service, emergency medical, and law enforcement agencies to include Skagit C.E.R.T. members in training opportunities.

LEAD AGENCY: Skagit County Department of Emergency Management
FUNDING SOURCE: Department of Emergency Management Budget
TIME-LINE: Short term (less than 3 years from funding)

2020 Status:
Examples of opportunities which occurred include:

- Training with the NW Incident Management Team
- Training with NGOs such as Red Cross, Citizen Corp, and Ham Radio Operators Club
- Participation in the Shell and Marathon refinery annual exercise
- Participation in the Puget Sound Electric Dam Exercise
- DEM annual Flood Awareness Week ECC Drill

These types of activities occur on a regular basis as a normal course of operations. As such, the County considers this project completed for the 2020 update, but will continue forward as a normal course of operations.

2014 Multiple-Hazard Action Item #5: Various members of the Skagit Natural Hazards Mitigation Steering Committee will continue their involvement with local efforts to support the United States Army Corps of Engineers General Investigation Study as well as assist in the updating of the Skagit County Comprehensive Flood Hazard Management Plan.

LEAD AGENCY: Skagit County Public Works Department
FUNDING SOURCE: Various federal, state, and local funding
TIME-LINE: This action item is currently active and on-going

2020 Status:
While limited progress can be identified for this status update, the Skagit County Comprehensive Flood Hazard Management Plan is still an active plan in place, and therefore, this initiative will be carried forward into the 2020 action plan.

2014 Multiple-Hazard Action Item #6: Develop and implement and awareness and education program to increase the awareness and understanding of local emergency responders regarding existing disaster planning and preparedness programs. Possible ideas include:

- Develop and distribute a variety of written materials to local law enforcement, fire and emergency medical agencies and organizations.
- Provide agency training regarding emergency warning and public information systems, evacuation planning efforts, and emergency responder roles/responsibilities during a disaster.
- Incorporate this training into existing agency training programs and incident Command system training.

LEAD AGENCY: Skagit County Emergency Management
FUNDING SOURCE: Emergency Management Budget
TIME-LINE: Short term (less than 3 years from funding)

2020 Status:
Several public outreach events occurred since the completion of the last plan, such as those identified above. The County continues to expand its various outreach efforts, including presentations by hazard-specific subject matter experts, and awareness programs. As such, this initiative will be carried forward into the 2020 action plan.

13.9 ADDITIONAL MITIGATION ACTIVITIES, CONCEPTS AND IDEAS

In addition to the projects identified above, additional mitigation efforts include, but are not limited to:

- Guemes Island Planning Advisory Committee led an effort in conjunction with the Skagit County Planning and Development staff in November 2018 to amend Skagit County Code 14.24.380 to include provisions for proscriptive rainwater catchment systems.[43]

- Various planning partners have also been involved in seismic studies for various structures countywide. This includes the Mount Vernon School District.

- The City of Mount Vernon erected a floodwall in 2018, which changed the inundation footprint.

- La Conner received grant awards for structural retrofitting and rehabilitation of the La Conner Public Schools, including the La Conner Middle School.

- The Lyman Slough Acquisition and Demolition Project included funding for debris removal from the Skagit River, as well as acquisition of three residential properties on the Skagit River which were impacted by previous flooding events. One of those structures is illustrated on the cover page of this HMP (Skagit Valley Herald, Scott Terrell).[44]

- Disaster mitigation funds were used to acquire a structure destroyed by a January 2009 landslide (see Figure 8-7).

[43] Skagit County Planning Department. Available online at: https://www.skagitcounty.net/Departments/PlanningAndPermit/2019CPA.htm?fbclid=IwAR2pRT7DfNuGz9V4vbrexnJdJB4MzsqLowZGX0AbWUm-bJ5M4OXtT-2-D-k

[44] https://www.goskagit.com/news/county-to-purchase-lyman-properties-damaged-byerosion/article_16d84827-61c4-5d67-85b8-e3882b839796.html

- As a result of the flooding and erosion occurring in the planning area, the County and its planning partners initiated buy-outs from citizens in several frequently flooded areas including, but not limited to: Lyman, Hamilton, and the unincorporated areas of the County.

- New dikes and levees have been built or reconstructed to help reduce the impact of flood events, as several of the existing dikes and levees, because of their significant age, have begun to show signs of failure, with some having substandard foundation materials, making them vulnerable to failure during major floods due to seepage and internal erosion (WSDOT, 2015).

- Working with Washington State Department of Transportation, several other county, tribal, and federal agencies, along with various special purpose districts formed a partnership whose purpose was to integrate various risk assessments conducted by multiple agencies, leveraging those studies to improve resiliency. As a brief background, flooding events that have occurred along the lower Skagit River Basin have filled reservoirs and natural storage areas situated in the vicinity of major thoroughfares in the area. Such events impact major highways and roadways in the area, which ultimately have the potential to negatively influence commodity flow throughout Washington State as the I-5 corridor travels through Skagit County. One primary focus of the study (among others) was to identify strategies, which when implemented, would lead to a more resilient transportation system, and which would be compatible with other proposed flood hazard reduction measures (such as dikes and levees) to avoid maladaptation. This study was led by WSDOT, who received grant funding from the Federal Highway Administration, to conduct the research and facilitate the effort. Reviewers wishing additional information will find the report available at: https://www.fhwa.dot.gov/environment/sustainability/resilience/pilots/2013-2015_pilots/washington/index.cfm

- As a result of potential climate change impact, the City of Anacortes rebuilt its Water Treatment Plant outside of the anticipated floodplain, increasing not only the capacity of the treatment plant, but taking into consideration potential climate risks. Working with various private- and public-sector organizations, the City worked for several years to determine potential impacts, including saltwater intrusion and load capacity. "The plant was ultimately rebuilt on site at an expected cost of $56 million dollars and improvements to this design better prepare the facility to meet increased service demand as well as projected changes in climate" (EPA).[45]

- Review of the County's *2016 Comprehensive Land Use Plan* (p. 454) also identifies transportation projects which, when implemented, will have a direct impact on not only enhanced resilience countywide, but also flood reduction. Specifically, the County is looking at the Skagit River Bridge Modification and I-5 Protection Project for transportation facilities near Skagit River. The intent is to study potential modifications of transportation facilities to improve flood control along the Skagit River, with a projected cost of $1.2 million.

- The County is reviewing the potential to establish new programs of varying types, including a Slope Stabilization Emergency Project study to address slope stabilization projects. The cost of the anticipated program is $90,000 (ibid. p. 456).

[45] https://www.epa.gov/arc-x/anacortes-washington-rebuilds-water-treatment-plant-climate-change

- The County is also exploring the potential of the Illabot Creek Alluvial Fan Restoration on Rockport Cascade Road, with the intent of constructing two new bridges to restore original channel migration. Anticipated cost for that project is projected at over $3.6 million.

- As a result of the floodplain management activities implemented by Skagit County, the Department of Homeland Security, Federal Emergency Management Agency (FEMA), determined that Skagit County's Community Rating System (CRS) would be increased to a Class 5, receiving flood insurance incentives of decreased costs for flood-insurance policy holders.

13.10 FUNDING OPPORTUNITIES

Although a number of the mitigation projects listed may not be eligible for FEMA funding, Skagit 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 13-3 identifies some of those grant requirements. Additional funding sources identified in Table 13-5 are also available which support various types of mitigation efforts on a countywide basis.

