Hoh Indian Tribe
Hazard Mitigation Plan Update

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The Hoh Indian Tribe
2022
HAZARD MITIGATION PLAN UPDATE

DECEMBER 2022

Prepared for:
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Hazard Mitigation Plan
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EXECUTIVE SUMMARY

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The Disaster Mitigation Act (DMA; Public Law 106-390) 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 requirements for the national post-disaster hazard mitigation grant program were established.

In recognition of tribal sovereignty and the government-to-government relationship that currently exists between FEMA and Indian Tribal governments, FEMA amended 44 CFR 201 at 72 Fed. Reg. 61720 on October 31, 2007, and provided further amendments on September 16, 2009, amending 74 Fed. Reg. 47471 to consolidate and clarify the requirements for Indian Tribal governments. These amendments established protocol for Tribal Hazard Mitigation Plans to be separate from State and Local Mitigation Plans. It also finalized the Mitigation Planning Guidelines. It is under those guidelines which this Tribal Hazard Mitigation Plan was developed. At the time the previous Hazard Mitigation Plan was developed, Tribal standards were based to a great extent to those requirements of a State-level plan as there was no other guidance in place specific to tribes. To the greatest extent possible, information from the previous plan has been incorporated into this document.

For consistency, 44 CFR 201.2 defines *Indian Tribal Government* as any Federally recognized governing body of an Indian or Alaska Native tribe, band, nation, pueblo, village, or community that the Secretary of Interior acknowledges to exist as an Indian Tribe under the Federally Recognized Indian Tribe List Act of 1994, 25 U.S.C. 479a.

The DMA encourages tribes, states, and local authorities to work together on pre-disaster planning, and it promotes sustainability as a strategy for disaster resistance. “Sustainable hazard mitigation” 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. 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.

Embracing this initiative as a foundation for proactive planning, the Hoh Indian Tribe has developed its 2022 Hazard Mitigation Plan (HMP) update in an effort to reduce loss of life and property resulting from disasters. While it is impossible to predict exactly when and where disasters will occur, or the extent to which they will impact the Tribe, with careful planning and collaboration among the relevant parties, it is possible to minimize losses that can occur from disasters. This has been and will continue to be the driving force behind this plan development. Utilizing the three primary characteristics of mitigation efforts to retreat, accommodate, or protect, the Tribe will develop techniques and practices that will contribute to the environment by developing non-regret actions which create multiple positive outcomes.

For planning purposes, *Hazard Mitigation* is defined as *long-term actions taken 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 on the Hoh Indian Tribe Reservation. It recognizes that the responsibility for hazard mitigation

lies with many, including private property owners; business and industry; and Tribal, local, state, and federal governments.

Many elements went into making this Tribal Hazard Mitigation Plan a success. The Tribe's Planning Team was instrumental in providing ideas, concepts, historical data and information, discussions, and support needed to develop this plan. Development of the update was completed in coordination with the Planning Team members and the Tribe's consultant, Bridgeview Consulting, LLC.

PLAN DEVELOPMENT METHODOLOGY

Development of the hazard mitigation plan included five phases:

- Phase 1—Organize and review
- Phase 2—Risk assessment
- Phase 3—Engage the public
- Phase 4—Assemble the plan
- Phase 5—Plan adoption

Phase 1—Organize and Review

Under this phase, the Hazard Mitigation Planning Team (hereinafter Planning Team) was assembled to oversee the development of the plan update. The Planning Team consisted of Tribal staff and Tribal citizens, other stakeholders in the planning area, and a consultant who provided technical support to the Planning Team. Coordination with other tribal, county, state, and federal agencies involved in hazard mitigation occurred from the onset of this plan's development through its completion. A multi-media public involvement strategy which centered on a hazard preparedness questionnaire/survey was developed during Phase 1, as well as identification of public presentations at various events which were scheduled to occur during the plan's development. Phase 1 included a comprehensive review of the Tribe's previous Hazard Mitigation Plan (2012), Washington State's Enhanced Hazard Mitigation Plan (2018), and a comprehensive review of existing programs within the planning area that may support or enhance hazard mitigation actions. A key function of the Planning Team was to review and update existing goals as appropriate, and to develop measurable objectives for the 2022 update.

Also occurring simultaneous with this update was the Tribe's Grant Application for funds from a 2022 Congressional Earmark, supported by Representative Derek Kilmer. Those fund, if received, will allow for the first major move of the Hoh Reservation to the Hoh Highlands, an area which includes land mass acquired since completion of the 2012 plan. That project was identified within the 2012 plan as a mitigation strategy. Many of the planning team members working on this plan update also worked diligently to ensure award of that earmark. Information captured during this plan update, as well as during development of the grant application, supported one another.

For future planning purposes, the Hazard Mitigation Planning Team adopted May 31, 2022 as the end date for incidents, information, and data incorporated in this plan. Future planning efforts shall commence with incidents and information beginning June 1, 2022 forward.

Also occurring simultaneous with this update was the continued global COVID-19 Pandemic outbreak. As such, non-customary approaches to this planning process were utilized to some extent to ensure continued public safety, while still meeting the requirements of 44 CFR 201.7.

Phase 2—Risk Assessment

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 assesses the vulnerability of people, buildings, cultural resources, and infrastructure to natural hazards. It focuses on the following parameters:

- Hazard identification and profiling
- Identification of Cultural resources
- The impact of hazards on physical, cultural, social and economic assets
- Vulnerability identification
- Estimates of the cost of damage or costs that can be avoided through mitigation.

The risk assessment for this hazard mitigation plan meets the requirements outlined in Chapter 44 of the Code of Federal Regulations (44 CFR). Phase 2 occurred simultaneously with Phase 1, with the two efforts using information generated by one another to generate valid data, supported by sound analysis.

Phase 3—Engage the Public

Specific to tribal plans, 44 CFR 201.7 states that tribal governments may define who they feel constitute "public" within the planning realm, as many tribal citizens have difficulty or apprehension about how to honor traditional beliefs and cultural attributes while still fully participating in the mitigation planning process.

Under this phase, a public involvement strategy was developed by the Planning Team that maximized the capabilities of the Tribe, while still maintaining their cultural beliefs and responsibilities to the Elements. The Planning Team provided information necessary for inclusion within the document. One of the first steps taken was the development of a contact list which included individuals whose input was needed to complete this plan to its fullest capacity. Additionally, the strategy also included: Tribal Council updates; public outreach to review the hazards of concern and draft plan; distribution of the draft plan to Planning Team members; utilization of a hazard mitigation survey; use of the Tribe's existing website dedicated to the plan, and social media releases throughout various stages in the process. Public engagement also included information from Jefferson County, the county in which the Hoh Indian Tribe owns and maintains properties. Throughout the course of this project, numerous meetings were held, in addition to briefings provided to various stakeholders involved in this effort. This strategy was deemed by the Hazard Mitigation Planning Team as a key function in the success of this planning effort.

Phase 4—Assemble the Plan

The Planning Team assembled key information from Phases 1 and 2 into a document to meet the DMA requirements. Under 44 CFR 201.7, a Tribal Hazard Mitigation Plan must include the following:

- A description of the planning process

- Risk assessment
- Mitigation Strategy
  - Goals
  - Review of alternatives
  - Prioritized “action plan”
- Plan Maintenance section
- Documentation of Adoption

Phase 5—Plan Adoption and Maintenance

The Project Manager for this plan was tasked with briefing the Tribal Council on the plan prior to its adoption after the Tribe received FEMA Approval Pending Adoption notice. A copy of the Adoption Resolution is included in Chapter 14.

This document, as written, includes a plan implementation and maintenance section that details the formal process for ensuring that the plan remains an active and relevant document. The plan maintenance process includes a schedule for monitoring and evaluating the plan’s progress annually and producing a plan revision every five years. This process seeks to keep a planning team in place that meets the criteria of the original Hazard Mitigation Plan to perform its annual review. This phase includes strategies for continued public involvement and incorporation of the recommendations of this plan into other planning mechanisms of the Tribe, such as comprehensive plans, capital improvement plans, application of building codes, and development design guidelines.

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CHAPTER 1.
GENERAL INFORMATION

1.1 PURPOSE AND AUTHORITY

The federal Disaster Mitigation Act (DMA) emphasizes the importance of planning for disasters before they occur by requiring tribes, states, and local governments to develop hazard mitigation plans as a condition for federal grant assistance. The DMA (Public Law 106-390; approved by Congress October 10, 2000), amended the Stafford Disaster Relief and Emergency Assistance Act by repealing its previous mitigation planning provisions and replacing them with a new set of requirements that emphasize the need to closely coordinate mitigation planning and implementation.

Hazard Mitigation Plan Requirements for Indian Tribal Governments

Requirements for Indian tribal governments were consolidated and clarified when the U.S. Federal Emergency Management Agency (FEMA) amended Title 44 of the Code of Federal Regulations (44 CFR; Section 201) on October 31, 2007 (72 Fed. Reg. 61720) and again on September 16, 2009 (74 Fed. Reg. 47471). These amendments were made in recognition of the status of tribal sovereignty and the government-to-government relationship between FEMA and Indian Tribal governments. They established a protocol for Tribal hazard mitigation plans to be separate from state and local mitigation plans. Final mitigation planning guidelines became effective March 2010. Tribal hazard mitigation plan requirements differ from local hazard mitigation plan requirements and are more like the requirements for a state-level type plan. This Hazard Mitigation Plan (HMP) for the Hoh Indian Tribe (herein Hoh Tribe or the Hoh) was developed under those guidelines. The federal statutes define *Indian Tribal Government* as "any Federally recognized governing body of an Indian or Alaska Native tribe, band, nation, pueblo, village, or community that the Secretary of Interior acknowledges to exist as an Indian Tribe under the Federally Recognized Indian Tribe List Act of 1994, 25 U.S.C. 479(a)" (44 CFR 201.2).

1.1.1 The Hoh Indian Tribe's Response to DMA

Underlying Principles of the DMA

The intent behind hazard mitigation is to reduce or alleviate loss of life, personal injury, property, and environmental damage that can result from a disaster through long- and short-term strategies. It involves 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, industry, and tribal, local, state, and federal government. The DMA encourages tribes, states, and local authorities to work together on pre-disaster planning, promoting sustainability for disaster resistance. *Sustainable hazard mitigation* includes the sound management of cultural and 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. The enhanced planning network called for by the DMA helps tribes and governments articulate accurate needs for mitigation, resulting in faster allocation of funding, and more cost-effective risk reduction projects.

In an effort to support the underlying principles of the DMA, the Hoh Tribe developed their first Hazard Mitigation Plan in 2012 as a stand-alone plan. This document serves as the update to the 2012 plan,

demonstrating the Tribe's continued efforts to ensure the safety of their Tribal members, staff, and visitors to the Reservation and surrounding lands, while also continuing to be good stewards to the environment by practicing sound and sensible mitigation efforts.

This 2022 plan has been developed in accordance with requirements of the DMA, including criteria addressing the planning process, risk assessment, mitigation strategy, plan maintenance, and the adoption process. To the greatest extent possible, data from the previous plan has been incorporated into this document; however, as planning requirements, guidance, and data have changed, there are new additions to this document which were previously not addressed. Likewise, some materials from the previous plan were considered no longer relevant, accurate, or applicable, and were therefore removed. Throughout this document, reflection to the previous plan is made when data was incorporated. The previous plan was utilized as a starting point and was fully reviewed during this update process by all Hazard Mitigation Planning Team Members.

1.1.2 Progress Report of 2012 Hazard Mitigation Plan

Since the 2010 Hazard Mitigation Plan (HMP) was approved, the Tribe has completed many initiatives identified throughout this document in an attempt to serve the population and increase economic growth throughout the planning area. Chapter 14 identifies the current status of the strategies contained in the previous plan. The 2012 plan maintenance strategy identified an annual meeting with all planning team members as its method of tracking project completion and identification of hazard impact. Such meetings did not occur due to staffing levels and workloads. The Tribe, however, does feel that such strategy remains effective as it relates to them, and has developed a similar process for their use as discussed in Plan Maintenance portion of this document. The Tribe Executive Director, who serves as the Tribe's Emergency Manager, will continue to work with the Tribal Council in the continued quest to reduce the risk and vulnerability to the Hoh People.

In addition to implementation of some of the 2012 mitigation strategies, the Tribe has developed a number of different efforts which have enhanced the Tribe's ability to support mitigation-friendly infrastructure development. During development of these various planning efforts, data from the previous Hazard Mitigation Plan were integrated to the greatest extent possible, with the HMP data serving as a starting point. A detailed list of the various efforts which support mitigation is contained within the Capability Matrix (Chapter 4).

Integrating mitigation efforts into the daily practices has become commonplace to a large extent. A number of Tribal Departments' daily practices support mitigation, including the Planning Department, Natural Resources Department, and Community and Culture, among others. These departments, as well as others, have continued to incorporate mitigation activities into various day-to-day functions. A few examples of those efforts include:

- Land use development projects emphasizing smart planning by utilizing the risk data to assist in selecting site locations, such as the Hoh Highlands for relocation of the Tribe;
- Regularly purchases land in the area of the Reservation with the intent of maintaining its natural habitat to create space which reduces the negative impact of flooding (lower portion of the Hoh Reservation);

- Utilizing building materials and standards based on recommended codes and their ability to reduce risk (siding or roofing materials which reduce wildfire risk);
- Overall assessment of the communities' usage of new construction to determine if multiple purposes exist, such as the new Public Safety Building, which, when fully operational, will also be used as a shelter and community resilience center in addition to police and fire administration; and
- During planning stages, project development includes prioritizing mitigation efforts based on impact (positive and negative), such as the project's proximity to the tsunami inundation zone, 100- and 500-year floodplain, landslide risk, and assessing the impact of climate change, among others.

The updated version of the hazard mitigation action plan is a key element of this plan. For the purpose of this document, mitigation action items are defined as: *activities designed to reduce or eliminate the long-term losses resulting from the impacts of natural hazards of concern*. It is through the implementation of the action plan that the Tribe can strive to become disaster-resilient through sustainable hazard mitigation.

Although one of the driving influences for preparing this plan was grant funding eligibility, that is not the focus of this plan. It was important to the Hoh Tribe that it examine initiatives that would work through all phases of emergency management and that contribute to, rather than remove from, the environment. It was significant to the Tribal Citizens that the mitigation efforts include mainstreaming adaptive, 'no-regrets' strategies which improved their abilities to live with the hazards of concern, while not adversely impacting their beliefs and culture. They have adopted a philosophy of *accommodate, retreat, or protect* when developing their mitigation strategies. As such, some of the initiatives outlined in this plan are not grant-eligible, and grant eligibility was not the focus of the selection. Rather, the focus was on the initiatives' effectiveness in achieving the goals of the plan, and whether or not they are within the Tribe's capabilities. Detailed descriptions for these actions can be found in Chapter 14.

1.1.3 Funding Sources

Once the Hazard Mitigation Plan is approved by FEMA, the Tribe will again be eligible for funding under the Stafford Act. FEMA grant programs provide various funding opportunities to support mitigation planning and projects to reduce potential disaster damages. It is the intent of the Tribe to pursue grant opportunities in the future to assist in mitigating against the Tribe's hazards of concern. Some of those current grant opportunities available which support mitigation efforts are delineated in Table 1-1. Additional funding sources are identified within the Strategy section of this document.

TABLE 1-1
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 and Project Grant	Stafford Act	Presidential Disaster Declaration	☑	☑
Building Resilient Infrastructure and Communities (BRIC) (previously Pre-Disaster Mitigation (PDM) Planning 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	☑	□
Tribal Homeland Security	Dept. of Homeland Security	Annual Appropriation	☑	□

☑ = Tribal Hazard Mitigation Plan Required
□ = No Tribal Hazard Mitigation Plan Required

1.2 IMPLEMENTATION AND ASSURANCES

Full implementation of the recommendations of this plan will require time and resources. This plan reflects an adaptive management approach in that specific recommendations and plan review protocols are provided to evaluate changes in vulnerability and action plan prioritization after the plan is adopted. The true measure of the plan's success will be its ability to adapt to the ever-changing climate of hazard mitigation. Funding resources are always evolving, as are programmatic changes based on new mandates. The Hoh Tribe has a long-standing tradition of proactive response to issues that may impact its members. The Tribe is forward-thinking and strives whenever possible to improve the lives of its members, and the residents living in the planning area. This tradition is reflected in the development of this plan, as it is not an easy task to accomplish. The Tribal Council will assume responsibility for adopting the recommendations of this plan and committing Tribal resources towards its implementation. The

framework established by this plan will help identify a strategy that maximizes the potential for implementation based on available and potential resources. It commits the Tribe to pursue initiatives when the benefits of a project exceed its costs, and adequate resources are available. Most important, the Tribe developed this plan with community input. These techniques will set the stage for successful implementation of the recommendations in this plan.

As established within the Code of Federal Regulations, the Tribal Council will continue to comply with all applicable federal statutes and regulations in effect, including those periods during which the Tribe receives grant funding to ensure grant contract compliance, and scheduled project quarterly and closeouts reports as identified and required within each specific grant. To ensure compliance, the Tribe, whenever necessary, will reflect new or revised federal statutes or regulations, or any material changes in Tribal policy or operation. It is understood that the Tribe will submit those amendments for review and approval in coordination with FEMA Region X. The Tribe, through assigned project managers and grant coordinators, will work with the granting authority to ensure all necessary reports and documentation as required by specific grants are completed in compliance with the established regulations.

This plan is intended to cover all properties owned and operated by the Hoh Indian Tribe, no matter what their location. This includes all fee and trust lands, as well as those areas associated with the Tribe's Usual and Accustomed Fishing and Hunting areas. These areas are inclusively referred to as the tribal planning area.

1.3 WHO WILL BENEFIT FROM THIS PLAN?

All tribal citizens and businesses of the Hoh Indian Tribe are the ultimate beneficiaries of this hazard mitigation plan. The plan reduces risk for those who live in, work in, and visit the planning area. It provides a viable planning framework for all foreseeable natural hazards. Participation in development of the plan by Tribal Hazard Mitigation Planning Team Members (and outside stakeholders as requested by the Tribe) helped ensure that outcomes will be mutually beneficial. The plan's goals and recommendations can lay groundwork for the development and implementation of local mitigation activities and partnerships.

1.4 HOW TO USE THIS PLAN

This hazard mitigation plan is organized into four primary parts, each of which includes elements required under federal guidelines to attain plan approval:

- Part 1— Introduction
- Part 2— The Planning Process
- Part 3— Community Profile
- Part 4— Risk Assessment
- Part 5—Mitigation Strategy.

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

- Appendix A—A glossary of acronyms and definitions.

- Appendix B—An example template for progress reports to be completed as this plan is implemented.

1.5 CHANGES BETWEEN THE 2012 AND 2023 PLAN UPDATE

Significant differences exist between the 2012 Hazard Mitigation Plan and the 2023 Plan. The plan has been expanded to meet all planning requirements identified within 44 CFR 201.7. All materials identified in the previous plan have been incorporated and updated as appropriate. This document is also intended to meet the mitigation plan requirements for the 2017 Tribal Declarations Pilot Guidance.

The plan itself is a comprehensive update of all data and includes best available science which has been enhanced since completion of the previous plan. New studies, reports, and scientific data has been reviewed, and all risk data has been updated to the greatest extent possible with that new data (discussed in detail in the profiles).

Hazards previously identified in the 2012 plan were reviewed and carried over as determined appropriate by the Hazard Mitigation Planning Team. Some of the weather events were re-grouped into a "Severe Weather" chapter. The Volcano hazard was removed for this edition of the plan update as the tribe has not experienced any significant impact from a volcanic eruption historically. Non-natural hazards were not addressed in this update, with the exception of hazardous materials sites which were queried to identify proximity to tribal properties and included as appropriate .

Based on the risk assessment, all maps, charts, graphics, and associated data has been updated to reflect current findings. Specific methodology for how each assessment was completed is included in Chapter 5.

A different method was utilized for the risk ranking of the hazards of concern, discussed in Chapter 13. The approach utilized is simplistic in nature and will make future updates less difficult. Social Vulnerability is also addressed in greater detail in this plan, as well as information concerning programs and efforts in place to help address issues associated with social vulnerability.

Structure data was modified to include only tribal structures and infrastructure, adding new structures and land mass acquired by the Tribe since completion of the last plan. This will more accurately reflect the actual losses which the Tribe can potentially experience as a result of hazard impact. It is understood that this list will be continually updated to include additional structures and land mass as it is acquired.

Census data was updated with the most current data available; however, there are limitations with respect to US Census data, as only very limited information was available specific to the Tribe. Such are indicated.

The Capabilities Assessment was enhanced to include a clearer perspective as to the capabilities of the Tribe, while also demonstrating areas on which focus must be given with respect to deficiencies which exist. In many instances, those deficiencies were identified as potential action items/strategies within Chapter 14. The previous goals and objectives were reviewed and approved during the June 29, 2022 Council Meeting. One goal was removed, relating to enrollment in the NFIP as that has been completed. The remaining goals and objectives were confirmed, with only minor grammatical updates as appropriate.

Specific strategies and action items identified previously have been discussed in detail in Chapter 13. Those strategies carried over to the 2022 plan are identified, and new strategies and action items are identified. Specific focus was placed on new construction, as the Tribe is actively expanding onto the Hoh Highlands Site, which is a new area acquired after completion of the 2012 plan. Additional items which reflect differences between the previous and current plan update are referenced throughout the plan itself where appropriate and significant.

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CHAPTER 2.
PLANNING PROCESS

2.1 PLANNING RESOURCE ORGANIZATION

The process followed to develop the Hoh Indian Tribe's Hazard Mitigation Plan Update had the following primary objectives, which are discussed in detail in the following sections:

- Secure grant funding
- Define the planning area
- Establish a Planning Team
- Coordinate with other agencies
- Review existing programs
- Engage the public (as defined by the Tribe)

2.1.1 Funding of the 2022 Hazard Mitigation Plan

This planning effort was funded through a FEMA grant, with a 90/10 split. The Tribe is considered an impoverished community, meeting all requirements for such recognition.

2.1.2 Defining the Planning Area

This document constitutes a Tribal Hazard Mitigation Plan for the Hoh Indian Tribe. The Plan covers all lands owned and operated by the Hoh Tribe, whether fee or trust. The planning area also includes those areas utilized and established for the hunting and fishing rights of members, including the right to take fish in usual and accustomed places as provided by treaty or executive order. The planning area is inclusive of the territory within the present boundaries of the Hoh Reservation as was established by Executive Order on September 11, 1893, and to such other lands without such boundaries as may hereafter be added under any law of the United States, except as otherwise provided by law. Currently the Tribe owns land in Jefferson and Clallam Counties. The focus of this plan is on the Reservation and lands within Jefferson County.

On September 11, 1893, by Presidential Executive Order, the Hoh Indian Reservation, which amounted to less than one square mile, was established at the mouth of the Hoh River. The Hoh Tribe was officially recognized by the federal government in 1960.

Situated 28 miles south of Forks in Jefferson County, and 80 miles north of Aberdeen (Grays Harbor County), the Hoh Reservation is situated within the Hoh Watershed, and has approximately one mile of beach front running east from the mouth of the Hoh River, south to Ruby Beach.

During the period 2008-2010, the Hoh Tribe acquired more than 700 acres of new land, which was brought into Tribal Trust Status. These lands lie east and adjacent to the original Tribal Reservation lands along Lower Hoh Road and along U.S. Highway 101.

The original Hoh Reservation lands and the western portions of the new Tribal Trust lands lie at low elevations adjacent to the Hoh River and the Pacific Ocean. Elevations of current Tribal housing units range in elevation from 20-55 feet above Mean Sea Level (msl). This places those housing units within the floodplain of the Hoh River as well as within the Pacific Ocean Tsunami Zone.

An 80-acre parcel of land which is roughly bisected by Highway 101 has been designated as the Hoh Highlands, to which the Hoh Tribe intend to relocate, and replace the structures currently in the hazard areas. These parcels total approximately 72.7 acres (an 80 acre parcel, less the Right of Way for Highway 101). Of this land, approximately 45.3 acres lie south of Highway 101. The east-central portion of this 45.3 acre area is designated as the site for the Hoh Highlands Housing Project (Westech, 2022).

The new Hoh Highlands development will be at elevations of 190-200 feet msl. This higher elevation and its location are well outside of any Tsunami zone and outside the River's flood zone. Access to the new housing will be via Highway 101, which is also outside of the Tsunami Zone and is unlikely to be affected by flooding in the Hoh River; a stark contradiction to the previous main access to the Reservation.

2.1.3 Formation of the Tribal Hazard Mitigation Planning Team

Hazard mitigation planning enhances collaboration and support among diverse parties whose interests can be affected by hazard losses. A Tribal Hazard Mitigation Planning Team (hereinafter may be referred to as Planning Team) made up of various Tribal staff and citizens was formed to help provide information and input into the plan development. The members of this team included key Tribal department heads, staff, planners, and Tribal citizens. Other stakeholders from within the planning area were also identified by Tribal Staff to provide relevant information. The Hoh Tribe also retained Bridgeview Consulting, LLC., to assist with development and implementation of the plan. The Bridgeview Consulting Project Manager, Beverly O'Dea, assumed the role of the lead planner, reporting directly to the Tribe's Project Manager/Executive Director, Robert Smith. Table 2-1 lists the members of the team.

2.1.4 Planning Team Meetings

The Planning Team agreed to meet as needed throughout the course of the plan's development. Because of COVID restrictions, these meetings occurred in various formats, including via conference calls, webinar meetings, in person, and one-on-one discussions. The Planning Team addressed a set of objectives based on the work plan established for the plan. Various members met beginning June 2022 through the plan's completion, soliciting subject matter expertise from team members as needed depending on the issue being addressed. Planning Team Members included all tribal Council Members and Department Directors.

TABLE 2-1
PLANNING MEMBERSHIP

Name	Position	Planning Task
Robert (Bob) Smith	Executive Director, Project Manager	Assisted with all tasks associated with the HMP development, including pre-award consultant solicitation; served as project manager, coordinating the capture of information as needed, working with all tribal departments. Mr. Smith also conducted regular briefings to council and others on the scope and project, and conduct public outreach during the planning process. Mr. Smith conducted plan review during drafting stages, as well as during final review prior to plan going public. Mr. Smith also served as a planning team member for the 2012 plan development.
Kristina Currie	Tribal Executive Assistant; Interim HR Director	Assisted with public outreach and distribution of information; provided input and data into plan; provided hazard-specific impact data and photographs; conducted risk assessment and strategy review and development; reviewed and commented on draft plan; assisted with plan adoption.
Latoya Hudson	Enrollment Specialist and Finance	Provided population and enrollment data; provided information and input on various elements of the plan, including impact data.
Maria Lopez	Vice Chairwoman, Business Committee/Tribal Council	Chairwoman Lopez provided information throughout the process; attended various meetings during which information was presented and sought; reviewed draft and final plan; attended tribal workshops for plan development milestones. Chairwoman Lopez was a member of the 2012 Planning Team.
Wendy Largent	GIS Analyst	Assisted with the development of critical asset list; provided GIS data for parcel data and roadway layer. Assisted in plan review; provided GIS and mapping assistance as needed throughout planning process.
Melvinjohn Ashue	Economic Development	Provided information on structures; provided information on existing businesses, and potential future business ventures.
Timothy Carradine	Website (Communications) Coordinator	Assisted with public outreach; IT and Website Developer; distributed materials via website and social media.
Josie Ward	Social Media Coordinator	Assisted with posting data, notifications, and information to social media accounts for the Tribe.

TABLE 2-1
PLANNING MEMBERSHIP

Name	Position	Planning Task
John Suggs	Chief of Police	Served as emergency manager, providing relevant information during update process for the hazards of concern and historic impact data. Attended meetings and council sessions for briefings and planning update; completed draft plan review and final review.
Britni Duncan	Health Director	Assisted with information sharing; review of hazards of concern; provided historical impact data; reviewed and commented on draft plan.
Julie Ann Koehlinger	Director, Department of Natural Resources	Provided general information on the Hoh Tribe, including historical information on hazards, forestry plan information, and fish hatchery information. Also provided information on tribal capabilities and the current existing plans in place; reviewed risk assessment and draft plan once completed.
Beverly O'Dea,	Bridgeview Consulting, LLC	Project Manager and Lead Planner
Cathy Walker	Bridgeview Consulting, LLC	Senior GIS Analyst

2.1.5 Coordination with Other Agencies

Opportunities for involvement in the planning process must 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 (44 CFR, Section 201.7(b)). This task was accomplished by the Planning Team as follows:

- **Planning Team Involvement**—Tribal department and various agency representatives were invited to participate on the Planning Team.
- **Agency Notification and/or Use of Information**—The following agencies were notified of the planning effort, provided relevant data, invited to participate in the plan development process, or were kept apprised of plan development milestones. These notifications took place via email or telephonic contact:
  - FEMA Region X – various personnel
  - Jefferson County Emergency Management
  - Washington State Department of Natural Resources (various divisions)
  - Washington State Department of Ecology (various divisions)

  These agencies received meeting announcements, meeting agendas, and meeting minutes by e-mail throughout the plan development process. These agencies supported the effort by providing feedback on issues.

- **Pre-Adoption Review**— Various agencies and departments were provided an opportunity to review and comment on this plan, primarily through the Tribe's website, which was utilized for the hazard mitigation plan update. E-mails were distributed containing informing concerning draft review, as well as a link to download the plan if desired.
- **Newsletters/Social Media —**In addition to the above, the Tribe distributes regular social media/newsletters, which announced plan development and milestones. The effort directed Tribal citizens to the newly developed website, the on-line survey, and completed risk maps.
- **Press Release –** The Tribe distributed a press release which announced the planning effort, and provided the address to the *Hazard Mitigation Survey*, asking citizens to complete the document. The Press Release was distributed through the various social media sites and posted on the Tribe's website. Information concerning the HMP process and survey were included.
- **Flyers –** The Tribe distributed flyers announcing the planning process, as well as inviting tribal members to take the survey. Flyers were distributed in various ways, including through handouts with elders' meal delivery.

Some of the various stakeholders and their areas of participation are identified in Table 2-2. This list is not all-inclusive, but does demonstrate the various topics and agencies utilized/contacted.

TABLE 2-2
STAKEHOLDERS AND AREAS OF PARTICIPATION

Stakeholders		Data and Information Provided
US Forest Service	Dan Isaak	NorWest Stream Temperature projections
FEMA Region X	Ted Perkins	Flood hazard information Risk Report
	Josha Crowley, PE Starr II – Region 10 Service Center	FEMA Risk Report Data and Depth Grid Data (Sea Level Rise)
	Marshall Rivers FEMA Risk Analyst	Floodplain Specialist
	Kevin Williams Lead HMA Specialist	Grant and Planning Assistance
WA DNR		Landslide and Tsunami Data

TABLE 2-2 STAKEHOLDERS AND AREAS OF PARTICIPATION		
Stakeholders		Data and Information Provided
WA DOE	Diane Fowler, Community Right to Know Coordinator Jerry Franklin	Reporting Hazmat sites in Jefferson County Risk Map Data
USGS		Earthquake Data

2.1.6 Review of Existing Information

Chapter 4 of this plan provides a detailed overview of existing information, laws, and ordinances in effect within the planning area that can affect hazard mitigation initiatives. As a whole, hazard mitigation planning must include review and incorporation, if appropriate, of existing plans, studies, reports, and technical information (44 CFR, Section 201.7(c)(1)(iii)), such as those identified below, many of which can affect mitigation within the planning area:

- Hoh Indian Tribe Constitution
- 2012 Hazard Mitigation Plan
- Jefferson County Draft RiskMap Report (2016)
- Jefferson County National Flood Insurance Study
- Comprehensive Emergency Management Plan
- Emergency Operations Plan
- Jefferson County Hazard Mitigation Plan (2018, with current 2022 edition pending)
- State of Washington Enhanced Multi-Hazard Mitigation Plan (2018)
- Washington Department of Ecology Hazardous Materials Annual Report for Jefferson County
- Various watershed restoration project reports
- Various papers and studies concerning the impacts of climate change
- Interpretive Map Series: Earthquake Hazard Maps, Tsunami, and Seismic Risk Assessment for Washington
- Hoh Tribe Environmental Impact Statements (various) (2022)

An assessment of all Tribe's regulatory, technical, and financial capabilities to implement hazard mitigation initiatives is presented in Chapter 4. Many of these relevant plans, studies and regulations are cited in the capability assessment.

2.1.7 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 201.7(b), 201.7(c)(1)(i) and 201.7(c)(1)(ii)).

Public Defined

For this planning effort, "public" is defined as tribal citizens, tribal employees, the contractor, and some members of surrounding jurisdictions. As a very remote Tribe, involvement from the general public was very limited. While surrounding jurisdictions and governmental agencies had some involvement in the planning effort, the Planning Team was primarily limited to Tribal government, Tribal citizens, Tribal employees, and the contractor. Part of the reason for this decision was to preserve information concerning the Tribe's cultural resources.

During development of the HMP, the COVID-19 Pandemic limited in-person group gatherings. As such, the Planning Team developed a comprehensive public involvement strategy using websites, various social media platforms, media outlets, email distribution lists, monthly newsletters, and utilized existing web-based meetings to gain input on the process.

The Tribe developed a webpage on their website to post announcements and draft plan materials, as well as notices and survey links. During meetings, Planning Team Members discussed the planning effort and directed interested parties to the website to gain better insight of the on-going endeavors, and to solicit input. Planning Team Members also identified non-tribal stakeholders who possessed relevant information, which were queried for specific data for inclusion in the plan update. The Tribe's Project Manager for this update also conducted one-on-one interviews to capture relevant information as appropriate, and to disseminate information which was captured during the plan's development.

Strategy

The strategy for involving the public in this plan emphasized the following elements:

- Include Tribal citizens and staff on the Planning Team. Including staff would allow members who are not Tribal. The Tribe's Project Manager facilitated the exchange of information throughout this effort with various Planning Team Members.
- Use a questionnaire/survey 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, as well as hard copies being made available if requested. The Tribe also posted a news release at various locations around the Reservation, seeking response and input.
- Utilize existing distribution lists to disseminate and capture relevant information. These lists historically have reached both tribal and non-tribal citizens.
- Identify and involve planning area stakeholders (non-tribal).

Planning Team Input

All of the members of the Planning Team live or work in the planning area. The make-up of the Planning Team proved to be integral in the success of this planning effort, as a representative from almost every department of the tribe was represented. This helped to add a historical perspective to this team that proved to be valuable in identifying direction for the plan development process.

Survey

A Hazard Mitigation Survey was developed by the Planning Team Members. The survey was designed to help identify vulnerable areas; to gauge household preparedness, and to identify the level of knowledge of tools and techniques that assist in reducing risk and loss from hazards. The answers helped guide the Planning Team in selecting goals, objectives, and mitigation strategies. The survey was disseminated throughout the planning area by multiple means, including hard-copy distribution and web-based. A link to the web-based version of the survey was made available on the Tribe's website (see Figure 2-1).

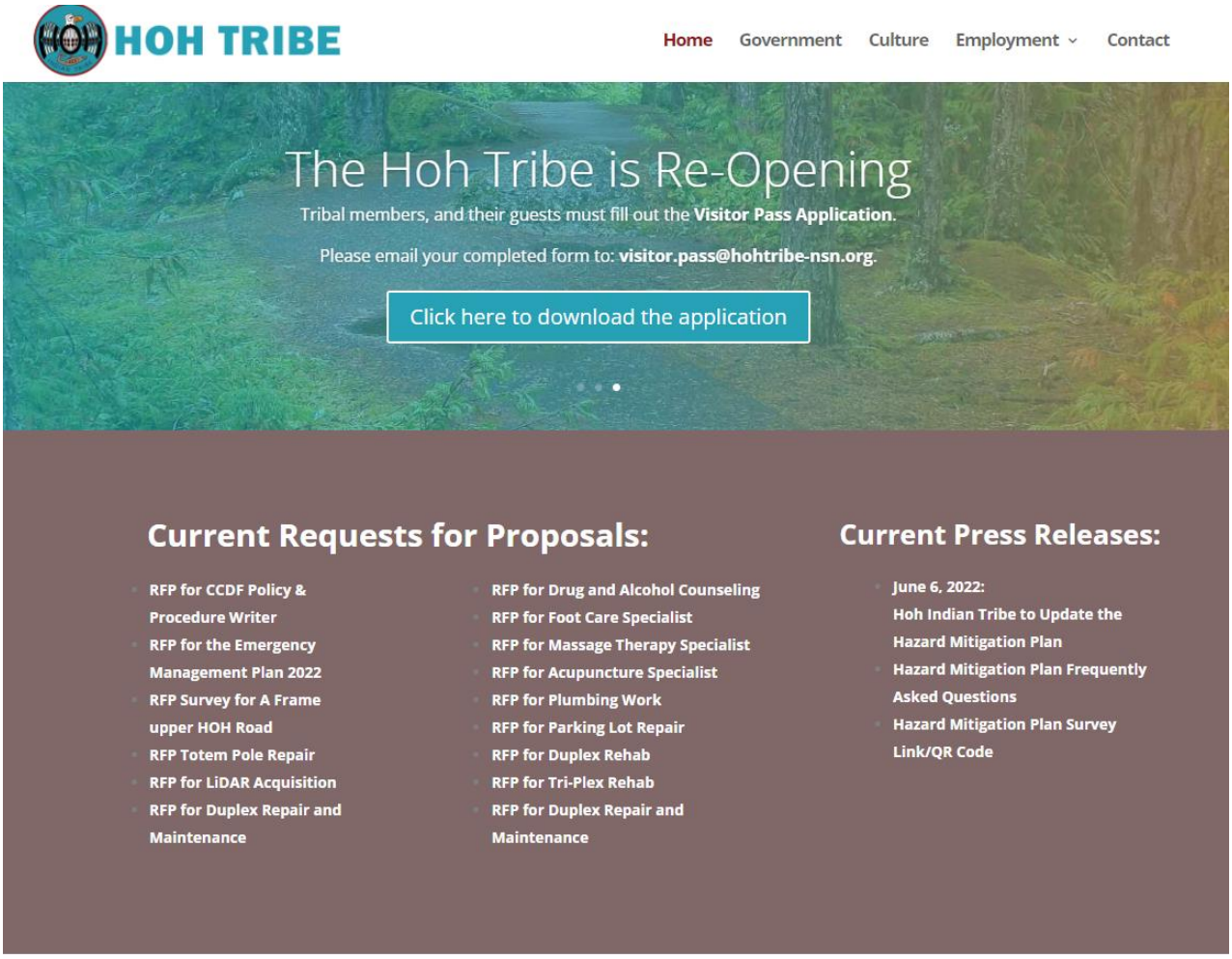

Figure 2-1 Hazard Mitigation Plan Information and Links

Survey Results

Review of the survey results indicates the following:

- When questioned about the hazards of greatest concern, tsunami was the hazard of greatest concern, with severe weather being the second hazard of greatest concern, followed by flood. Earthquake ranked fourth in the hazard ranking. Landslide, wildfire, and drought were the hazards of least concern. These rankings very closely resemble the results of the planning team with respect to the hazards of greatest concern.
- 71 percent of respondents have previously been impacted by a natural disaster. Of those impacted, 65 percent were impacted by a flood event; 71 percent impacted by a severe weather event, and 12 percent have been impacted by an earthquake.
- 59 percent have been impacted by 1-3 disaster events, with 35 percent impacted by five or more disasters; 41 percent of respondents indicate that the disasters have occurred while they have lived or worked in the tribal planning area, with 80 percent indicating their ability to utilize their residence or place of work was impacted.
- 88 percent of respondents indicate that they are familiar with the hazards of concern that have the potential to impact them.
- When queried, 47 percent of respondents indicate that they are somewhat prepared with respect to self-preparedness; 13 percent indicate they are adequately prepared; 7 percent indicate they very well prepared, but 33 percent indicate they are not prepared at all.
- Preparedness efforts include 81 percent of responders receiving first aid/CPR training; 19 percent have received Community Emergency Response Training; all respondents have taken mitigation actions to reduce the risk of wildfire; 25 percent have developed a fire escape plan, with 38 percent having established a family meeting place or out-of-area phone contact. 50 percent of respondents have medical supplies, including medications, with 69% having stored food and water.
- 69 percent of respondents confirmed that if the primary access to their home were impacted, there would be no alternate escape route. This issue was identified in the plan as an issue of primary concern for all of the hazards, supporting a greater need for sheltering capacity on the Reservation (particularly outside of the tsunami and flood inundation zones) not only for tribal members, but also for employees of the Reservation, and individuals in proximity to the Reservation or traveling through the area as isolation would be significant.
- The Internet (63 percent), public awareness campaigns (56 percent), Tribal meetings (56 percent), and Tribal Newsletters (44 percent) are the selected means of obtaining hazard information. These were the avenues utilized by the planning team to disseminate information during the development of the hazard mitigation plan.
- The majority of respondents (44 percent) ranged in age from 31 to 50, with 19 percent ranging in age from 51 to over 61.