Alternate funding sources which may further support mitigation efforts of various types include, but are not limited to, the following:

- **U.S. Department of Housing and Urban Development, Community Development Block Grants (CDBG)—**The CDBG program is a flexible program that provides communities with resources to address a wide range of community development needs. CDBG money can be used to match FEMA grant money. More information: http://www.hud.gov/offices/cpd/communitydevelopment/programs/
- **U.S. Fish & Wildlife Service Rural Fire Assistance Grants—** The U.S. Fish & Wildlife Service (USF&W) provides Rural Fire Assistance grants to fire departments to enhance local wildfire protection, purchase equipment, and train volunteer firefighters. USF&W staff also assist with community projects. These efforts reduce the risk to human life and better permit US F&W firefighters to interact with community fire organizations when fighting wildfires. The Department of the Interior receives a budget each year for the Rural Fire Assistance grant program. The maximum award per grant is $20,000. The assistance program targets rural and volunteer fire departments that routinely help fight fire on or near Department of Interior lands. More information: http://www.fws.gov/fire/ living_with_fire/rural_fire_assistance.shtml

Table 13-3
Grant Opportunities

Program	Enabling Legislation	Funding Authorization	Hazard Mitigation Plan Requirement	
			Grantee	Sub-Grantee
Public Assistance, Categories A-B (e.g., debris removal, emergency protective measures)	Stafford Act	Presidential Disaster Declaration	☐	☐
Public Assistance, Categories C-G (e.g., repair of damaged infrastructure, publicly owned buildings)	Stafford Act	Presidential Disaster Declaration	☑	☐
Individual Assistance (IA)	Stafford Act	Presidential Disaster Declaration	☐	☐
Fire Management Assistance Grants	Stafford Act	Fire Management Assistance Declaration	☑	☐
Hazard Mitigation Grant Program (HMGP) Planning Grant	Stafford Act	Presidential Disaster Declaration	☑	☐
HMGP Project Grant	Stafford Act	Presidential Disaster Declaration	☑	☑
Pre-Disaster Mitigation (PDM) Planning Grant	Stafford Act	Annual Appropriation	☐	☐
PDM Project Grant	Stafford Act	Annual Appropriation	☑	☑
Flood Mitigation Assistance (FMA)	National Flood Insurance Act	Annual Appropriation	☑	☑
Severe Repetitive Loss (SRL)	National Flood Insurance Act	Annual Appropriation	☑	☑
Repetitive Flood Claims (RFC)	National Flood Insurance Act	Annual Appropriation	☑	☐
Homeland Security	Dept. of Homeland Security	Annual Appropriation	☑	☐

☑ = Hazard Mitigation Plan Required
☐ = No Hazard Mitigation Plan Required

Table 13-4
Countywide Fiscal Capabilities which Support Mitigation Efforts

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Y
Capital Improvements Project Funding	Y
Authority to Levy Taxes for Specific Purposes	Y
User Fees for Water, Sewer, Gas or Electric Service	Y
Incur Debt through General Obligation Bonds	Y
Incur Debt through Special Tax Bonds	Y
Incur Debt through Private Activity Bonds	Y
Withhold Public Expenditures in Hazard-Prone Areas	Y
State Sponsored Grant Programs	Y
Development Impact Fees for Homebuyers or Developers	Y

- **U.S. Department of Homeland Security—**Enhances the ability of states, local and tribal jurisdictions, and other regional authorities in the preparation, prevention, and response to terrorist attacks and other disasters, by distributing grant funds. Localities can use grants for planning, equipment, training and exercise needs. These grants include, but are not limited to areas of critical infrastructure protection, equipment and training for first responders, and homeland security. More information: http://www.dhs.gov/

- **FEMA, Hazard Mitigation Grant Program (HMGP)**—The HMGP provides grants to states, Indian tribes, local governments, and private non-profit organizations to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. More information: http://www.fema.gov/ government/grant/hmgp/
- **FEMA, Pre-Disaster Mitigation (PDM) Competitive Grant Program**—The PDM program provides funds to states, territories, Indian tribal governments, communities, and universities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations. PDM grants are to be awarded on a competitive basis and without reference to state allocations, quotas, or other formula-based allocation of funds. More information: http://www.fema.gov/government/grant/pdm/index.shtm
- **U.S. Bureau of Land Management (BLM), Community Assistance Program**—BLM provides funds to communities through assistance agreements to complete mitigation projects, education and planning within the wildland urban interface. More information: http://www.blm.gov/nifc/st/en/prog/fire/community_assistance.html
- **U.S. Department of Agriculture Community Facilities Loans and Grants**—Provides grants (and loans) to cities, counties, states and other public entities to improve community facilities for essential services to rural residents. Projects can include fire and rescue services. Funds have been provided to purchase fire-fighting equipment for rural areas. No match is required.
- **General Services Administration Sale of Federal Surplus Personal Property**—This program sells property no longer needed by the federal government. The program provides individuals, businesses and organizations the opportunity to enter competitive bids for purchase of a wide variety of personal property and equipment. Normally, there are no restrictions on the property purchased. More information: http://www.gsa.gov/portal/category/21045
- **FEMA Readiness, Response and Recovery Directorate, Fire Management Assistance Grant Program**—Program provides grants to states, tribal governments and local governments for the mitigation, management and control of any fire burning on publicly (non-federal) or privately owned forest or grassland that threatens such destruction as would constitute a major disaster. The grants are made in the form of cost sharing with the federal share being 75 percent of total eligible costs. Grant approvals are made within 1 to 72 hours from time of request. More information is available at: http://www.fema.gov/ government/grant/fmagp/index.shtm
- **Hazardous Materials Emergency Preparedness Grants**—Grant funds are passed through to local emergency management offices and Hazmat teams having functional and active local emergency planning committees. More information: http://www.phmsa.dot.gov/hazmat/grants

CHAPTER 14.
CAPABILITY ASSESSMENT

14.1 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.

14.1.1 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 saltwater.

The Clean Water Act

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

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

National Flood Insurance Program

The National Flood Insurance Program (NFIP) provides federally backed flood insurance in exchange for communities enacting floodplain regulations. Participation and good standing under NFIP are prerequisites to grant funding eligibility under the Robert T. Stafford Act. Skagit County and its cities and towns participate in the NFIP and have adopted regulations that meet the NFIP requirements. Existing flood maps are dated. 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.

14.1.2 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 saltwater.

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. [Most communities statewide are currently in the process of updating the plan, to include current shoreline conditions, new scientific information concerning the management and protection of our shorelines, protecting shorelines during development, and to better align current environmental and land-use laws, addressing all things necessary.]

Wild and Scenic River

A federal designation that is intended to protect the natural character of rivers and their habitat without adversely affecting surrounding property.

Zero-Rise Floodway

A 'zero-rise' floodway is an area reserved to carry the discharge of a flood without raising the base flood elevation. Some communities have chosen to implement zero-rise floodways because they provide greater flood protection than the floodway described above, which allows a one foot rise in the base flood elevation.

Washington State Building Code

The Washington State Building Code Council adopted the 2016 editions of national model codes, with some amendments. The Council also adopted changes to the Washington State Energy Code and Ventilation and Indoor Air Quality Code. Washington's state-developed codes are mandatory statewide for residential and commercial buildings.

Comprehensive Emergency Management Planning

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

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

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

Washington Administrative Code 118-30-060(1)

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

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

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

Washington State Floodplain Management Law

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

Flood Control Assistance Account Program

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

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

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

14.1.3 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. The following sections present additional regulatory information that applies to the planning partnership.

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).