Public Meetings

Due to both the remoteness of the Reservation and the COVID health crisis, large public gatherings were limited. As such, the Tribe conducted public outreach events via the internet and web, and made use of existing meetings already scheduled meetings, both in person and virtual, including department head meetings and regularly scheduled bi-weekly Council meetings. Public Outreach also included the October

22, 2022 General Membership Meeting, which included notice of the meeting and topics of discussion to all registered tribal members.

Such events allowed attendees to examine information and still have direct conversations with project staff, as each outreach effort provided direct contact information. Information generated from the risk assessment was shared with attendees via the Tribe's website, with notices distributed in several different ways, making use of existing capabilities and resources. Maps, charts, and data were provided for the primary hazards to which the planning area is most vulnerable. The hazard profiles and risk assessment findings were published on the Tribe's website once completed, asking for citizen review and comments.

Planning Team Members were available to answer questions, with email addresses provided to which questions and comments were also directed. Citizens were asked to complete the on-line survey if they had not yet done so, and each was given an opportunity to provide written comments to the Planning Team. The Planning Team also distributed flyers, providing information on the project. Each distribution provided the Tribe's website address on which all information was maintained, including the link to the survey. Flyers were distributed at various times throughout the process, as well as discussed at every council meeting. Additional specific details of outreach events are identified in Table 2-2.

Comments received were reviewed and vetted through the Planning Team Members, and data incorporated as appropriate. The initial draft plan was distributed to the Planning Team Members beginning October 12, 2022. After comments and information gathered during the review process were incorporated, the final draft plan was again distributed for review by all Tribal Citizens beginning October 17, 2022. Copies of the plan were made available via the Tribe's Mitigation webpage. Notice of its availability was provided through multiple sources, including website postings, internal email distribution lists, and employee distribution lists. Announcement was also made during the Tribe's Annual General Meeting occurring on October 22, 2022, at which various risk and other data was available in handout format. The draft plan was available from October 17, 2022 - November 11, 2022. Comments received were integrated into the plan as appropriate after approved by the planning team.

The final public meeting was held on xxxxx, during which time the plan was presented to the Tribal Council, and at which time the Council approved and adopted the plan prior to submission to FEMA, with the provision that any revisions required by FEMA would not require re-adoption by the Tribe unless they were of a monetary nature. Due to the allocated grant pending drawdown and use based on plan finalization, the Tribe felt that adoption prior to submission to FEMA for review was appropriate with the given caveat so that there was no delay in pre-adoption and approval letters.

News Releases / Newsletters

The Tribe's Newsletter, which is distributed electronically and hardcopy to Tribal Citizens, was also utilized during this process to regularly to provide information concerning on-going efforts with respect to the survey, and on-going planning effort. By engaging the public through the public involvement strategy, the concept of mitigation was introduced to the public, and the Planning Team received feedback that was used in developing the components of the plan.

Tribal Council Meetings and Website

At the beginning of the plan development process, information was added to the Tribe's website to inform and keep the public advised on plan development milestones and to solicit relevant input. Discussions during Tribal Council meetings also occurred, during which the Project Manager, Robert Smith, provided status updates on the process, solicited information from meeting attendees, and advised of the various project milestones. Tribal leaders, directors, and some tribal citizens attended the various meetings, which are regularly scheduled meetings.

The Tribe's website address was publicized in all press releases, mailings, flyers, questionnaires, and public meetings. Information on the plan development process, the Planning Team, the questionnaire, and phased drafts of the plan were made available to the public on the site. The Tribe intends to keep their website active after the plan's completion to keep the public informed about successful mitigation projects and future plan updates.

2.1.8 Plan Development Chronology/Milestones

Table 2-3 summarizes some of the important milestones in the development of the plan, including public outreach events. The planning team members communicated at least on a weekly basis throughout this entire process with the intent to capture and present relevant data and information. This included on a very regular basis outreach with FEMA Region X personnel due to the pending Congressional Earmark, which was awarded in September 2022. The Executive Director also provided briefings and information-gathering sessions at all of the established Council meetings, as well as during the Tribe's Strategic Planning Meetings to ensure adequate information exchange.

TABLE 2-3
PLAN DEVELOPMENT MILESTONES

Date	Group	Description
2022		
Jan-May	Initiate consultant procurement	Seek a planning expert to facilitate the process
June	Select Bridgeview Consulting, LLC to facilitate plan development	Facilitation contractor secured
June	Kick-Off Meeting (During June 15th Council Meeting) Website Launched	Website launched identifying project; Frequently Asked Questioned posted to website, Press Release prepared and distributed. Notice distributed on Facebook page, an Email blast to all tribal government employees and Tribal businesses; and announced on the bi-weekly Executive Director's address during Council Meetings. Hazards of concern identified and confirmed for this update cycle. New methodology for risk ranking and strategy prioritization identified and confirmed.
June	Newsletter / News Releases	A News Release was distributed to all tribal members and posted in various locations throughout the Reservation, announcing the kick-off of the HMP project and soliciting all tribal members and employees to take the Hazard Mitigation Survey and take part in the planning process.
June	Planning Meeting	Continued formation of the Planning Team. Began review of existing plan and existing documentation supporting effort (e.g., studies, other planning documents, etc.) Distributed sample Goals and Objectives (approved), defined Critical Facilities, confirmed Hazards of Concern. Identified potential public outreach strategy for presentation. Will use Website and email distribution lists, which reach tribal and non-tribal citizens; will utilize existing (bi-weekly) council meetings as primary planning team meetings and information exchange as all meetings are regularly scheduled and open to all tribal members, with minutes provided by Council Secretary. Other avenues will be utilized as meetings and events are scheduled and occur.
June	Survey Launched	Deployed Survey via web, developed posters with survey address, which was included in Tribal Newsletter distributed in August. Email distributions were also made to tribal citizens and tribal staff and tribal enterprises.
June 22	Planning Meeting	Continued data capturing re: hazard impact; review of existing plan.
June 29	Planning Meeting	Capabilities assessment discussed; various tables distributed to capture current capabilities information. Tribal Executive Director/Project Manager took lead to capture data from various departments, the Tribe's attorneys, and personnel as appropriate, conducting one-on-one meetings.
July	Planning Meeting	Planning meeting re: map layout presented and approved; call for photographs from previous events; discussion re: NFIP flood maps; discussion re: previous hazard impacts. Data capture re: land use development and tribal roadways.

TABLE 2-3
PLAN DEVELOPMENT MILESTONES

Date	Group	Description
Aug 8	Planning Team	Strategy Development – reviewed old strategies and began update of current status; continued new strategy development, with focus on potential projects for enhancement within the Hoh Highlands area.
Sept 29	Planning Meeting	Internal review of draft plan risk assessment and methodology used to conduct the analysis; confirmation of risk analysis and ranking; continued strategy development and prioritization. Planning Team Members and Tribal staff provided information regarding strategies for inclusion in the HMP update and status of previous strategies.
Oct 3	Public Council Meeting, Presentation of Risk, Review of Updated Strategies, Continued Strategy Development	Presented Risk Findings and Hazard Rankings based on analysis conducted. Discussions regarding grant opportunities and strategy development. Reviewed strategies developed to date, with call for any potential additional strategies; Tribal Council approved risk ranking as presented.
Oct 3	Public Outreach	Hazard profiles posted on tribal website for risk review; email distribution to all tribal employees and citizens registered re: availability of risk assessment information.
Oct 7	Planning Team	Internal review of remaining portions of draft HMP by Planning Team Members begins.
Oct 17	Public Outreach	The Draft HMP was made available on the Tribe's Website. Email distribution made to the tribe's defined "public" of plan's availability for review.
Oct 22	General Body Meeting - Public Comment Period of Draft Plan Review Continues	During the Tribe's annual General Body Meeting, the Tribe's Executive Director and Tribal Co-Chair provided an overview of planning process, hazards addressed, and availability of draft plan for public review process. Notice of the plan's availability was also sent out via various email lists. The plan remained available for comment until November 7, 2022.
Nov x	Plan Adoption	Final public meeting on Plan presented at Tribal Council Meeting. Tribal Council adopted plan. Resolution forwarded to FEMA.
Nov x	Plan Submittal	Draft Plan submitted to FEMA Region X for review.
	Plan Approval	Final plan approved by FEMA

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CHAPTER 3.
HOH INDIAN TRIBE PROFILE

3.1 HISTORY AND GOVERNMENT

The Hoh, Quileute and Quinault originally met with territorial governor and Indian supervisor Isaac Stevens to negotiate the Quinault River Treaty on July 1, 1855. Within this Treaty, the natives would cede lands to the government in turn for reserved tracts of land for their exclusive use. The parties to this Treaty signed the document on January 25, 1856; it was ratified March 8, 1859 and proclaimed on April 11, 1859. The treaty originally established a 10,000-acre reservation around the village of the current-day Taholah. In exchange, the Hoh, Quinault, Quileute and Queets Tribes gave up all of the lands north of Grays Harbor to the area of the Makah Tribe.

On September 11, 1893, by Presidential Executive Order, the Hoh Indian Reservation, which amounted to less than one square mile, was established at the mouth of the Hoh River. The Hoh Tribe was officially recognized by the federal government in 1960.

The Treaty also provided for compensation in the amount of $25,000 for lands ceded to the United States, which was thought by Tribal members to be an insufficient amount. Approximately 70 years later, on April 17, 1963, the Indian Claims Commission awarded the Hoh's and the Quileute's compensation for ceded lands in the amount of $112,152.60.

The Hoh are governed by a constitution, adopted on July 1, 1969. The Hoh Tribe governing body is the General Council, which is comprised of all enrolled members 18 years of age and older. Governmental operations function through a seven-member Business Committee, established by Article III of the Hoh Tribe's Constitution. The Business Committee body are elected by the General Council for two-year terms to oversee tribal administration and business. The Business Committee is elected to specific positions composed of the Chairman, Vice-Chairman, Secretary, Treasurer, Member at Large 1, Member at Large 2, and Member at Large 3. The elected Business Committee members govern the Reservation and all trust lands belonging to the Tribe's members.

The tribe's administrative functions are overseen by the Executive Director who reports directly to and receives policy direction from the Business Committee. The Executive Director oversees tribal operations through a departmental structure. The tribe's organizational structure and management system promote a separation of policymaking and management functions and establish clear lines of authority within the organization.

The Hoh Tribe provides a wide variety of public services to the community. These services include law enforcement, a court system, various health and welfare services such as Indian Child Welfare, Community Health Resources, Substance Abuse, Housing, Social Services, Youth Programs, and Guardian ad Litem services. The Tribe also has a Natural Resources Department, which establishes annual fishing rules and regulations within the U&A. The Department of Community includes public works, utilities, food, water and custodial operations.

3.2 LOCATION AND GEOGRAPHY

The Hoh Indian Tribe Reservation is situated on the west Olympic Peninsula in Jefferson County, Washington. The nearest town to the Hoh Indian Reservation, Forks, is located approximately 30 miles south, where the closest grocery store is located. The Tribe also owns a small amount of land in Clallam County, Washington consisting of a triplex (part of the Tribal Housing), a structure currently rented by a non-tribal member as a gift shop, and two additional small structures. While those structures are not profiled within the risk assessment, this mitigation plan covers all land mass and structures owned and operated by the Hoh Tribe.

The Hoh Tribe Reservation was originally situated on 640 acres of land, or one square mile. The Tribe is bordered by the Hoh River and the Pacific Ocean. The ocean and the river have slowly claimed much of the original lands through erosion and changes in tide and river courses. Of the 640 original Reservation acres, land base now includes only 443 acres of dry land; more than a 30% decrease.

The Hoh River flows 56 miles from its headwaters to the Pacific Ocean. The South Fork Hoh River is 17 river miles in length and enters the main stem at the Olympic National Park boundary at Road Marker 30. The upper section of the Hoh watershed lies entirely within the Olympic National Park (ONP). The middle section of the river flows through state and industrial forest and valley homesteads. The Lower Hoh River encompasses the lower third of the watershed, 16 river miles from Highway 101 to the Pacific Ocean. 750 miles of tributaries flow into the river below ONP. Of these, 250 miles provide fish habitat. Numerous spring-fed terrace tributaries feed the Hoh River and its tributaries.

The Hoh River descends more than 7,000 feet from the Olympic glaciers to tidewater in only 50 miles, and is a critical aspect of the environment that makes traditional aboriginal lifeways possible in the watershed. The annual rainfall results in abundant and unique rainforest vegetation.

The Hoh River watershed is home to four species of wild salmon and steelhead as well as many other fish and wildlife species. Famous for its temperate rainforest and large conifers, the Hoh River is considered one of the few relatively healthy rivers remaining in the lower 48 states.

From testimony of Chairman Walter Ward during a hearing before the House Natural Resources Committee on H.R. 1061 in support of The Hoh Indian Tribe Safe Homelands Act (2009), "90% of the Hoh Reservation is located within a 100-year flood plain, and 100% is located within a tsunami zone. Winter and spring floods now regularly impact Reservation homes, government facilities, and utility structures. Flooding restricts further development and causes ongoing problems with existing structures. In addition to the flooding danger, all of the Reservation facilities and homes are at or below 40 feet elevation and within inundation zones if a major tsunami were to strike."

Located at the mouth of the Hoh River, the Hoh Indian Tribe is dependent on the fish and wildlife of the Hoh River for their subsistence and commercial economy. The protection of the watershed's function is key to preserving these important resources, not only for the tribe, but also for fishing and recreational communities in nearby cities and towns, and up and down the coast. The entire watershed of the Hoh River lies within the Usual and Accustomed (U & A) area of the Hoh Tribe, and the tribe is a partner in all management issues related to the watershed alongside several partners.

3.2.1 Usual and Accustomed Fishing Areas

The Hoh Tribe is heavily dependent economically, culturally, and spiritually upon natural resources found within the Tribe's Usual and Accustomed (U&A) hunting, fishing, and gathering area. Through litigation, including the Western Boldt decision, the tribe has rights of co-management of natural resources found within the Tribe's U&A, including fish and wildlife. The U&A is much larger than the ceded reservation lands, and for conservation purposes includes an area of over 400 square miles of watershed and a marine U&A of thousands of square miles. Figure 3-1 shows the U&A area.

For over 30 years the tribe has hired resource professionals to manage tribal hunting and fishing, wildlife, and fishery stocks within the U&A. Since the Tribe is small and many federal grants are allocated in direct proportion to the number of persons in the tribe, the funds generated for administration of the resources have been low. The U&A physical size and its fish and wildlife component, however, rival those of much larger tribes who have access to much greater funding sources. In essence, the Hoh Tribe has had to do resource management on a very large area, with many fewer resources than many other tribes. This has resulted in the Hoh Tribe being under-represented in many facets of resource management in the tribal U&A and environmental protection of its ceded reservation lands.

3.2.2 Characterization of the Hoh River Watershed

The Hoh River is on the west Olympic Peninsula in Jefferson County, Washington State. The river flows 56 miles from its headwaters to the Pacific Ocean. The South Fork Hoh River is 17 river miles in length and enters the main stem at the Olympic National Park boundary at River Mile 30. The upper section of the Hoh watershed lies entirely within the Olympic National Park. The middle section of the river flows through state and industrial forest and valley homesteads. The Lower Hoh River encompasses the lower third of the watershed, 16 river miles from Highway 101 to the Pacific Ocean. 750 miles of tributaries flow into the river below the Olympic National Park. Of these, 250 miles provide fish habitat. Numerous spring-fed terrace tributaries feed the Hoh River.

The Hoh River watershed is home to four species of wild salmon and steelhead, as well as many other fish and wildlife species. Famous for its temperate rainforest and large conifers, the Hoh River is considered one of the few relatively healthy rivers remaining in the lower 48 states.

Natural hazards can disrupt fisheries and can cause secondary hazards that can have consequences much greater than the hazard itself. Any event occurring anywhere within the U&A ecosystem can have significant impact anywhere within the area. Several of the hazards to which the Tribe is vulnerable can cause these secondary impacts. Increased frequency of wildfires in the mountainous ranges enhances the vulnerability to landslides and mudflows, which can significantly impact salmon spawning and disrupt fishers. Similarly, earthquakes can increase landslide and mudflows. Flooding, especially within the Hoh Watershed, can cause log jams or deposit debris, destroying or damaging kelp beds and other salmon food habitats, destroying or diminishing flood supplies.

Figure 3-1. Hoh Tribe U&A

Industry and man-made threats are perhaps the most significant threats to the U&A. Washington State is home to several of the largest ports worldwide and is also home to many refineries which ship oil. The highway system is a direct corridor from U.S. border to border. This highway system carries enormous amounts of hazardous materials. Whether release of oil or chemicals is caused by human error, acts of terrorism, or as the result of a natural hazard event, the impacts are the same: entire ecosystems potentially destroyed.

The protection of the watershed's function is key to preserving these important resources, not only for the tribe, but also for fishing and recreational communities in nearby cities and towns, and up and down the coast. The entire watershed of the Hoh River lies within the U&A area of the Hoh Tribe, and the tribe is a partner in all management issues related to the watershed alongside several partners.

3.2.3 Archeological Overview

There are only a few documented archeological sites along the Hoh River. With the number of known indigenous residence locations, the reasons for few documented sites are probably fluctuations in the river, and minimal public lands in the middle Hoh. The documented sites that fall within this watershed analysis include the Hoh River mouth area, which has a long and varied history of use. There is a cedar grove on state land that was the former site of canoe manufacture in proximity to the Barlow/Anderson residences near Coal Creek. Cedar stumps showing signs of hand tools and remains of canoes never finished have been found along the Hoh. One area for processing canoes, documented as a state

archeological site, is located above Missy Barlows. On the South Fork there is a rock shelter that contains some evidence of cultural use. There are numerous known village, fishing and hunting locations in the ethnographic record; however, there has been no physical documentation of these places.

3.3 CLIMATE

The Hoh Reservation on average receives ~120-140+/- inches of rainfall annually, making it one of the wettest areas of the lower 48 states. Most of the precipitation occurs from October through April, which contributes to the occurrence of winter floods on the Hoh River. The driest period is during the spring, when snowmelt runoff is the dominant source of water for the Hoh River. The climate in the planning area supports an extensive mix of conifer forests, consisting of western hemlock, Douglas fir, and western red cedar, as well as a deciduous forest consisting of big-leaf maple, red alder, black cottonwood, upland scrub-shrub (thimbleberry, salmonberry, Douglas spiraea), and riparian or forested wetlands.

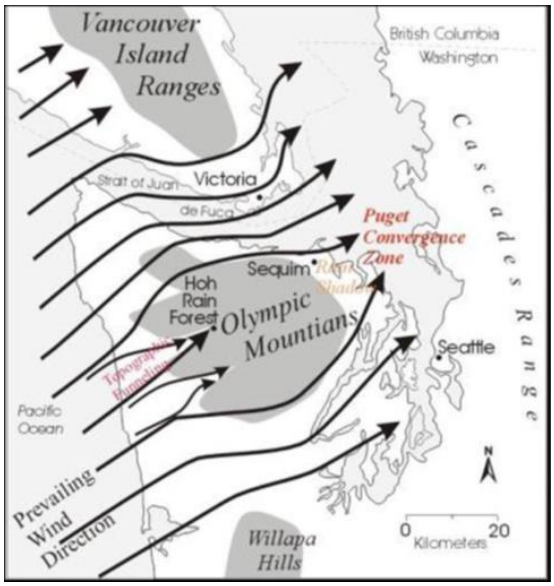

Figure 3-2 Prevailing Wind Direction

Weather system flow direction (see Figure 3-2) demonstrates that most climatic incidents occur over the open waters of the ocean and flow on-shore. The ocean currents that flow along Washington State's coast and the Pacific westerlies (also known as the jet stream or storm track) influence the Tribe's moderate climate. Temperatures are fairly mild within the Hoh Region compared to other portions of the state. Average high temperatures range from 44ºF in January to 72ºF in August (see Table 3-1). Winds have been recorded at and above 100 mph during the storm season, which normally occurs November through February.

Because the Hoh River runs through the temperate rainforest of the Olympic Mountains, it receives considerable rain in its watershed. While peak flows on the Hoh River occur in November and December, the average daily flows are greatest in June because of glacial melt. Low flows typically occur in August and September. Because of its location in the Hoh Rainforest, the region has not been impacted by drought events like other portions of the state, although they did experience impact to the fishing industry as a result of the 1994 Disaster Declaration for the El Nino effect on the salmon industry.

Table 3-1.
Annual Temperature and Precipitation Hoh Reservation

	Average high in °F	Average low in °F	Av. precipitation - inch
Jan	44	34	16.65
Feb	49	35	15.47
March	52	35	13.5
April	57	38	8.98
May	62	43	6.14
June	66	47	3.82
July	70	50	2.8
Aug	72	50	2.76
Sep	69	47	4.37
Oct	59	42	11.06
Nov	49	37	17.72
Dec	44	34	18.46

3.4 DEMOGRAPHICS, DEVELOPMENT AND REGULATION

Knowledge of the composition of the population and how it has changed in the past and how it may change in the future is needed for making informed decisions about the future. 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. Population changes are useful socio-economic indicators. A growing population generally indicates a growing economy, while a decreasing population signifies economic decline.

3.4.1 Tribal Enrollment

Based on Hoh Enrollment data, enrolled tribal population as of 2022 is approximately 275 citizens. Approximately 85 enrolled members live on or near the Reservation, although that number may be low when consideration is given that many families are multi-generational within the same household. The Hoh do anticipate a continued increase in population, with more tribal citizens returning to the area once the Hoh Highlands area has been developed. Currently, there are 80 families on the waiting list to move onto the Reservation. For planning purposes, the sum of 4.35 per person, per household was utilized to identify potential population impact.

3.4.2 Age Distribution

In general, as a group, the elderly (65 and over) are more apt to lack the physical and economic resources necessary for response to hazard events and are more likely to suffer health-related consequences making recovery slower. They are more likely to be vision, hearing, and/or mobility impaired, and more likely to experience mental impairment or dementia. Elderly residents living in their own homes may have more difficulty evacuating their homes and could be stranded in dangerous situations. This population group is

more likely to need special medical attention, which may not be readily available during natural disasters due to isolation caused by the event. Specific planning attention for the elderly is an important consideration given the current aging of the American population.

Children under 5 are also particularly vulnerable to disaster events because of their young age and dependence on others for basic necessities. Very young children may additionally be vulnerable to injury or sickness; this vulnerability can be worsened during a natural disaster because they may not understand the measures that need to be taken to protect themselves from hazards.

According to Census data (2021), the median age distribution on the Reservation is 37.2 years.[1] Based on Census data, approximately 8 residents are under 5 years of age, with 4 residents over the age of 65.

3.4.3 Income

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

U.S. Census Bureau data identifies the median household income on the Reservation to be $38,750 (2022 figures), with $64,994 being the median household income nationwide. Approximately 47.1 percent of the Tribal Members living on the Reservation and 25% of seniors over 65 fall below the poverty line (2020 Census). Per capita income is $14,260, approximately two-fifths of the amount in the United States, which is $35,384.

The Hoh Tribe does meet the criteria for recognition as an Impoverished Community.

3.4.4 Disabled Populations

The 2010 U.S. Census Bureau estimates 54 million (non-institutionalized) Americans with disabilities in the U.S. This equates to about one-in-five persons. People with disabilities are more likely to have difficulty responding to a hazard event than the general population. Knowing that local government is the first level of response to assist individuals, coordination of efforts to meet the access and functional needs of individuals with disabilities is paramount to life safety efforts. In this respect, it is important for emergency managers to distinguish the differences between *functional* and *medical* needs to allow them to plan

[1] Census Report. Accessed 29 June 2022. Available at: https://censusreporter.org/profiles/25000US1460-hoh-indian-reservation-and-off-reservation-trust-land/

accordingly for incidents which require evacuations and sheltering needs. Pre-determining the percentage of population impacted with a disability will provide emergency management personnel and first responders the information necessary to pre-plan by having individuals available who can provide those services necessary to meet the requirements of those with access and functional needs.

The 2020 Census identifies a total of seven (7) individuals living on the reservation with a disability, broken down by age as follows: one (1) under the age of 18 years; four (4) between the ages of 18-64, and two (2) 65 years of age and over.

3.4.5 Economy

The Tribe has limited access to economic hubs due to both its remote location, and its inability to develop land outside of the hazard area. With the development of the Hoh Highlands area, which is anticipated to be completed during the life cycle of this plan, the Hoh Tribe is hopefully that it will be able to develop some forms of economic expansion. At present, however, the unemployment rate on the Reservation continues to be high, similar to that as it was during development of the 2012 Hazard Mitigation Plan.

Washington State Employment Security Department, in conjunction with the federal Bureau of Labor Statistics annually compile a list of distressed areas within Washington state by averaging the employment and unemployment numbers for the prior three years. Distressed areas are counties where the three-year unemployment rate is at least 20 percent higher than the statewide average. At present, Jefferson County, the County in which the Reservation is located is considered a distressed area, with 7.2 percent of its population unemployed, which is an increase from 6.1 percent during 2011, when the last plan was completed (see Figure 3-3).[2] The Tribe again feels that the percentage of unemployed on the Reservation is much higher, with approximately 50-60 percent of the population unemployed.

[2] Washington State Employment Security Department – Distressed Areas List (2021). Accessed 29 June 2022. Available online at: ESDWAGOV - Distressed areas list

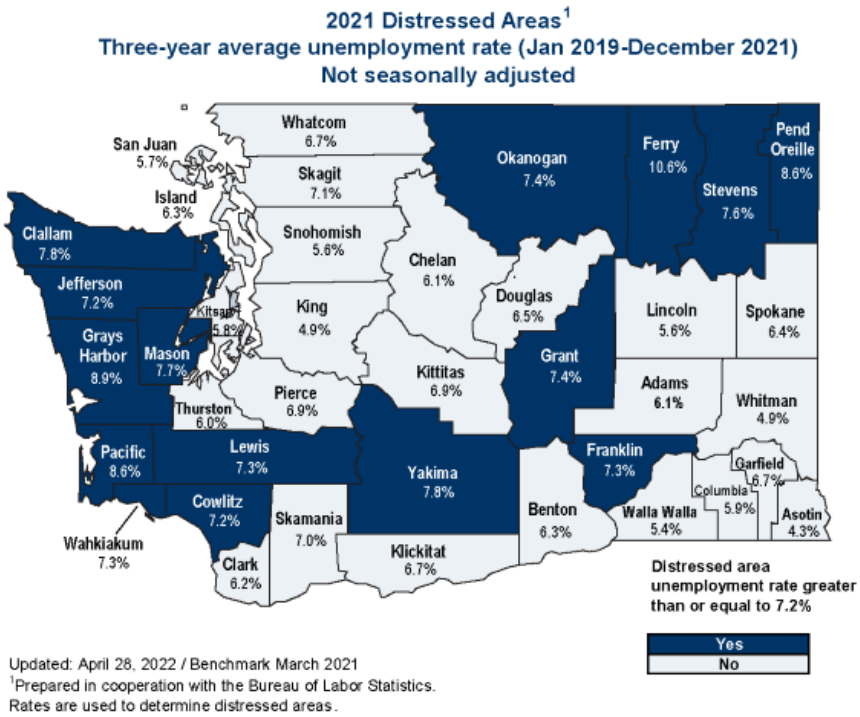

Figure 3-3 Washington State 2021 Distressed Areas

3.5 MAJOR PAST HAZARD EVENTS

Presidential disaster declarations are typically issued for hazard events that cause more damage than tribal governments can handle without assistance from the federal government, although no specific dollar loss threshold has been established for these declarations. A presidential disaster declaration puts federal recovery programs into motion to help disaster victims, businesses, tribal and public entities. In some instances, grant funding from disaster declarations are also matched by state programs and funds, for which the Tribe may be eligible.

Table 3-2 identifies all Federal Disaster Declarations which have occurred in Jefferson County since 1953 for which presidential disaster declarations were issued, or in the case of fire, where the fire management was issued. A total of 26 disasters occurred (one for Hurricane Katrina Evacuees is not listed).

Unfortunately, many natural hazard events do not trigger or rise to the level of a federal disaster declaration, but nonetheless have significant impacts on their communities. These events are also important to consider in establishing recurrence intervals for hazards of concern. Limited dollar loss data is available to identify impact to the Hoh Tribe for most events. The Hoh have identified the capture of such loss data as a strategy for future planning efforts, as well as to support grant opportunities.

TABLE 3-2
DISASTER HISTORY 1953-2021

Type of Event	FEMA Disaster #	Date
Severe Winter Storms, Snowstorms, Straight-line Winds, and Flooding	4650	12/26/2021
Flooding and Landslides	4635	11/23/2021
Severe Winter Storms, Straight-line Winds, Flooding, Landslides, and Mudslides	4593	12/29/2020
COVID-19 Pandemic (x2)	4481	01/20/2020
Severe Winter Storms, Straight-line Winds, Flooding, Landslides, Mudslides and Tornado	4418	12/10/2018
Severe Storms, Straight-line Winds, Flooding, Landslides, Mudslides and Tornado	4253	12/1/2015
Severe Storms, Straight-line Winds, Flooding, Landslides, Mudslides	4249	11/12/2015
Severe Windstorm	4242	8/29/2015
Severe Winter Storm and Record and Near Record Snow	1825	3/2/2009
Severe Winter Storm, Landslides, Mudslides, and Flooding	1817	1/30/2009
Severe Storms, Flooding, Landslides, and Mudslides	1734	12/8/2007
Severe Storms, Flooding, Landslides, and Mudslides	1671	12/12/2006
Severe Storms, Flooding, Tidal Surge, Landslides and Mudslides	1641	05/17/2006
Severe Storms and Flooding	1499	11/7/2003
Nisqually Earthquake	1361	3/1/2001
Severe Storms, Flooding, Landslides, and Mudslides	1172	4/2/1997
Severe Winter Storms/Flooding	1159	1/17/1997
Storms/High Winds/Floods	1079	1/3/1996
El Nino Effects (Salmon Industry)	1037	08/02/1994
High Tides, Severe Storm	896	3/8/1991
Flooding, Severe Storm	883	11/26/1990

TABLE 3-2 DISASTER HISTORY 1953-2021		
Type of Event	**FEMA Disaster #**	**Date**
Severe Storms, flooding	757	2/15/1986
Volcano, Mt. Saint Helens	623	5/21/1980
Storms, High Tides, Mudslides, Flooding	612	12/31/1979
Heavy Rains, Flooding and Wind	137	10/20/1962

The most common disasters to occur - severe storms and flooding, are further broken down by month, year, recurrence intervals (not based on order of magnitude), probability of occurrence, and FEMA ranking as illustrated in Table 3-3 (based on FEMA event typing). For these generalized purposes, recurrence intervals are determined by the number of events divided by the number of years to obtain an average. In some instances, recurrence intervals based on magnitude are contained within the hazard profiles. The recurrence intervals are not based on the order of magnitude (e.g., a 100-year storm), but rather on the fact that the event occurred, no matter what the magnitude. The Percent Probability of Occurrence is calculated by the dividing the number of events by years, and then multiplying that sum by 100 to create the percent probability of an event occurring in any given year.

TABLE 3-3
STORM DISASTER HISTORY BY MONTH, RECURRENCE, AND PROBABILITY OF OCCURRENCE

Hazard Type	Jan	Feb	Mar	Ap	May	June	July	Aug	Sept	Oct	Nov	Dec	Total	Years of Occurrence	FEMA Rank	Recurrence / Years (No Order of Magnitude)	Probability/ (Percent risk that an event may occur)
Flood	2	2	2	1	0	0	0	0	0	0	1	1	**9**	62, 79, 86, 90, 91, 97, 09, 16, 21	2	7.5	13.24
Severe Storm (including Wind)	3	0	2	1	1	0	0	0	0	1	1	2	**11**	86, 96, 97, 03, 06, 07, 09, 15, 16, 19, 21	1	6.18	16.18
TOTAL	**5**	**2**	**4**	**2**	**1**	**0**	**0**	**0**	**0**	**1**	**2**	**3**	**20**				

Based on FEMA designation and dates.

3.6 LAND USE AND FUTURE DEVELOPMENT TRENDS

As a Sovereign Nation, decisions on land use are governed by tribal government, who maintain legislative and policy-making authority.

The Tribe has adopted the most recent edition of the International Building Codes, and regularly updates its existing Tribal Code to ensure the most current codes are in place. In addition, in July 2011, the Tribe began development of its first Comprehensive Land Use Plan in accordance with NFIP (and other) regulations. In general, land use categories are divided into six zones: Forested Lands, Rural/Agricultural, Commercial, Mixed-Use, Residential, and Sensitive Lands, which includes Environmental and Cultural lands. Sensitive Lands may overlay any other zone.

The uppermost main stem of the Hoh River, which abuts the Olympic National Park, is federally regulated. Private forest lands are regulated under the Forest Practices Act. Residences and agricultural land surround the Reservation are covered under Jefferson County's Unified Development Code. The most conservative regulations in the planning area are those on the Olympic National Park. Of significance is development in areas that are considered culturally sensitive. The Tribe works closely with local communities to protect its cultural resources both on and off the Reservation.

For new construction which are built with funding from the Bureau of Indian Affairs (BIA) or other federal funds (such as grants), the following underlying principles will form the foundation for the Tribe's land use goals and policies.

- Create complete and integrated communities (or neighborhoods) containing housing, shops, work places, campsites, parks, pedestrian and bicycle paths, and civic facilities essential to the daily life of the Tribe while keeping cultural resources and cultural heritage intact.
- Encourage the development of a tribal center that combines commercial, civic, cultural and recreational uses.
- Design new mixed-use communities so that housing, jobs, daily needs and other activities are within easy walking (or limited driving) distance of each other.
- Encourage integration of housing, commercial, office park and public uses in designated mixed-use areas, while preserving the locations of culturally sensitive areas.
- Develop zoning codes and regulations that allow for clustering of commercial and business areas to facilitate walking. Limit the linear extent of commercial areas along major thoroughfares to discourage auto-oriented sprawl and increase community viability and growth.
- Allow for a mixed use of businesses in new residential subdivisions and planned residential areas. Consider grocery stores, childcare, hotels, recreation areas, campgrounds, open space, fishing and other public and commercial services that residents and tourists need and want on a regular basis as appropriate.
- Encourage site design that promotes sustainability, as well as pedestrian access, business development and potential transit use. Locate as many activities as possible close together to enhance tourism.

- Ensure that streets, pedestrian paths and bike paths contribute to a system of fully connected and interesting routes to all destinations. Encourage pathways that facilitate pedestrian and bicycle use by being adequately sized and spatially defined by buildings, trees and lighting, and by discouraging high-speed traffic.
- Provide an ample supply of specialized open space in the form of squares, greens and parks, fishing and campgrounds, whose frequent use is encouraged through placement and design.
- Ensure that the Tribe maintains well-defined edges, such as agricultural and forest greenbelts, wildlife corridors and urban separators, which are permanently protected from development.
- Ensure that planning and development are pedestrian-oriented and designed to enhance the human scale, creating a greater sense of community and place that enhances the livability of the Reservation, while promoting its hopes for expansion.
- Respect the integrity and character of existing natural topography, vegetation and landscape features when locating roads and other development.
- Establish maximum impervious surface lot coverage standards for land use designations to maintain the overall integrity of the land and surrounding area.
- Promote development that supports natural drainage and infiltration for new subdivisions, multifamily development, and commercial development in a manner which is economically sound and environmentally feasible.

The Tribe's present land use designations and development status would be defined as mixed use with cluster-density. However, no new or additional housing development has occurred on the Reservation for over 30 years and the majority of all public facilities were developed before 1983.

Structure Development Since Completion of Last Plan

Since completion of the last plan, minimal development has occurred. A new Fish Hatchery Building was constructed in 2017 to replace an older structure which had previously been impacted by flood and severe storm events and became unreliable. The structure is a pole-barn type structure, built to existing International Building Codes. The new hatchery structure was also equipped with a generator to help ensure survival of the hatchery fish, since previous power outages have caused extensive fish kills. The generator is on an elevated platform, which is above base flood elevation. While the structure does fall within the floodplain and tsunami inundation zone, all precautions have been taken to reduce the potential for impact from a flood or severe weather event to the extent possible.

The Tribe also constructed a Public Safety Building (2014) and a new water storage tank facility (2012), both of which are in the area of the Hoh Highlands, and outside of the hazard zones of flooding and tsunami. Both structures serve as critical facilities for the Tribe, with no negative hazard impact resulting from construction of the facilities.

In approximately 2012, the Tribe did construct a wastewater treatment facility due to the old system continually failing as a result of flood and other hazard impact. That facility is on the existing Reservation due to proximity of use to the facilities and structures. The facility was built to code. No increased hazard impact is expected from construction of the new facility should the facility sustain damages from a hazard

incident as the older facility was in very poor condition and had a greater hazard risk factor due to its age and condition. The new facility is built to higher and better standards, with multiple safeguards built into the system.

Homeownership consists of individual, BIA, and HUD housing (including rentals) located on the Reservation. There are currently 25 single-family residential structures owned by individual tribal members, as well as two duplex units owned by Tribal Housing, for a total of 29 residential structures on the Reservation. There is also one triplex structure located Clallam County, which is also part of Indian Housing, but not located within the study region for purposes of vulnerable population estimates.

Community water, roads and other (public) utilities have been developed within the area, but the tribe utilizes every possible means to ensure that new development or remodel does not have an adverse impact on the hazards of concern.

Much of the owned tribal lands are considered culturally sacred; however, there are specific areas which are particularly more significant, such as areas designated for archaeological preservation. The Tribe's cultural resource protection program provides protection to ancestral and sacred sites and landscapes in cooperation with federal, state, and local land management agencies, private developers, and landowners.

Much of the existing Reservation is located within the 100- and 500-year floodplain; the entire existing Reservation is within the Tsunami Inundation Zone. These factors reduce the amount of land available for economic development or community facilities and are areas on which any type of land development is either totally restricted, or highly monitored. Expansion to the new Hoh Highlands area will allow for economic development and additional community facilities.

Permitting and Enforcement

The Hoh Tribe does not require permitting for construction occurring on the Reservation or on Tribal lands, but fully comply with existing permitting and code requirements in place at the local level for tribal structures remodeled or built off of the Reservation on lands not yet in trust. Structures built on the Reservation or trust lands are inspected by the tribal building official, with electrical inspections completed by State inspectors.

Once infrastructure is in place in the Hoh Highlands, development will conform to the International Building Codes for any new construction. That area will serve as the primary residential use area for the Reservation.

At present, new buildings funded with Federal dollars are required to be built to existing International Building Code (IBC) standards. The Hoh Tribe has always utilized the most stringent codes in place at the time of construction when any construction or remodeling has occurred. Once complete, this 2023 update to the Hazard Mitigation Plan, along with existing development regulations, will be utilized to support land use development in the future by providing vital information on the risk associated with natural hazards in the planning area, and support development in such a way as to reduce the impact of the hazards on the Tribal citizens and visitors to the planning area. The Tribe will incorporate by reference the Hazard Mitigation Plan in any future comprehensive or land use plans as completed. This will assure

that all future trends in development can be established with the benefits of the information on risk and vulnerability to natural hazards identified in this plan, as well as continue to protect the natural environment.

Future Development

Future development during the life cycle of this plan includes housing, governmental structures (including essential facilities), and economic expansion.

Congress previously awarded the Tribe approximately 37 acres of land within the Olympic National Park. The Tribe and the Forest Service are working on an agreement that will allow the Tribe to develop hiking trails from Highway 101 to the Pacific Ocean. They are also working together to development agreements on programs for the public to learn about the culture and traditions of the Tribe through a partnership with the Olympic National Park. Once completed, the trails will also provide evacuation routes from the lower portion of the Reservation to the new Hoh Highlands area.

While the Hoh Tribe presently has a limited level of tourism traveling specifically to visit the Reservation, it is well-known that the Hoh are a well-established fishing tribe. Because of this, desire by non-tribal members to fish on the Reservation does draw a level of tourists to the tribal lands. During the life cycle of this plan, it is hoped the Tribe will be constructing a new business center in the Hoh Highlands area, which will enhance tourism to the Reservation. The Tribe anticipates a retail store to sell handmade goods, as well as a convenience store, a potential restaurant, campground area (once the existing Reservation is relocated and the land remains open space) and a tour business for hiking and fishing on the Reservation. The tribe did purchase a fueling station (~2012), which is outside of the flood and tsunami zone on the Upper Hoh River Road; however, the station is not currently operational. Once expansion of the Hoh Highlands is completed, it is anticipated that the fueling station will again become operational.

With development of the Hoh Highlands area, the following are under review for future development (these areas have been included within the current risk assessment):

- Residential structures, including single family and multi-unit complexes;
- Government administrative facilities;
- Community Center, Health and Wellness Structures, Social Service Buildings; and
- Gas/Fueling Station.

Examples of the positive and low-impact activities undertaken by the Tribe are discussed throughout the document, but include, among other efforts, acquisition of properties for open space, including the removal of structures from those properties, and elevation of portions of previously flooded buildings. Additional projects are further discussed in Chapter 13.

3.6.2 Critical Facilities and Infrastructure

Figure 3-4 Hoh Wastewater Treatment Facility

Critical facilities and infrastructure are those that are essential to the health and welfare of the population. These become especially important after a hazard event. Critical facilities typically include police and fire stations, schools, shelters, and emergency operations centers, among others. 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. As defined for this Hazard Mitigation Plan, critical facilities are focused on tribal-owned facilities, and include, but are not limited to the following:

- Tribal owned facilities such as department, agency, council facilities, and administrative offices that provide essential services to the Hoh People.
- Emergency response facilities needed for disaster response and recovery, including, but not limited to: public safety buildings/emergency services buildings; emergency supply storage facilities (e.g., food bank), and shelters.
- Medical and health facilities and offices used during both emergency response or in the normal course of business.
- Facilities that may be used to house or shelter disaster victims, such as: gymnasium, schools/day care/head start facilities, senior or community centers.
- Utilities and infrastructure vital to maintaining or restoring normal services to the areas damaged by the disaster.
- Community gathering places, including culturally significant areas, parks, community centers, structures, and meeting halls.
- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic, and/or water-reactive materials.
- Cultural sites that are vitally important to maintaining the Tribe's cultural history, language, and traditions, such as burial grounds, archaeological sites, and artifact storage facilities.
- All residential/housing units (single or multi-family).

The Planning Team developed a detailed list of those structures meeting the identified definition, which was utilized as the primary source of risk assessment during this process.

The critical facilities identified for this plan update incorporate ~53 structures, including culturally significant structures, 25 individual residences (tribal member ownership), and three tribal-owned residential structures (two duplex units and one triplex unit). (The residential structures are included because of the inability to replace the units should they be destroyed as they are within the floodplain and tsunami inundation zones.) The list of structures itself is not provided within this document and is considered confidential in nature. The Tribe will continue to rely on the Jefferson and Clallam County's Hazard Mitigation Plans to identify critical or essential facilities which are not owned or managed by the Tribe which are at risk to the hazards of concern.

For emergency management planning purposes, building structure values considered in this plan which are owned and operated by the Hoh Tribe total approximately $14.6 million. Table 3-4 identifies illustrates the critical facilities in the Tribal Planning Area.

TABLE 3-4
CRITICAL FACILITIES

Critical Facility Type	Count	Building Values (Combined)
Commercial	8	$1,438,621
Government/Administration	8	$2,398,414
Hazmat (Tribal Owned gas station currently fuel tank empty)	1	$30,930
Medical	1	$250,000
Protective	4	$2,445,000
Residential	25	$4,742,000
Schools (Daycare, Head Start)	1	$325,000
Shelters (Gym)	1	$635,000
Transportation (bridges)	0	0
Water (value includes two underground wells; no structures)	3	$1,129,892
Wastewater	1	$1,200,000
Totals	**53**	**$14,594,857**

3.6.3 Age and Type of Building Stock

The year of construction is significant in determining the potential impact from various hazards due to construction standards in place at the time. Structures built pre-1975 historically have maintained lower building standards than current codes in place. Moderate code are those structures built after 1975. New construction is built to higher standards. The oldest structure on the Reservation is the gym/shelter facility, built in 1975. Remaining structures are post-1975, with the most recent being completed in 2017.

All structures are wood framed with the exception of the wastewater treatment plant and the water storage tank (metal and concrete). These structures were built in 2012, to existing building codes in place.

There are a limited number of modular buildings in place, which have taken the place of structures previously damaged by flood or severe weather events.

3.6.4 Transportation and Bridges

The Tribe owns limited roadways on the Reservation, utilizing Highway 101 as its major transportation route. No bridges are on the Reservation; however, the bridge located on Forks, Washington serves as a major component of evacuation of the area should a major incident occur. If the Forks bridge is compromised, it would significantly impact the area by restricting traffic.

3.6.5 Rail

Union Pacific Railroad owns land in proximity of the Tribe, with approximately 27 acres of land purchased by the Hoh Tribe from Union Pacific, including 12 acres which provide a right of way to Union Pacific. At present, no railroads operate in Jefferson County within the vicinity of the Tribe.

3.6.6 Hazardous Materials

Hazardous materials can be released for many reasons, including as a potential terrorist target, human error, or the structural integrity being compromised by a natural hazard event, such as an earthquake, tsunami, flood, or landslide (among others). Release of hazardous materials could cause significant damage to the environment and people.

The planning area has no hazardous materials sites situated within a one-mile radius of tribal structures identified in Washington State Department of Ecology's Hazardous Materials Annual Report (2021). The Tribe owns one gas station facility on tribal lands, which is currently not operational and its tanks empty.

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CHAPTER 4.
CAPABILITY ASSESSMENT

The Planning Team performed an inventory and analysis of existing authorities and capabilities called a "capability assessment." A capability assessment creates an inventory of the Tribe's mission, regulations, programs, and policies in place, and evaluates the capacity to carry them out. Table 4-1 summarizes the legal and regulatory capabilities of the Tribe. Table 4-2 summarizes the administrative and technical capability. Table 4-3 summarizes fiscal capability. Table 4-4 identifies mitigation efforts which are on-going in the planning area. This information illustrates an integration of on-going tribal planning efforts, including FEMA programs and initiatives, among others.

TABLE 4-1
LEGAL AND REGULATORY CAPABILITY

	Tribal Authority or Program in Place	Other Jurisdictional Plan or Program in Place	State Mandated	Comments
Codes, Ordinances & Requirements				
Building Code IBC Standards	Y		Y	The Hoh Tribe utilizes and has regularly adopted the most currently building code standards in place.
Floodplain Ordinance				The Tribe's Flood Ordinance was developed in 2012. Most current flood maps are dated 2019, indicating Flood Zones A, VE and X.
Stormwater Management	Y	Y	Y	Follow WA State Stormwater Manual
Growth Management	Y			The Tribe has established areas for development which has been updated as new land mass is acquired; however, no formal growth management policies have been developed. While the Tribe is not required to address growth management in the same manner as applicable counties and cities in the state of Washington, it has developed smart land use decisions which are consistent with the county and state requirements as applicable.

TABLE 4-1
LEGAL AND REGULATORY CAPABILITY

	Tribal Authority or Program in Place	Other Jurisdictional Plan or Program in Place	State Mandated	Comments
Tribal Health and Safety	Y	Y	Y	Health and Safety as it relates to public health of tribal citizens is addressed by Tribal Wellness, who administers programs and provide assistance with medical services. Limited application of medical services occurs on the Reservation. For some matters, the Tribe also works with Jefferson County and State Dept. of Health to provide various types of health campaigns.
Climate Change Adaptation	Y		Y	The Tribe is actively engaged in various climate change issues. The Tribe has had a practice of purchasing surrounding lands which are frequently flooded. Those lands have remained in their natural environment, embracing climate change adaptation practices as climate change continues to impact and exacerbate hazard prone areas as a result of, among other causes, increased precipitation, and severe storm events. Much of the coastal area of the Tribe has also been lost due to climate change and erosion. Much of the bluff area on the reservation continues to be eroded. The Tribe has restricted most efforts to stop the impacts, but instead has adopted to embrace the changes as they have occurred.
Environmental Protection	Y			Tribal programs as well as EPA regulated programs.

TABLE 4-1
LEGAL AND REGULATORY CAPABILITY

	Tribal Authority or Program in Place	Other Jurisdictional Plan or Program in Place	State Mandated	Comments
Forestland-Urban Interface Fire Protection Act	Y			The Tribe works closely with its federal and local fire protection service entities and enlists the aid of property owners toward the goal of turning properties into less volatile zones, enhancing firefighter safety and effectiveness. While not mandated, the Tribe is actively involved in forestland protection activities, working with ONP personnel. At present fire response is 45 minutes one way from the Reservation, so the Tribe fully recognizes the benefits of the Fire Protection Act. With the new development in the Hoh Highlands, fire hydrants will be in place to help reduce wildfire impact as much as possible.
Planning Documents				
Improvement Plan	Y			Improvement plans via the Business Committee and Natural Resources exist for developed areas, and several undeveloped parcels.
Floodplain or Basin Plans or Activities	Y			The Tribe is engaged in planning efforts to reduce flood damages and protect aquatic species in the watersheds throughout the area.
Capital Improvement Plan	Y			The Tribe has a plan in place for future development and enhancement of existing structures.
Habitat Conservation or Clean-Up Plans	Y			Climate Change plans, air/water quality monitoring, among others.

TABLE 4-1
LEGAL AND REGULATORY CAPABILITY

	Tribal Authority or Program in Place	Other Jurisdictional Plan or Program in Place	State Mandated	Comments
Community Wildfire Protection Plan	N	N	N	The Tribe does not have a CWPP. However, the Tribe does participate in planning initiatives as available with surrounding communities and the National Park to ensure forest health and works with the fire suppression organizations as needed. The Tribe also provides information to Tribal citizens concerning reducing wildfire fire risk in the area. The Tribe has previously established Outdoor Burning Bans and identifying acceptable burn practices.
Transportation Plan	N			The Tribe has very minimal roadways on the Reservation and has no Long-Range Transportation Plan or Safety Plans in place.
Response/Recovery Planning				
Comprehensive Emergency Management Plan / Emergency Operations Plan	Y			Currently under revision as a subset of this HMP development.
Post-Disaster Recovery Plan	N			The Tribe has various plans in place to address disaster impact, but no specific recovery plan. The emergency manager has identified this as a potential strategy over the lifecycle of this plan.
Continuity of Operations Plan	N			
Administration, Boards, and Commission				
Mitigation Planning Committee	Y			A Hazard Mitigation Committee was established to develop this plan. Those members will remain on the committee during the lifecycle of this plan and will conduct the annual reviews as identified in the plan maintenance section while in office.

TABLE 4-1
LEGAL AND REGULATORY CAPABILITY

	Tribal Authority or Program in Place	Other Jurisdictional Plan or Program in Place	State Mandated	Comments
Maintenance programs to reduce risk (e.g., tree trimming, clearing drainage systems, chipping, etc.)				Several programs are in place to reduce impact from the hazards of concern, including various environmental and climate change programs.
Mutual Aid Agreements / Memorandums of Understanding	Y		N	The Tribe has MOUs with various entities from which it receives and provides various services.

TABLE 4-2
ADMINISTRATIVE AND TECHNICAL CAPABILITY

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Executive Director, Natural Resources Director, Economic Development Department Staff and Contracted Services
Professionals trained in building or infrastructure construction practices (building officials, fire inspectors, etc.)	Yes	Executive Director and County/State Resources
Engineers or inspectors specializing in construction practices?	Yes	Executive Director and Contracted Services
Planners or engineers with an understanding of natural hazards	Yes	Under Contracted Services
Staff with training in benefit/cost analysis	Yes	Tribe has performed BCAs.
Surveyors	Yes	Contracted Service Agreement.
Personnel skilled or trained in GIS applications	Yes	GIS professional on staff.
Personnel skilled or trained in Hazus use	No	(Contracted Services as needed)
Scientist familiar with natural hazards in local area	No	
Emergency Manager	Yes	Designated Emergency Manager is Police Chief Public Safety/Law Enforcement.
Grant writers	Yes	Contracted Services
Warning Systems/Services	Yes	Through County and State services

TABLE 4-2 ADMINISTRATIVE AND TECHNICAL CAPABILITY		
Hazard data and information available to public	Yes	Risk assessment maps are available for review in person and on website. Various flood hazard maps also available.
Maintain Elevation Certificates	Yes	On file for some tribal structures in flood zones.

TABLE 4-3 FISCAL CAPABILITIES	
Financial Resources	**Accessible or Eligible to Use?**
1. Community Development Block Grants	Yes
2. Capital Improvements Project Funding	Yes
3. Authority to Levy Taxes for Specific Purposes	Yes, but none in place.
4. User Fees For Water, Sewer, Gas or Electric Service	No
5. Impact Fees for Buyers or Developers of New Development/Homes (Not at present, but potentially may occur during life cycle of HMP)	No
6. State-Sponsored Grant Programs	Yes
7. Bureau of Indian Affairs Sponsored Grant	Yes
8. Indian Health Services Grant	Yes
9. U.S. Dept. of Agriculture, Rural Development Agency	Yes
10. U.S. Environmental Protection Agency	Yes
11. U.S. Fire Administration	Yes
12. Tribal Homeland Security Grants	Yes – Eligible but never applied
13. Stafford Act Grants	Yes
14. Healthy Forest Restoration Act	Yes

TABLE 4-4
ON-GOING MITIGATION EFFORTS

Mitigation Effort	Available? Yes/No	Department/Agency/Position
Hazardous Vegetation Abatement Program	Y	Through various partnerships with the Forest Service and Tribal maintenance programs
Defensible space inspections program	N	
Creek, stream, culvert, or storm drain maintenance or cleaning program	Y	Actively involved as needed.
Stream restoration program	Y	Various on-going efforts as well as several completed efforts.
Erosion or sediment control program	Y	Actively involved in various restoration projects throughout the area in support of erosion and sediment control efforts, particularly as they impact fish habitat and spawning areas.
Other		

4.1 EXISTING REGULATIONS

Some pertinent federal laws are described below. It should be noted that the Hoh Indian Tribe is a sovereign nation, and as such is not required to adhere to any local or state planning regulations; however, in an effort to be a good steward and neighbor, the Hoh Tribe does strive to plan in consideration of state and local requirements. The Tribe must comply with applicable federal regulations for construction and maintenance of facilities, such as those administered by HUD and EPA, as well as other federal agencies. This places a significant burden upon the Tribe as it is doubly impacted in their efforts when attempting to implement land use authority and other regulatory statutes. The Tribe does assert that application of such regulations during its land use development has reduced the impact and vulnerability from the hazards of concern.

4.1.1 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 eligibility for future hazard mitigation funds.

Endangered Species Act

The federal Endangered Species Act (ESA) was enacted in 1973 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 for listed species. The ESA outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species and contains exceptions and exemptions. Criminal and civil penalties are provided for violations of the ESA.

Federal agencies must seek to conserve endangered and threatened species and use their authorities in furtherance of the ESA's purposes. 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 for threatened species 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."

Nation Landslide Preparedness Act

On January 5, 2021, the National Landslide Preparedness Act (P.L. 116-323) was signed into law authorizing a national landslide hazards reduction program and a 3D elevation program within the USGS. This broadened the already existing Landslide Hazards Program under the Natural Hazards Mission Area, and the 3D Elevation Program under the National Geospatial Program and required additional coordination with other federal agencies.

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, 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. The EPA recognizes that Indian Tribes face serious human health and environmental problems and are working with the Indian Tribes to protect the health and environment of waters in Indian Country.

The Hoh Tribe has EPA approved surface water quality standards that were created to protect the water resources of the Tribe's Usual and Accustomed Area. The Tribe's Department of Natural Resources actively monitors the streams and rivers of the watershed.

Presidential Disaster Declarations

Presidentially declared disasters are disaster events that cause more damage than state, tribe or local governments/resources can handle without federal assistance. 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. Tribal entities have the option of seeking a direct Presidential Declaration, and are not required to join See Sandy Recovery and Improvement Act of 2013 for additional information.

Non-FEMA Disaster Declarations

Unique to tribes is the fact that disaster declarations can also be granted by other federal agencies other than FEMA, such as the Department of Housing and Urban Development and the Bureau of Indian Affairs. In such cases, similar to a Presidentially declared event, funds are designated to help the tribes recover from the impact of disaster events, and customarily carry a match requirement. Those funds are limited to specific needs and are limited in nature.

4.1.2 State-Level Planning Initiatives

The Hoh Tribe must comply with all applicable Federal regulations, which many times are much more stringent than those regulations which state or local jurisdictions must address, placing a much heavier burden on the Tribe as they continue to grow and develop tribal lands. As a sovereign nation, they are not subject to state or local requirements; however, in the spirit of being a good neighbor and in partnership with the surrounding jurisdictions, the Tribe does consider its local communities in all of its planning initiatives. Some planning initiatives which the Hoh Tribe are undertaking also coincide with the following state and local planning initiatives:

- International and Washington State Building Code
- Washington State Enhanced Hazard Mitigation Plan
- Jefferson and Clallam Counties' Hazard Mitigation Plans
- Climate Change Adaptation Planning

4.1.3 General Public Safety Information

Emergency Management:

Emergency management functions are the responsibility of the Police Chief, who has designated the Emergency Manager; however, duties for emergency management planning are shared throughout several departments. The various departments have taken proactive steps to enhance the Tribe's capabilities with respect to emergency response and recovery efforts for both pre-and post-disaster efforts as discussed throughout this plan.

While many of these activities (such as this mitigation plan) have been grant funded through various federal programs, policy development to enhance resilience of the Tribe has been funded through other Tribal funds, demonstrating the Tribe's commitment to developing a robust and applicable *all hazards*

emergency management program. During the life cycle of this plan, the Tribe will continue to seek funds to assist in the development of various response plans, including potentially a: Comprehensive Emergency Management Plan; Continuity of Operation's Plan, and a Recovery Plan, which will further enhance the Tribe's resiliency to disasters.

National Incident Management System (NIMS):

The Hoh Indian Tribe has adopted the National Incident Management System (NIMS) as its operating structure for emergency events.

Schools, Community Centers, and Shelters:

There are no elementary, middle, or high schools owned or operated by the Tribe; however, the Tribe does maintain Childcare/Head Start facility. The Gym/Community Center serves as a gathering place for Tribal citizens and could be utilized as an emergency shelter as needed, including as a cooling and warming shelter. The Tribe does provide emergency food vouchers.

Disaster Declaration Policy:

The Tribe does have an established Disaster Declaration Policy which allows it to request disaster assistance directly to FEMA (and others). The Tribe does have the capacity to administer its own grant and recovery program and would be able to establish an Administrative Plan to administer and track any such grants it receives as a result of any disaster. The Hoh Tribe has previously gone directly to FEMA for disaster declarations. Completion of this mitigation plan is a necessary step in meeting the requirements for that effort, and once approved, the Tribe will continue to be in a position to do so.

Hazardous Materials Response:

There are no personnel trained for a Hazmat response, and the Tribe does not have any capacity in this regard. The Tribe relies on local fire agencies, WSP, and WA DOE for hazmat response and cleanup.

Law Enforcement and Gaming Enforcement

The Tribe does have a Law Enforcement Department for enforcement of Tribal Criminal Code and gaming/hunting enforcement. Additional law enforcement support is provided by Jefferson County Sheriff's department, as necessary.

Tribal Court:

There is a Court facility housing a Court of General Jurisdiction. The Tribe has criminal, civil, domestic violence, probate, and youth operations.

Medical/ Fire Services / Ambulance / Hospital:

Fire services are provided by Jefferson County; Ambulance provides both Advanced Life Support and Basic Life Support. The closest hospital is located in Forks, Washington, and takes approximately 45 minutes each way. The Tribe currently has no ability to provide medical services beyond an Emergency Medical Technician currently on staff (not as an EMT, but in other capacities), and some diabetic and massage therapy, but does provide medical services through Indian Health Services. Medical services also include behavioral health services. The Tribe is in the process of working with Indian Health Services to establish a tribal medical clinic with contracted medical service providers in Forks, but access during an evacuation or emergency situation will reduce capabilities.

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CHAPTER 5.
HAZARD IDENTIFICATION AND RISK ASSESSMENT METHODOLOGY

5.1 OVERIEW

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.

Occurring simultaneous with this plan development, the COVID-19 Pandemic was continuing, with Tribal Nations continuing to be extremely hard-hit – the Hoh being no exception. Response to the Pandemic did impact the ability to develop this plan, with some restrictions existing for meeting/gathering attendance. As such, more one-on-one telephonic meetings occurred, with the Tribe's Executive Director holding additional meetings / information gathering sessions as possible due to restrictions established by the Tribe with respect to work-at-home orders. The Hoh Tribe relied heavily on the use of existing Council Meetings, the internet, email distribution lists, and the one-on-one meetings to capture and disburse relevant data.

The goal of the risk assessment is to determine which hazards present the greatest risk and what areas are the most vulnerable to hazards. The Tribe is exposed to many natural and other hazards. The risk assessment and vulnerability analysis helps identify where mitigation measures could reduce loss of life or damage to property in the planning region. Each hazard-specific risk assessment provides risk-based information to assist the Tribe in determining priorities for implementing mitigation measures.

The methodology utilized for this risk assessment differs significantly from the methodology utilized for the 2012 plan. The current method is more streamlined, and easier to maintain for future updates. It also allows for a more simplistic methodology for adding new or additional hazards of concern.

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.

This 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 to all of the data captured.

The following is provided as the foundation for the standardized risk terminology utilized in this effort:

- Hazard: Natural, human caused or technological 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, when possible, risk includes potential future losses based on probability, severity and vulnerability, expressed in dollar losses. 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.
- Extent and Location: The area of potential or demonstrated impact within the area in which the analysis is being conducted. In some instances, the area of impact is within a geographically defined area, such as a floodplain. In other instances, such as for severe weather, there is no established geographic boundary associated with the hazard, as it can impact the entire area.
- Severity/Magnitude: The extent or magnitude on 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.

5.2 HAZARD IDENTIFICATION AND PROFILES

For this plan, a full range of natural hazards that could impact the planning area was considered. 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 of concern addressed in the last plan as a start point. In review of that list, for this 2022 update, the Planning Team felt Volcano should be removed for this update as Volcano was felt to be of limited potential impact. While ash may accumulate, there was minimal impact during the eruption of Mount Saint Helens, and therefore, it will be removed from this update. The remaining list of hazards was felt to be consistent with the previous plan, with slight modifications to expand Severe Weather and to include discussion on Climate Change within each profile.

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:

- Climate Change (not as a separate hazard, but incorporated into other hazards of concern)
- Drought
- Earthquake
- Flood
- Landslide
- Severe Weather
- Tsunami
- Wildfire

Based on the full spectrum of hazards addressed, it is the intent of the Tribe to use this risk assessment in lieu of preparing a separate hazard identification and vulnerability assessment for other planning efforts which may require same.

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

Identify and profile the following information for each hazard:

- 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.

5.3 RISK ASSESSMENT PROCESS AND TOOLS

The hazard profiles and risk assessments describe the risks associated with each identified hazard of concern. Each chapter describes the hazard, the planning area's vulnerabilities, and probable event scenarios. Chapter 13 summarizes all analysis through completion of the Calculated Priority Risk Index (CPRI) for hazard ranking. This method of profiling the hazards is modified slightly from the previous plan edition, with data reorganized for ease in review and continued update, simplifying the process.

Once the profiles were completed, the following steps were used to define the risk vulnerability 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 probability of occurrence of each event and assessing structures, facilities, and systems that are exposed to each hazard. Tools such as GIS and Hazus (discussed below) were used in this assessment.
- Where specific quantitative assessments could not be completed, vulnerability was measured in general, qualitative term, summarizing the potential impact based on past occurrences, spatial extent, and subjective damage and casualty potential. Those items were categorized utilizing the criteria established in the CPRI (see below).
- The final step in the process was to assign a significance level determined by review of the results of vulnerability based on the CPRI schedule, assigning an ordinal 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.

5.3.1 Calculated Priority Risk Index Scoring Criteria

For the 2022 update, the Planning Team utilized a Calculated Priority Risk Index Score for each hazard of concern, addressing impact primarily at the reservation level. In some cases, this may include areas off the reservation, but vulnerabilities are focused on tribal-owned structures. 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 the tribe 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. 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 13 summarizes the analysis conducted by way of completion of the Calculated Priority Risk Index (CPRI) for hazard ranking.

5.3.2 Hazus and GIS Applications

Earthquake and Flood Modeling Overview

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

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

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that it can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.

- Facilitates the review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Is administered by the tribal or local government and can be used to manage and update a hazard mitigation plan throughout its implementation.

Levels of Detail for Evaluation

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

- **Level 1**—All of the information needed to produce an estimate of losses is included in the software's default data. This data is derived from national databases and describes in general terms the characteristic parameters of the planning area.
- **Level 2**—More accurate estimates of losses require more detailed information about the planning area. To produce Level 2 estimates of losses, detailed information is required about local geology, hydrology, hydraulics and building inventory, as well as data about utilities and critical facilities. This information is needed in a GIS format.
- **Level 3**—This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the planning area.

Building Inventory

A User Defined Facility approach was used to model exposure and vulnerability to the critical infrastructure identified during this process. GIS building data utilizing detailed structure information for tribal facilities was loaded into the GIS and Hazus model. Building information was developed using best available Tribal data, including building address points, aerial imagery, and Hoh Tribe staff resources. Building and content replacement values were estimated using values from various sources, including valuation by Hoh Tribe staff and Tribal First Insurance Coverage data, which identified replacement values, years built, construction type, etc.. Building design codes were determined based on the *Advanced Engineering Building Module (AEBM) Technical and User's Manual.* In some instances, estimations were made where missing data existed to allow for the use of the Hazus Model for Earthquake.

Hazus Application for This Plan

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

- **Flood**—A Hazus Level 2 analysis was performed. Analysis was based on current FEMA regulatory 100- and 500-year flood hazard data, to include the 2017 Hoh Reservation FIRM.
- **Earthquake**—A Hazus Level 2 analysis was performed to assess earthquake risk and exposure. Earthquake shake maps 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. One scenario event was modeled:

  - The scenario event utilized was the Cascadia M9.0 Earthquake.

- **Tsunami** – FEMA and Washington State DNR and EMD recently conducted Tsunami Impact Analysis for much of Washington's Coastline, including the Hoh Tribal Area (2019). That analysis would be similar in nature as to what would be conducted by the Planning Team for purposes of updating this plan – redundant in nature. As that data represents current and Best Available Science at the time of this plan's update, no additional analysis was conducted, but data was reiterated within this document in such a manner to align with the profiling of the hazard.

Severe Weather and Wildfire

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

Drought—The risk assessment methodologies used for this plan focus on damage to structures. Because drought does not impact structures, the risk assessment for drought was more limited and qualitative than the assessment for the other hazards of concern, and discussed within the severe weather hazard with only a brief overview. The potential impact from drought also references fish loss associated with the negative impact of climate change on water levels, and sedimentation issues resulting from drought situations. No additional data

Landslide—Historic landslide hazard data was used to assess exposure to landslides using Washington State Department of Ecology Landslide Susceptibility data. This data depicts landslide susceptibility at a 10-meter resolution across the state of Washington. Utilizing elevation data and WA DNR identified slope susceptibility at anything greater than 40 percent slope, 100', 500', and 1000' buffers were used to identify any potential critical facilities falling within these potential landslide hazard areas. It should be noted that *this data is for mitigation planning purposes only, and should not be considered for life safety matters.* No landslide hazard analysis was conducted, but rather, only reprojection of existing data. Additional landslide data is available at: http://www.dnr.wa.gov/programs-and-services/geology/geologic-hazards/landslides

Severe Weather—Severe weather data was downloaded from various sources, including the Natural Resources Conservation Service and the National Climatic Data Center, PRISM, Tornado Project, and other sources as referenced. A lack of data separating severe weather damage from flooding, windstorms, and landslide damage prevented a detailed analysis for exposure and vulnerability, as well as the fact that there are no generally accepted damage functions for the hazard. For planning purposes, it is assumed that the entire planning area

is exposed to some extent to severe weather. Certain areas are more exposed due to geographic location and local weather patterns, as well as the response capabilities of local first responders.

Volcano - 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. No historical data was available specifically for the Hoh Tribe with respect to impact and losses associated with the eruption of Mount St. Helens on which impact could be based. Therefore, for planning purposes, it is assumed that the entire planning area is exposed to some extent to ash accumulations from eruption of Mt. Rainier, Mt. Saint Helens, or Mt. Adams. Those structures would be vulnerable to the excessive weight of tephra and rainfall. Certain areas are more exposed to ash accumulations due to geographic location and local weather patterns, as well as the response capabilities of local first responders. No structures were within the Lahar inundation zones. Therefore, this hazard was not profiled within the plan update.

Wildfire— There is currently no validated damage function available to support wildfire mitigation planning because no such damage functions have been generated. Instead, dollar loss estimates were developed by calculating the value of exposed structures identified utilizing the various LANDFIRE Fire Regime (1-5) datasets. Information on wildfire analysis was captured from various sources, including Washington State Department of Natural Resources, Wildfire Protection data, US Forest Service data, LAND FIRE data, and Wildland Urban Interface Zone data, among other sources as available for the tribal planning area.

5.3.3 Probability of Occurrence and Return Intervals

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

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

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

For life safety considerations, even natural hazard events with return periods of more than 1,000 years are often deemed significant if the consequences of the event happening are very severe (extremely high damage and/or substantial loss of life). For example, the seismic design requirements for new construction are based on the level of ground shaking with a return period of 2,475 years (2 percent probability in 50 years). Providing life safety for this level of ground shaking is deemed necessary for

seismic design of new buildings to minimize life safety risk. Of course, a hazard event with a relatively long return period may occur tomorrow, next year, or within a few years. Return periods of 100 years, 500 years or 1,000 years mean that such events have a 1 percent, a 0.2 percent or a 0.1 percent chance of occurring in any given year.

5.4 LIMITATIONS

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

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

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate. *The results do not predict precise results and should be used only to understand relative risk for planning purposes; not life-safety measures.*

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CHAPTER 6. DROUGHT

6.1 GENERAL BACKGROUND

Droughts originate from a deficiency of precipitation resulting from an unusual weather pattern. If the weather pattern lasts a short time (a few weeks or a couple 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.

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.

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 Tribe 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.

6.2 HAZARD PROFILE

6.2.1 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.

When averaged, the nationwide annual impacts of drought are greater than the impacts of most other natural hazard. Impacts occur in all sectors, including agriculture, transportation, recreation and tourism, forestry, and energy sectors. Social and environmental impacts are also significant.

Drought affects both groundwater sources and 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. 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 stream flows are lowest. Reduced water levels in wells also means that the wells are subject to saltwater intrusion. While historically the Tribe has not experienced a drought situation, drought conditions throughout Jefferson County and other surrounding areas may increase pressure on local aquifers, with increased pumping potentially resulting in saltwater intrusion into freshwater aquifers. Should this occur, it could cause restrictions on growth and development, impacting the economy of the Tribe.

The Tribal Planning Area's drinking water comes from the local watersheds, with the water tank on the Reservation storing approximately 73,000 gallons. This equates to approximately a four-day supply of freshwater on the Reservation.

6.2.2 Previous Occurrences

While there is no record of data indicating that the Reservation has ever experienced a drought, the Tribe was declared in 1994 under Disaster Declaration 1037 for an El Nino effect on the salmon industry.

Fish mortality caused by low water levels are immediate and the impacts can be expected to be seen over a much longer-term starting with reduced spawning runs four years later, then subsequently on each four-year return cycle. If subsequent de-watering events happen in the alternate years, multiplicative affects against the salmon spawning can be expected. The Tribe operates a salmon hatchery to ensure the survival of the salmon in the waters on and surround the Reservation, particularly within the U&A areas. A drought situation impacting salmon and other wildlife would have a significant impact upon the tribe's limited economy and subsistence, on which tribal members rely heavily.

Presently, various Palmer indexes demonstrate the Tribal region to be in the normal range for moisture content. However, because of the potential impacts from climate change, the densely wooded terrain and lack of fire services, drought is a concern of Tribal members.

In the past century, Washington has experienced several drought episodes, including several that lasted for more than a single season—1928 to 1932, 1992 to 1994, and 1996 to 1997. Table 6-1 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 6-2 illustrates the variations between the two droughts affecting Washington by late September of their respective years.

TABLE 6-1
DROUGHT OCCURRENCES

July-August 1902	No measurable rainfall in Western Washington
August 1919	Drought and hot weather occurred in Western Washington
July – August 1921	Drought in all agricultural sections.
June-August 1922	The statewide precipitation averaged 0.10 inches.
March – August 1924	Lack of soil moisture retarded germination of spring wheat.
July 1925	Drought occurred in Washington
July 21-August 25, 1926	Little or no rainfall was reported.
June 1928-March 1929	Most stations averaged less than 20 percent of normal rainfall for August and September and less than 60 percent for nine months.
July – August 1930	Drought affected the entire state. Most weather stations averaged 10 percent or less of normal precipitation.
April 1934-March 1937	The longest drought in the region's history – the driest periods were April-August 1934, September-December 1935, and July-January 1936-1937.
May – September 1938	Driest growing season in Western Washington.
1952	Every month was below normal precipitation except June. The hardest hit areas were Puget Sound and the central Cascades.
January – May 1964	Drought covered the southwestern part of the state. Precipitation was less than 40 percent of normal.
Spring 1966	Drought throughout Washington
June – August 1967	Drought throughout Washington
January – August 1973	Dry in the Cascades.
October 1976 – September 1977	Worst drought in Pacific Northwest history. Below normal precipitation in Olympia, Seattle, and Yakima. Crop yields were below normal and ski resorts closed for much of the 1976-77 season. 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.

TABLE 6-1 DROUGHT OCCURRENCES	
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 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 crop and aquatic species. Many rivers and streams experienced record low flows.

TABLE 6-1 DROUGHT OCCURRENCES	
2019	On May 20, 2019, Governor Jay Inslee issued an emergency drought declaration in 24 watersheds statewide. According to the Washington State Department of Ecology, very dry conditions over several months and a diminished snowpack impacted streamflow, which were identified to be well below normal conditions across most of the state.[3] 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. While stream flows were strong in the southeast corner of the state, 27 out of 62 watersheds were declared for drought as of May 20, 2019, including watersheds within Jefferson County.
2020	Several months in a row of below-average precipitation brought drought to the Pacific Northwest in spring 2020, with only the northwestern corner of Washington, around Seattle, free of any kind of drought or abnormal dryness. As the region's dry summer approached, the winter and spring precipitation deficits pose a threat to livestock operators, farmers, and fish, and heighten the risk of wildfires. In this event, while precipitation falling as snow was initially at normal levels, the higher-than-average temperatures caused rapid snow melt, with runoff coming earlier in the year causing high rates of soil moisture evaporation.
2021	The spring of 2021 was the second-driest on record, and then an unprecedented late-June heatwave smashed temperature records across the state. In response, Washington State Department of Ecology issued an emergency drought declaration in July 2021 covering 96 percent of the state. Only Seattle, Everett, and Tacoma – cities with ample water storage – escaped the designation.

TABLE 6-2
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.

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

TABLE 6-2
COMPARISON OF IMPACTS OF 1977 DROUGHT TO 2001 DROUGHT

Impact	1977 Drought	2001 Drought
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.

6.2.3 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 criterion for drought is a water supply below 75% of normal and a shortage expected to create undue hardship for some water users.

Droughts customarily do not directly impact structures; however, droughts do impact individuals (farmers, laborers, etc.), the agricultural and natural resource industries, and other precipitation-dependent sectors. Lack of snowpack has forced ski resorts into bankruptcy, and campgrounds to close. There is increased danger of forest /wildland fires. Millions of board feet of timber have been lost. Loss of forests and trees increases erosion, causing 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. The fishing industry can also be impacted through depleted water sources, or increased water temperatures, causing fish kill that perpetuate for many years.

All areas of Washington are vulnerable to drought to some degree, although the level of impact varies. The coastal areas of Washington, the Olympic Peninsula, and areas in Central Washington east of the Cascades are particularly vulnerable. Many of these areas 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.

A drought lasting for more than one season would most likely reduce the annual snowpack 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 area would be impacted. Customarily when such events occur, the initial response is to institute voluntary water conservation measures, particularly in those communities which receive water supplies from the depleted watersheds. Such was the case with the 2019 drought throughout much of Washington.

The Hoh River Watershed is the primary source of water for the Hoh Reservation. While previously not impacted as significantly as other watersheds in the area, the impact of drought, when coupled with climate change, could increase the negative affects the Hoh River Watershed more significantly, impacting not only the water supply, but the abundance of natural resources on which the Hoh continue to be dependent, including the fish and wildlife.

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 both short-term and the current status of the potential for an agricultural drought or moisture surplus, which can change rapidly from week to week. Both indices indicate general conditions and not local variations caused by isolated rain.