Skagit County last completed an update to its Comprehensive Land Use Plan as required under the GMA in 2019. Since the original plan was written, amendments to various elements of the comprehensive plan have been made on an almost-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. Skagit County was required to complete a comprehensive review and revision by 2016 pursuant to (RCW 36.70A.130(5)(b)). Opportunities for public participation in this process will be provided (see RCW 36.70A.035).

Critical Areas Ordinance

Washington's Growth Management Act requires local governments to protect five types of critical areas: important fish and wildlife habitat areas, wetlands, critical aquifer recharge areas, frequently flooded areas, and geologically hazardous areas, such as bluffs. Skagit County's critical areas regulations are a response to that law; they regulate how development and redevelopment can safely occur on lands that contain critical areas. Chapter 14.24 of the Skagit County Code identifies the Critical Areas Ordinance of Skagit County.

Although Washington's Watershed Management Act does not require planning, Skagit County and local governments have undertaken related planning activities for the protection of its watersheds and basins.

Puget Sound Regional Catastrophic Disaster Coordination Plan

The Regional Catastrophic Planning Team was formed to guide and manage the Puget Sound Regional Catastrophic Preparedness Grant Program funded by FEMA. Supporting the coordination of regional all-hazard planning for catastrophic events that may impact the region, the effort includes the development of integrated planning communities, plans, protocols, and procedures to manage a catastrophic event. The Regional Catastrophic Planning Team consists of representatives from designated emergency management interests across an eight-county area (see Figure 14-1), including Skagit County.

Figure 14-1 Counties in Puget Sound Regional Catastrophic Planning Region (2013)

14.2 MITIGATION-RELATED REGULATORY AUTHORITY

Hazard mitigation builds on a community's existing capabilities in place, including financial, regulatory, programmatic and planning capabilities. The 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 following information and tables identify the County's capabilities with respect to (mitigation) efforts of varying types. Each planning partner also completed the same tables within their respective Annex documents.

Building Codes

The Skagit County Building Division has adopted and enforces, as mandated by the State of Washington, the current editions of the International Code Council's Building, Residential, Fire, Mechanical, Fuel Gas and Existing Building Codes, the Washington State Energy Code, and the Uniform Plumbing Code with state and local amendments.

Skagit County has adopted the 2015 International and Uniform Building Codes. Title 15 of the Skagit County Code includes the 2015 editions of the International Building, Residential, Mechanical, Fire, Existing Building and Fuel Gas codes and the 2015 editions of the Uniform Plumbing Code and Washington State Energy Code.[46]

[46] https://www.codepublishing.com/WA/SkagitCounty/#!/SkagitCounty15/SkagitCounty1504.html

Washington State Farmland Preservation

Washington State, through the Department of Revenue, provides tax incentives for open space enrollment of land designated as farmlands. The program is one tool for making farmland more affordable, thus keeping it out of development.

Current use classification lowers the taxable value of farm and agricultural lands and other resource lands relative to other land uses. Land that would be assessed at $10,000 an acre for its "highest and best use" might be valued at perhaps $3,000 an acre as farmland. The effect of this lower valuation is to lower the tax assessed on lands classified as "current use," thereby making the land more affordable to keep in farm production.

Regulatory, Technical, Community Organizations, Programs and Social Systems

Regulatory capabilities currently available are summarized in Table 14-1. In addition to the administrative and technical capabilities summarized in Table 14-2, Table 14-3 identifies the fiscal capabilities available. In addition, there are other programs available, some of which provide incentives for citizens. Such programs further enhance resiliency throughout the County. Two such programs include the National Flood Insurance Program, and the Community Rating System, both of which are discussed in detail in Chapter 7 – Flood.

Social systems can be defined as community organizations and programs that provide social and community-based services, such as health care or housing assistance, to the public. In planning for natural hazard mitigation, it is important to know what social systems exist within the community because of their existing connections to the public.

Table 14-1
Skagit County Legal and Regulatory Capability

	Local Authority	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements				
Building Code	Yes	Yes	Yes	2015 International Building Code
Zoning Ordinance	Yes		Yes	Updated as required under GMA. Last review/update occurred 2019.
Subdivision Ordinance	Yes		Yes	Updated regularly through Comprehensive Land Use Plan.
Floodplain Ordinance	Yes	Yes	Yes	Ordinance in place; meets/exceeds FEMA Requirements
Stormwater Management	Yes		Yes	
Growth Management	Yes		Yes	Updated 2016; partial update 2019. Available at: https://www.skagitcounty.net/PlanningAndPermit/Documents/CompPlan2016/comp-plan-2016-adopted-text-only.pdf
Critical Areas Ordinance	Yes		Yes	Skagit County Code Chapter 14.24 - Critical Areas identified and regulatory authority established.

Table 14-1
Skagit County Legal and Regulatory Capability

	Local Authority	Other Jurisdictional Authority	State Mandated	Comments
Site Plan Review	Yes			
Public Health and Safety	Yes	Yes	Yes	
Coastal Zone Management	Yes	Yes	Yes	
Shoreline Master Program	Yes			Adopted within 2016 Comp Plan. Available at: https://www.skagitcounty.net/Departments/PlanningAndPermit/SMPMain.htm SMP currently in update process, with Draft SMP available at: https://www.skagitcounty.net/Departments/PlanningAndPermit/SMPmain.htm
Natural Hazard Specific Ordinance (stormwater, steep slope, wildfire, etc.)	Yes		Yes	Reviewed and/or updated annually as needed.
Environmental Protection	Yes	Yes	Yes	Through various departments and with other entities.
Planning Documents				
General or Comprehensive Plan	Yes		Yes	
Is the plan equipped to provide linkage to this mitigation plan? Yes				
Floodplain or Basin Plan	Yes		Yes	Various plans in place maintained by several departments throughout county.
Stormwater Plan	Yes			Various plans are in place
Capital Improvement Plan	Yes		Yes	
Habitat Conservation Plans	Yes			Critical Areas Ordinance and Shoreline Master Plans.
Shoreline Management Plan	Yes		Yes	Yes
Community Wildfire Protection Plan	Yes		Yes	2019 Update serves as Wildfire Hazard Profile for plan.
Transportation Plan	Yes		Yes	2019 Update with Comprehensive Plan
Response/Recovery Planning				
Comprehensive Emergency Management Plan	Yes		Yes	2019 Update In-progress concurrent with HMP development.
Terrorism Plan	Yes			Law enforcement maintains
Post-Disaster Recovery Plan	Yes			Maintained within the CEMP
Continuity of Operations Plan	Yes			Each department has a plan in place, as well as an overall plan that is an annex to the County's 2019 CEMP.
Public Health Plans	Yes			Various public health plans are in place both through the Health Department and through the hospital districts.

Table 14-1
Skagit County Legal and Regulatory Capability

	Local Authority	Other Jurisdictional Authority	State Mandated	Comments
Administration, Boards and Commission				
Planning Commission	Yes		Yes	
Mitigation Planning Committee	Yes		No	Steering Committee established for plan development and annual maintenance of HMP.
Emergency Management Advisory Board	Yes	No	No	The County maintains not only the advisory board, but is also involved in several regional activities for response, recovery, exercise, and training.
Maintenance programs to reduce risk (e.g., tree trimming, clearing drainage systems, chipping, etc.)	Yes		Yes	Various programs in place, including tree trimming, drainage systems, etc.