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 at the following address: https://www.cpc.ncep.noaa.gov/products/Drought/

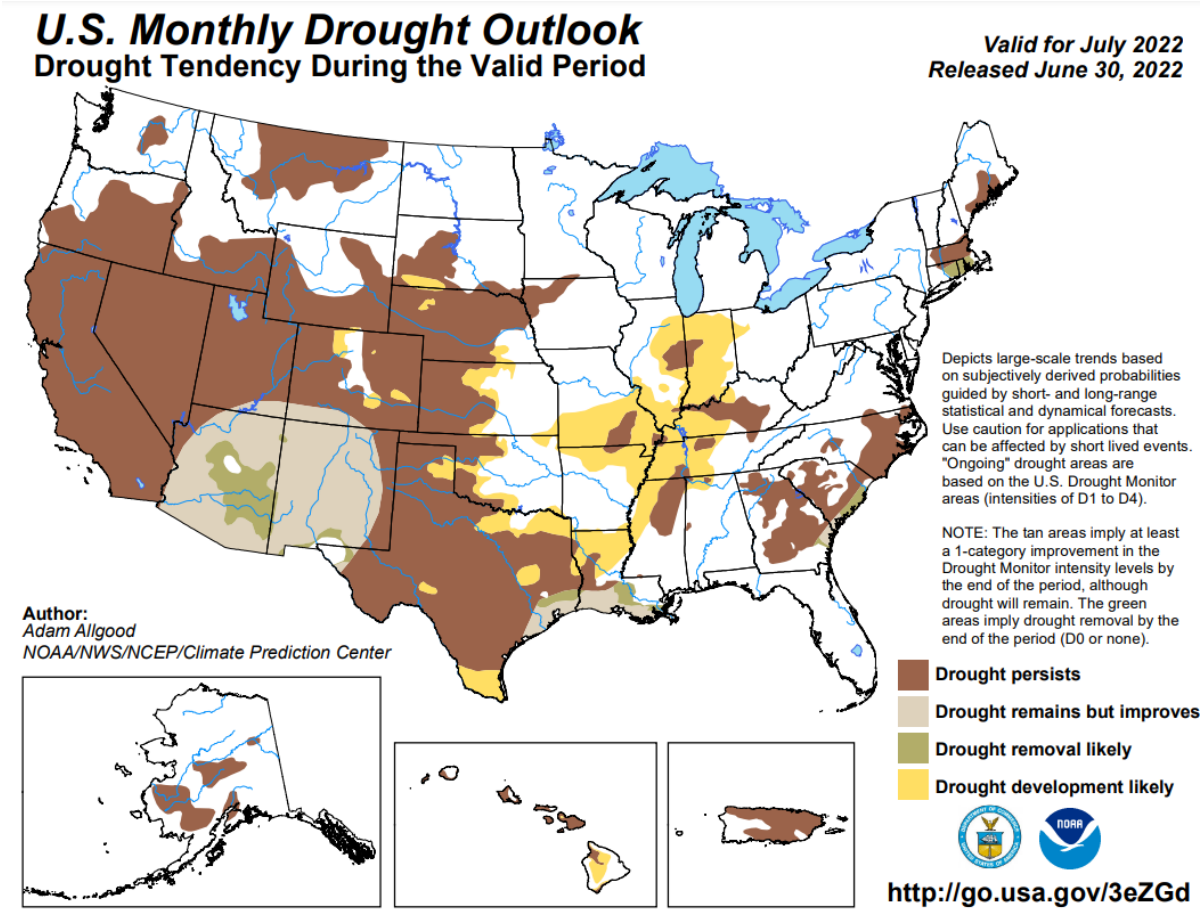


Figure 6-1 June 2022 Drought Monitor Outlook (for July 2022)
Source: NOAA http://go.usa.gov/3eZGd

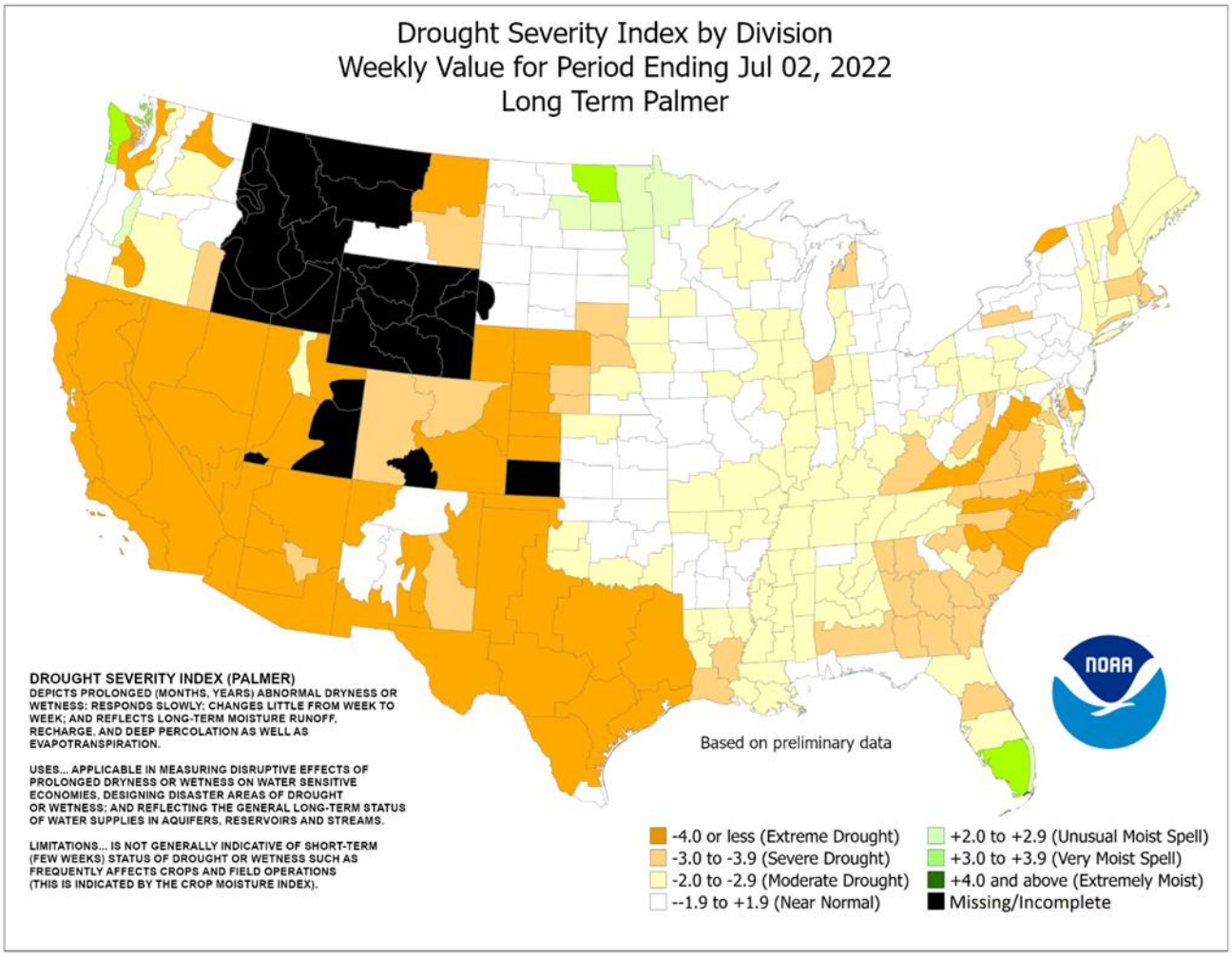


Figure 6-2 Palmer Drought Severity Index July 2022

Source: NOAA https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/regional_monitoring/palmer.gif

The Palmer Crop Moisture Index (Figure 6-3) measures short-term drought on a weekly scale and is used to quantify drought's impacts on agriculture during the growing season (NOAA https://www.weather.gov/ncrfc/LMI_WS_DroughtLinks).

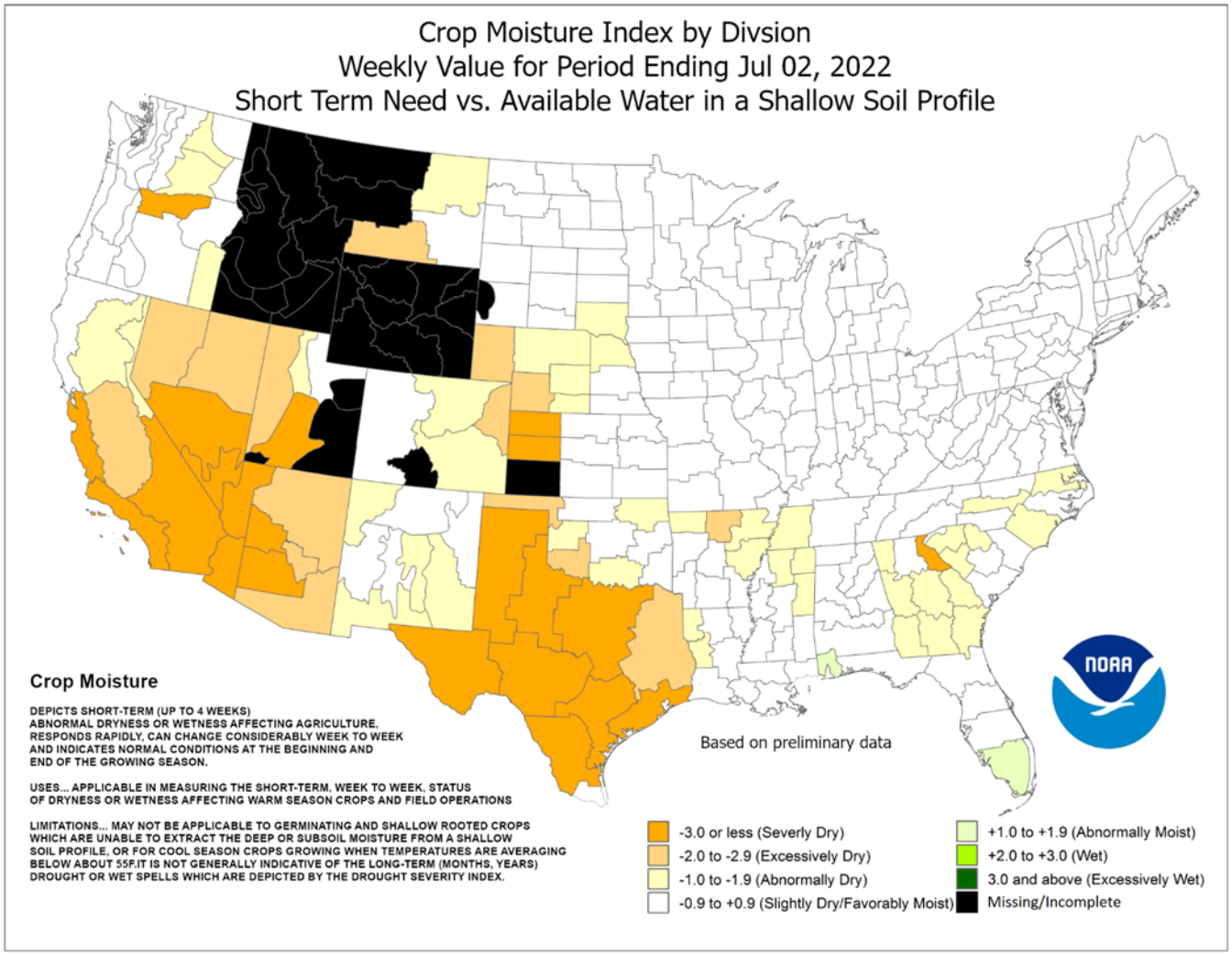


Figure 6-3 Crop Moisture Index

6.2.4 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 currently attainable one 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.

Figure 6-4 illustrates the U.S. Seasonal Drought Outlook as predicted by NOAA for the period July 1 – September 30, 2022. Review of the data illustrates the drought within a portion of Eastern Washington remains in place, but it appears to be improving for the majority of the remainder of the state. No drought is predicted during the period illustrated for Western Washington.

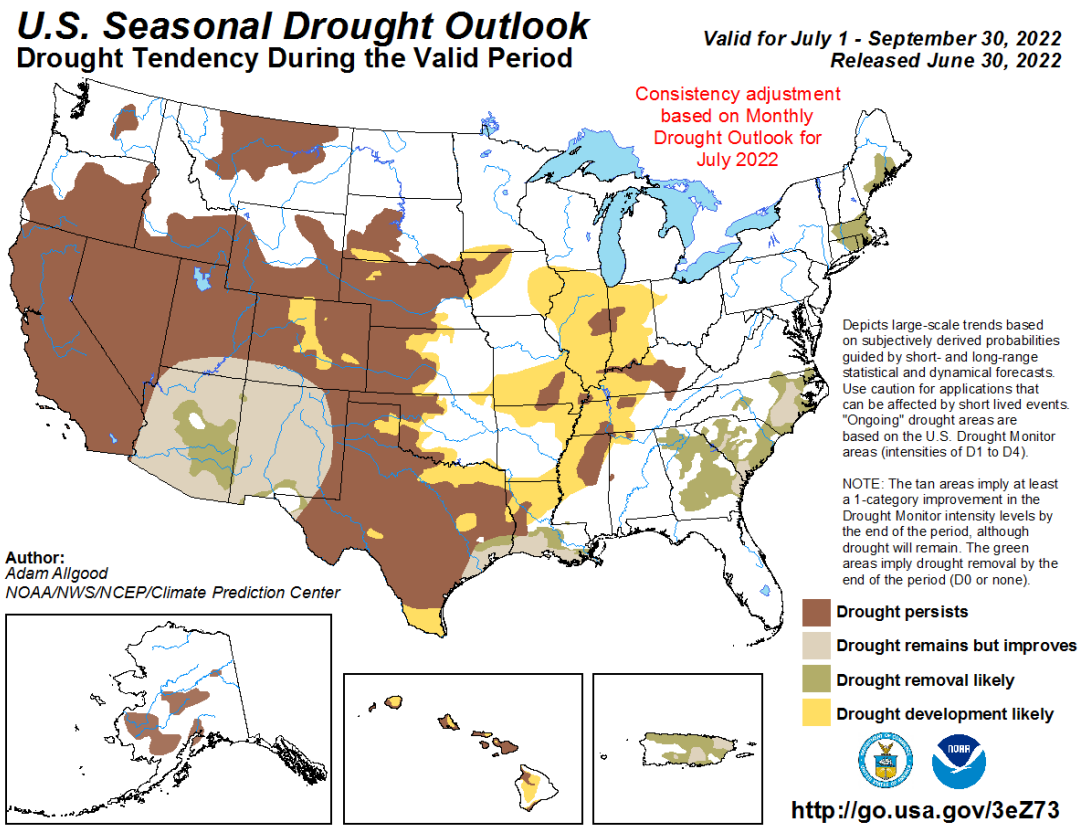


Figure 6-4 NOAA - US Seasonal Drought Outlook Prediction

https://www.cpc.ncep.noaa.gov/products/expert_assessment/sdo_summary.php

6.3 VULNERABILITY ASSESSMENT

6.3.1 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 which host campers, increase the exposure to forest fires. Additional exposure comes in the form of economic impact should a prolonged drought occur, which would impact fishing, fish rearing, recreation, agriculture, and timber harvesting, which is a primary source 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 (2018) 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 the tribal planning area among those areas referenced as being in a "low" status with respect to vulnerability to drought (see Figure 6-5). (As of this writing, the State's HMP is in the process of its 2023 update, but is not yet available for review.)

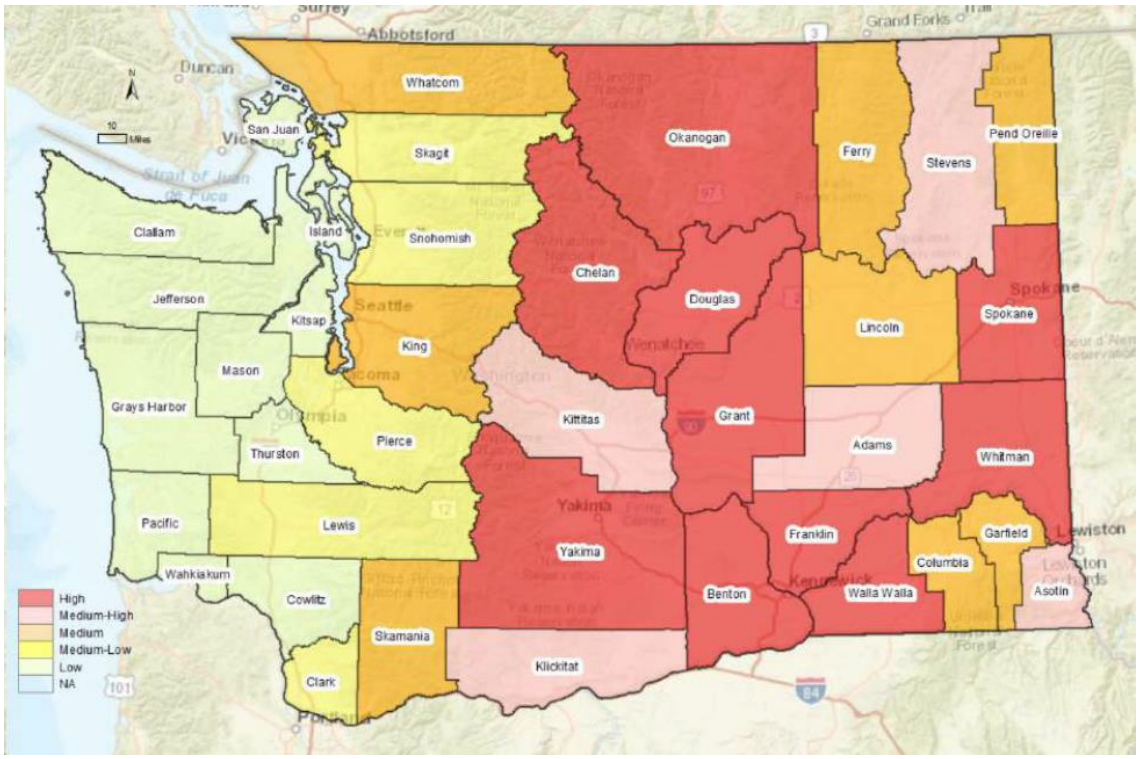


Figure 6-5 WA EMD Drought Risk Index (2018)

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 few months 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.

6.3.2 Impact on Life, Health, and Safety

A drought directly or indirectly impacts all people in affected areas. The Tribe does have limited ability to minimize impacts on residents and water consumers should several consecutive dry years occur. While no significant life or health impacts are anticipated as a result of a drought within the planning area, secondary impacts from reduced income could pose health impacts from lack of availability of foods, health care availability, and, if long term, water source.

Within the planning region, several industries could be forced to curtail operations as a result of a drought situation, resulting in layoffs, impacting income. With much of Washington's energy coming from hydroelectric plants (including Clallam County PUD, which supplies power to the Hoh Reservation), a drought could mean increased power costs coming from dams. Such has become an issue within Washington State 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.

6.3.3 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. Drought could also impact local wells in the area if aquifers are impacted.

6.3.4 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 water 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.

6.3.5 Impact on Economy

As indicated above, economic impact from a drought is associated with different aspects, including, among others, the potential loss of agri- and aqua-cultural production and, of importance within the tribal planning area, tourism associated with recreational fishing services provided by some tribal members. If the fishing industry is negatively impacted, the sale of fish may also be impacted.

Problems of domestic and municipal water supplies have historically been corrected by building another reservoir, a larger pipeline, new well, or some other facility. The Hoh Tribe is reliant on its own wells for its water supply, stored in its water tower.

A drought impacting the watersheds' supply would be significant. 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 this potential, a drought situation, if prolonged, could restrict building within specific areas due to lack of supporting infrastructure, thereby impacting the economy of the Tribe by limiting growth. This will be particularly relevant once construction of the new Hoh Highlands area is completed, as the Tribe intends to develop some structures for economic purposes, such as, potentially, a store and RV/camping sites. 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.

6.3.6 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, among others.

The Hoh Watershed are home to several species of salmon, as well as unique wildlife, flora, and fauna. A severe drought could cause reduced stream flows, thereby creating a major environmental and economic impact on local salmon runs due to potentially warmer waters and low water levels. With the fish hatchery releasing approximately 80,000 fry each year, a drought situation could impact their ability to survive, which would have long-term impacts on future salmon runs due to the lifecycles for fish spawning.

Some effects are short-term, and conditions quickly return to normal after the drought. Other effects linger or even become permanent. Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes, and vegetation, but many species will eventually recover from this effect. Degraded landscape quality, including soil erosion, may lead to a more permanent loss of biological productivity.

Public awareness and concern for environmental quality has led to greater attention to these effects. Drought conditions within the planning area could increase the demand for water supplies. Water shortages would have an adverse impact on the environment. If such conditions persisted for several years, the economy of the area could experience significant environmental setbacks.

6.3.7 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 available for fish spawning due to increased temperatures. It will also impact availability for agricultural growers 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, irrigation and watering of livestock, and firefighters to control and fight fires.

6.4 FUTURE DEVELOPMENT TRENDS

With an increase in population, there is also a propensity to increase water demands, as well as increase demands on other infrastructure, and increase the potential for wildfires. Practicing a low water-use lifestyle will increasingly become the norm for many as summer flows substantially reduce many of our rivers. Reducing water use will help meet future needs and result in cost savings and decrease energy use, helping preserve the environment.

The Hoh Tribe continues to provide information, tools, and incentives to assist Tribal Citizens and local residents to design and implement comprehensive and proven conservation strategies. As the Tribe continues to acquire lands within the planning area, in many instances, such is done with the intent to re-establish or maintain its natural environment. Such actions help to protect the area, and significantly reduce the impacts from drought.

6.5 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.

6.6 IMPACT AND RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from Drought throughout the area is likely. While the Tribe has not experienced a drought beyond that of the 1994 Disaster, Declaration #1037 for the El Nino effect on the salmon industry, with the changing environment due to climate change, impact is likely.

The planning area as a whole has experienced drought conditions, with drought incidents occurring in 2015 and 2019. The State experienced one of its driest summers on record for the last 30 years in 2017, with several counties in the state also issuing declarations in April and June 2019. June 2021 saw record-setting temperatures throughout the state. With anticipated increase in temperatures as a result of

climate change continuing, drought situations will only intensify. In addition, higher temperatures anticipated with climate change would increase vulnerability of the population due to excessive heat, while also potentially impacting power supplies at the hydro-dam in the area. The Reservation is small, with limited resources. With the development of the new Hoh Highlands area, a shelter location is intended, which will serve as a cooling (and warming) facility. Likewise, new houses will be built to higher codes, including better insulation to help reduce levels of heat in residential and governmental structures, as well as the potential for air conditioning for heat, and air filtration systems to help reduce the impact of smoke.

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

Based on the potential impact, the Planning Team determined the CPRI score to be 2.35, with overall vulnerability determined to be a low level.

CHAPTER 7.
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.

7.1 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.

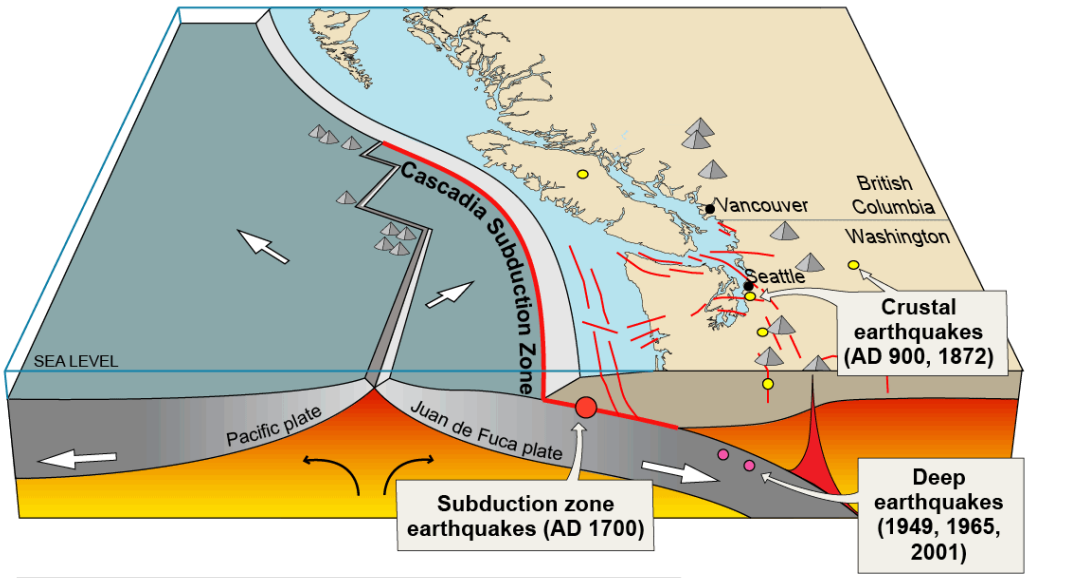
Earthquakes tend to reoccur along faults, which are zones of weakness in the crust. Even if a fault zone has recently experienced an earthquake, there is no guarantee that all the stress has been relieved. Another earthquake could still occur.

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 7-1. 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 7-1 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.

7.2 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.

Table 7-1 presents a classification of earthquakes according to their magnitude.

TABLE 7-1
EARTHQUAKE MAGNITUDE CLASSES

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

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

Intensity

There are many measures of the severity or intensity of earthquake ground motions. The Modified Mercalli Intensity scale (MMI) was widely used beginning in the early 1900s. MMI is a descriptive, qualitative scale that relates severity of ground motions to the types of damage experienced. MMI values range from I to XII (USGS, 1989). Table 7-2 compares the moment magnitude scale to the modified Mercalli intensity scale.

TABLE 7-2
EARTHQUAKE MAGNITUDE AND INTENSITY

Magnitude (Mw)	Intensity (Modified Mercalli)	Description
1.0—3.0	I	I. Not felt except by a very few under especially favorable conditions
3.0—3.9	II—III	II. Felt only by a few persons at rest, especially on upper floors of buildings. III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it is an earthquake. Standing cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
4.0—4.9	IV—V	IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like a heavy truck striking building. Standing cars rocked noticeably.
5.0—5.9	VI—VII	VI. Felt by all; many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight. VII. Damage negligible in buildings of good design and construction; slight in well-built ordinary structures; considerable in poorly built or badly designed structures. Some chimneys broken.
6.0—6.9	VII—IX	VIII. Damage slight in specially designed structures; considerable damage in ordinary buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
7.0 and higher	VIII and higher	X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent. XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly. XII. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

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

frequency of earthquake waves. Earthquake ground motions also include both horizontal and vertical components.

Ground Motion

Earthquake hazard assessment is also based on expected ground motion. This involves determining the probability that certain ground motion accelerations will be exceeded over a time period of interest. A common physical measure of the intensity of earthquake ground shaking, and the one used in this mitigation plan, is peak ground acceleration (PGA). PGA is a measure of the intensity of shaking relative to the acceleration of gravity (g). For example, an acceleration of 1.0 g PGA is an extremely strong ground motion, which does occur near the epicenter of large earthquakes. With a vertical acceleration of 1.0 g, objects are thrown into the air. With a horizontal acceleration of 1.0 g, objects accelerate sideways at the same rate as if they had been dropped from the ceiling. A PGA equal to 10% g means that the ground acceleration is 10 percent that of gravity. Figure 7-2 illustrates the USGS's analysis identifying earthquake hazard areas/levels nationwide. Figure 7-3 illustrates the PGA that Washington State can expect (most current available showing PGA as of 2022 update).[4]

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.

[4] USGS. Accessed 13 July 2022. Available at: https://earthquake.usgs.gov/earthquakes/search/

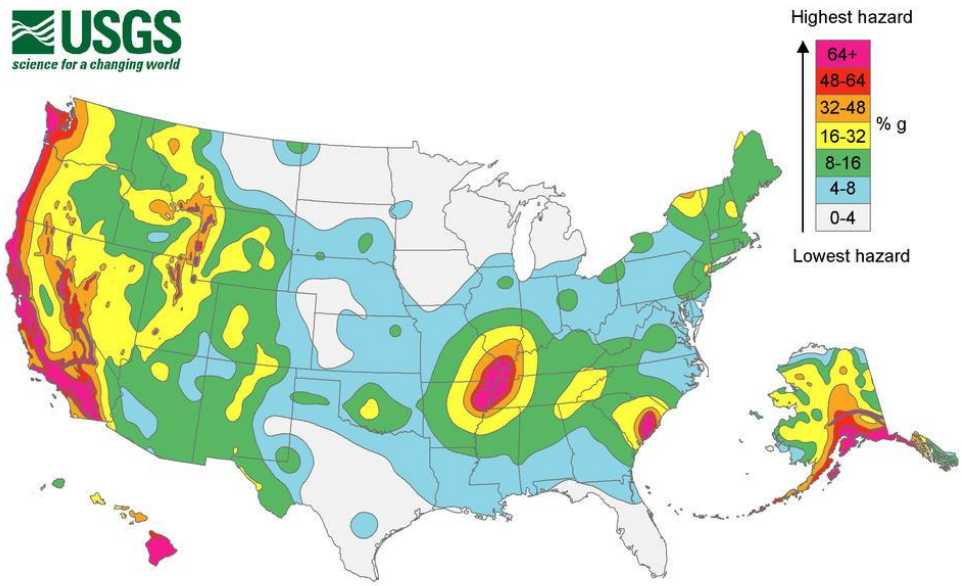


Figure 7-2 USGS Ranked Earthquake Hazard Areas Nationwide (2022)

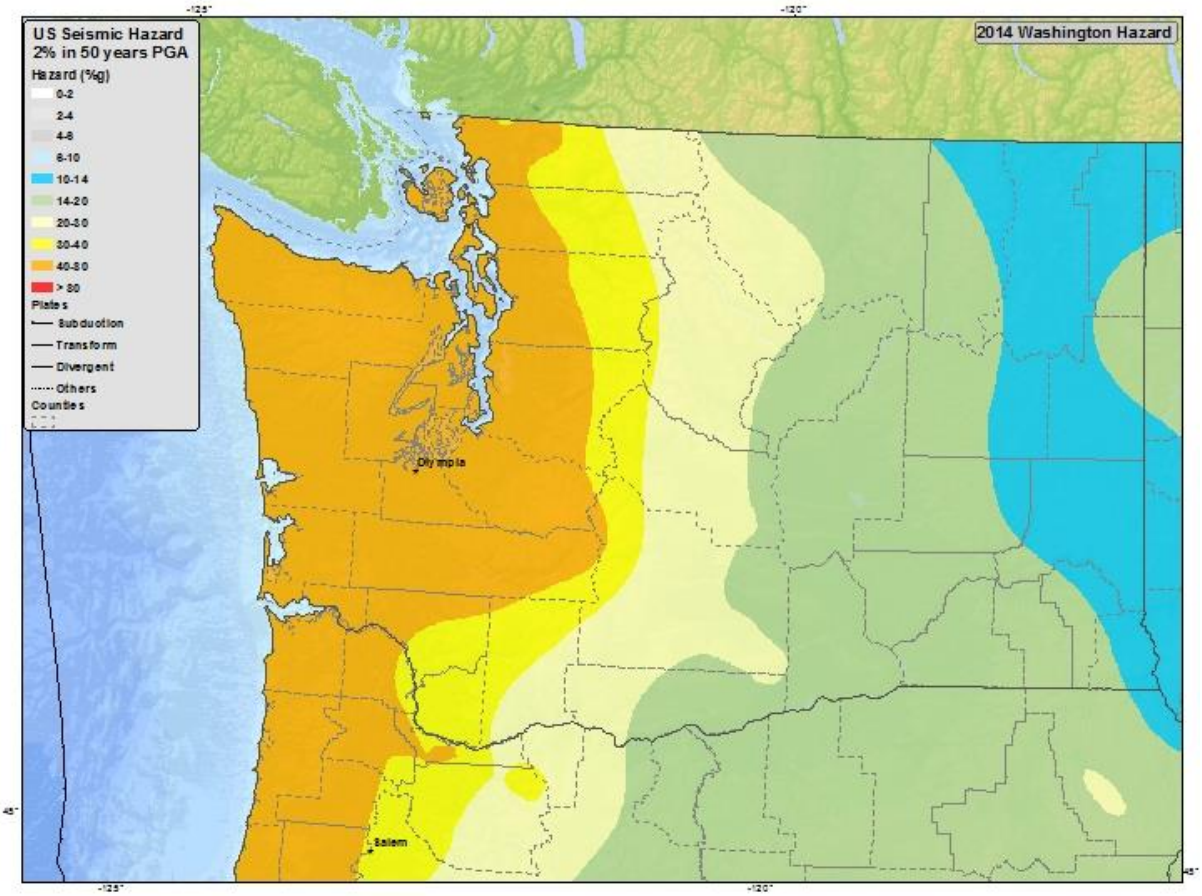


Figure 7-3 USGS PGA for Washington State (2014)

PGA is the basis of seismic design categories that are included in building codes such as the International Building Code (see Figure 7-4).[5] Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake.

PGA values are directly related to these lateral forces that could damage "short period structures" (e.g. single-family dwellings). Longer period response components determine the lateral forces that damage larger structures with longer natural periods (apartment buildings, factories, high-rises, bridges). The amount of earthquake damage and the size of the geographic area affected generally increase with earthquake magnitude:

- Earthquakes below M5 are not likely to cause significant damage, even near the epicenter.
- Earthquakes between about M5 and M6 are likely to cause moderate damage near the epicenter.
- Earthquakes of about M6.5 or greater (e.g., the 2001 Nisqually earthquake in Washington) can cause major damage, with damage usually concentrated fairly near the epicenter.
- Larger earthquakes of M7+ cause damage over increasingly wider geographic areas with the potential for very high levels of damage near the epicenter.
- Great earthquakes with M8+ can cause major damage over wide geographic areas.
- 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 7-3 identifies damage potential and perceived shaking by PGA factors, compared to the Mercalli scale.

[5] Source: fema_hazard_maps_western-map_graphic.jpg

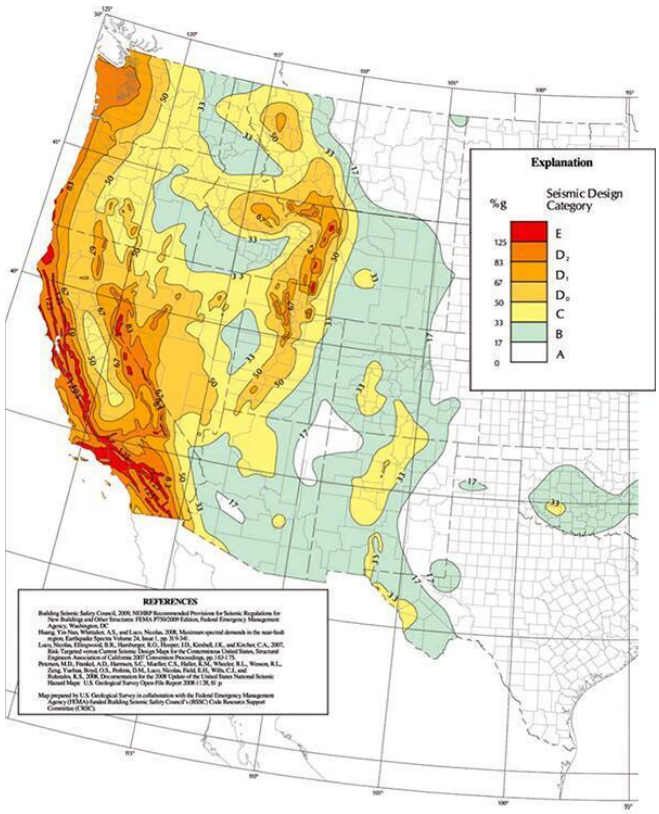


Figure 7-4 USGS Seismic Design Category (2020)

TABLE 7-3
COMPARISON OF MERCALLI SCALE AND PEAK GROUND ACCELERATION

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

a. PGA measured in percent of g, where g is the acceleration of gravity
Sources: USGS, 2008; USGS, 2010

7.3 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 identify areas subject to liquefaction. Table 7-4 identifies NEHRP soil classifications and identifies by acre(s) the types of soils on tribal lands. 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 7-5 identifies the number and types of tribal-owned structures within each soil classification. Figure 7-5 illustrates the areas in which the soil classifications are situated.

TABLE 7-4
TYPES OF NEHRP SOIL CLASSIFICATIONS ON HOH TRIBAL LANDS

NEHRP Soil Type	Description	Hoh Reservation Soils Type (in acres)
A	Hard Rock	0.00
B	Firm to Hard Rock	0.00
C	Dense Soil/Soft Rock	761.75
D	Stiff Soil	0.00
E	Soft Clays	148.95
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 m thick)	0.00

TABLE 7-5
HOH TRIBE CRITICAL FACILITIES / INFRASTRUCTURE IN NEHRP SOIL CLASSIFICATIONS

NEHRP Soil Type	Description	Government Function	Hazardous Materials	Medical	Protective Services	Residential	Schools	Shelter	Commercial	Transportation	Water	Wastewater	Total
A	Hard Rock	0	0	0	0	0	0	0	0	0	0	0	**0**
B	Firm to Hard Rock	0	0	0	0	0	0	0	0	0	0	0	**0**
C	Dense Soil/Soft Rock	5	1	0	1	0	1	0	6	0	1	0	**15**
D	Stiff Soil	1	0	0	0	25	0	0	1	0	2	0	**29**
E	Soft Clays	2	0	1	3	0	0	1	1	0	0	1	**9**
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**

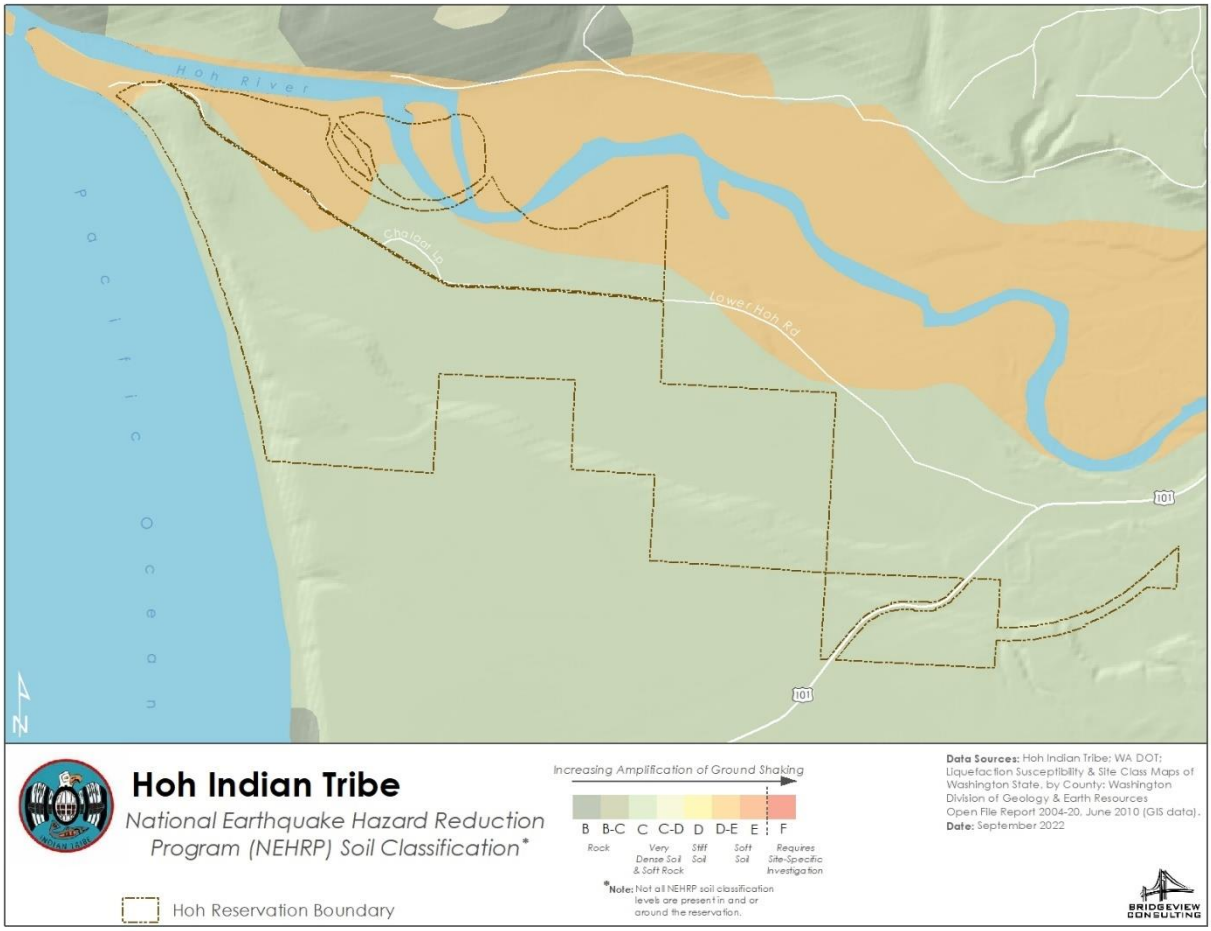


Figure 7-5 NEHRP Soil Classifications on Reservation

7.3.1 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.