Table 14-2
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	
Planners or engineers with an understanding of natural hazards	Y	Geologists, Floodplain Manager
Staff with training in benefit/cost analysis	Y	Various personnel in different departments
Surveyors	Y	
Personnel skilled or trained in GIS applications	Y	
Personnel skilled or trained in Hazus use	N	
Scientist familiar with natural hazards in local area	Y	The county has hazard-specific subject matter experts on staff in various departments, available via contracting mechanisms, and available through state resources.
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.

Table 14-2
Administrative and Technical Capability

Staff/Personnel Resources	Available?	Department/Agency/Position
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 14-3
Skagit County Fiscal Capability

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	No
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	No
Withhold Public Expenditures in Hazard-Prone Areas	No
State Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	Yes

Table 14-4
National Flood Insurance Program Compliance

What department is responsible for floodplain management in your community?	Planning and Development Services
Who is your community’s floodplain administrator? (department/position)	Jack Moore, Building Official, Floodplain Manager, Fire Code Official
Do you have any certified floodplain managers on staff in your community?	Yes
What is the date of adoption of your flood damage prevention ordinance?	Latest update 2011, joined NFIP 1975
When was the most recent Community Assistance Visit or Community Assistance Contact?	November 8, 2007
To the best of your knowledge, does your community have any outstanding NFIP compliance violations that need to be addressed? If so, please state what they are.	No
Do your flood hazard maps adequately address the flood risk within your community? (If no, please state why)	Yes, but currently in the process of being updated.
Does your floodplain management staff need any assistance or training to support its floodplain management program? If so, what type of assistance/training is needed?	No

Table 14-4 National Flood Insurance Program Compliance	
Does your community participate in the Community Rating System (CRS)? If so, is your community seeking to improve its CRS Classification? If not, is your community interested in joining the CRS program?	Yes. Received updated CRS Classification during 2020 update process.

Often, actions identified by the plan involve communicating with the public or specific subgroups within the population (e.g. elderly, children, low income). The County and its planning partners can use existing social systems as resources for implementing such communication-related activities because these service providers already work directly with the public on a number of issues, one of which could be natural hazard preparedness and mitigation.

The following highlights organizations and programs that are active within Skagit County, which may be potential partners for implementing mitigation actions. The various tables include information on each organization or program's service area, types of services offered, populations served, and how the organization or program could be involved in natural hazard mitigation. The three involvement methods are defined below.

- Education and outreach – organizations could partner with the community to educate the public or provide outreach assistance on natural hazard preparedness and mitigation.
- Information dissemination – organizations could partner with the community to provide hazard-related information to target audiences.
- Plan/project implementation – organizations may have plans and/or policies that may be used to implement mitigation activities or the organization could serve as the coordinating or partner organization to implement mitigation actions. Table 14-5 identifies several of the ongoing efforts which assist in notification and social service programs, further enhancing the resilience of the County.

Table 14-5
Education and Outreach

Program/Organization	Available?	Department/Agency/Position and Brief Description
Local citizen groups or non-profit organizations focused on emergency preparedness?	Y	CERT and SAR trained personnel
Local citizen groups or non-profit organizations focused on environmental protection?	Y	Skagit County Conservation District
Organization focused on individuals with access and functional needs populations	N	
Ongoing public education or information program (e.g., applicable insurance coverage, National Flood Insurance Program, Community Rating System, Flood Hazard Awareness, Tsunami Awareness, responsible water use, fire safety, household preparedness, environmental education)	Y	Various agencies at the county and state levels which promote educational efforts such as Firewise, Forestland-Urban Interface Fire Protection Act, and Fire Adapted Communities from the National Cohesive Wildfire Strategy, the Community Rating System, FCAAP, NFIP, StormReady, TsunamiReady.
Natural disaster or safety related school programs?	Y	Pursuant to the RCW, schools are required to develop and exercise hazard-specific response plans.

Table 14-5
Education and Outreach

Program/Organization	Available?	Department/Agency/Position and Brief Description
Public-private partnership initiatives addressing disaster-related issues?	Y	Various public education outreach; provide information and presentations; NFIP insurance; outreach for Continuity Planning, public involvement for update to the County's Comprehensive Land Use Plan.
Multi-seasonal public awareness program?	Y	The County maintains information on its website to address specific hazards at issue; also, as situations arise, the website, email lists and local area broadcasting provides public service announcements and information. The county also participates in specific awareness opportunities, such as the October Flood Hazard Awareness program, among others.

14.3 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.

14.3.1 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 14-6 identifies the Public Protection Classification for Skagit County and its fire departments.

Table 14-6
Countywide Public Protection Classification

Community	Protection Class Grade
Anacortes	5
Burlington	5
Concrete	6
Hamilton	7
La Conner	6
Lyman	6
Mount Vernon	5
Sedro Woolley	5
Skagit County	N/A
Skagit County F.P.D. 2	7
Skagit County F.P.D. 1	5
Skagit County F.P.D. 10	7
Skagit County F.P.D. 11	6
Skagit County F.P.D. 12	7
Skagit County F.P.D. 13	6
Skagit County F.P.D. 14	7
Skagit County F.P.D. 15	8
Skagit County F.P.D. 16	8
Skagit County F.P.D. 17	7
Skagit County F.P.D. 19	8
Skagit County F.P.D. 3	6
Skagit County F.P.D. 4	5
Skagit County F.P.D. 5	7
Skagit County F.P.D. 6	5
Skagit County F.P.D. 7	8
Skagit County F.P.D. 8	6
Skagit County F.P.D. 9	5

Data effective as of April 2019

14.3.2 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 14-7 identifies the BCEGS for the planning partnership.

Table 14-7
Countywide Building Code Effectiveness Grading

Community	Commercial	Dwelling
Anacortes	4	4
Burlington	3	4
Concrete	5	5
Hamilton	4	4
La Conner	4	4
Lyman	4	4
Mount Vernon	3	3
Sedro Woolley	4	4
Skagit County	4	4
Skagit County F.P.D. 2	4	4
Skagit County F.P.D. 1	4	4
Skagit County F.P.D. 10	4	4
Skagit County F.P.D. 11	4	4
Skagit County F.P.D. 12	4	4
Skagit County F.P.D. 13	4	4
Skagit County F.P.D. 14	4	4
Skagit County F.P.D. 15	4	4
Skagit County F.P.D. 16	4	4
Skagit County F.P.D. 17	4	4
Skagit County F.P.D. 19	4	4
Skagit County F.P.D. 3	4	4
Skagit County F.P.D. 4	4	4
Skagit County F.P.D. 5	4	4
Skagit County F.P.D. 6	4	4
Skagit County F.P.D. 7	4	4
Skagit County F.P.D. 8	4	4
Skagit County F.P.D. 9	4	4

Data effective as of April 2019

14.3.3 Public Safety Programs

Access and Functional Needs

One of the most important roles of local government is to protect their citizens from harm, including helping people prepare for and respond to emergencies. Making local government emergency preparedness and response programs accessible to people with special needs is a critical part of this responsibility. Skagit County Department of Emergency Management (DEM) has the mission to assess and plan for all hazards and emergencies, and works with other public safety and local government agencies to ensure public welfare for all of its citizens.

Skagit County Fire Districts

Skagit County has a total of 19 fire districts serving its citizens, in addition to the local municipalities' fire departments. Within these fire districts and departments, there are a total of 44 fire stations (including City Departments) which protect the county during emergency situations. The purpose of Skagit County Fire Districts is the provision of fire prevention and preparedness services, fire suppression services, emergency medical services, and for the protection of life and property.

Wildfire prevention in Skagit County is mainly focused on wildland-urban interface areas and is done through a Firewise community program in coordination with the WA DNR, and the USFS. Extensive public outreach efforts have also occurred throughout the County, including partnerships with various school districts, where Firewise information and mitigation-related projects are presented.

Skagit County is a StormReady® County

Skagit County is also a recognized StormReady® County under the National Weather Service Program. Achieving such status requires a significant level of effort. Being part of a Weather-Ready Nation is about preparing for your community's increasing vulnerability to extreme weather and water events. The program helps arm America's communities with the communication and safety skills needed to save lives and property--before, during and after the event. StormReady helps community leaders and emergency managers strengthen local safety programs. The County is in the process of submitting its application to become a TsunamiReady® program as well, and hopes to gain that recognition over the life cycle of this plan.

Emergency Management Advisory Board

By Resolution, ~16 representatives from various departments, agencies and municipalities that have contracted with the County by inter-local agreement for emergency management (and other) services are appointed and invited to participate for the purpose of advising the Emergency Management Director and Skagit County Commissioners and Skagit County Administration on matters concerning the coordination of emergency services and disaster-related functions of public agencies, affected private persons, corporations, and organizations.

Drone Usage

The County and several of its planning partners have utilized drones in various capacities to support emergency management, response and recovery activities, and search and rescue efforts. Currently, the Sheriff's Department is certified to request the clearing of air space when circumstances support such need. Drones are also utilized for search and rescue activities by various agencies countywide. With the intended expansion of the use of drones, the County has established a separate annex within the County's Comprehensive Emergency Management Plan which define uses, including future plans to utilize the drones for damage assessment activities and potentially for alert and warning.

Response Plans

Skagit County and its jurisdictions have developed various response plans to be utilized during incident-specific events. Plans such as the Tsunami Response and Evacuation Plan and Flood Response Plan provide guidance to first responders and community members in what actions need to be taken during such event. These plans go through a training and exercise phase to help ensure quick response when the plans are activated. New to the 2019 planning effort are Tsunami Evacuation signage, which will be installed during the update of this plan (anticipated by summer 2019), as well as emergency sirens which will be installed during the summer of 2019, which were donated by Puget Sound Energy. That signage is based off of the newly completed Tsunami Study, which now provides pedestrian evacuation time data.

CHAPTER 15.
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.

The CRS program credits NFIP communities points for adopting the Plan; establishing a procedure for implementation, review, and updating the Plan; and submitting an annual evaluation report.

This section of the plan is focused on the plan maintenance strategy, and details the formal process that will ensure that the Skagit 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 Skagit 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 Skagit County Emergency Management Director will maintain lead responsibility for overseeing the plan implementation and maintenance strategy, utilizing an advisory committee which will annually be convened to review the various plan components, develop an annual report identifying strengths, weaknesses, opportunities for enhancement, and an overview of the action items identified within the 2020 update. Once the annual report is completed and distributed to all planning partners, additional 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).

15.1 MONITORING, EVALUATION AND UPDATING THE PLAN

15.1.1 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; however, the County and its current planning partners were heavily engaged in further developing the Community Rating System, establishing a very robust Flood Hazard Awareness Week with a multi-faceted approach to gain community involvement for public outreach efforts and education of its citizens, and the tsunami evacuation project to identify tsunami inundation zones and evacuate routes, among other projects.

Those efforts required a very large level of involvement by the Emergency Management Department, as well as other departments within the County, and its planning partners. In addition, during this period, FEMA and the USACE, as well as several state agencies (e.g., Department of Natural Resources, Department of Ecology, local colleges) conducted significant studies in the region for the various hazards of concern. All of these efforts impeded the County's ability to do a comprehensive annual review and written update. While the plan review did not occur 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 13. In conjunction with those projects completed since 2015, a synopsis of outreach and hazard identification 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 completes over 30 outreach efforts per year, where hazards of concern and potential mitigation efforts are discussed.
- Flood Reduction - During the life cycle of the 2015-2020 plan, the County and its planning partners continued to work with FEMA on the RiskMap project to update the coastal flood hazard maps within the County, as well as determine impact from new levees.
- 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 over 500 trained individuals who will be able to provide safe and effective assistance to their communities after a disaster incident occurs.
- Flood Hazard - Enhance county roads and drainage projects—The Skagit County Public Works Department, in conjunction and cooperation with the various Dike and Drainage Districts, has completed several upgrades to enhance county roads and drainage issues, and continues to work with the special purpose districts and citizens throughout the county to help ensure safety. Public works and the Dike and Drainage Districts also 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, causing and exacerbating slides in the area.
- Landslide and Erosion Hazard – Working with Washington State Department of Natural Resources and Ecology, several studies are scheduled to be underway to identify areas of concern to 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.

15.1.2 Plan Implementation and Maintenance

The effectiveness of the hazard mitigation plan depends on its implementation and incorporation of its action items into partner jurisdictions' existing plans, policies and programs. Together, the action items in the plan provide a framework for activities that the partnership can implement over the next 5 years. The planning partners have established goals and objectives and have prioritized mitigation actions that will be implemented through existing plans, policies, and programs.

44 CFR requires that local hazard mitigation plans be reviewed, revised if appropriate, and resubmitted for approval in order to remain eligible for benefits under the DMA (Section 201.6.d.3). The Skagit County planning 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 Emergency Management Director and the mitigation plan advisory committee, but there will be a minimum of one review per year. The minimum task of each planning partner will be the evaluation of the progress of its individual action plan during a 12-month performance period. This review will include the following:

- Summary of any hazard events that occurred during the performance period and the impact these events had on the planning area.
- Review of mitigation success stories.
- Review of continuing public involvement.
- Brief discussion about why targeted strategies were not completed.
- Re-evaluation of the action plan to determine if the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term one because of new funding).
- Recommendations for new projects.
- Changes in or potential for new funding options (grant opportunities).
- Impact of any other planning programs or initiatives that involve hazard mitigation.

A template to guide the planning partners in preparing a progress report has been created as part of this planning process (see Appendix D). The Emergency Management Director, with input from the advisory committee, will then prepare a formal annual report on the progress of the plan. This report should be used as follows:

- Posted on the Skagit 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. It also provides an informational tool to the citizens of the County to provide new risk data, identify completion of mitigation strategies, identify new mitigation strategies and projects, while continuing to provide information sustaining community engagement.

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, the local jurisdiction councils, and the Special Purpose District Commissioners for adoption. The County 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.

15.2 IMPLEMENTATION THROUGH EXISTING PROGRAMS

Skagit 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 County's Comprehensive Plan and the comprehensive plans of the planning partners are considered to be integral parts of this plan. The County and its jurisdictional partners, through adoption of comprehensive plans and zoning ordinances, have planned for the impact of natural hazards. The plan development process provided the County and its cities 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 Skagit County. An update to a comprehensive plan may trigger an update to the hazard mitigation plan.

All planning partners are committed to creating a linkage between the hazard mitigation plan and their individual comprehensive and other 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
- Landslide reports and planning
- Evacuation planning
- Transportation planning
- Regional response and recovery planning efforts

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.

15.3 CONTINUED PUBLIC INVOLVEMENT

Skagit 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 county's website and the annual progress reports that will be provided to the media. All planning partners have agreed to provide links to the Hazard Mitigation Plan website on their websites to increase avenues of public access to the plan. The Skagit 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, and risk data, including on-going situations. Upon initiation of future update processes, a new public involvement strategy will be initiated. This strategy will be based on the needs and capabilities of the planning partnership at the time of the update. At a minimum, this strategy will include the use of social media and local media outlets within the planning area.