7.4 HAZARD PROFILE

Seismic-related hazards 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 planning area 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.

7.4.1 Extent and Location

Washington State as a whole is one of the most seismically active states in United States. Figure 7-6 depicts the faults known or suspected to be active within the state. Figure 7-7 illustrates the shaking hazard of those fault. Figure 7-8 illustrates the fault lines in proximity to the Hoh Indian Reservation (due to illustration and distance to faults, greater detail can be obtained at U.S. Quaternary Faults (arcgis.com) (USGS 2022).

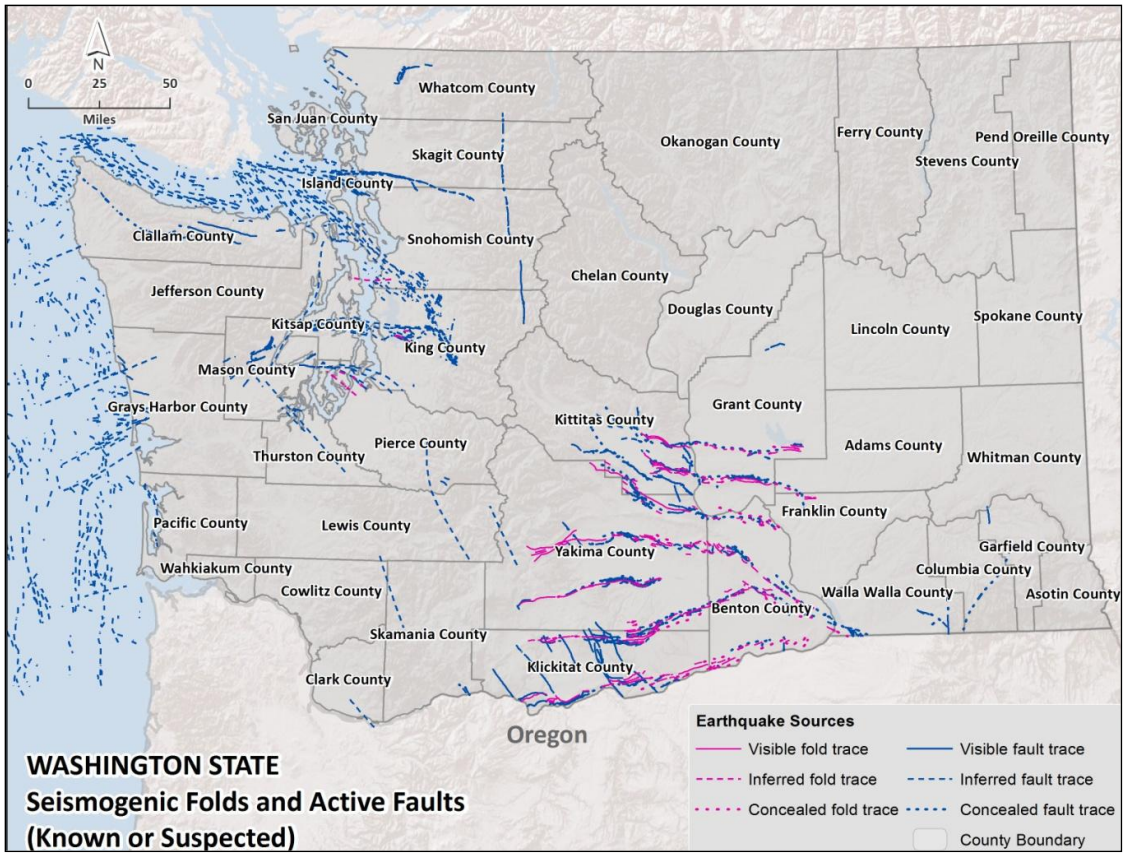


Figure 7-6 Washington State Seismogenic Folds and Active Faults

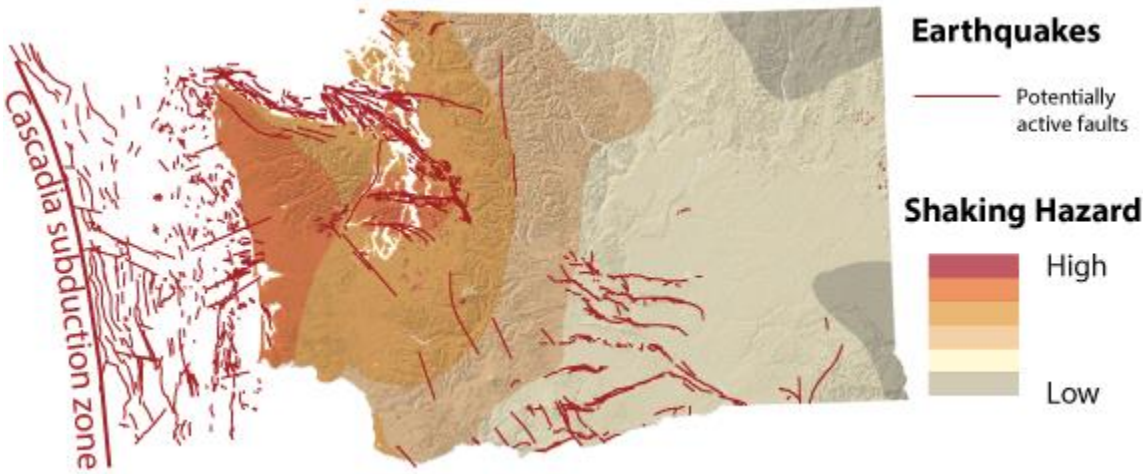


Figure 7-7 Washington State Earthquakes and Faults with Shaking Hazard

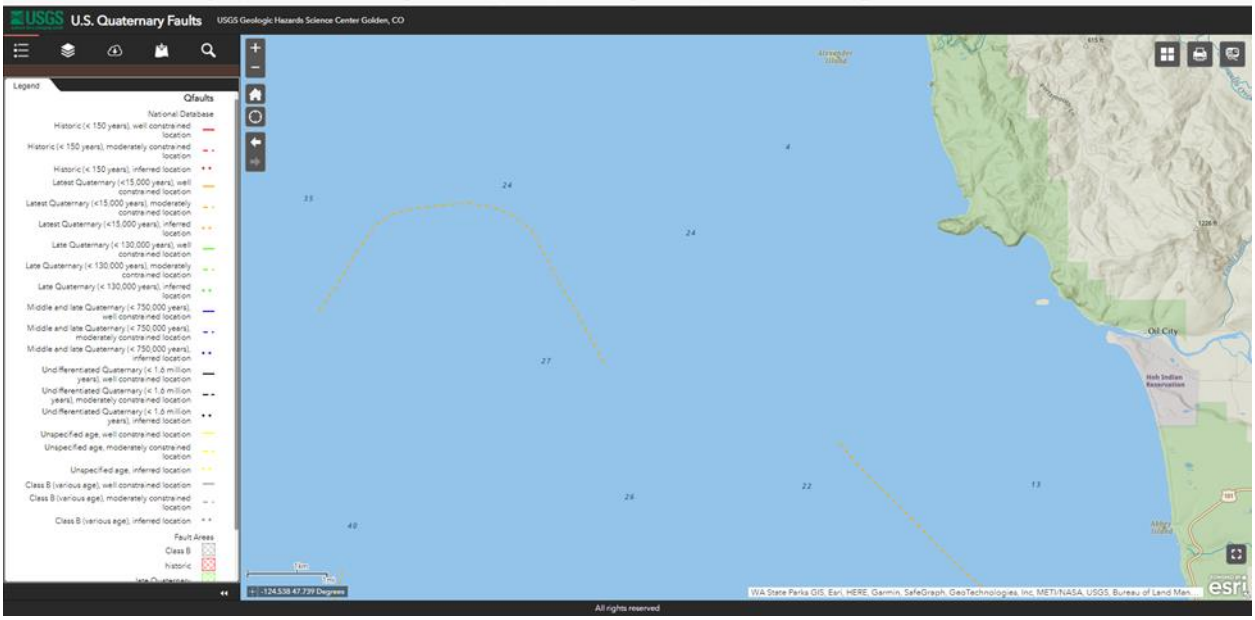


Figure 7-8 Faults in Proximity to Hoh Reservation

There are a number of faults running near the Hoh Indian Reservation, although none are directly on the Reservation. There are significant faults in the eastern portion of Jefferson County (Port Ludlow, Quilcene, Daboob Bay, etc.), which would be impacted by a South Whidbey Island Fault versus a Cascadia Subduction Zone type earthquake, such as the Hoh Reservation would be. There are also several faults which run through the bordering counties of Clallam (north of the Reservation, and the city of Forks), Mason (southeast of the Reservation), and Grays Harbor (south of the Reservation) Counties. Grays Harbor faults include the Grays Harbor Fault Zone, the Willapa Bay Fault Zone, Saddle Hills Fault Zone, Langley Hill fault, and Canyon Creek fault, which runs on the Grays Harbor and Mason Counties' borders near the Olympic National Forest. Due to limited roadways, should an earthquake occur on any of the existing faults in the surrounding communities, there would be impact to the Hoh Tribe, including for supply chain issues and evacuation, among others.

Ground shaking from earthquakes on shallow faults typically last from 20 to 60 seconds and are localized to the source. At present, there are no known faults which cross the reservation boundary, but a quake from the Cascadia Subduction Zone would significantly impact the Tribe, both by ground shaking because of the age of the structures, and also by a Tsunami. Additional information on local faults is available from Washington State Department of Natural Resources Scenario catalogue, available online at: https://www.dnr.wa.gov/programs-and-services/geology/geologic-hazards/earthquakes-and-faults#what-are-faults-and-earthquakes?.9

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 which shows the impacts of these components was utilized 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.

- 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.

For this plan development, the Cascadia M9.0 Earthquake Scenario was utilized to illustrate potential impact. Figure 7-9 illustrates the shaking intensity.

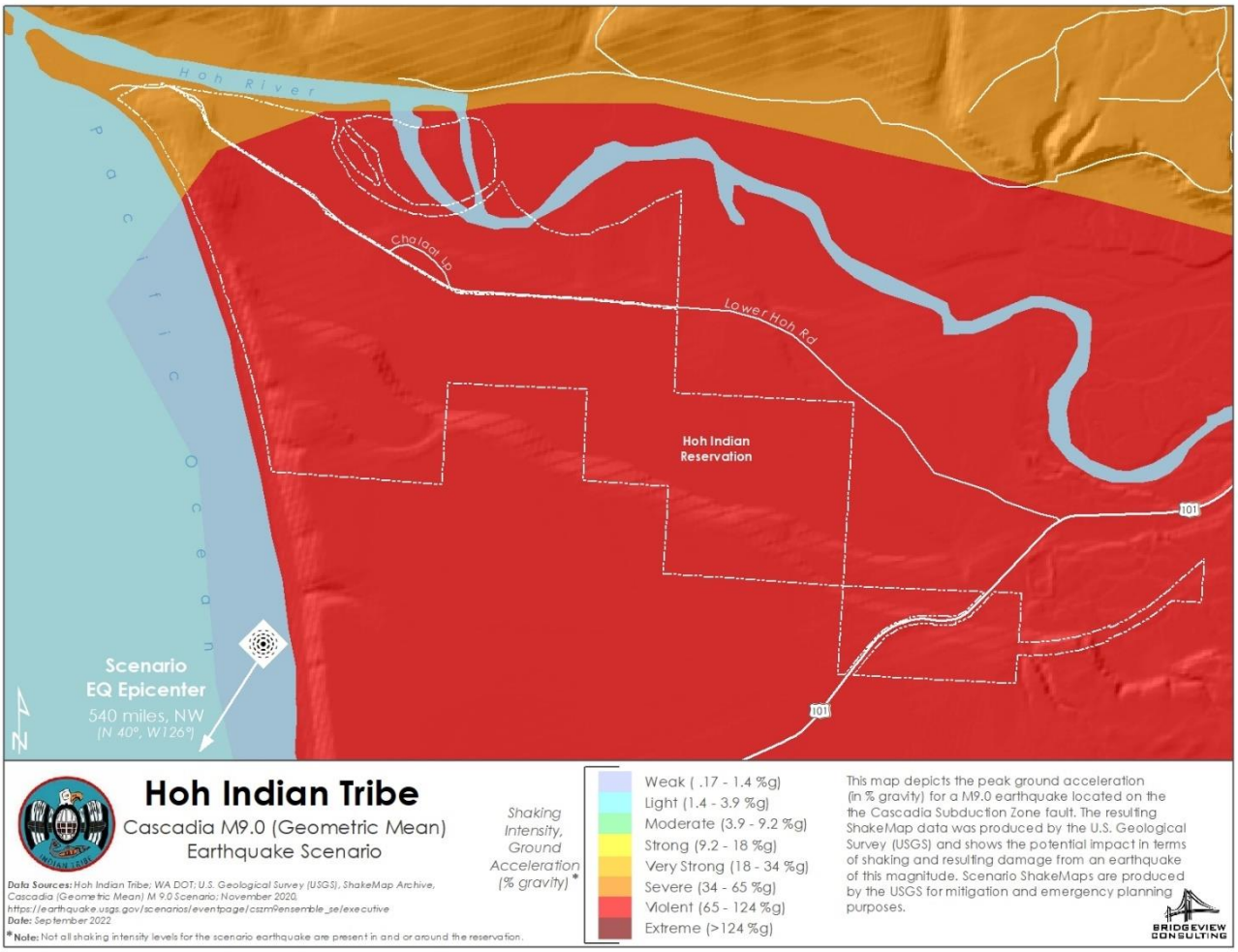


Figure 7-9 Cascadia M9.0 Earthquake Scenario Modified Mercalli Shaking Intensity

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 (see Table 7-5 for identification of number of structures in each soils type). 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. Table 7-6 identifies the number of acres of liquefiable soil within the Reservation boundary. Figure 7-10 illustrates liquefaction susceptibility in the surrounding areas where tribal structures are located.

TABLE 7-6 ACRES OF LIQUEFACTION SUSCEPTIBILITY ON RESERVATION	
Liquefaction Susceptibility Classification	**Hoh Indian Reservation**
High	0.00
Moderate to High	132.76
Moderate	0.00
Low to Moderate	0.00
Low	0.00
Very Low to Low	0.00
Very Low	761.74
Not Susceptible to Liquefaction	
Bedrock	0.00
Peat	0.00
Water	16.19

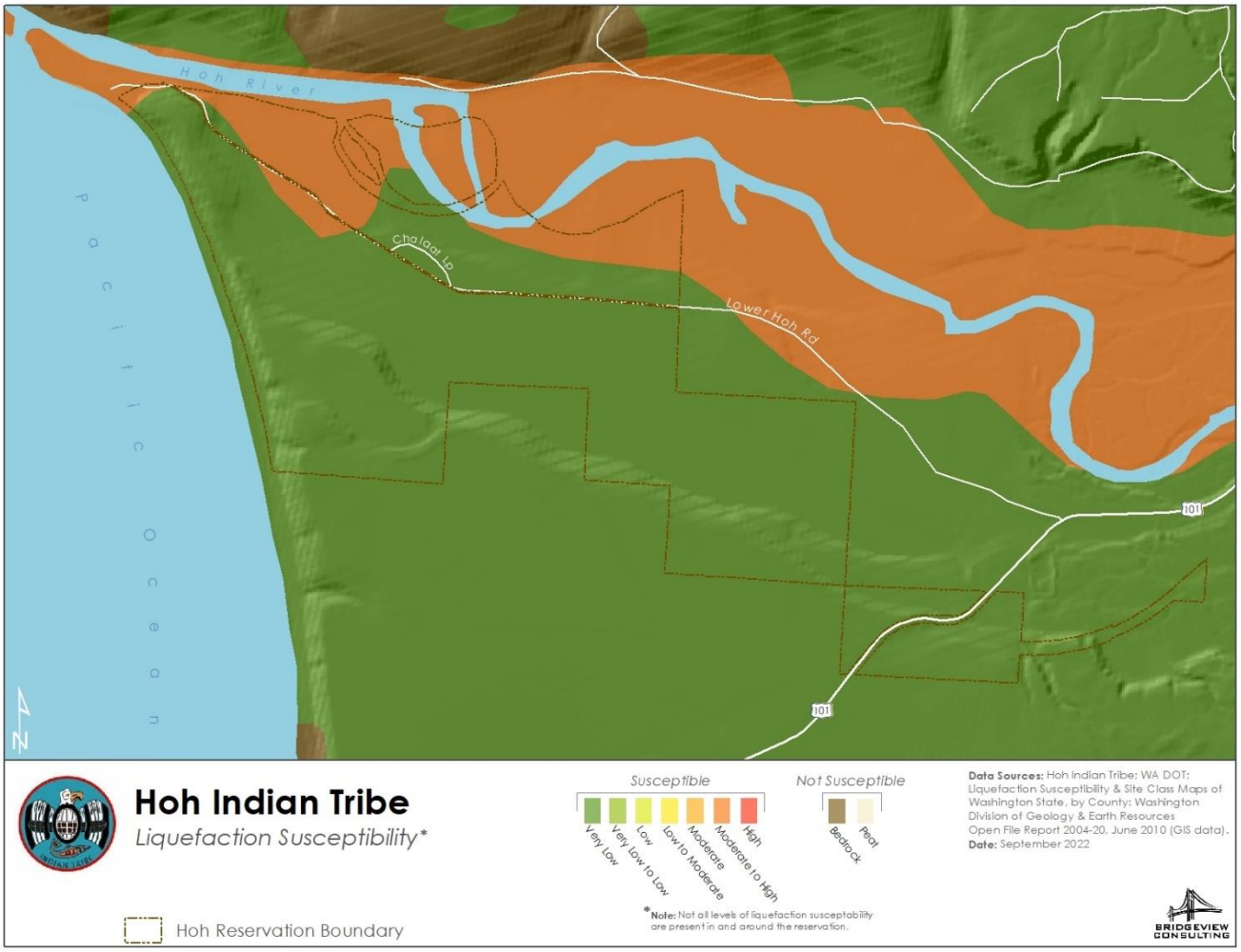


Figure 7-10 Liquefaction Susceptibility Zones Within Reservation Boundary

7.4.2 Previous Occurrences

Earthquakes have been reported in Jefferson County at least as early as 1834, when a series of three events that the Port Townsend Leader newspaper reported were strongly felt at the courthouse and throughout the Strait of Juan de Fuca region (Ludwin, 2006, as cited in FEMA RiskMap, 2016).

Shaking at a Modified Mercalli Intensity of at least VI (which means strong enough to be felt by all and to move heavy furniture), Jefferson County experienced additional earthquakes of similar intensity with the 1872 North Cascades earthquake, in addition to the 1909, 1949, 1965, and 2001 Puget Sound earthquakes (FEMA RiskMap, 2016).

No major damaging earthquakes have been shown to have occurred in the area before the advent of the Pacific Northwest Seismic Network (PNSN) in 1969. The largest earthquake recorded in Jefferson County by PNSN was a magnitude 4.2 event on June 8, 1980, about 10 miles south of Blyn. It was located at a

depth of about 30 miles, which makes it a Benioff Zone event, a type of earthquake that takes place in the subducting crust. Table 7-7 lists past seismic events that have affected the Puget Sound area. [6,7]

The most recent significant earthquake is the Nisqually earthquake. 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. Eastern Jefferson County felt the shaking, with one fire station in Port Ludlow being significantly impacted.

The Hoh Tribe was not impacted and received no reimbursements from FEMA for any damages as a result of the Nisqually earthquake. Review of historic insurance records also show no reimbursements for damages. While the Tribe experienced no structural damages, surrounding counties' roadways leading into the planning area were impacted. Impacts included major traffic tie-ups in the eastern portion of Grays Harbor County (including Highway 12 in Porter) as cars were rerouted around damage in other counties. Small power outages were also experienced throughout the planning area.

For the Hoh Tribe, the largest earthquake threat would likely be from a Cascadia Subduction Zone earthquake. Abundant physical evidence for an earthquake in AD 1700 includes evidence for abrupt tectonic subsidence along the Copalis River and subsequent drowning of a spruce and cedar forest. This event is presumed to be ~M9 and is the largest earthquake in Grays Harbor County in the historic or paleoseismic record. The evidence for this earthquake is documented in Atwater and others (2005) and Goldfinger and others (2012). The fault runs from California to British Columbia and has an average recurrence interval of approximately 500 years for earthquakes of ~M9. Researchers predict a 10 to 14 percent chance that another could occur in the next 50 years.

[6] WADNR Earthquake Energy and Frequency. Accessed 21 July 2022. Available online at: https://www.dnr.wa.gov/pictures/ger/ger_hazards_eq_mag_freq_1140.png?ahvn0n

[7] PNSN, 2022

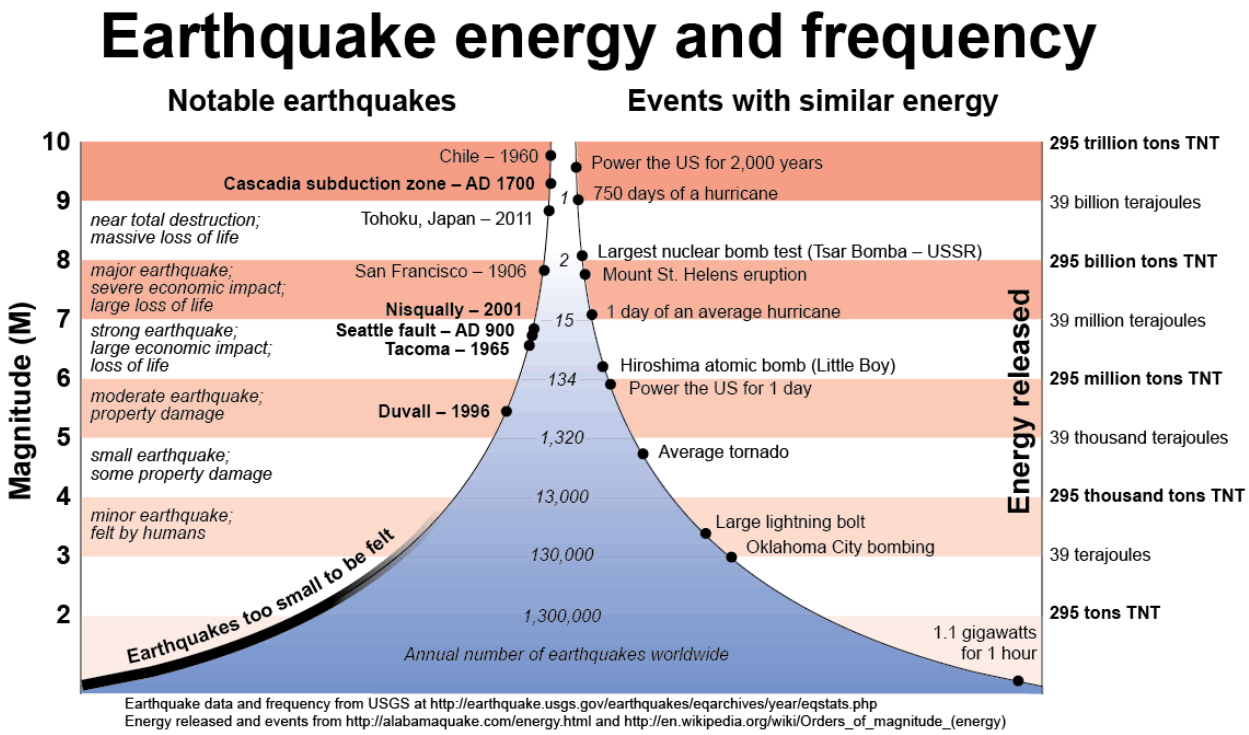


Figure 7-11 Earthquake Energy and Frequency

TABLE 7-7
HISTORICAL EARTHQUAKES IMPACTING THE PLANNING AREA

Year	Magnitude	Epicenter
1/2009	4.5	Near Kingston
7/2002	3.1	North Bend
5/2002	4.2	Friday Harbor, San Juan Islands
2/28/2001 (DR 1361)	6.8	Olympia (Nisqually)
6/10/2001	5.0	Matlock
7/3/1999	5.8	5 miles north of Satsop
2/1998	2.8	Northeast of Seattle
8/1997	3.4	Unknown*
7/1997	3.1	Duvall
6/23/1997	4.7	Bremerton
7/1996	5.4	5 miles east-northeast of Duvall
5/3/1996	5.5	Duvall
1/29/1995	5.1	Seattle-Tacoma
10/25/1991	3.4	Unknown*
4/14/1990	5.0	Deming Area

TABLE 7-7
HISTORICAL EARTHQUAKES IMPACTING THE PLANNING AREA

Year	Magnitude	Epicenter
2/14/1981	5.5	Mt. St. Helens
9/9/76	4.5	Union
5/11/1965 (DR 196)	6.6	18.3 KM N of Tacoma
4/29/1965	6.5	11 miles North of Tacoma
4/13/1949	7.1	Olympia
1/13/1949	7.0	8 miles east-northeast of Olympia
6/23/1946	7.3	Strait of Georgia
2/14/1946	6.3	Puget Sound
4/29/1945	5.7	North Bend (8 miles south/southeast)
11/13/1939	5.8	Puget Sound – Near Vashon Island
5/15/1936	5.7	Southwest Washington
7/17/1932	5.3	Central Cascades
1/23/1920	5.5	Puget Sound
12/6/1918	7.0	Vancouver Island
8/18/1915	5.6	North Cascades
1/11/1909	6.0	Puget Sound
3/6/1904		Washington coastline and Olympic Mountains
3/27/1884		Hoquiam
4/30/1882	5.8	Olympia area
12/15/1872	6.8	Pacific Coast

Source: Pacific Northwest Seismic Network

7.4.3 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 7-12 shows the PGA with a 2 percent exceedance chance in 50 years in Washington.

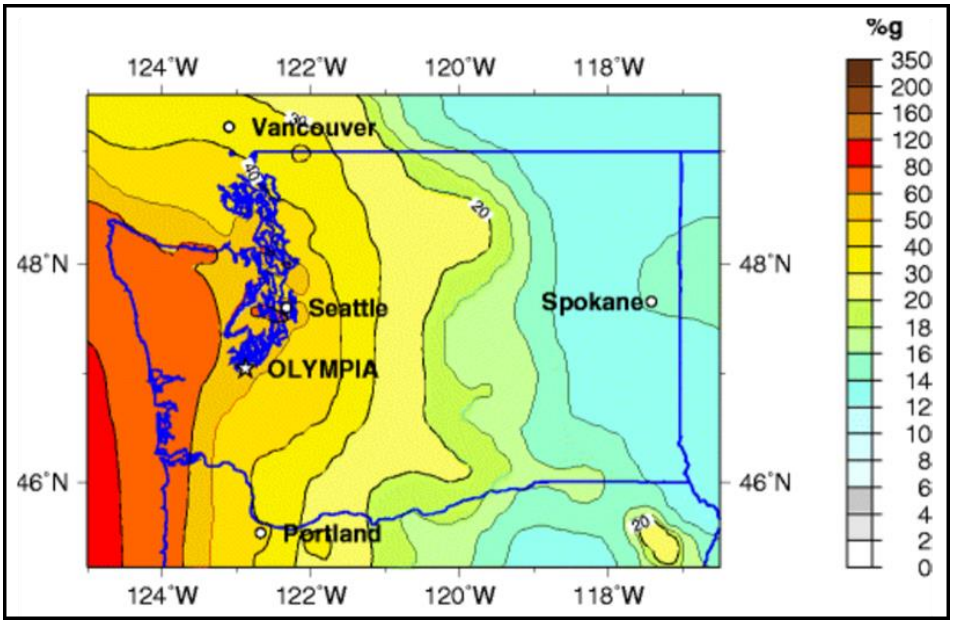


Figure 7-12 PGA with 2-Percent Probability of Exceedance in 50 Years, Northwest Region

For the eastern portion of Jefferson County, a South Whidbey Island Fault earthquake would be the most damaging. For the western portion of the County where the Hoh Tribe is situated, a Cascadia Subduction Zone earthquake would be devastating, both due to the age of the tribal structures, but also as a result of expected Tsunami waves, which would cover the majority of the existing lower reservation.

A Cascadia Subduction Zone earthquake is felt to be the largest earthquake threat to the state as a whole. Abundant physical evidence for the 1700 earthquake includes evidence for abrupt tectonic subsidence, as well as producing both near- and far-tsunamis. This event was estimated to be about M9 and is one of the largest earthquakes in historic or paleoseismic record. This fault has an average recurrence interval of approximately 500 years for earthquakes of approximately M9.

Effects of such a major earthquake in the region could be catastrophic, providing the worst-case disaster. Potentially thousands of residents could be killed, and a multitude of others left injured and homeless. Figure 7-13 illustrates the potential peak ground velocities for such an event (Frankel, 2018).

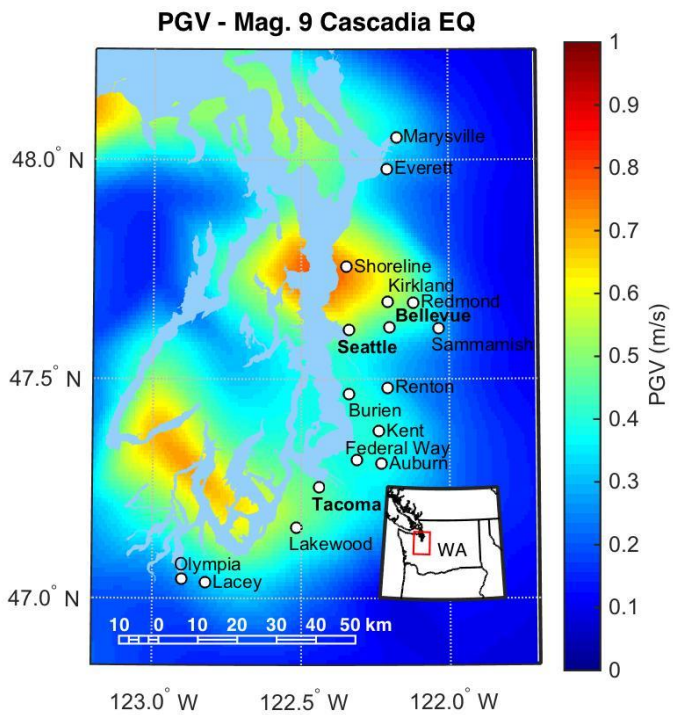


Figure 7-13 Estimated Peak Ground Velocities - M9.0 Cascadia Subduction Zone Earthquake

7.4.4 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).

- 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.

7.5 VULNERABILITY ASSESSMENT

7.5.1 Overview

Several faults within the planning region have the potential to cause impact, with the Cascadia Subduction Zone fault being the closest to the Reservation, and the South Whidbey Fault impacting the eastern portion of Jefferson County. There are several faults along the coastal areas, including within Grays Harbor County and north of Ocean Shores, and Clallam County which would have the potential to impact Tribe, including potential tsunami wave impact and impact to major roadways used for ingress and egress (e.g., Highway 101), which would hinder evacuation.

While the intensity of ground motions diminishes with increasing distance from the epicenter, impact is nonetheless possible. 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 and structures 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 due to impact to roadways.

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

- 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 may be damaged or possibly fail.
- 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 areas with larger populations and needs.

- The overall economy of the area and possibly the region could be affected.
- Large areas lying within the floodplains, such as the Hoh Reservation, are susceptible to liquefaction.

Warning Time

There is currently no reliable way to predict the day or month that an earthquake will occur at any given location. Newly developed warning systems that use the low energy waves that precede major earthquakes 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 equipment.

7.5.2 Impact on Life, Health, and Safety

The entire population of the planning area is exposed to direct and indirect impacts from earthquakes. This would include residents, visitors, and employees of the Tribe. This would also include individuals seeking services or referrals for health and other services which the Hoh provide. Also for consideration would be the number of tourists traveling to the ocean beaches or Olympic National Park, which would travel in direct proximity to the Reservation, with the Reservation being the primary developed area within 26 miles to services (e.g., the closest grocery store to the Reservation is in Forks, WA). Olympic National Park estimates over 3 million people visit the area annually (2019 count).

Two of the most vulnerable populations to a disaster incident such as this are the young and the elderly. Linguistically isolated populations and those living below poverty level are also more susceptible. Based on 2020 Census data, Jefferson County in general has the highest percent population age 18 and over statewide. The planning area as a whole (when looking at county-based data) has a high population of people over 65 (>39%) and individuals with disabilities under 65 years of age (10.8%), both higher than the state averages (16.2% and 8.8%, respectively).

The vulnerable population (65 and over and under 5 years of age) living on the Reservation is 12 (not inclusive of additional family members visiting tribal members). The County as a whole, and particularly the Tribe, has a higher than state-average percent of population living in poverty, with the per capita income countywide at $38,176, which is lower than the statewide per capita income of $40,837. It is estimated that ~50-60 percent of the tribal population is unemployed.

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. At present, the Tribe does not have its own fire and EMS services and relies on the local municipality to provide such services. One-way response times for fire and EMS is ~45 minutes. 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 lack of first responders within a reasonable distance is a significant factor when considering the travel time required, daily population at the Tribal offices, on the Reservation, and for services provided by the Tribe, as well as individuals staying at the various hotels and vacation rentals in the area, or traveling to and from other areas of the Olympic Peninsula. It is anticipated that due to the distance to the more populated area, the Tribe will be significantly impacted with respect to any type of assistance, with the more populated areas receiving services first.

Additionally, the degree of exposure is also dependent on many factors, including the soil type on which structures are built, 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 would undoubtedly isolate populations on the reservation, and loss of functions of utilities could impact populations that suffered no direct damage from an event itself.

It should be noted that there are significant variables that exist in the data which is used to populate the inputs necessary to reach conclusions identified within this document, including 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. Such efforts far exceed the scope of this project, and as such, outputs gained during this process should be considered for planning purposes only, and in no manner should be considered for life-safety measures.

7.5.3 Impact on Property

All structures owned by the Tribe are at risk to impact from earthquake. The current plan includes ~53 structures total, 27 governmental structures and 25 residential structures, with a total structure value in excess of $14.6 million dollars. Due to the area of impact and the proximity to a fault or epicenter location, all structures could be impacted.

Building Age

The majority of structures have been built post-1972, which include seismic standards for construction. One structure was built prior to 1975, which is pre-code. That structure, the existing gym, serves as a shelter location and gathering place for the Tribe. While older structures have an increased impact potential, for the Hoh Tribe, several of the post-1975 structures have been damaged by severe storms and flooding events, so the buildings may not perform as well during an earthquake and may be impacted to some degree. It is anticipated that during the lifecycle of this plan, with the development of the Hoh Highlands area in the upper area of the Reservation, as development occurs, the older structures on the lower portion of the Reservation will be removed as they are replaced in the Hoh Highlands.

The Hoh Tribe has adopted the International Building Codes and continues to adopt its successors on a regular basis. As such, it is assumed that buildings in the planning area constructed after those dates of adoption are built to the highest standards. When federal funding is utilized for any construction, the Tribe in actuality must adhere to more stringent guidelines than the state regulations require based on stipulations imposed to receive federal funding.

In some cases, the Hoh Tribe has purchased structures not built by the Tribe. In such instances, those structures must adhere to the existing building codes in place at the time of construction. Within the State of Washington, the State 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. It should be noted, however, that issues such as code enforcement and code compliance could impact this assumption. 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 structures are 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.

It should be noted that the Hazus program 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, 3.6.3 identifies the age of structures owned by the Hoh Tribe which were included in this update.

7.5.4 Impact on Critical Facilities and Infrastructure

Similar to the impact to property, all critical facilities are exposed to the earthquake hazard. The degree of impact from an earthquake is largely determined based on proximity, magnitude, and ground motion causing liquefaction. Based on the minimal distribution of structures owned by the Hoh Tribe within the planning area, it can be determined that impact will be similar.

Review of the identified critical facilities and infrastructure information captured during this process provides the following, which would apply with respect to application of building codes and age of the critical facilities and infrastructure, particularly when considering the ability of structures to withstand ground shaking:

- Several tribal structures are considerably older in nature, some potentially falling on the Historic Preservation List.
- The gym/shelter facility was built in 1975 and is used as a primary gathering place on the Reservation. It has previously been impacted by flood events, and while repaired, the building is worn, and protected by a constant wall of sandbags.
- The majority of existing structures were built post-1975.
- The majority of structures are wood framed with the exception of the wastewater treatment plant and the water storage tank (metal and concrete). These structures were built in 2012, to existing building codes in place.
- Several structures are built with slab on grade. No structure identified has a basement, but all residential structures have a crawlspace.
- There are two pole buildings.
- There are a limited number of modular buildings in place, which have taken the place of structures previously damaged by flood or severe weather events. Those structures are not permanently affixed to either a slab or foundation.
- The water treatment facility, pump house, and water storage tank are of made of steel/concrete.

Earthquakes can also cause disruption to communications, electrical power, wastewater and potable water services and supplies. Such disruptions should be expected. Earthquakes may also trigger fires, dam failures, landslides, or releases of hazardous material. Hazardous materials releases can occur during an earthquake from both fixed facilities or transportation-related incidents, leaking into the surrounding area or an adjacent waterway, having a disastrous effect on the environment.