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Multi-Jurisdiction Hazard Mitigation Plan 2020 Update

APPENDIX A
ACRONYMS AND DEFINITIONS

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ACRONYMS

ASHRAE—American Society of Heating, Refrigerating, and Air-Conditioning Engineers
BOR—U.S. Bureau of Reclamation
CFR—Code of Federal Regulations
cfs—cubic feet per second
CIP—Capital Improvement Plan
CRS—Community Rating System
DFIRM—Digital Flood Insurance Rate Maps
DHS—Department of Homeland Security
DMA —Disaster Mitigation Act
DSO—Dam Safety Office
EAP—Emergency Action Plan
EPA—U.S. Environmental Protection Agency
ESA—Endangered Species Act
FCAAP—Flood Control Assistance Account Program
FCMP—Flood Control Maintenance Program
FEMA—Federal Emergency Management Agency
FERC—Federal Energy Regulatory Commission
FIRM—Flood Insurance Rate Map
FIS—Flood Insurance Study
GIS—Geographic Information System
GMA—Growth Management Act
Hazus-MH—Hazards, United States-Multi Hazard
HMGP—Hazard Mitigation Grant Program
IBC—International Building Code
IRC—International Residential Code
MM—Modified Mercalli Scale
NEHRP—National Earthquake Hazards Reduction Program
NFIP—National Flood Insurance Program
NFPA—National Fire Protection Association
NFR—Natural fire rotation
NOAA—National Oceanic and Atmospheric Administration
NWS—National Weather Service
PDM—Pre-Disaster Mitigation Grant Program
PDI—Palmer Drought Index
PGA—Peak Ground Acceleration
PHDI—Palmer Hydrological Drought Index
RCW—Revised Code of Washington
SCS—U.S. Department of Agriculture Soil Conservation Service
SFHA—Special Flood Hazard Area
SHELDUS—Special Hazard Events and Losses Database for the US
SPI—Standardized Precipitation Index
USGS—U.S. Geological Survey

WAC—Washington Administrative Code
WDFW—Washington Department of Fish and Wildlife
WUI— Wildland Urban Interface

DEFINITIONS

100-Year Flood: The term "100-year flood" can be misleading. The 100-year flood does not necessarily occur once every 100 years. Rather, it is the flood that has a 1 percent chance of being equaled or exceeded in any given year. Thus, the 100-year flood could occur more than once in a relatively short period of time. The Federal Emergency Management Agency (FEMA) defines it as the 1 percent annual chance flood, which is now the standard definition used by most federal and state agencies and by the National Flood Insurance Program (NFIP).

Acre-Foot: An acre-foot is the amount of water it takes to cover 1 acre to a depth of 1 foot. This measure is used to describe the quantity of storage in a water reservoir. An acre-foot is a unit of volume. One acre foot equals 7,758 barrels; 325,829 gallons; or 43,560 cubic feet. An average household of four will use approximately 1 acre-foot of water per year.

Asset: An asset is any constructed or natural feature that has value, including, but not limited to, people; buildings; infrastructure, such as bridges, roads, sewers, and water systems; lifelines, such as electricity and communication resources; and environmental, cultural, or recreational features such as parks, wetlands, and landmarks.

Base Flood: The flood having a 1% chance of being equaled or exceeded in any given year, also known as the "100-year" or "1% chance" flood. The base flood is a statistical concept used to ensure that all properties subject to the National Flood Insurance Program (NFIP) are protected to the same degree against flooding.

Basin: A basin is the area within which all surface water—whether from rainfall, snowmelt, springs, or other sources—flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains, and ridges. Basins are also referred to as "watersheds" and "drainage basins."

Benefit: A benefit is a net project outcome and is usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of benefit-cost analysis of proposed mitigation measures, benefits are limited to specific, measurable, risk reduction factors, including reduction in expected property losses (buildings, contents, and functions) and protection of human life.

Benefit/Cost Analysis: A benefit/cost analysis is a systematic, quantitative method of comparing projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

Building: A building is defined as a structure that is walled and roofed, principally aboveground, and permanently fixed to a site. The term includes manufactured homes on permanent foundations on which the wheels and axles carry no weight.

Capability Assessment: A capability assessment provides a description and analysis of a community's current capacity to address threats associated with hazards. The assessment includes two components: an inventory of an agency's mission, programs, and policies, and an analysis of its capacity to carry them out. A capability assessment is an integral part of the planning process in which a community's actions to reduce losses are identified, reviewed, and analyzed, and the framework for implementation is identified. The following capabilities were reviewed under this assessment:

- Legal and regulatory capability
- Administrative and technical capability
- Fiscal capability

Community Rating System (CRS): The CRS is a voluntary program under the NFIP that rewards participating communities (provides incentives) for exceeding the minimum requirements of the NFIP and completing activities that reduce flood hazard risk by providing flood insurance premium discounts.

Critical Area: An area defined by state or local regulations as deserving special protection because of unique natural features or its value as habitat for a wide range of species of flora and fauna. A sensitive/critical area is usually subject to more restrictive development regulations.

Critical Facility: Facilities and infrastructure that are critical to the health and welfare of the population. These become especially important after any hazard event occurs. For the purposes of this plan, critical facilities include:

- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic and/or water reactive materials;
- Hospitals, nursing homes, and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a hazard event.
- Police stations, fire stations, vehicle and equipment storage facilities, and emergency operations centers that are needed for disaster response before, during, and after hazard events, and
- Public and private utilities, facilities and infrastructure that are vital to maintaining or restoring normal services to areas damaged by hazard events.
- Government facilities.

Cubic Feet per Second (cfs): Discharge or river flow is commonly measured in cfs. One cubic foot is about 7.5 gallons of liquid.

Dam: Any artificial barrier or controlling mechanism that can or does impound 10 acre-feet or more of water.

Dam Failure: Dam failure refers to a partial or complete breach in a dam (or levee) that impacts its integrity. Dam failures occur for a number of reasons, such as flash flooding, inadequate spillway size, mechanical failure of valves or other equipment, freezing and thawing cycles, earthquakes, and intentional destruction.

Debris Avalanche: Volcanoes are prone to debris and mountain rock avalanches that can approach speeds of 100 mph.

Debris Flow: Dense mixtures of water-saturated debris that move down-valley; looking and behaving much like flowing concrete. They form when loose masses of unconsolidated material are saturated, become unstable, and move down slope. The source of water varies but includes rainfall, melting snow or ice, and glacial outburst floods.

Debris Slide: Debris slides consist of unconsolidated rock or soil that has moved rapidly down slope. They occur on slopes greater than 65 percent.

Disaster Mitigation Act of 2000 (DMA); The DMA is Public Law 106-390 and is the latest federal legislation enacted to encourage and promote proactive, pre-disaster planning as a condition of receiving financial assistance under the Robert T. Stafford Act. The DMA emphasizes planning for disasters before they occur. Under the DMA, a pre-disaster hazard mitigation program and new requirements for the national post-disaster hazard mitigation grant program (HMGP) were established.

Drainage Basin: A basin is the area within which all surface water- whether from rainfall, snowmelt, springs or other sources- flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains and ridges. Drainage basins are also referred to as **watersheds** or **basins**.

Drought: Drought is a period of time without substantial rainfall or snowfall from one year to the next. Drought can also be defined as the cumulative impacts of several dry years or a deficiency of precipitation over an extended period of time, which in turn results in water shortages for some activity, group, or environmental function. A hydrological drought is caused by deficiencies in surface and subsurface water supplies. A socioeconomic drought impacts the health, well-being, and quality of life or starts to have an adverse impact on a region. Drought is a normal, recurrent feature of climate and occurs almost everywhere.

Earthquake: An earthquake is defined as a sudden slip on a fault, volcanic or magmatic activity, and sudden stress changes in the earth that result in ground shaking and radiated seismic energy. Earthquakes can last from a few seconds to over 5 minutes, and have been known to occur as a series of tremors over a period of several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties may result from falling objects and debris as shocks shake, damage, or demolish buildings and other structures.

Exposure: Exposure is defined as the number and dollar value of assets considered to be at risk during the occurrence of a specific hazard.

Extent: The extent is the size of an area affected by a hazard.

Fire Behavior: Fire behavior refers to the physical characteristics of a fire and is a function of the interaction between the fuel characteristics (such as type of vegetation and structures that could burn), topography, and weather. Variables that affect fire behavior include the rate of spread, intensity, fuel consumption, and fire type (such as underbrush versus crown fire).

Fire Frequency: Fire frequency is the broad measure of the rate of fire occurrence in a particular area. An estimate of the areas most likely to burn is based on past fire history or fire rotation in the area, fuel conditions, weather, ignition sources (such as human or lightning), fire suppression response, and other factors.

Flash Flood: A flash flood occurs with little or no warning when water levels rise at an extremely fast rate

Flood Insurance Rate Map (FIRM): FIRMs are the official maps on which the Federal Emergency Management Agency (FEMA) has delineated the Special Flood Hazard Area (SFHA).

Flood Insurance Study: A report published by the Federal Insurance and Mitigation Administration for a community in conjunction with the community's Flood Insurance rate Map. The study contains such background data as the base flood discharges and water surface elevations that were used to prepare the FIRM. In most cases, a community FIRM with detailed mapping will have a corresponding flood insurance study.

Floodplain: Any land area susceptible to being inundated by flood waters from any source. A flood insurance rate map identifies most, but not necessarily all, of a community's floodplain as the Special Flood Hazard Area (SFHA).

Floodway: Floodways are areas within a floodplain that are reserved for the purpose of conveying flood discharge without increasing the base flood elevation more than 1 foot. Generally speaking, no development is allowed in floodways, as any structures located there would block the flow of floodwaters.

Floodway Fringe: Floodway fringe areas are located in the floodplain but outside of the floodway. Some development is generally allowed in these areas, with a variety of restrictions. On maps that have identified and delineated a floodway, this would be the area beyond the floodway boundary that can be subject to different regulations.

Fog: Fog refers to a cloud (or condensed water droplets) near the ground. Fog forms when air close to the ground can no longer hold all the moisture it contains. Fog occurs either when air is cooled to its dew point or the amount of moisture in the air increases. Heavy fog is particularly hazardous because it can restrict surface visibility. Severe fog incidents can close roads, cause vehicle accidents, cause airport delays, and impair the effectiveness of emergency response. Financial losses associated with transportation delays caused by fog have not been calculated in the United States but are known to be substantial.

Freeboard: Freeboard is the margin of safety added to the base flood elevation.

Frequency: For the purposes of this plan, frequency refers to how often a hazard of specific magnitude, duration, and/or extent is expected to occur on average. Statistically, a hazard with a 100-year frequency is expected to occur about once every 100 years on average and has a 1 percent chance of occurring any given year. Frequency reliability varies depending on the type of hazard considered.

Fujita Scale of Tornado Intensity: Tornado wind speeds are sometimes estimated on the basis of wind speed and damage sustained using the Fujita Scale. The scale rates the intensity or severity of tornado events using numeric values from F0 to F5 based on tornado wind speed and damage. An F0 tornado (wind speed less than 73 miles per hour (mph)) indicates minimal damage (such as broken tree limbs), and an F5 tornado (wind speeds of 261 to 318 mph) indicates severe damage.

Goal: A goal is a general guideline that explains what is to be achieved. Goals are usually broad-based, long-term, policy-type statements and represent global visions. Goals help define the benefits that a plan is trying to achieve. The success of a hazard mitigation plan is measured by the degree to which its goals have been met (that is, by the actual benefits in terms of actual hazard mitigation).

Geographic Information System (GIS): GIS is a computer software application that relates data regarding physical and other features on the earth to a database for mapping and analysis.

Hazard: A hazard is a source of potential danger or adverse condition that could harm people and/or cause property damage.

Hazard Mitigation Grant Program (HMGP): Authorized under Section 202 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, the HMGP is administered by FEMA and provides grants to states, tribes, and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to disasters and to enable mitigation activities to be implemented as a community recovers from a disaster

Hazards U.S. Multi-Hazard (Hazus-MH) Loss Estimation Program: Hazus-MH is a GIS-based program used to support the development of risk assessments as required under the DMA. The Hazus-MH software program assesses risk in a quantitative manner to estimate damages and losses associated with natural hazards. Hazus-MH is FEMA's nationally applicable, standardized methodology and software program and contains modules for estimating potential losses from earthquakes, floods, and wind hazards. Hazus-MH has also been used to assess vulnerability (exposure) for other hazards.

Hydraulics: Hydraulics is the branch of science or engineering that addresses fluids (especially water) in motion in rivers or canals, works and machinery for conducting or raising water, the use of water as a prime mover, and other fluid-related areas.

Hydrology: Hydrology is the analysis of waters of the earth. For example, a flood discharge estimate is developed by conducting a hydrologic study.

Intensity: For the purposes of this plan, intensity refers to the measure of the effects of a hazard.

Inventory: The assets identified in a study region comprise an inventory. Inventories include assets that could be lost when a disaster occurs and community resources are at risk. Assets include people, buildings, transportation, and other valued community resources.

Landslide: Landslides can be described as the sliding movement of masses of loosened rock and soil down a hillside or slope. Fundamentally, slope failures occur when the strength of the soils forming the slope exceeds the pressure, such as weight or saturation, acting upon them.

Lightning: Lightning is an electrical discharge resulting from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a "bolt," usually within or between clouds and the ground. A bolt of lightning instantaneously reaches temperatures approaching 50,000ºF. The rapid heating and cooling of air near lightning causes thunder. Lightning is a major threat during thunderstorms. In the United States, 75 to 100 Americans are struck and killed by lightning each year (see http://www.fema.gov/hazard/thunderstorms/thunder.shtm).

Liquefaction: Liquefaction is the complete failure of soils, occurring when soils lose shear strength and flow horizontally. It is most likely to occur in fine grain sands and silts, which behave like viscous fluids when liquefaction occurs. This situation is extremely hazardous to development on the soils that liquefy, and generally results in extreme property damage and threats to life and safety.

Local Government: Any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity.

Magnitude: Magnitude is the measure of the strength of an earthquake, and is typically measured by the Richter scale. As an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Mass movement: A collective term for landslides, mudflows, debris flows, sinkholes and lahars.

Mitigation: A preventive action that can be taken in advance of an event that will reduce or eliminate the risk to life or property.

Mitigation Actions: Mitigation actions are specific actions to achieve goals and objectives that minimize the effects from a disaster and reduce the loss of life and property.

Objective: For the purposes of this plan, an objective is defined as a short-term aim that, when combined with other objectives, forms a strategy or course of action to meet a goal. Unlike goals, objectives are specific and measurable.

Peak Ground Acceleration: Peak Ground Acceleration (PGA) is a measure of the highest amplitude of ground shaking that accompanies an earthquake, based on a percentage of the force of gravity.

Preparedness: Preparedness refers to actions that strengthen the capability of government, citizens, and communities to respond to disasters.