In the event of a major earthquake, areas lying within the floodplain are susceptible to liquefaction. Magnitude 7+ earthquakes can potentially trigger slope failures as well. The potential for landslide-induced roadway closure is of concern, in addition to the steep and/or unstable slopes in various locations susceptible to landslides. The Tribe itself has experienced minimal landslides, most often restricted to the bluff areas along the confluence of the Hoh River meeting the Pacific Ocean, and roadways leading on and off the reservation which have previously been impacted by landslides. The Hoh Tribe Reservation is on the Hoh River, with several streams running through other areas of the reservation leading to the river. Liquefaction along the tributaries of the river could increase landslide susceptibility, increase flooding, and shift the course of the river, as has previously occurred many times.

Of the structures on the Reservation, the following can be extrapolated from the analysis:

Liquefaction:

- 9 structures are in the moderate-to-high liquefaction zone.
- 44 structures are in the very low to low liquefaction zone.

The Tribe does own a water system with one storage tank on the upper area of the reservation in the Hoh Highlands area. It also owns a wastewater system and two wells. The water supply is utilized for all structures on the Reservation, including the hatchery from which 80,000 fish annually are released.

The Tribe has previously experienced isolation as a result of roadways being impacted by flood events on a fairly regular basis annually. While flood-related impact has lasted for only a few days (unless it was a significant flood), that may not be the case during an earthquake, particularly a widespread earthquake such as anticipated with a Cascadia event, or as experienced with the Nisqually Earthquake in 2001. In the case of an earthquake, given the rural locations, it may take significantly longer for the state, county, and local municipalities to be able to make repairs, allowing for traffic flow.

While new structures and roadways are built to current code standards, they could nonetheless be impacted. Many of the roadways in the area have also been funded through Tribal grant programs, and are part of the National Tribal Transportation Facility Inventory. The Tribe works in unison with local municipalities to maintain roadways in good repair. As indicated, an earthquake could cause isolation if the roadways were impacted. Closure of major arterials would also require increased evacuation periods, in some instances by several hours, if passage is even possible. With a potential ensuing tsunami as a result of an earthquake (whether a near or distant tsunami), residents and tourists along the coastline would attempt to flee the area. If roadways were impacted, evacuation and emergency response would be significantly hindered, as would the ability for communities to quickly recover.

7.5.5 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.

The Tribe has no businesses which currently operate on the Reservation but do have commercial rental properties in Clallam County which it rents to various enterprises. Economic impact would also include loss to the various business ventures owned and operated by individual tribal members, the value of which cannot be determined in this assessment.

In addition, loss of goods and services may hamper recovery efforts, and even preclude residents from rebuilding within the area, causing further impact. No specific loss data is available with respect to the Tribe's loss of inventory, wages, income, and revenue.

7.5.6 Impact on Environment

Earthquake-induced landslides up or down-stream of rivers or streams can significantly impact habitat on the Hoh Reservation. It is also possible for streams to be rerouted after an earthquake. This can change water quality, possibly damaging habitat and feeding areas. The tribe annually releases ~80,000 salmon of different species which it rears in its hatcheries. 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, among others.

7.5.7 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. Sea level rise is not anticipated to impact the earthquake hazard, as the normal tidal flows mimic a similar increase.

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.

7.6 FUTURE DEVELOPMENT TRENDS

The Hoh Tribe does utilize the International Building Code as established within the areas of construction. Such requires structures to be built at a level which supports soil types and earthquake hazards (ground shaking). Presently, as existing buildings are renovated, provisions are in place which require reconstruction at higher standards. With the development of the Hoh Highlands area, structures will be built to the standards in place at the time of construction, with the older structures on the lower reservation removed over time as they are replaced, potentially lowering impact from the hazards of concern. The Tribe regularly reviews and updates its land use code to maintain compliance with various regulatory agencies, including federal requirements for new construction. Minimal construction has occurred since completion of the last plan, with only a few new structures built to replace older structures. The newer structures are built to much higher standards than their predecessors. Several of the older structures have been removed when the newer structures are completed. Some of the structures, such as the water tower, have been built to existing earthquake standards, and outside of the tsunami

inundation zone, which is a secondary hazard associated with earthquakes. The soils in the Highlands area are also different, providing greater support with respect to liquefaction that exists on the lower reservation, which is in very close proximity to both the coastline and the Hoh River. The Tribe does not feel that the development that has occurred since the last plan was completed has increased their vulnerability beyond the mere fact that new structures have been acquired, which increases the overall valuation of structures owned. In many instances, the opposite is more accurate because structures of lower quality and standards have been removed.

7.7 ISSUES

While the planning 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, including evacuation, as well as impacting 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. Bridges, 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 such as those that exist along the coastline, riverbeds, and riverbanks.

Earthquakes can cause large and sometimes disastrous landslides and mudslides. Bluff areas along the coastline such as those that border the Hoh Reservation are extremely susceptible. 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, bridge, 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.

7.8 IMPACT AND RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from an Earthquake throughout the area is highly likely. A Cascadia-type event, such as that utilized as the scenario modeled for this update, has a high probability of occurring within the region. Likewise, all structures owned and operated by the Hoh Tribe would be impacted to some degree, with newer structures theoretically sustaining less damage as a result of more stringent building codes in place.

When considering the ranking of this hazard, the Planning Team also considered additional factors given the widespread impact a Cascadia event would have on western Washington. Items considered include:

- A Cascadia-type earthquake could generate a large amount of damage within the general planning area in which the reservation is situated, or in areas where the tribe owns landmass. Municipalities within the surrounding counties (Jefferson, Clallam, and Grays Harbor) have a large number of older structures, particularly in the downtown hub areas. In this respect, the Planning Team considered not only Tribal-owned structures, but also structures which are residences for Tribal citizens; those which provide services to Tribal citizens (e.g., hospitals, medical offices, etc.); or on which Tribal businesses rely (e.g., supply-chain). Collapse or damages to the structures could divert emergency response personnel away from the Reservation or tribal structures.
- Further consideration was given with respect to the distance between the Reservation and the nearest town being approximately 28 miles away, and the response capabilities both by the tribe itself, or through services provided by Jefferson County or other local service provider (e.g., fire districts).
- While the Tribe maintains law enforcement, it is of limited sizes. Given the potential inaccessibility of roadways which have previously been impassible in areas (such as resulted with the Nisqually Earthquake), or impact to the I-5 corridor, the potential for law enforcement response from one area to other areas may be impacted. Such would also be the case for fire response, ambulance transport, or medical services. All of these services are ones for which the Tribe must rely on surrounding communities to provide.
- With the potential of a Cascadia event generating a tsunami wave at 100 feet in height at the mouth of the river and 43 feet in height at the Lower Hoh Tribal Center (WA DNR, 2022), evacuation from the reservation and surrounding beach areas would significantly increase traffic on both major and local roadways. Depending on the area, in some cases, tsunami waves are anticipated to make shore on the Hoh Reservation, Jefferson, and Grays Harbor Counties within 20 minutes, Port Angeles within 60 minutes, and Clallam Bay within 30 minutes.
- The structural integrity of the Forks Bridge and roadways coming from the surrounding counties would undoubtedly be impacted from the earthquake itself, leaving tourists or residents attempting to evacuate isolated in the rural areas, including the reservation and areas immediately around the reservation. With the large number of estimated tourists visiting the area annually, this would, in essence, put roadways at a standstill. Should a Cascadia event occur during a summertime month when a high number of tourists are in the area, resources throughout the region would be significantly taxed in addition to roadway congestion.
- The gym, which currently serves as the community center and shelter, falls within the tsunami inundation zone. The structure is also the oldest structure on the Reservation (1975). The new public safety building in the Hoh Highlands area is outside of the tsunami inundation zone, but as of this writing, does not have power, water, or restroom facilities; it is, in essence, an empty shell structure. Future expansion of the structure with a generator is part of the new planned development to occur within the next year once grant funds are received. Once completed, that structure would be able to serve as the shelter and community resilience center not only for tribal members, but also potential evacuees unable to leave the area. The intent is to also include facilities for motorhomes traveling through the area that are trapped, including power and dump facilities.

- The Hoh Highlands area is identified by Jefferson County as a location to be utilized as a potential heliport location, including for medical evacuations.
- The Tribe currently has no ability to provide medical services beyond an Emergency Medical Technician currently on staff (not as an EMT, but in other capacities). The Tribe is in the process of working with Indian Health Services to establish a tribal medical clinic with contracted medical service providers in Forks, but access during an evacuation or emergency situation will reduce capabilities.
- During a significant event, potential injuries could lead to mass-casualty events throughout the region, wholly taxing capabilities.

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 8.
FLOOD

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

DEFINITIONS

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

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

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

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

8.1 GENERAL BACKGROUND

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

- Riverine flooding, including overflow from a river channel, flash floods, alluvial fan floods, dam-break floods and ice jam floods;
- Local drainage or high groundwater levels;
- Fluctuating lake levels;
- Coastal flooding;
- Coastal erosion;
- Unusual and rapid accumulation or runoff of surface waters from any source;
- Mudflows (or mudslides);
- Collapse or subsidence of land along the shore of a lake or similar body of water that result in a flood, caused by erosion, waves or currents of water exceeding anticipated levels (Floodsmart.gov, 2012);
- Dam failure (no dams within the immediate area of the Hoh Reservation)
- Sea level rise; and
- Climate Change.

8.1.1 Flooding Types

Many floods fall into one of three categories: riverine, coastal, or shallow. 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, riverine/stormwater flooding are the main flood types of concern for the planning area.

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.

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 watersheds. 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).

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. 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.

8.1.2 Measuring Floods and Floodplains

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

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

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

8.1.3 Flood Insurance Rate Maps

According to FEMA, flood hazard areas are defined as areas that are shown to be inundated by a flood of a given magnitude on a map (see Figure 8-1). These areas are determined using statistical analyses of records of river flow, storm tides, and rainfall; information obtained through consultation with the community; floodplain topographic surveys; and hydrologic and hydraulic analyses. Three primary areas make up the flood hazard area: the floodplains, floodways, and floodway fringes. Figure 8-2 depicts the relationship among the various designations, collectively referred to as the special flood hazard area.

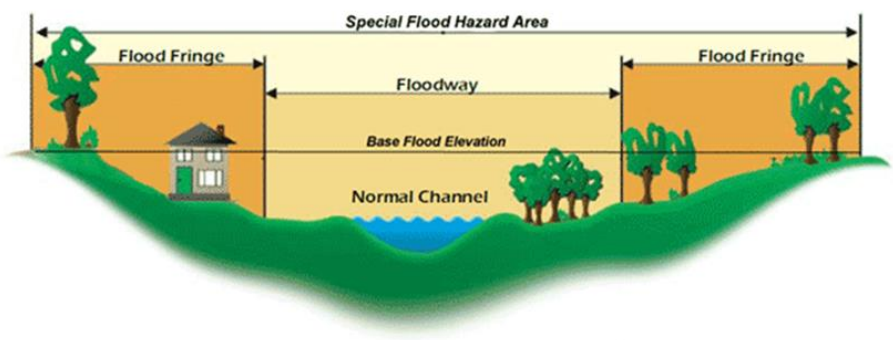


Figure 8-1 Flood Hazard Area Referred to as a Floodplain

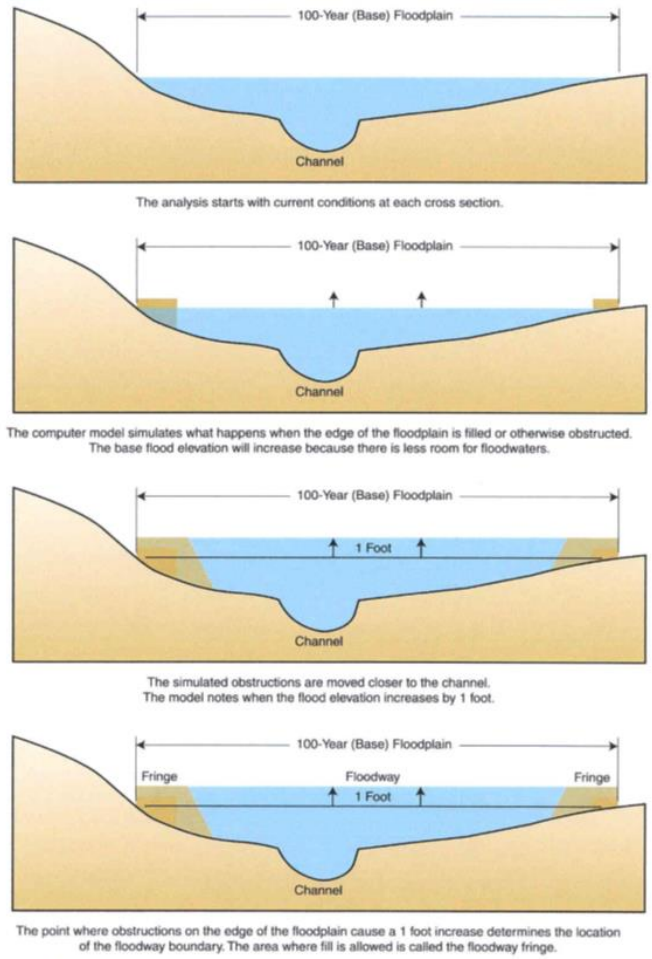


Figure 8-2 Special Flood Hazard Area

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 (various years). Table 8-2 identifies the various rate map zones.

TABLE 8-1 FLOOD INSURANCE RATE MAP ZONES	
Moderate to Low Risk Areas: Areas of moderate or minimal hazard are studied based upon the principal source of flood in the area. However, buildings in these zones could be flooded by severe, concentrated rainfall coupled with inadequate local drainage systems. Local stormwater drainage systems are not normally considered in a community's flood insurance study. The failure of a local drainage system can create areas of high flood risk within these zones. Flood insurance is available in participating communities but is not required by regulation in these zones. Nearly 25-percent of all flood claims filed are for structures located within these zones.	
Zone	**Description**
B and X (shaded)	Area of moderate flood hazard, usually the area between the limits of the 100-year and 500-year floodplain area with a 0.2% (or 1 in 500 chance) annual chance of flooding. B Zones are also used to designate base floodplains of lesser hazards, such as areas protected by levees from 100-year flood, or shallow flooding areas with average depths of less than one foot or drainage areas less than one (1) square mile.
C and X (unshaded)	Area of minimal flood hazard usually depicted on FIRMs as above the 500-year flood level. Zone C may have ponding and local drainage problems that do not warrant a detailed study or designation as base floodplain. Zone X is the area determined to be outside the 500-year flood and protected by levee from 100-year flood.
High Risk Areas: Special Flood Hazard Areas represent the area subject to inundation by 1-percent-annual chance flood. Structures located within the SFHA have a 26-percent chance of flooding during the life of a standard 30-year mortgage. Federal floodplain management regulations and mandatory flood insurance purchase requirements apply to participating communities in these zones.	
Zone	**Description**
A	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these zones.
AE	The base floodplain where base flood elevations are provided. AE Zones are now used on new format FIRMs instead of A1-A30 Zones.
A1-30 (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 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

TABLE 8-1 FLOOD INSURANCE RATE MAP ZONES	
	requirements will apply, but rates will not exceed the rates for unnumbered A zones if the structure is built or restored in compliance with Zone AR floodplain management regulations.
A99	Areas with a 1% annual chance of flooding that will be protected by a Federal flood control system where construction has reached specified legal requirements. No depths or base flood elevations are shown within these zones.
High Risk – Coastal High Hazard Areas (CHHA): These represent the area subject to inundation by 1-percent-annual chance flood, extending from offshore to the inland limit of a primary front al dune along an open coast and any other area subject to high velocity wave action from storms or seismic sources. Structures located within the CHHA have a 26-percent chance of flooding during the life of a standard 30-year mortgage. Federal floodplain management regulations and mandatory purchase requirements apply in the following zones.	
Zone	**Description**
V	Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26% chance of flooding over the life of a 30-year mortgage. No base flood elevations are shown within these zones.
VE, V1-30	Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
Undetermined Risk Areas	
Zone	**Description**
D	Areas with possible but undetermined flood hazard. No flood hazard analysis has been conducted. Flood insurance rates are commensurate with the uncertainty of the flood risk.

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. 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 8-2
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%

8.1.4 National Flood Insurance Program (NFIP)

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

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

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.

NFIP Status and Severe Loss/Repetitive Loss Properties

The Hoh Tribe is a member of the NFIP, Community #530329A, but are currently sanctioned. The Tribe does have regulatory authority within its land use planning which regulates development to IBC standards, although the NFIP portion needs updating. The Tribe also has not yet adopted the 2019 flood maps. The Tribe has no previous claim history under the NFIP. They have no current flood insurance policies in place as of July 2020.[8]

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 maintaining a Repetitive Loss Strategy. 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.

A Repetitive Loss Strategy must identify the specific actions taken to reduce the number of repetitive loss properties, which must include severe repetitive loss properties, and specify how the Tribe intends to reduce the number of such repetitive loss properties. In addition, the hazard mitigation plan must describe the strategy it will take to reduce the number of these properties, including the development of Tribal hazard mitigation plan.

In preparation of this plan, the Planning Team did review Washington State's 2018 Hazard Mitigation Plan, which does contain a Repetitive Loss Strategy. While a sovereign nation and not required to adhere to state policies and procedures, the Hoh Tribe, as appropriate, will continue to work with the state in its endeavor to reduce impact from flooding within the tribal planning area. At the Hoh Tribe's election, this may include seeking opportunities for mitigation funds under the various Stafford Act Grant Programs.

- As of July 22, 2022, the Tribe has no repetitive flood claims.[9]

Tribal Repetitive Loss Strategy:

The Hoh Tribe will continue to address repetitive loss properties by ensuring that new construction is built to the highest building code standards required, and also continue to view the mitigation plan for identified areas of risk. As was previously done, the Tribe will continue to mitigate structures within the floodplain, including, if feasible, to move (or rebuilt) structures out of the floodplain or to take other such corrective actions as appropriate.

The Planning Team will use the five-year updates of this Hazard Mitigation Plan as an opportunity to evaluate hazard management laws, regulations, and policies, and work with the Tribe's legal and planning

[8] Based on email from FEMA Region X Flood Insurance Liaison Scott Van Hoff July 2022.
[9] Ibid.

departments to create the most effective and efficient regulatory authority when necessary to do so in an effort to continue to mitigate flood issues on the properties owned by the Hoh Tribe.

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 July 2022, the Hoh Tribe have no severe repetitive loss properties.[10]

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.

- The Hoh Tribe is not a CRS Community.

8.2 HAZARD PROFILE

8.2.1 Extent and Location

Flooding is the most common hazard occurring in the tribal planning area, albeit not always rising to the level of a disaster declaration. Flooding is most often due to riverine flooding.

The severity of flood damage is dependent upon ground elevation, the surrounding topography, peak flow volumes, surface flow velocities, tides, driving winds, and the storm surge impacting the drainage of the Hoh River. The risk of flooding is one of the primary reasons the Hoh Tribe has been unable to develop economic activities on the Reservation. At present, there are ~202 acres of reservation land in the 100-year flood zone, and 709 acres in the 500-year flood zone, which encompasses the majority of land mass

[10] Ibid.

of the existing developed area of the Reservation, located in the lower portion of the Reservation. The flood zones do not include the area in the new Hoh Highlands, which is outside of the flood plain.

Of significant concern during periods of flooding are the number of tourists who can be impacted. As the Tribe is in proximity to the Olympic National Park, it is common for tourists to be traveling on or near the Reservation. Currently, the Tribe has no means to provide assistance to these individuals, as there are no lodging, fueling, or food services on the Reservation. This is one of the reasons that the Tribe is undertaking the effort to relocate the current village to the lands in the Hoh Highlands area. Once completed, the area will be able to provide assistance to any stranded tourists in the area.

Presently, the northern one-third of the Reservation contains the river and floodplain. The rest of the Reservation is situated on higher, unflooded terraces and steep slopes. The Tribal Center and nearby buildings are located on a high floodplain. The riverbank presently stands only 25 feet from the Tribe's main water well, which the Tribe was forced to replace since completion of the last plan due to contamination from a flood event. Flooding also overwhelmed the tribe's sewer system, causing raw sewage to wash over the main road, which also required replacement since completion of the last plan.

Causes of Flooding

The Hoh River carries a tremendous volume of water as a result of the Olympic Mountains receiving more rain and snow than any other place in the conterminous United States. This means that the Hoh River has more transport capacity (discharge being a component of capacity) than similarly sized rivers in areas of lower precipitation. During long periods of rainfall, river and stream channels fill to overflowing. Intense precipitation combined with mild temperatures will cause snowmelt on the south slopes of the Olympic Mountains that can also induce or increase flooding, or in the foothills of the Cascade Mountains. River floods happen most often when winter storms bring heavy rains from the southwest.

Because the Reservation is bordered by the Pacific Ocean with the mouth of the Hoh River flowing into the ocean, tides have a great deal of impact on the Reservation's flooding. Any given year can bring high tides. Historically, beginning the first week of July, the Reservation experiences its lowest tides, averaging 6 to 8 feet. The tides continue to become higher in later months, and by mid-January the Reservation begins to experience its highest tides at 10 to 12 feet. High tides are also often impacted by storm surges, high winds, and periods of driving rain, causing water levels on the Hoh River to rise and flooding the Reservation.

Factors contributing to flooding include the logging of excessively steep state land, which has resulted in frequent and sustained sliding and debris torrents in obstructed creeks. These events contribute wood and massive quantities of silt and gravel to the valley streams. The logging has also resulted in logjams, which change location during periods of higher or swifter flow, causing channels to be partially or extensively blocked. Logjams create an increase in water velocity, which widens the bank by erosion or deepens the channel. Single stumps or projecting logs have also influenced channel creation by cutting into the bank. Large old-growth falling into the river as a result of undercutting of the bank and being held in place by remaining roots and limbs embedded in the stream bottom causes side-washing and bank erosion around the root wad by higher velocity flow until the roots and limbs are released.

Channel migration issues have been a primary cause of flooding within the Hoh floodplain area. Historic evidence of migration was well documented in a 2004 Channel Migration Study commissioned by the Bureau of Reclamation on behalf of the Hoh Tribe and Jefferson County (most recent available as of this 2022 update).

Figure 8-3 below demonstrates the various stream channels. Upstream from Reach 1, the river is very dynamic and migrates rapidly across its floodplain. In Reaches 2 through 4, river channels have occupied virtually the entire floodplain in the last 100 years. Meander bends have moved across the floodplain at average rates of 25 to nearly 90 feet per year, with faster short-term erosion rates up to about 200 feet per year. Large woody debris (LWD) jams commonly have caused the river to shift sideways one to three channel widths and create side channels. The river also is prone to jumping across its floodplain, leaving forested islands in between the old and new main channels. The abrupt switching of the river channel to a new location is called an avulsion. Nine large avulsions occurred between 1928 and 2003. These channel relocations occurred over lengths of 0.3 to 0.9 mile and cross valley widths of 0.2 to 0.7 mile.

The forested floodplain on which many tribal buildings are located has become smaller as the river has eroded its banks have. A large meandering bend in the river moved south and eroded about 6 to 8 acres of the Hoh Reservation between 1952 and 1964. The river historically has abandoned its banks and switched course. Downstream from the former bend, a new bend started moving southwest and has eroded an additional 28 acres of reservation land. By 1998, the river reached a high terrace, threatening tribal housing and the Tribe's water supply wells, which have been contaminated previously during flood events. Figure 8-4 depicts the high hazard zones based on the 2004 study. The channel migration zone is the area within which this movement of the river channel is most likely expected to occur.

As part of the 2004 study, a comparison was made of gage data and an evaluation of increase in drainage basin size in the downstream direction. Such indicated that flood magnitudes in the Middle Hoh may be two to three times that of floods in the Olympic National Park depending upon the contribution of runoff from the South Fork drainage. Based on two USGS gages that provided a record of discharge data near the study areas, the annual flood peaks and the frequency of floods equal to or greater than the 2-year flood have both increased on the Hoh River in the study area since 1927, the beginning of the period of record. Between 1927 and 1971 (44 years), the 2- year flood was exceeded between 18 and 50 percent of the years evaluated, but since 1971 it has been exceeded in greater than 70 percent of the years evaluated. In certain Reaches (7 and 8 of the 2004 study), the fastest rate of channel meander bend migration occurred during the period 1977 to 1981 when the 25-year flood was twice exceeded.

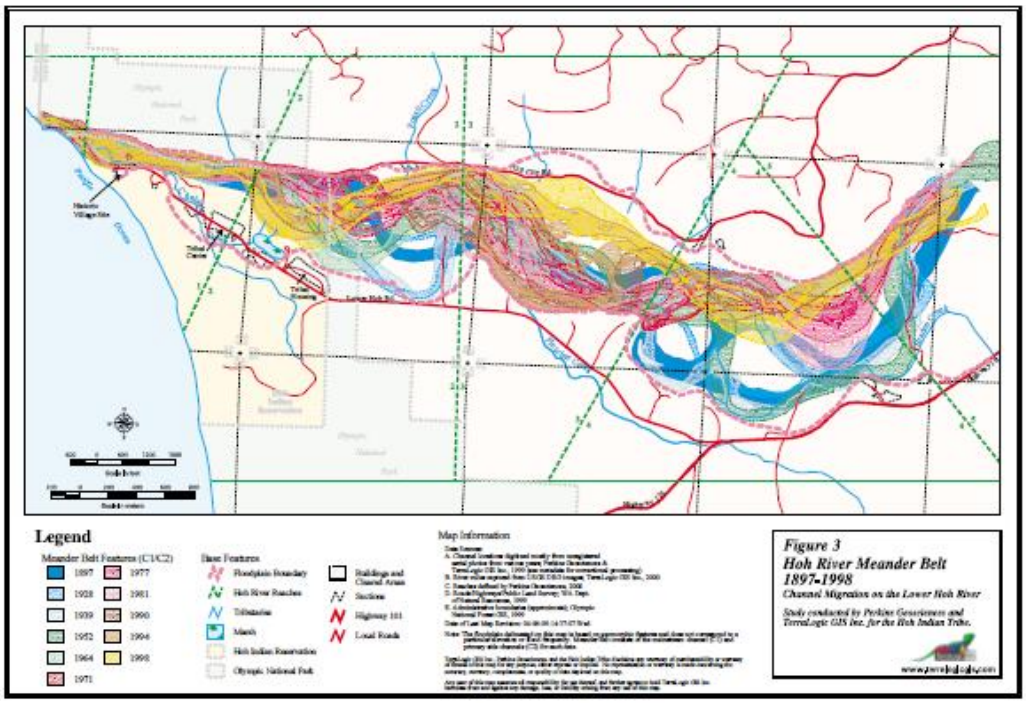


Figure 8-3 1897-1998 Hoh River Meander Belt (2004 Bureau of Reclamation Jefferson County Study)

More recently, the ability of weather forecasters to provide early warning to citizens when significant weather-related events are to occur does provide residents with the ability to evacuate prior to the weather system arriving. Due to the geologic and physical environment of the Hoh Reservation, the area may flood up to five (or more) times annually, during all seasons, with summertime flooding often times associated to snow melt when temperature increase. In most cases these smaller events are minor and more of a nuisance-type, causing disturbance to daily life in the area. Roadways regularly are blocked by floodwaters, causing people to be unable to engage in normal activities of traversing roadways, and causing isolation of the area. However, the more significant events have caused flooding of residential structures, as well as the contamination of the wells, which are the only source of water for the Reservation. Such incident occurred in 2012, requiring the construction of a new, totally sealed well.

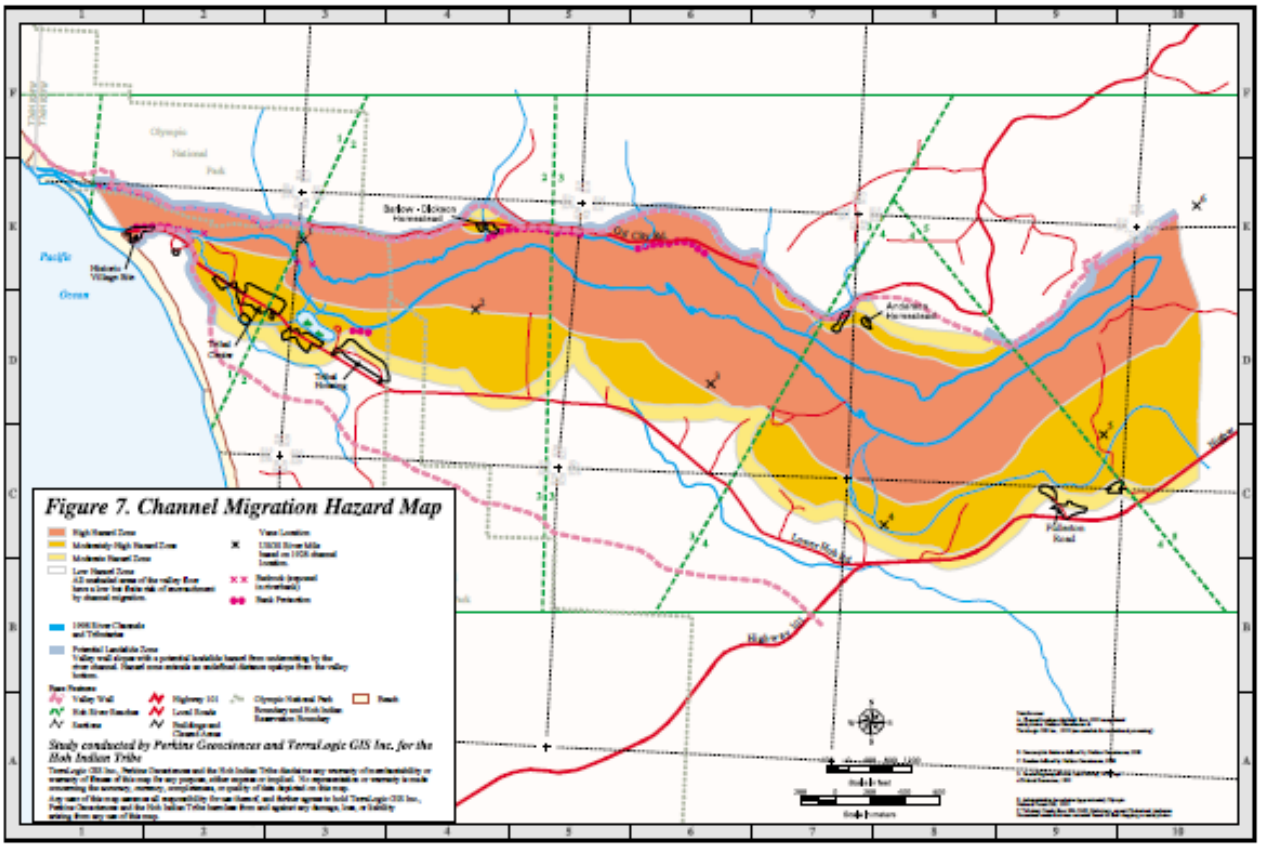


Figure 8-4 Channel Migration Hazard Map (2004 Bureau of Reclamation Study)

Since completion of the 2004 Study by the Bureau of Reclamation, as of this 2022-2023 update, the Hoh River at the location of the Reservation has on an almost annually occurrence, abandoned its banks. This more frequent flooding and higher magnitude floods have not only caused higher rates of channel migration, but also higher amounts of lateral expansion of the HCMZ. Such migration continues to occur, occupying more of the Reservation lands. Even with support from the USACE with the placement of boulders and riprap to help mitigate impact, the Hoh River continues to erode the banks and expand closer onto the Reservation. Figure 8-4 and Figure 8-5 (courtesy of the Hoh Tribe) are illustrative of the impact of flood events occurring within the last five years.

Figure 8-5 Current Channel Migration and Movement of Riprap Placed by USACE

Figure 8-6 Continued River Channel Expansion in Proximity to Hoh Tribal Housing Structures

FEMA Flood Maps

FEMA performed a Flood Insurance Study (FIS) for Jefferson County in 2016. The study and the resulting new maps were issued thereafter; however, the Hoh Tribe have not yet adopted the maps. For purposes of this plan update, the 2019 maps generated by FEMA have been utilized in this analysis. The various flood zones associated with the study are illustrated in Figure 8-7 depict the flood hazard areas on which tribal properties are located.

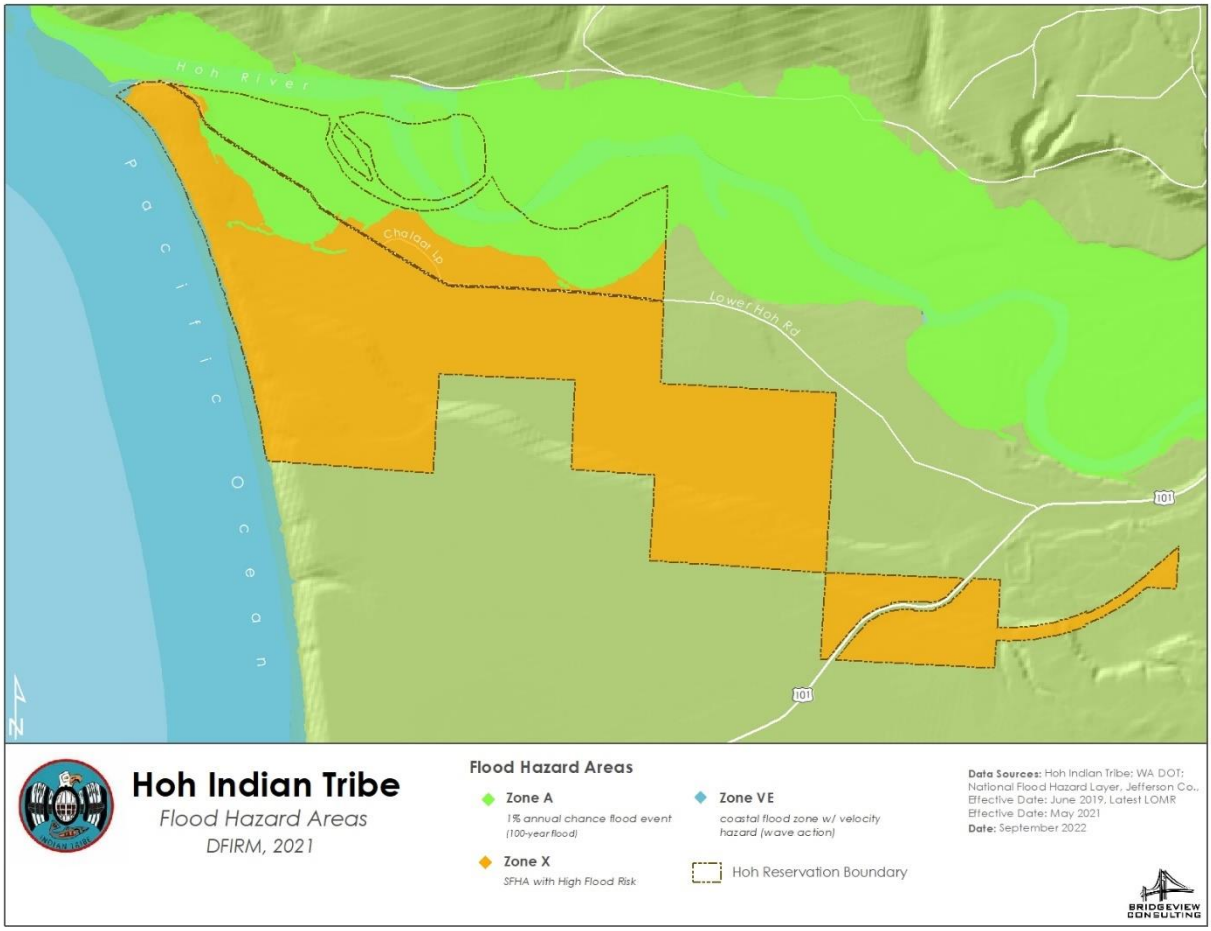


Figure 8-7 Hoh Tribe Flood Hazard Areas

8.2.2 Previous Occurrences

Flooding has a long history on the Hoh Reservation. The month highest in number for declared flood or flood-included events (e.g., severe storm) is January (five events). This is followed by February (four events), March and December (three events), April and November (two events) and October (one event).

Historically, beginning the first week of July the Reservation experiences its lowest tides, averaging 6 to 8 feet high. The tides become higher in later months, and by mid-January, the Reservation begins to experience its highest tides at 10 to 12 feet. Given its proximity to the Hoh Rain Forest, rainfall annually contributes to the Reservation's flooding issue. High tides are also often impacted by storm surges, high winds, and periods of driving rain, causing the water levels on the river to rise, flooding the Reservation.

From late fall through mid-spring, the Tribe continually monitors the flood hazard. When the three conditions occur simultaneously (high water discharge, winds, and high tides), notifications begin. Historically, as the Tribe is very small and most housing is close proximity to one another, Tribal members help spread the word of possible flooding. Customarily, this means mean door to door alerts and phone notifications.

Floods on the Hoh River have damaged governmental structures, roads and bridges, eroded public and private properties, and interrupted transportation. Road and bridge washouts near the Reservation and elsewhere in western Jefferson County in recent years have isolated the Reservation and necessitated the airlift of supplies. Rising waters on the Hoh River have also necessitated sandbagging and other emergency measures for members of the Hoh Tribe residing at the end of the Lower Hoh Road.

As identified in Chapter 3, Section 3.5 – Major Past Hazard Events Table, the planning area has received 20 disaster declarations typed by FEMA as Flood or Severe Storm events. Because limited data is available for the Hoh Reservation independent of Jefferson County, County data was used to populate this data. At present, the dollar value of property damage on the Reservation is unknown. In the future, the Tribe will begin a system for maintaining historical data specific to the Reservation.

Major floods in the planning area have resulted from intense rainstorms customarily between October and May. Some of the events impacting the tribe follow.

- One of the more significant floods included the 1995 event. Tribal buildings were significantly flooded when a 47,600-cubic-foot-per-second discharge on the Hoh River coincided with a high tide. In response to the 1995, Jefferson County workers halted erosion of the river's north bank across from the Reservation by installing a wall of large rocks, which Tribal officials believed caused the river to be redirected immediately towards the Tribal settlement.
- October 2003 – a flood of 58,000 to 60,000 cubic feet per second (USGS estimates). During the 2003 flood event, water traveled over the Reservation's main road and inundated buildings, including the Tribal Center.
- 2015 – An atmospheric river passed over parts of western Washington. Over the following 48 hours, intense precipitation fell on much of the coast and interior of the state. The area experienced many landslides. This was a historic flood of record. Jefferson County incurred nearly $1.6 million in road repair costs due to landslides and flooding in the western end of the County (area of the Hoh Tribe). Of the $1.6 million, $300,000 was directly related to flood damage to the Oil City Road. A neighboring Reservation, The Quinault Indian Reservation, sustained significant impact when the bridge near Quinault Village on Moclips Highway 109 (main ingress and egress to the Tribe) washed out, leaving ~1,000 residents on the Reservation isolated. Up to 13 inches of rain was reported in the Olympic Mountains.
- 2007 – (DR-1734) December 2-3, 2007. Snow followed by a "Pineapple Express" caused major flooding. During the 2007 flood, the water moved swiftly and covered the Reservation to record water depths within 24 hours of notification of flooding. Wells and the Tribal septic systems were swamped and well heads were overtopped.

8.2.3 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 that have the potential to impact 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 USGS maintains limited stream gage data which is available real-time for viewing. Figure 8-8 and Figure 8-9 illustrates the type of data available from the USGS. Readers may elect to obtain data on stream gages directly from the USGS at: https://waterdata.usgs.gov/wa/nwis/rt.