Presidential Disaster Declaration: These declarations are typically made for events that cause more damage than state and local governments and resources can handle without federal government assistance. Generally, no specific dollar loss threshold has been established for such declarations. A Presidential Disaster Declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, designed to help disaster victims, businesses, and public entities.

Probability of Occurrence: The probability of occurrence is a statistical measure or estimate of the likelihood that a hazard will occur. This probability is generally based on past hazard events in the area and a forecast of events that could occur in the future. A probability factor based on yearly values of occurrence is used to estimate probability of occurrence.

Repetitive Loss Property: Any NFIP-insured property that, since 1978 and regardless of any changes of ownership during that period, has experienced:

- Four or more paid flood losses in excess of $1000.00; or
- Two paid flood losses in excess of $1000.00 within any 10-year period since 1978 or
- Three or more paid losses that equal or exceed the current value of the insured property.

Return Period (or Mean Return Period): This term refers to the average period of time in years between occurrences of a particular hazard (equal to the inverse of the annual frequency of occurrence).

Riverine: Of or produced by a river. Riverine floodplains have readily identifiable channels. Floodway maps can only be prepared for riverine floodplains.

Risk: Risk is the estimated impact that a hazard would have on people, services, facilities, and structures in a community. Risk measures the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate, or low likelihood of sustaining damage above a particular threshold due to occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Risk Assessment: Risk assessment is the process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards. This process assesses the vulnerability of people, buildings, and infrastructure to hazards and focuses on (1) hazard identification; (2) impacts of hazards on physical, social, and economic assets; (3) vulnerability identification; and (4) estimates of the cost of damage or costs that could be avoided through mitigation.

Risk Ranking: This ranking serves two purposes, first to describe the probability that a hazard will occur, and second to describe the impact a hazard will have on people, property, and the economy. Risk estimates for the City are based on the methodology that the City used to prepare the risk assessment for this plan. The following equation shows the risk ranking calculation:

Risk Ranking = Probability + Impact (people + property + economy)

Robert T. Stafford Act: The Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-107, was signed into law on November 23, 1988. This law amended the Disaster Relief Act of 1974, Public Law 93-288. The Stafford Act is the statutory authority for most federal disaster response activities, especially as they pertain to FEMA and its programs.

Sinkhole: A collapse depression in the ground with no visible outlet. Its drainage is subterranean. It is commonly vertical-sided or funnel-shaped.

Special Flood Hazard Area: The base floodplain delineated on a Flood Insurance Rate Map. The SFHA is mapped as a Zone A in riverine situations and zone V in coastal situations. The SFHA may or may not encompass all of a community's flood problems

Stakeholder: Business leaders, civic groups, academia, non-profit organizations, major employers, managers of critical facilities, farmers, developers, special purpose districts, and others whose actions could impact hazard mitigation.

Stream Bank Erosion: Stream bank erosion is common along rivers, streams and drains where banks have been eroded, sloughed or undercut. However, it is important to remember that a stream is a dynamic and constantly changing system. It is natural for a stream to want to meander, so not all eroding banks are "bad" and in need of repair. Generally, stream bank erosion becomes a problem where development has limited the meandering nature of streams, where streams have been channelized, or where stream bank structures (like bridges, culverts, etc.) are located in places where they can actually cause damage to downstream areas. Stabilizing these areas can help protect watercourses from continued sedimentation, damage to adjacent land uses, control unwanted meander, and improvement of habitat for fish and wildlife.

Steep Slope: Different communities and agencies define it differently, depending on what it is being applied to, but generally a steep slope is a slope in which the percent slope equals or exceeds 25%. For this study, steep slope is defined as slopes greater than 33%.

Sustainable Hazard Mitigation: This concept includes the sound management of natural resources, local economic and social resiliency, and the recognition that hazards and mitigation must be understood in the largest possible social and economic context.

Thunderstorm: A thunderstorm is a storm with lightning and thunder produced by cumulonimbus clouds. Thunderstorms usually produce gusty winds, heavy rains, and sometimes hail. Thunderstorms are usually short in duration (seldom more than 2 hours). Heavy rains associated with thunderstorms can lead to flash flooding during the wet or dry seasons.

Tornado: A tornado is a violently rotating column of air extending between and in contact with a cloud and the surface of the earth. Tornadoes are often (but not always) visible as funnel clouds. On a local scale, tornadoes are the most intense of all atmospheric circulations, and winds can reach destructive speeds of more than 300 mph. A tornado's vortex is typically a few hundred meters in diameter, and damage paths can be up to 1 mile wide and 50 miles long.

Vulnerability: Vulnerability describes how exposed or susceptible an asset is to damage. Vulnerability depends on an asset's construction, contents, and the economic value of its functions. Like indirect damages, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power. Flooding of an electric substation would affect not only the substation itself but businesses as well. Often, indirect effects can be much more widespread and damaging than direct effects.

Watershed: A watershed is an area that drains down gradient from areas of higher land to areas of lower land to the lowest point, a common drainage basin.

Wildfire: These terms refer to any uncontrolled fire occurring on undeveloped land that requires fire suppression. The potential for wildfire is influenced by three factors: the presence of fuel, topography, and air mass. Fuel can include living and dead vegetation on the ground, along the surface as brush and small trees, and in the air such as tree canopies. Topography includes both slope and elevation. Air mass includes temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount, duration, and the stability of the atmosphere at the time of the fire. Wildfires can be ignited by lightning and, most frequently, by human activity including smoking, campfires, equipment use, and arson.

Windstorm: Windstorms are generally short-duration events involving straight-line winds or gusts exceeding 50 mph. These gusts can produce winds of sufficient strength to cause property damage. Windstorms are especially dangerous in areas with significant tree stands, exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and aboveground utility lines. A windstorm can topple trees and power lines; cause damage to residential, commercial, critical facilities; and leave tons of debris in its wake.

Zoning Ordinance: The zoning ordinance designates allowable land use and intensities for a local jurisdiction. Zoning ordinances consist of two components: a zoning text and a zoning map.

Skagit County
Multi-Jurisdiction Hazard Mitigation Plan 2020 Update

APPENDIX B
PUBLIC OUTREACH MATERIALS AND RESULTS

APPENDIX B
PUBLIC OUTREACH MATERIALS AND RESULTS

Attached as a separate document due to size.

APPENDIX C
PLAN ADOPTION RESOLUTIONS FROM PLANNING PARTNERS

APPENDIX C
PLAN ADOPTION RESOLUTIONS FROM PLANNING PARTNERS

To be provided with final release and contained in a separate file on county's website

APPENDIX D
EXAMPLE TEMPLATE FOR FUTURE PROGRESS REPORTS

APPENDIX D
EXAMPLE TEMPLATE FOR FUTURE PROGRESS REPORTS

Skagit County
Hazard Mitigation Plan
Annual Progress Report

Reporting Period: (Insert reporting period)

Background: Skagit 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 ______, 2025. 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 Skagit 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 Skagit 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 _____, 20__. 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]				
Initiative #__—___________________[description]				
Initiative #__—___________________[description]				
Initiative #__—___________________[description]				
Initiative #__—___________________[description]				
Initiative #__—___________________[description]				
Initiative #__—___________________[description]				
Initiative #__—___________________[description]				

TABLE 2 **ACTION PLAN MATRIX**				
Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O,✓)
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
Initiative #__—______________________[description]				
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 Skagit County hazard mitigation plan website. Any questions or comments regarding the contents of this report should be directed to:

INSERT NAME AND ADDRESS