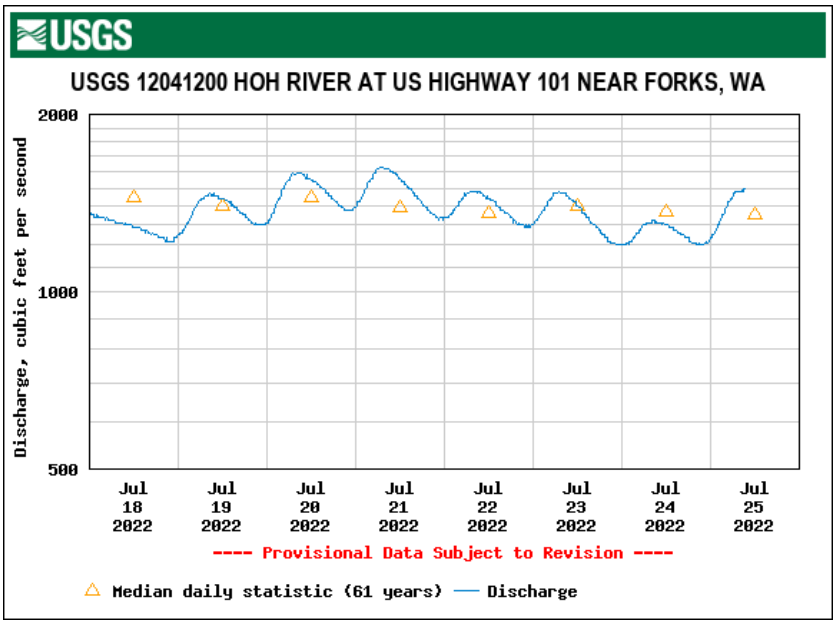


Figure 8-8 Sample Hoh River USGS Gage Data

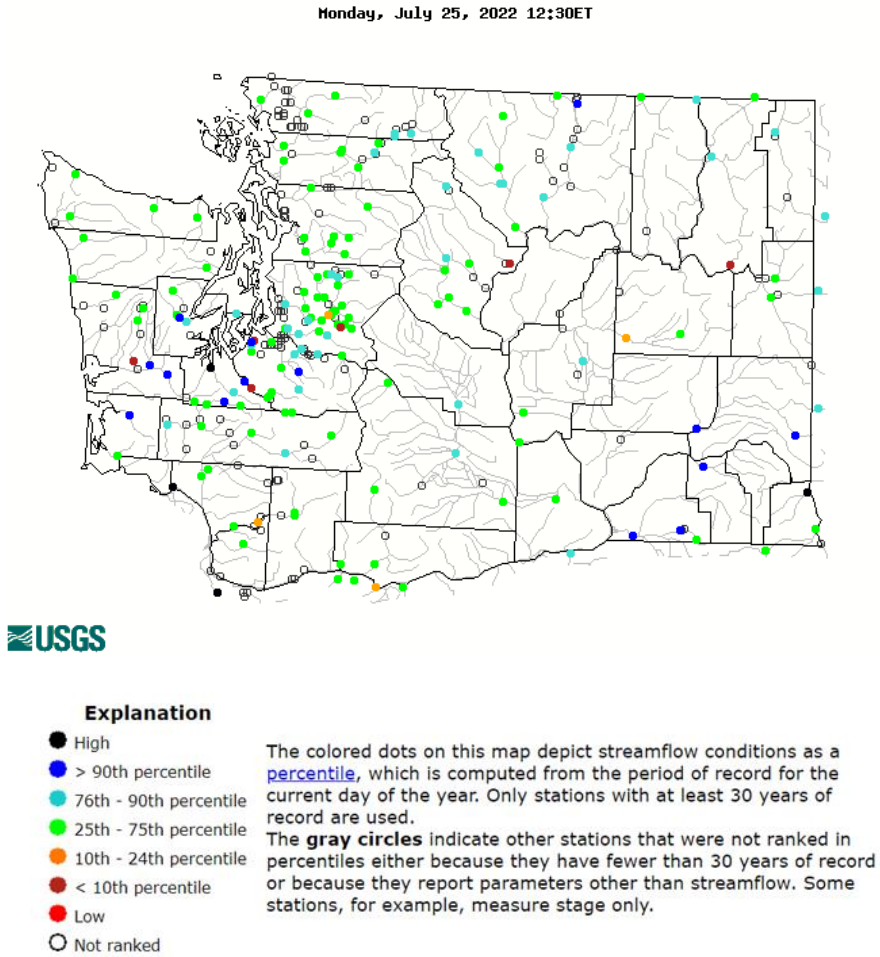


Figure 8-9 USGS Stream Flow Data for July 25, 2022

Tribal members know three conditions must simultaneously occur for major flooding to occur on the Reservation:

- Tides of 10 feet or more
- Westerly winds
- A Hoh River discharge of 45,000 cubic feet per second or more.

Such occurrences customarily begin in July, as indicated, and escalate throughout the remainder of the year.

8.2.4 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.

As indicated, the Hoh Reservation is subject to minor flooding five or more times annually. The frequency of flooding is caused by the unique geologic and physical environment of the Hoh Reservation. These minor floods occur primarily along on the northwestern area of the Reservation and cover up to half of the Reservation for periods of one or more days. Although minor, these smaller events tend to limit access to areas of the Reservation, causing isolation, disrupting services, including wells and wastewater systems. Flooding sufficient to limit access to the Reservation, covering Reservation access roads occur annually.

Major floods resulting in severe impacts, including evacuation of people from residences in low-lying areas, and the inundation of major access roads, such as U.S. Highway 101, has historically occurred every 7-8 years, with two incidents occurring during 2022. Severe storms that also include flooding occur more frequently, approximately every two-three years, with two incidents occurring in 2006, one of which included tidal surge. The planning area has sustained nine declared *Flood* incidents during the period 1996-2022, not inclusive of *Severe Storm/Weather* incidents which also include an element of flood. There are an additional 11 Severe Storm incidents that include some level of flooding.

The Washington State Hazard Mitigation Plan (2018) identifies Jefferson County as being at medium level with respect to counties vulnerable and at-risk to Flooding. However, what customarily constitutes the "normal" flood season of October through April in Western Washington does not apply to the Hoh River, which has received flood warnings issued by the National Weather Service during the month of July – normally one of the state's dryer months.

Flood events have continued to increase over the decades, with the majority of the declared incidents impacting the Reservation being flood or flood related (e.g., sever weather events which include a flood component). As damages have grown in frequency and in size, flood management efforts have been accelerated by the Hoh Tribe to help reduce the impact of flooding. In many cases, these actions were funded or developed by the Tribe.

8.3 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 on Tribal assets.

8.3.1 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; loss of continuity of government, and displacement of persons from homes and places of employment.

Warning Time

Due to the sequential pattern of meteorological conditions needed to cause 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. Tidal inundation due to high tides has considerable advanced notice.

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 (such as those recognized by the Hoh Peoples) 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. Flood threat systems in the planning area consist of a network of precipitation gauges throughout the watersheds and stream gauges at strategic locations 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.

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.

8.3.2 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. The Hoh Tribe has experienced the loss of one life as a result of highwater levels on the Hoh River in 2009 (both flood and severe weather event) when a fishing boat capsized. That incident led to new regulations, restricting fishing on the river when it reaches certain levels.

Exposure to life, health, and safety represents the population living in or near floodplain areas that could be impacted should a flood event occur. Currently, there are approximately 85 individuals living on the reservation and additional family members regularly visiting. Thus, the average daily population is estimated to be 125. All of those individuals are exposed to the flood hazard as a result of isolation during most flood events, even those more minor in nature.

With respect to the Hoh Tribe, however, exposure cannot be limited to only those who reside or work in a defined hazard zone, but rather, everyone who may be affected by the effects of a hazard event (e.g., people are at risk while traveling in flooded areas, or when their access to emergency services is compromised during an event). That degree of impact will vary and is not measurable with any specificity.

Of significant consideration and concern to the Hoh is the number of tourists and guests utilizing the various local tourist destinations who can be impacted during periods of flooding. Tourism is a very large economic base in Jefferson and Clallam Counties (surrounding counties of the Hoh Reservation). Within the planning region as a whole, many tourists travel through the area at all times of the year.

The Tribe also has various health and social service programs which provide services to all tribal members and employees, whether a member of the Hoh Tribe or not. In some instances, such as with the COVID response, the Tribe provided testing and immunization for anyone in the area – whether a tribal member or not.

Of the population exposed, the most vulnerable include the economically disadvantaged, and the populations under 5 years of age, or 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. Chapter 3 discusses in detail the vulnerable population on the Reservation, but utilizing Census data, is it estimated that 12 people fall within the vulnerable criteria, not inclusive of individuals with disabilities, guests and visitors, or tourists in the area.

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, but can occur, such as the Hoh Tribe has already experienced. 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, or not evacuating with floodwaters rise. With roadways being impacted due to floodwaters overtopping them, or landslides occurring off the reservation which close transportation routes down, there potentially could be a significant number of individuals impacted.

8.3.3 Impact on Property

Review of the flood hazard areas indicates that eight structures are within the 100-year floodplain, including the Tribe's wastewater facility, one hazardous materials location (unused gas station), one commercial facility, and its tribal administration building. There are 14 additional structures within the 500-year floodplain (or VE Flood Zone), including (but not limited to) the tribal center and tribal administration structures; foodbank; two duplex units (four housing units total); the wastewater treatment plant, and five commercial properties (hatcheries, etc.).

The Tribe has initiated removal and restoration of some frequently flooded projects on tribal lands which were subject to impact from floods. Such activities have been extremely important to the Tribe in protecting its lands and the environment. The Tribe is also in the initial phases of redevelopment of all structures into the area of the Hoh Highlands, which is out of the floodplain. Once all structures are replaced in the upper portion (Hoh Highlands), the properties on the lower portion of the Reservation in the flood zone will be removed.

8.3.4 Impact on Critical Facilities and Infrastructure

As indicated, all facilities identified for this plan update are considered critical in nature. Due to the limited housing stock, all residential structures were identified for assessment. As such, all properties identified in Section 8.3.3 are critical facilities exposed in the FEMA 100-year flood hazard areas.

The total structure value for the critical facilities at risk in the 100-year flood zone are approximately $2.5 million. The total structure value for the critical facilities at risk in the 500-year flood zone are approximately $3.5 million.

In addition, the majority of all roadways both on the reservation and leading to the reservation could be inundated to different depths, causing isolation. Such has been the case many times historically on the reservation.

8.3.5 Impact on Economy

Impact on the economy related to a flood event would include loss of property, inventory, equipment, and loss of business revenue for those individual tribal members which operate businesses. In the case of the Hoh, over the course of the lifecycle of this plan, they will hopefully be establishing different types of businesses in the Hoh Highlands area as the beginning phases of establishing an economic base on the Reservation. Flooding would have the potential to impact revenue generated by the Tribe, particularly if roadways leading into the tribal planning area was impacted.

Flooding has the potential to impact all industrial sectors. Depending on the duration between the 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.

In addition to the Tribe's economic loss, Tribal citizens who work for either the Tribe or other non-native surrounding businesses would be impacted due to loss of income. There is a high volume of forestland in the surrounding area which may be subject to flooding. As such, all industrial sectors could also be negatively impacted.

8.3.6 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. Flooding has significant impact on migrating fish, which can be washed onto roadways or over leaves, with no possibility of escape, or the chemicals or pollutants can wash into rivers and streams, killing the fish and their food supplies. The Hoh do have a fish hatchery, which rears and releases 80,000 fish annually.

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 peak and fall 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.

8.3.7 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 many areas 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, increased sedimentation will occur, 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 wastewater treatment facilities and storm drains.

Sea Level Rise

Sea level and temperature are interrelated (U.S. EPA, 2016). 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.

8.4 FUTURE DEVELOPMENT TRENDS

Development has affected the natural features of the land over time as the area has been 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 area. Encroachment on floodplains by structures and fill material reduces carrying capacity and increases flood heights and velocities.

The local municipalities in the area are subject to the provisions of the Washington State Growth Management Act (GMA) which regulate identified critical areas, but until those lands directly impacted can be returned to their normal condition, flooding will continue.

The Hoh has established land use regulations, including a flood ordinance. This is particularly true in its application of the ordinance since the Tribe now has FEMA flood maps, which help identify the areas of concern; something which they did not have when the last plan was completed. The Tribe is now more prepared to address flooding issues through various mitigation activities, including its restoration projects, and building outside of the floodplain when new construction occurs. In some cases, when development may occur in the floodplain, it is regulated such that the degree of risk and vulnerability is reduced through

building standards and performance measures as the Tribe deems appropriate, thereby decreasing the level vulnerability since completion of the last plan.

8.5 ISSUES

Large portions of the Tribal lands have the potential to be impacted from a flood event, generally in response to a succession of winter rainstorms, increased snow melt beginning in July, and high tides, which can occur at any time. Storm patterns of warm, moist air are normal events, usually occurring between October and April, but the Tribe has received flood warnings in July. All of these events can cause some level of flooding in the area, which can occur at any time.

A worst-case scenario for a flood event 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 which would impact the Hoh River's ability to discharge. These types of events have occurred in the planning area. High in-channel flows would cause watercourses to scour, possibly washing out roads or impacting bridges, creating more isolation or evacuation problems. 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.

8.6 IMPACT AND RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from Flood throughout the area is highly likely. The area can experience in excess of five flood events annually, albeit not to the level of a disaster declaration. The area has been impacted nine times since 1953 at the level to gain a federal disaster declaration, and FEMA has identified the flood hazard as the second most significant hazard to occur (behind severe weather).

While structural damage may vary due to flood depths and existing floodplain management regulations, roadways both on and off the reservation are regularly impacted, causing isolation. With individuals traveling through the area, this has the potential to significantly impact the tribe with respect to individuals trapped in the area until floodwaters recede.

Emergency response would also be impacted as a result of water inundating roadways, making evacuation impossible for extended periods of time. This is one of the reasons why the Tribe has discussed a medical evacuation site in the new Hoh Highlands area for use by the County for medical evacuations. Of additional consideration are the tribal restoration projects which have also been impacted by repeated flooding in the area. 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 9.
LANDSLIDE

9.1 GENERAL BACKGROUND

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

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

DEFINITIONS

Landslide—The 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.

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.

9.2 HAZARD PROFILE

Landslides are caused by one or a combination of the following factors: 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. In general, landslide hazard areas are where the land has characteristics that contribute to the risk of the downhill movement of material, such as the following:

- A significant slope
- 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 or potential for snow avalanches
- 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 in Figure 9-1 through Figure 9-4. The most common is the shallow colluvial slide, occurring particularly in response to intense, short-duration storms. The largest and most destructive are deep-seated slides, although they are less common than other types.

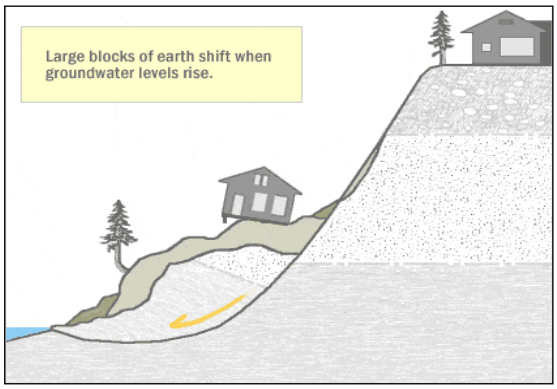


Figure 9-1. Deep Seated Slide

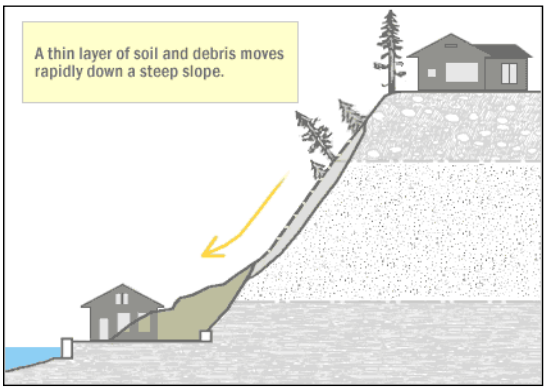


Figure 9-2. Shallow Colluvial Slide

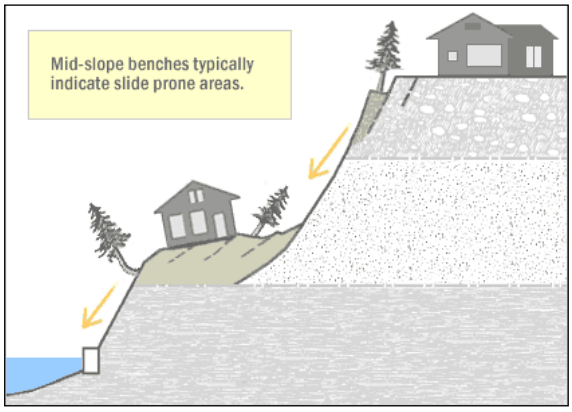


Figure 9-3. Bench Slide

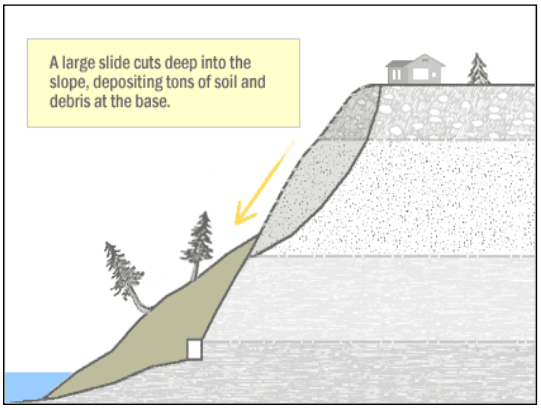


Figure 9-4. Large Slide

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

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

Although erosion is a natural process, as with landslides, human land use policies also have an effect on erosion, especially industrial agriculture, deforestation, and urban sprawl. Land that is used for industrial agriculture generally experiences a significantly greater rate of erosion than that of land under natural vegetation, or land used for sustainable agricultural practices. This is particularly true if tillage is used in farm practices, which reduces vegetation cover on the surface of the soil and disturbs both soil structure and plant roots that would otherwise hold the soil in place. However, improved land use practices can limit erosion, using techniques such as terracing or terrace-building, no or limited tilling, limited logging or replanting if logged, and the planting of vegetation to limit erosion through ground cover.

While a certain amount of erosion is natural and healthy for an ecosystem, such as gravel continuously moving downstream in watercourses, excessive erosion causes serious problems, such as receiving water sedimentation, ecosystem damage and loss of soil and slop stability. Erosion can cause a loss of forests and trees, which can damage aquatic life, irrigation, and power development by heavy silting of streams, reservoirs, and rivers.

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.

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). 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

9.2.2 Extent and Location

The best predictor of where movement of 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 proportion of them may become active in any given year, with movements concentrated within all or part of the landslide masses or around their edges.

The recognition of ancient dormant mass movement sites is important in 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. Figure 9-5 and Figure 9-6 shows identified landslide hazard areas in and around the Hoh Reservation. The areas identified as deep seated and deep seated earthflow are primarily along a ridgeline in uninhabited areas of the Reservation. The majority of the Reservation has never experienced a landslide; however, there are areas along the coastal bluff and the mouth of the Hoh River where erosion has been a continual issue (see Figures 9-7 and 9-8).

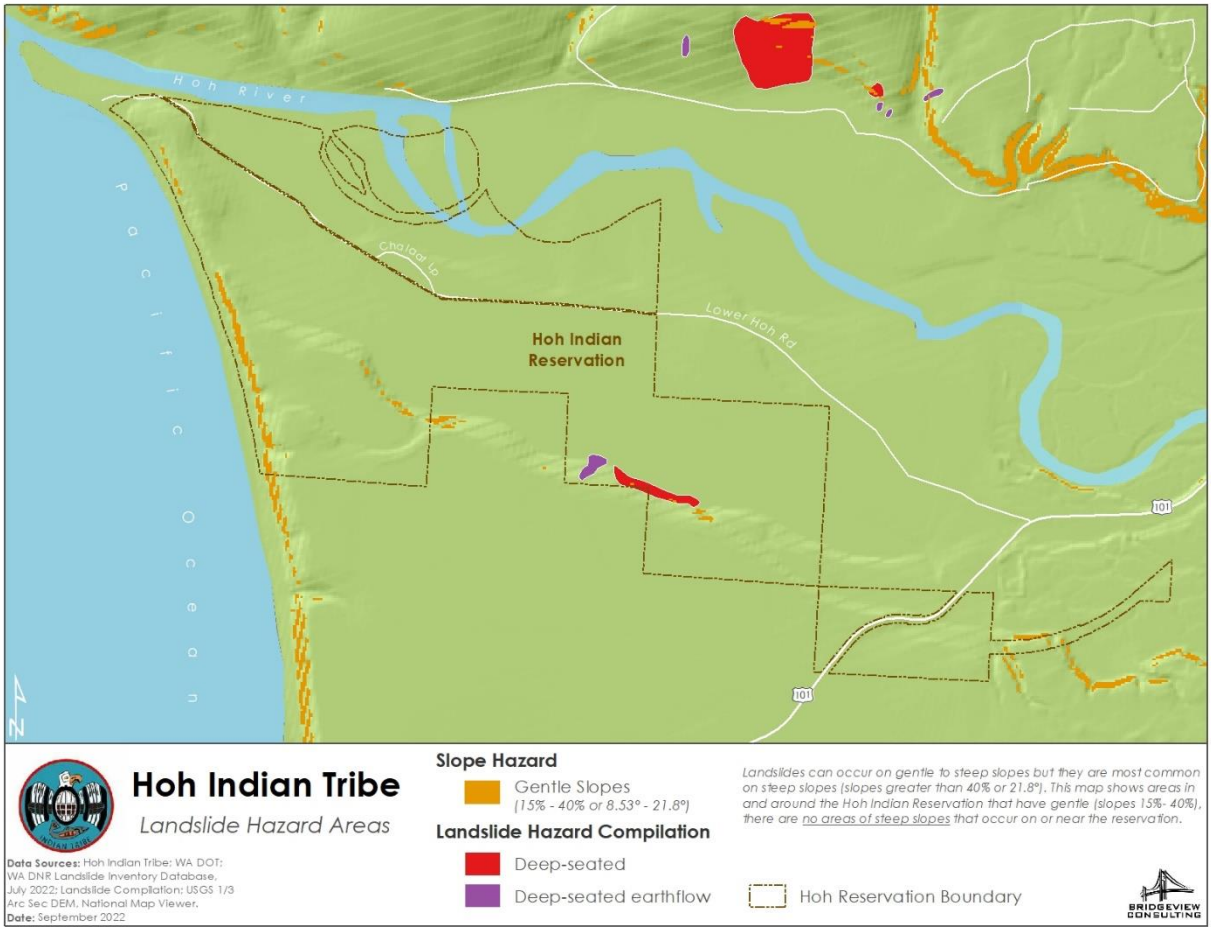


Figure 9-5. Landslide Hazard Areas on the Hoh Reservation

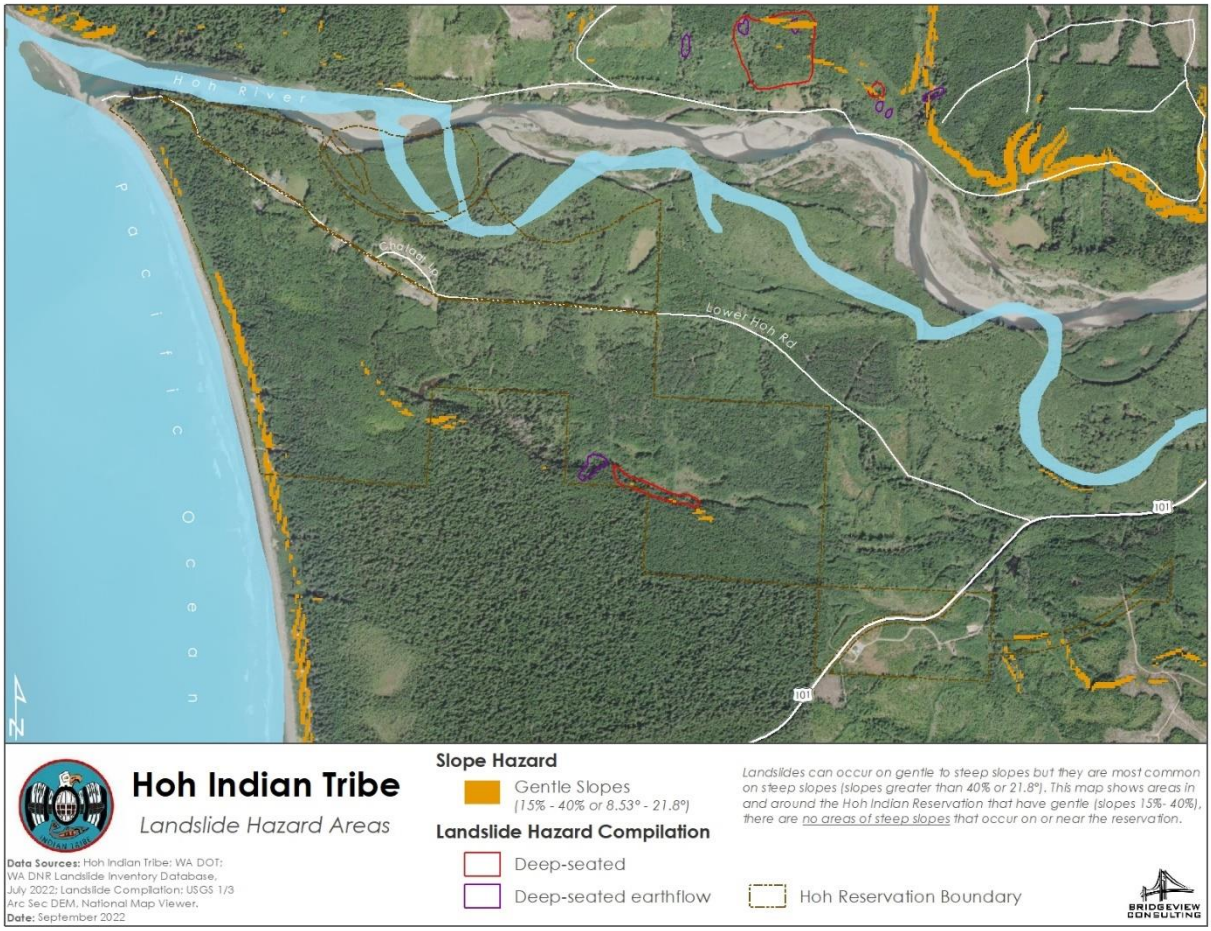


Figure 9-6 Landslide Hazard with Aerial Imagery

Figure 9-7 Hoh Tribe Bluff Erosion

Figure 9-8 USACE-Installed Break Wall on Hoh Reservation

9.2.3 Previous Occurrences

The Hoh Tribe has not experienced a landslide in the area of the Reservation where residential or governmental structures are located. The coastal areas and bluffs along the entrance to the Hoh Tribe where the Hoh River meets the confluence of the ocean is regularly impacted by wave action and storm surges, significantly eroding the landmass of the Hoh Tribe.

In addition, while not owned by the Hoh Tribe, Highway 101, the primary roadway providing ingress and egress to the Reservation has been washed out numerous times, particularly in the areas where the Hoh and Bogachiel Rivers have undercut the hillside after heavy rains and snowpack melts. With the addition of water from rain and runoff, these rivers have had a long history of eroding their banks, causing slopes to slide. But one example of this was during the December 2007 storm event, which was one of the highest-producing landslide events in Washington, leading to a disaster declaration in the County. With snow, strong winds, and heavy rainfall battering western Washington, the December 2007 storm triggered thousands of landslides and caused major flooding on countless rivers, including the Hoh River. The first part of the storm reached the Washington–Oregon border with winds and heavy snow to higher elevations and lighter snow to lower elevations. Snow depths in higher elevations reached up to 14 inches, whereas lower elevations received 1 to 4 inches. Situated in the Olympic National Forest, the Reservation

received more rain than snow from this event. As the first storm moved away from Washington, a second storm approached. By December 2, the temperatures, which had originally allowed snow to accumulate, rose quickly, and heavy rainfall began. As a result of the number of landslides occurring, the Washington DNR conducted extensive field and aerial studies as a result of this event. Reports indicate that within Jefferson and bordering Mason Counties, 214 landslides were recorded: 80 shallow undifferentiated landslides, 23 debris flows, 108 debris slides, 1 deep-seated landslide, and 2 hyper-concentrated flows. Numerous other hyper-concentrated flows were observed but not recorded due to lack of damage, small size, and time constraints.

At least 16 landslides blocked or damaged U.S. Highway 101, two blocked or damaged State Route 106 along Hood Canal, and five blocked or damaged other roads. For the Hoh Reservation, the damage to Highway 101 was significant, as this is the Tribe's only ingress and egress from the Reservation, connecting the Reservation to other areas of Jefferson, Clallam, Grays Harbor and Mason Counties. It is also a major access-way to the Hoh Rain Forest in the Olympic National Park.

There is little additional recorded information regarding any landslides specific to the Reservation itself, and the Tribe has no records of damages sustained. Review of the SHELDUS and FEMA websites list 16 recorded landslide events since 1960 within Jefferson County as a whole (inclusive of severe weather events which include landslides), as follows:

- January 26, 1965
- February 27, 1972
- March 5, 1972
- December 18, 1972
- January 1986
- December 1996-February 1997
- March 1997
- February 2006
- November 6, 2006
- December 3, 2007
- January 2009
- November 12 – 15, 2015
- December 1 – 14, 2015
- December 10 – 24, 2018
- December 29, 2020 – January 16, 2021
- November 13 – 15, 2021

Ten of these events coincided with presidential disaster declarations for severe storms and/or flooding events for Jefferson County. The Tribe did not seek a direct FEMA disaster declaration for any of those

events. There are no recorded fatalities attributed to mass movement, but there have been injuries reported in the County.

9.2.4 Severity

Landslides can quickly kill people, destroy property and infrastructure, and can have a long-lasting effect on the environment. 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 Jefferson County to be 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.

Precipitation influences the timing of landslides on three scales: total annual rainfall, monthly rainfall, and single precipitation events. Landslides are most likely to occur during periods of higher-than-average rainfall. The ground must be saturated prior to the onset of a major storm for significant landslides to occur. For the Hoh Reservation, this includes six months out of the year, from October through May, with the month of January being the highest month with the number of occurrences. Those months are the ones during which water tables have risen.

9.2.5 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. Within Jefferson County, landslides typically occur during and after major storms, so the potential for landslides largely coincides with the potential for sequential severe storms that saturate steep, vulnerable soils.

Landslide events were identified by FEMA typing during the winter storms of 1997, 2006 (both February and November 2006), December 2007 (discussed above), December 2008-January 2009 event, and the second January 2009 severe winter storm event. The 2015 severe weather events did cause the break wall (previously installed in 2008 by USACE to help reduce erosion) to move (photographed above). The 2015 event also caused issues with the roadways throughout both Clallam and Jefferson Counties.

According to data reviewed from various sources, including the Tribe, Jefferson County Hazard Mitigation Plan (2012), SHELDUS, and FEMA records, the planning area has been impacted by severe storms, which include landslides, at least 16 times since 1960. Until better data is generated specifically for landslide hazards, the severe storm/landslide frequency is appropriate for the purpose of ranking risk associated with the landslide hazard. Using a basic averaging of years/events, this would equate to a landslide event occurring on average every 4.3 years. Based on data from FEMA's National Risk Index, the County as a whole has a frequency of 0.1 events per year, with a very low historic loss ratio.[11]

[11] FEMA National Risk Index. (2022). Accessed 26 July 2022. Available online at: Map | National Risk Index (fema.gov)

9.3 VULNERABILITY ASSESSMENT

9.3.1 Overview

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. Some methods used to monitor mass movements can provide an idea of the type of movement and the amount of time prior to failure. It is also possible to determine what areas are at risk during general time periods. Assessing the geology, vegetation and amount of predicted precipitation for an area can help in these predictions. However, there is no practical warning system for individual landslides. The current standard operating procedure is to monitor situations on a case-by-case basis, and respond after the event has occurred. Generally accepted warning signs for landslide activity include:

- Springs, seeps, or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavements or sidewalks
- Soil moving away from foundations
- Ancillary structures such as decks and patios tilting and/or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls or fences
- Offset fence lines
- Sunken or down-dropped road beds
- Rapid increase in creek water levels, possibly accompanied by increased turbidity (soil content)
- Sudden decrease in creek water levels though rain is still falling or just recently stopped
- Sticking doors and windows, and visible open spaces indicating jambs and frames out of plumb
- A faint rumbling sound that increases in volume as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together.

9.3.2 Impact on Life, Health, and Safety

Population vulnerable to landslides could not be examined by landslide hazard area in the customary manner of using census block information because census block information does not exist for the Reservation. Also, due to very limited housing available on the Reservation, many residences sustain more than one family, with an average value of 4.35 persons residing in each residence. The most significant factor for the Reservation population is the potential landslide area cutting off ingress and egress, which has the potential to impact all 125 Tribal members, as well as any visitors who may be trapped on the Reservation should a landslide block Highway 101. While the Tribe itself has not experienced a landslide in the existing residential and government structure areas, roadways have been impacted, causing

isolation. For these reasons, the Planning Team determined the impact on people to be of medium level of concern.

9.3.3 Impact on Property

Currently, none of the inhabited residences or public facilities on the Reservation are in a landslide prone area. In review of the landslide data, there are 14 structures of varying types that are within 1,000 feet of what DNR identifies as a gentle slope. There are a number of cultural resources and locations that could be impacted by landslides. Those resources have been discussed during Planning Team meetings, and strategies to address them will be developed separately from this document due to the sensitive nature of the cultural resources. It is not possible to assign a property value to the cultural aspect exposed to the landslide hazard for risk ranking purposes.

9.3.4 Impact on Critical Facilities and Infrastructure

Currently, the Tribe has no critical facilities on the Reservation that would be impacted by a landslide, although there are culturally sensitive areas which are exposed to the landslide hazard. The Planning Team has reviewed the potential impacts from mass movement upon those areas, but a more in-depth analysis of mitigation measures should be taken in an effort to prevent damage from mass movement, and to determine in greater detail if those areas could withstand impacts of a mass movement. No valuation can be placed on the cultural sites.

Throughout the immediate surrounding area (off tribal lands), several types of infrastructure are exposed to mass movements and highly susceptible to the landslide throughout Jefferson County. Impact to that infrastructure would pose a threat or increased vulnerability to the Hoh Tribe. Those include:

- **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. The Hoh Tribe is extremely isolated, with only Highway 101 serving as the main thoroughfare in the area.
- **Bridges**—Landslides can significantly impact road bridges. Mass movements can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use. The Forks Bridge, located approximately 30 miles from the Hoh Reservation, serves as a major access point along Highway 101. Should impact occur to the Bridge, traffic along Highway 101 would be impassable.
- **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 underneath 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. This is a significant factor for the Reservation as it is at the end of the distribution lines owned by Clallam County PUD, and even a minor power outage anywhere along the line has the potential to last for days by the time power is restored to the Reservation. At present, the Tribe averages at least two power outages per month, many of which are not weather

related. With the development of the Hoh Highlands area, power lines onto the Tribal lands will be underground. Several governmental facilities, once completed, will also be equipped with generators to provide a source of power for use during emergencies. This includes the Public Safety Building, which will serve as a shelter and the resilience center for the Tribe and surrounding community.

9.3.5 Impact on Environment

Environmental problems as a result of mass movements can be numerous. Landslides that fall into 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 due to landslides. The Tribe currently has several hatcheries, from which they release ~80,000 fry per year. Due to the lifecycle of salmon, impact in any given year from a landslide could have long-reaching impact to the Tribe.

9.3.6 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, raise sea levels, and increase beach erosion such as that which the Hoh Tribe has been experiencing for many years, shrinking the size of the Reservation. 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.

9.4 FUTURE DEVELOPMENT TRENDS

The Tribe has experienced very slow growth over the past 10 years but has taken significant proactive steps to stimulate growth on the Reservation. Specifically, in an effort to strengthen tribal resilience to flood and tsunami events, the Tribe has acquired 465 acres of trust lands onto which the Tribe will relocate, vacating the original village, which will remain primarily open space. Likewise, the Tribe has developed a business plan, which will provide for greater economic vitality of the Tribe by providing businesses that will stimulate the economy through retail sales and services, such as campground facilities, tours and fishing excursions. The Tribe is optimistic that marginal, sustained growth will return to the Reservation as local, county, state and national economies strengthen.

The Tribe Is equipped to handle future growth in landslide hazard areas. The Tribe anticipates development of land use regulations that will address landslide risk areas. Additionally, the Tribe is committed to linking its general land use and capital improvement plans to this hazard mitigation plan in determining site suitability for future growth. This will create an opportunity for wise land use decisions as future growth impacts landslide hazard areas.

The Tribe is in the process of adopting the most current International Building Code (IBC) for all future development, as it has historically done. With much of the funding for construction activities coming from HUD or BIA funds, such codes have always been utilized as required. Once the land use authority has been adopted, the IBC will continue to be mandatory Reservation-wide, and will enhance the resiliency of the Tribe with respect to development in hazard-prone areas.

9.5 ISSUES

Landslides on the Reservation would most likely would occur as a result of soil conditions that are affected by severe storms, groundwater, or human development. The worst-case scenario for landslide hazards in the planning area would generally correspond to a severe storm that had heavy rain and caused flooding. Landslides are most likely during late fall and winter, when the water tables are high. After heavy rains from October to May, 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, further weakening the slope. Poor drainage, steep bank cutting, a rising groundwater table, and poor soil exacerbate hazardous conditions. Also of concern for the Reservation are those areas along the mouth of the Hoh River during high tides, particularly when such tides occur during storm events.

Most mass movements would be isolated events affecting specific areas. Given historic records, it is not probable that private and public property, including infrastructure, would be affected. However, 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, such as the Hoh Reservation and the Olympic National Park in general. Landslides carrying vegetation such as shrubs and trees may cause a break in utility lines, cutting off power and communication access to residents, may block ingress and egress to the Reservation, and may cause flooding by disrupting the path of travel for the river, or any of its smaller tributaries. Should a landslide occur that impacts the river, there is a high likelihood that fishing and fish spawning would be impacted for many years.

Important issues associated with landslides on the Reservation include the following:

- The degree of vulnerability of homes in landslide risk areas depends on the codes and standards by which the structures were constructed. Information to this level of detail is not currently available.
- Future development could lead to more homes in landslide risk areas.
- Currently, the Tribe has steep banks at the site where the Hoh River empties into the Pacific Ocean. That area is being severely impacted by coastal erosion, causing landslides as the ground continues to wash away. In that area are situated some of the Tribe's most culturally sensitive resources.
- Mapping and assessment of landslide hazards are constantly evolving. As new data and science become available, assessments of landslide risk should be reevaluated.
- 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 on the Reservation. 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 riverbanks, ultimately impacting the flow of water bodies.
- The risk associated with the landslide hazard overlaps the risk associated with other hazards such as earthquake, flood, and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.

9.6 IMPACT AND RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from a landslide throughout the area (including portions of Clallam and Jefferson Counties due to the roadway issues) is highly likely. The area experiences some level of landslides annually. The coastal bluff area along the mouth of the Hoh River as well as other unincorporated areas of Jefferson County have identifiable landslide risk, with several areas off the Reservation marked with signage indicating sliding rocks.

While there are large areas on the Reservation where no landslide risk is 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 sensitive areas such as landslide areas, is regulated by the Tribe on tribal lands. Beyond the structural impact, there is the potential impact of slides to the fisheries industry and the hatchery releasing the salmon. The Planning Team also considered the significance of impact to those cultural resources exposed to the hazard. Secondary impact includes potential isolation and commodity shortages, which also has the potential to impact the entire region. Based on the potential impact, the Planning Team determined the CPRI score to be 2.7, with overall vulnerability determined to be a medium level.

CHAPTER 10.
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 Hoh Tribe 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 hailstorm. Hail has a diameter of 0.20 inches or more. Hail is composed of transparent ice or alternating layers of transparent and translucent ice at least 0.04 inches thick. Although the diameter of hail is varied, in the United States, the average observation of damaging hail is between 1 inch and golf ball-sized 1.75 inches. Stones larger than 0.75 inches are usually large enough to cause damage.

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.

10.1.1 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 October, reaching a peak in winter, and gradually decreasing by late spring.

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

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

The Hoh Reservation on average receives 120 to 140 inches of rainfall annually, making it one of the wettest areas of the lower 48 states. Most of the precipitation occurs from October through April, which contributes to the occurrence of winter floods on the Hoh River. The driest period is during the spring, when snowmelt runoff is the dominant source of water for the Hoh River. The climate in the planning area supports an extensive mix of conifer forests, consisting of western hemlock, Douglas fir, and western red cedar, as well as a deciduous forest consisting of big-leaf maple, red alder, black cottonwood, upland scrub-shrub (thimbleberry, salmonberry, Douglas spiraea), and riparian or forested wetlands.

Because the Hoh River runs through the temperate rainforest of the Olympic Mountains, it receives considerable rain in its watershed. While peak flows on the Hoh River occur in November and December, the average daily flows are greatest in June because of glacial melt. Low flows typically occur in August and September.

Temperatures are fairly mild within the Hoh Region compared to other portions of the state. Average high temperatures range from 44ºF in January to 72ºF in August. Winds have been recorded at and above 100 mph during the storm season, which normally occurs November through February.

Atmospheric Phenomenon

Atmospheric rivers (see Figure 10-1) are relatively long, narrow regions in the atmosphere – like rivers in the sky – that transport most of the water vapor outside of the tropics. These columns of vapor move with the weather, carrying an amount of water vapor roughly equivalent to the average flow of water at the mouth of the Mississippi River. When the atmospheric rivers make landfall, they often release this water vapor in the form of rain or snow. Those that contain the largest amounts of water vapor and the strongest winds can create extreme rainfall and floods, often by stalling over watersheds vulnerable to flooding. These events can disrupt travel, induce mudslides and cause catastrophic damage to life and property. A well-known example is the "Pineapple Express," a strong atmospheric river that is capable of bringing moisture from the tropics near Hawaii over to the U.S. West Coast. [12]

El Niño-Southern Oscillation (ENSO) cycle is a scientific term that describes the fluctuations in temperature between the ocean and atmosphere in the east-central Equatorial Pacific. ENSO is one of the most

[12] NOAA. What are atmospheric rivers? Accessed 18 Sept 2022. Available online at: https://www.noaa.gov/stories/what-are-atmospheric-rivers

important climate phenomena on Earth due to its ability to change the global atmospheric circulation, which in turn, influences temperature and precipitation across the globe. Though ENSO is a single climate phenomenon, it has three states, or phases, it can be in. The two opposite phases, “El Niño” and “La Niña,” require certain changes in both the ocean and the atmosphere because ENSO is a coupled climate phenomenon. “Neutral” is in the middle of the continuum.

- La Nina (translated from Spanish as “little girl”) is a natural ocean-atmospheric phenomenon marked by cooler-than-average sea surface temperatures across the central and eastern Pacific Ocean near the equator. La Nina typically brings above-average precipitation and colder-than-average temperatures along the northern tier of the U.S., along with below-average precipitation and above-average temperatures across the South.
- An El Nino (translated from Spanish as “little boy”) is marked by warmer-than-average sea surface temperatures in the region. Typical El Niño effects are likely to develop over North America during the upcoming winter season. Those include warmer-than-average temperatures over western and central Canada, and over the western and northern United States. Wetter-than-average conditions are likely over portions of the U.S. Gulf Coast and Florida, while drier-than-average conditions can be expected in the Ohio Valley and the Pacific Northwest. The presence of El Niño can significantly influence weather patterns, ocean conditions, and marine fisheries across large portions of the globe for an extended period of time.

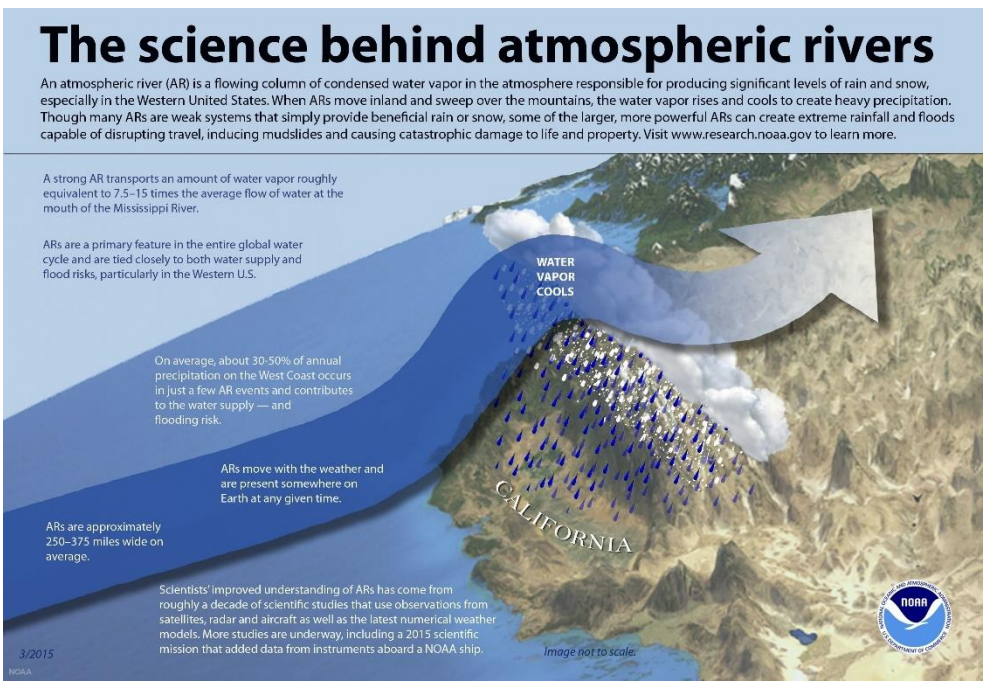


Figure 10-1 Atmospheric Rivers

10.1.2 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 10-2):

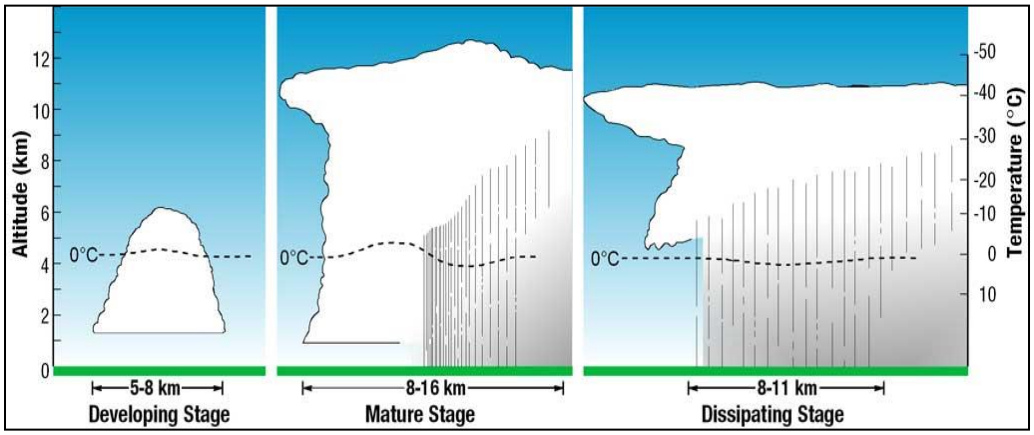


Figure 10-2 The Thunderstorm Life Cycle

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 of 2021 (last full year reported) Washington ranked 48th nationwide for lightning strikes with 55,779 recorded (down five from 2020). For lightning strike density (by area), Washington ranked 50th. During 2021, NOAA reported 11 fatalities, below the previously recorded low of 16 deaths in 2017 (see Figure 10-3). None of the fatalities occurred in Washington State. Based on an analysis updated in 2021 by John Jensenius, Jr., of the National Lightning Safety Council, victims of lightning fatalities were again most often engaged in leisure activities (eight), followed by work-related activities (three). Of the 11 fatalities, all but one was male. On average, lightning strikes start 14 percent of wildfires annually in the United States, with those fires resulting in 58 percent of the acreage burned each year (Vaisala, 2021). 2021 also saw historic severe weather outbreaks impact central and eastern portions of the United States in mid-December, a month during which thunderstorms are customarily low.

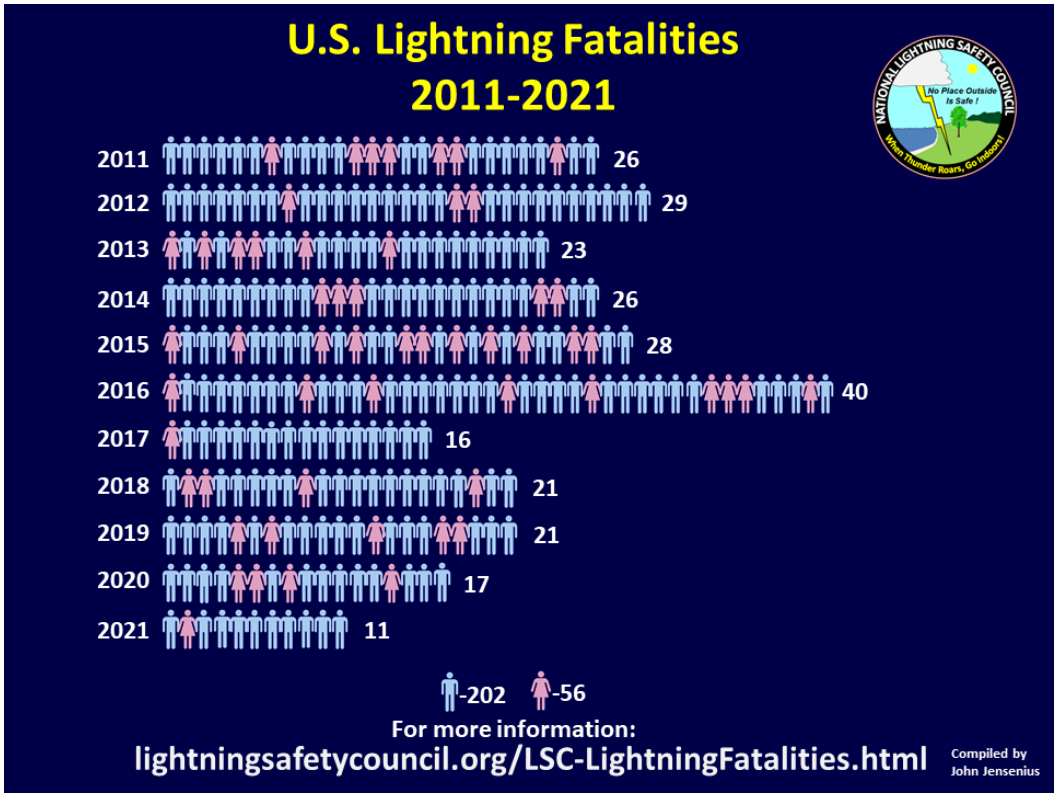


Figure 10-3 Lightning Fatality Statistics 2011-2021

10.1.3 Damaging Winds

Damaging winds are classified as those exceeding 60 mph, although winds at 55 mph can cause structural damage. 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 10-4. 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.

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 10-5. These zones were utilized to guide structure development beginning with the 2006 International Building Code. The 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.

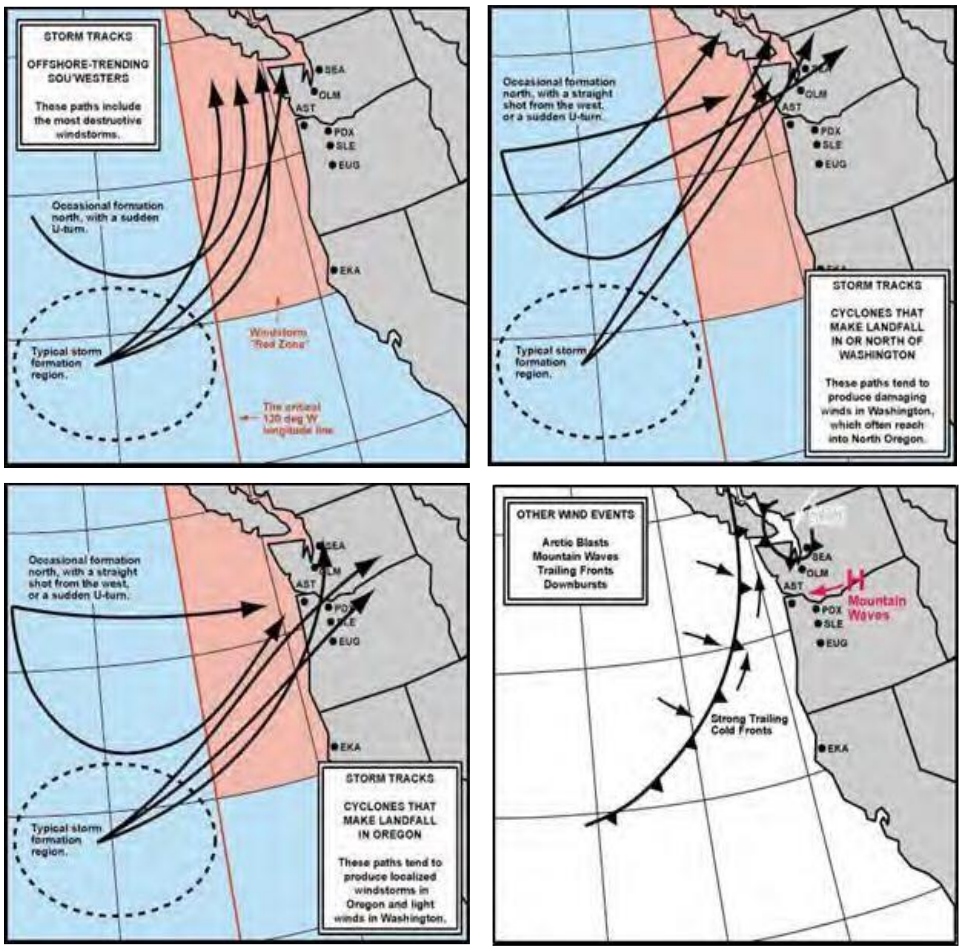
For each wind direction considered, an exposure category that adequately reflects the characteristics of ground surface irregularities are determined for the site at which the building or structure is to be constructed. Also taken into account is the variations in ground surface roughness that arise 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:

- <u>Surface Roughness B</u>. 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.

For the Hoh Reservation, the strongest winds are generally from the south or southwest and occur during fall and winter, although can occur at any time of the year. Wind velocities regularly reach 40 to 50 mph each winter, with 75 to 100 mph occurring a few times annually. Winds have been recorded at and above 100 mph during the storm season, which normally occurs November through February. The highest summer and lowest winter temperatures generally occur during periods of easterly winds.



Source: Oregon Climate Service, 2015

Figure 10-4 Windstorm Tracks Impacting the Pacific Northwest

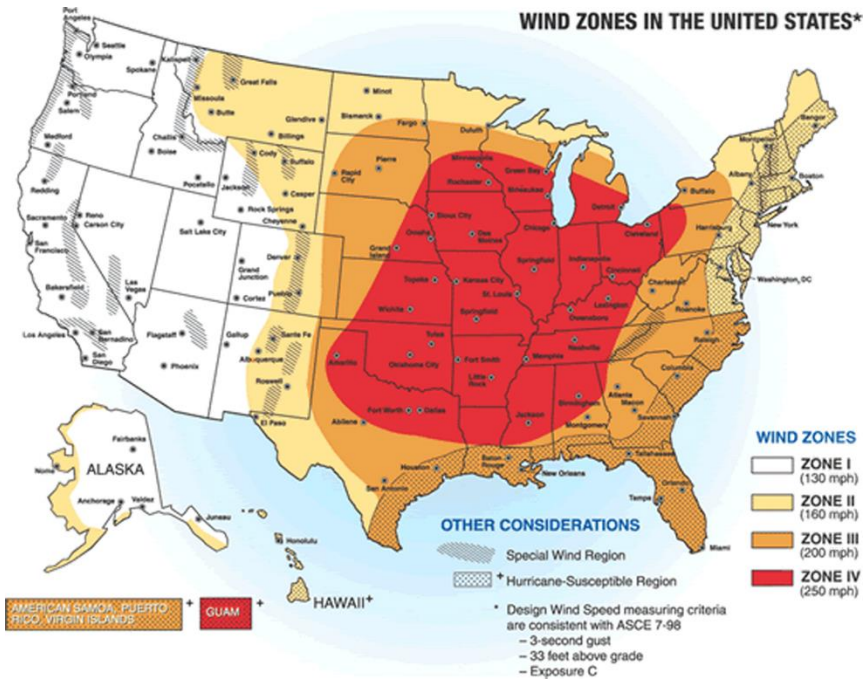


Figure 10-5 United States Wind Zones

10.1.4 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.

10.1.5 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 10-6).

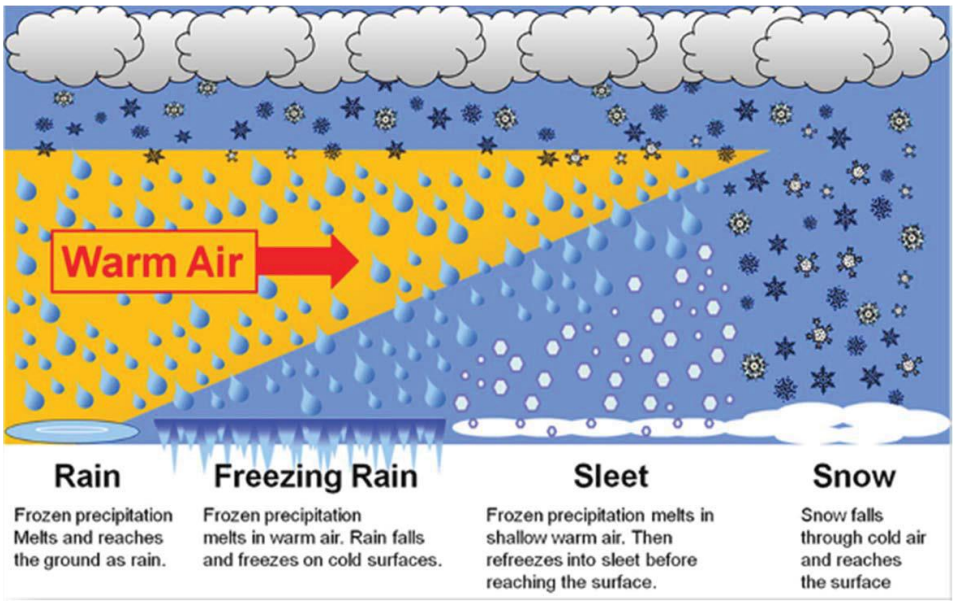


Figure 10-6 Types of Precipitation

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 ¼ mile or less for at least 3 hours.

Portions of the planning area throughout Jefferson County do experience a significant amount of snow on a regular basis, particularly in those areas abutting the mountainous regions. However, in the low-lying area of the existing Reservation, limited snowfall occurs. That snowfall in the surrounding municipalities does impact the tribe with respect to increased motor vehicle accidents, as well as (limited) supply-chain issues. Snowfall in parts of Clallam County has impacted power on the Reservation due to the weight of the snow Damaging power lines leading to the areas of the Reservation.

10.1.6 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 10-7 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.

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

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

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

Where, T= Air Temperature (°F) V= Wind Speed (mph) Effective 11/01/01

Figure 10-7 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 days or weeks are defined as extreme heat (FEMA, 2022; CDC, 2017). 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. 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 10-8 identifies some of those consequences and associated temperatures. [13]

Certain populations are considered vulnerable or at greater risk during extreme heat events. These populations include the elderly age 65 and older, infants and young children under five years of age (see Figure 10-9), pregnant woman, the homeless or poor, the overweight, and people with mental illnesses, disabilities, and chronic diseases.

[13] NCDC, 2000

Relative Humidity (%) \ Temperature (°F)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

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 10-8 Heat Stress Index

Wind-Chill Factor Chart (in Fahrenheit)

Air Temperature \ Wind Speed in mph	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 %)

Air Temperature (F) \ Relative Humidity (Percent)	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 10-9 Heat and Wind Chill Index for Children

10.1.7 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 a funnel cloud. Tornadoes are rated by their intensity and damage to vegetation and property. There are two common rating scales, the Fujita scale (F-Scale) and the Enhanced Fujita Scale (EF-Scale). The Fujita scale is a tornado scale introduced in 1971 by Tetsuya Fujita and the scale evaluates total damage. In the United States the Fujita scale was replaced with the Enhanced Fujita scale, which is now the primary scale used the United Sites and Canada. The Enhanced Fujita scale not only considers damage, but also takes into account wind speed. Figure 10-10 illustrates the two tornado rating scales.

On a local-scale, tornadoes are the most intense of all atmospheric circulations and wind 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. Figure 10-11, adapted from FEMA, illustrates the potential impacts and damage from tornadoes of different magnitudes. Tornadoes can occur throughout the year at any time of day but are most frequent in the spring during the late afternoon. As shown in Figure 10-12, Washington has a low risk compared to states in the Midwestern and Southern U.S.; however, the area does have recorded Tornadoes.[14]

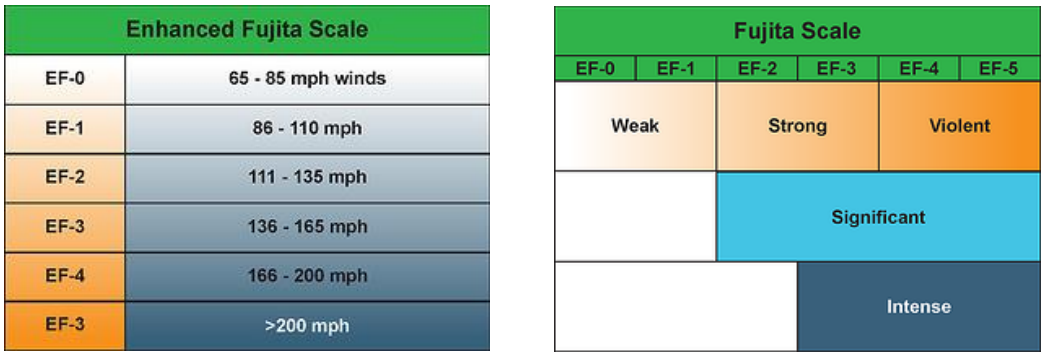
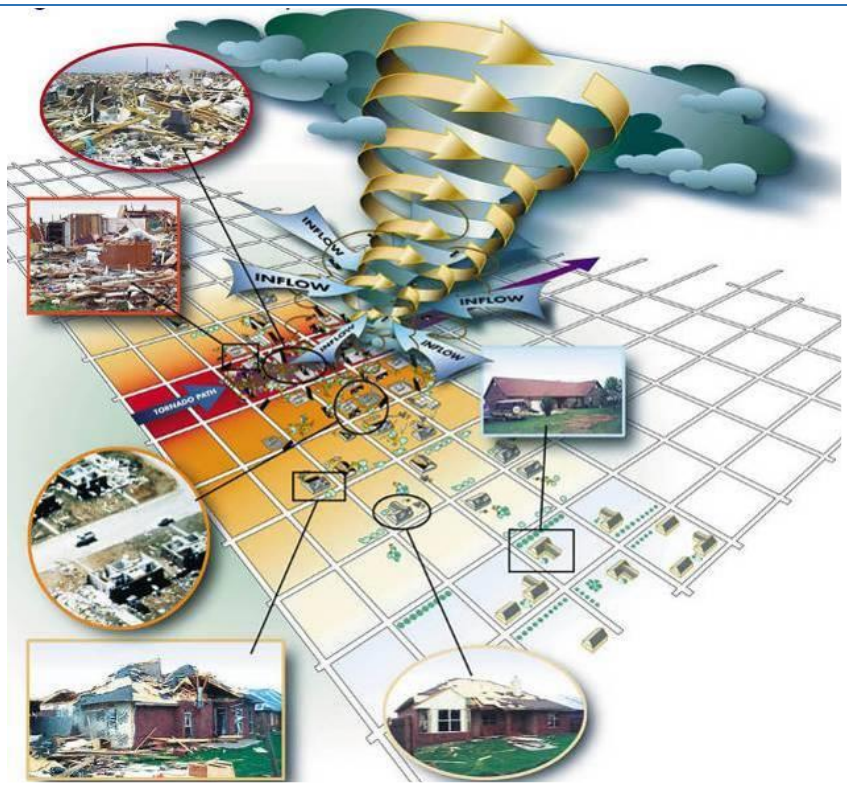
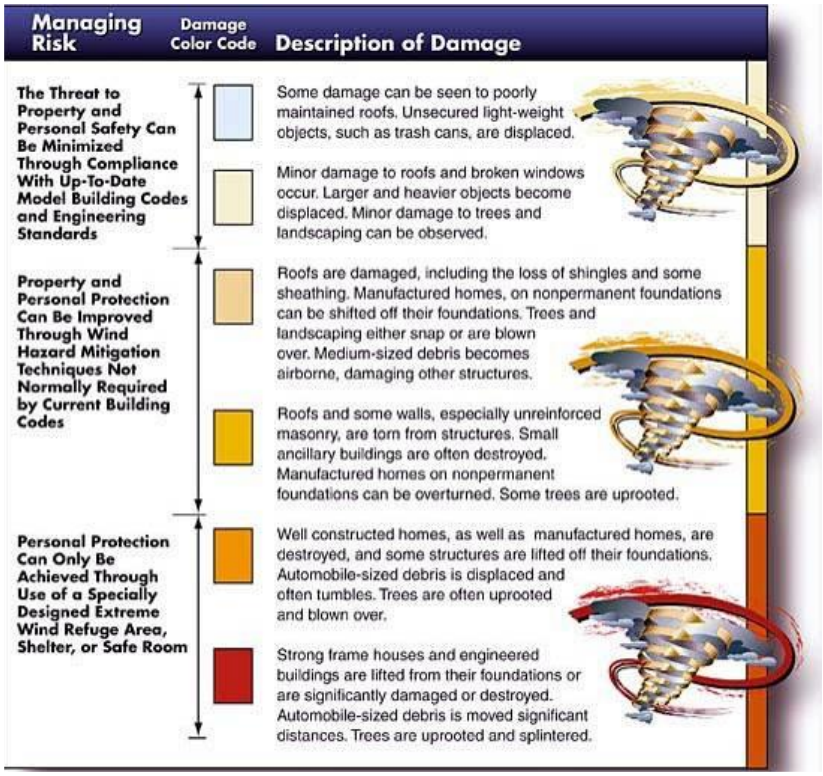


Figure 10-10 Tornado Ratings

[14] Tornado Hazard. National Risk Index. (2022). Accessed 28 July 2022. Available online at: https://hazards.fema.gov/nri/tornado





Managing Risk	Damage Color Code	Description of Damage
The Threat to Property and Personal Safety Can Be Minimized Through Compliance With Up-To-Date Model Building Codes and Engineering Standards		Some damage can be seen to poorly maintained roofs. Unsecured light-weight objects, such as trash cans, are displaced.
		Minor damage to roofs and broken windows occur. Larger and heavier objects become displaced. Minor damage to trees and landscaping can be observed.
Property and Personal Protection Can Be Improved Through Wind Hazard Mitigation Techniques Not Normally Required by Current Building Codes		Roofs are damaged, including the loss of shingles and some sheathing. Manufactured homes, on nonpermanent foundations can be shifted off their foundations. Trees and landscaping either snap or are blown over. Medium-sized debris becomes airborne, damaging other structures.
		Roofs and some walls, especially unreinforced masonry, are torn from structures. Small ancillary buildings are often destroyed. Manufactured homes on nonpermanent foundations can be overturned. Some trees are uprooted.
Personal Protection Can Only Be Achieved Through Use of a Specially Designed Extreme Wind Refuge Area, Shelter, or Safe Room		Well constructed homes, as well as manufactured homes, are destroyed, and some structures are lifted off their foundations. Automobile-sized debris is displaced and often tumbles. Trees are often uprooted and blown over.
		Strong frame houses and engineered buildings are lifted from their foundations or are significantly damaged or destroyed. Automobile-sized debris is moved significant distances. Trees are uprooted and splintered.

Figure 10-11 Potential Impact and Damage from a Tornado

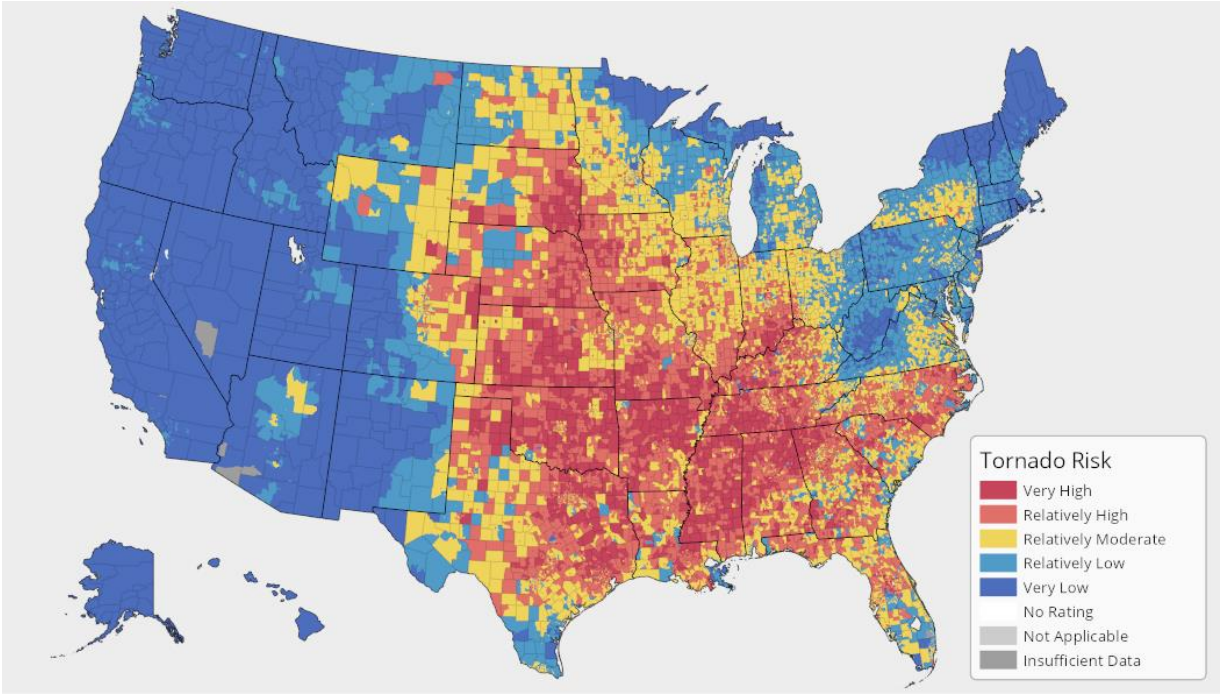


Figure 10-12 Tornado Risk Areas in the United States (2022)

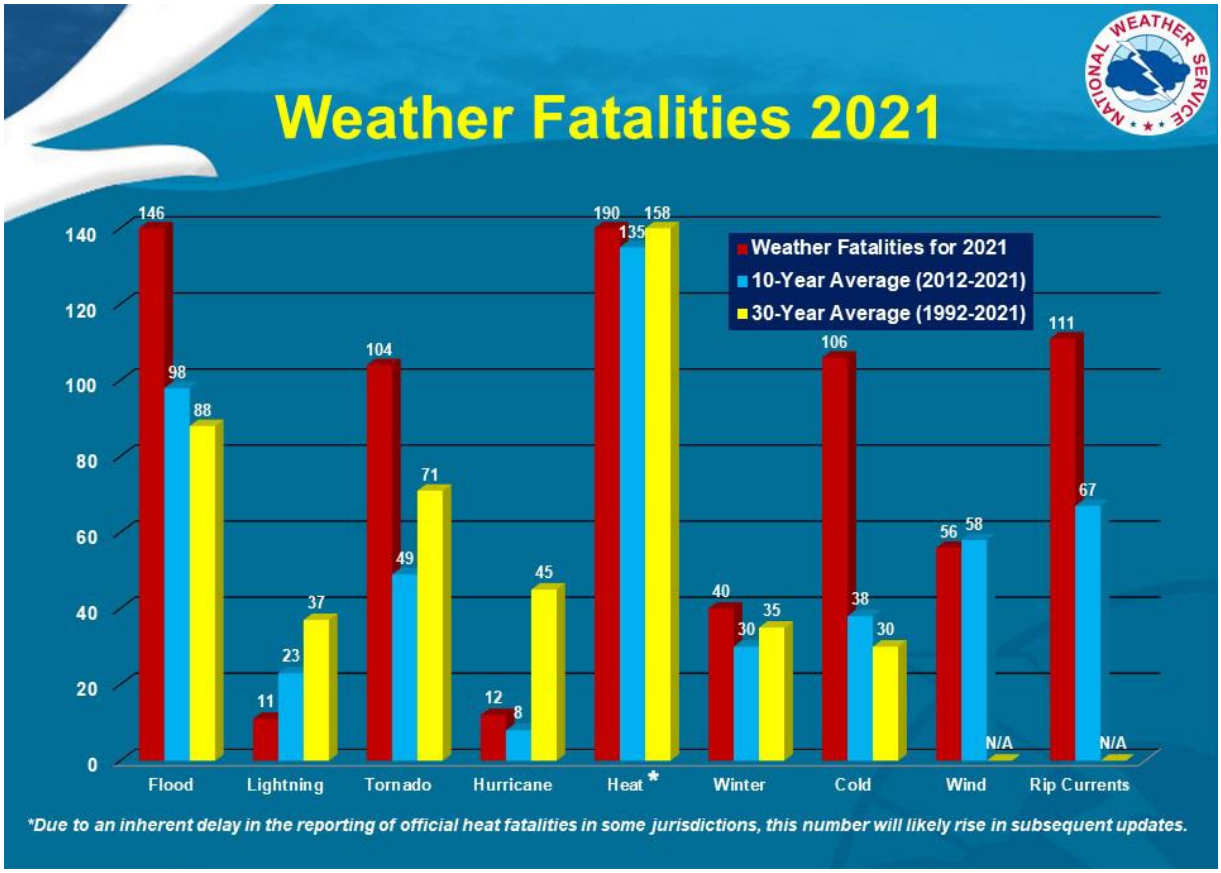


Figure 10-13 Average Number of Weather-Related Fatalities in the U.S.

Figure 10-13 identifies the number of weather fatalities based on 10-year and 30-year averages.[15] Extreme heat is the number one weather-related cause of death in the U.S. over the 30-year average, followed by flood. On average, more than 1,500 people die each year from excessive heat.

Depending on severity, duration, and location, extreme heat events can create or provoke secondary hazards, which include droughts, wildfires, water shortages and power outages, among other issues. 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, various dates).

10.2 HAZARD PROFILE

10.2.1 Extent and Location

The entire planning area is susceptible to the impacts of severe weather. Severe weather events customarily occur during the months of October to May, although they have occurred year-round. When reviewing NOAA and FEMA data, the months of January (three events), March (two events), and December (two events) have the highest severe weather occurrences. The area has been impacted by strong winds, rain, snow (limited), or other precipitation, and have experienced thunder or lightning storms. Tornado warnings have been issued, but no direct impact has been experienced.

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 damaging to the planning area. 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 and increased precipitation. 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 area, winds can be accelerated in small areas.

Severe storms and weather also affect transportation. Access is sometimes unpredictable as roads are vulnerable to damage from severe storms, flooding, and landslide/erosion. Severe storms and storm surges also cause flooding and channel migration, which can cause floodwaters to travel inland for many miles along waterways. Such has been a regular occurrence within the planning area, particularly as it relates to the Hoh River flooding areas of the Reservation, causing damage along Highway 101. The Bogachiel River also contributes to road closures and flooding along Highway 101, impacting ingress and egress to the Reservation. While the Reservation itself does not experience large quantities of snow, the Olympic Mountains, which feed into the various watersheds in the area, including the Hoh River, does. The snow melt associated with the area has caused flooding events during otherwise dry conditions.

A tornado is the smallest and potentially most dangerous of local storms. A tornado is formed by the turbulent mixing of layers of air with contrasting temperature, moisture, density, and wind flow. This

[15] NOAA, 2020. Accessed 28 July 2022. Available online at https://www.weather.gov/hazstat/

mixing accounts for most of the tornadoes occurring in April, May, and June, when cold, dry air moving into the Puget Sound region from the north or northwest meets warm, moister air moving up from the south. If a major tornado struck a populated area, damage could be widespread. Businesses could be forced to close for an extended period or permanently, fatalities could be high, many people could be homeless for an extended period, and routine services such as telephone or power could be disrupted. In the case of extremely high winds, some buildings may be damaged or destroyed. Due to the (often) short warning period, livestock are commonly the victims of a tornado or windstorm.

10.2.2 Previous Occurrences

Since 1953, 11 severe weather events (including FEMA's severe winter, severe wind, and severe storm-typing) have been declared in Jefferson County (see Disaster History Table 3-1, Chapter 3); seven of those events also include high winds, while two included snow and two included tornado.

Table 10-1 describes several of the more significant severe weather events impacting the area since 1960. In addition to the federally declared events identified, the area also sustains impact from other events which do not rise to the level of a declaration but have significant impact on the area.

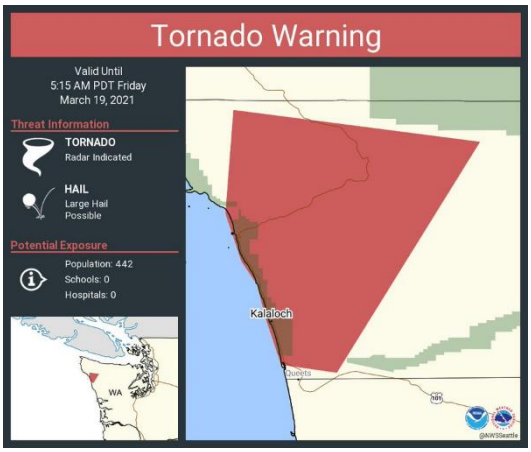


Figure 10-14 National Weather Service Tornado Warning

On October 10, 2020 a weak (EF1) tornado, with estimated wind speeds of 90 MPH occurred near Neilton in Grays Harbor County, WA. The damage was limited to trees across Moclips Highway and a nearby forest service road. A Quinault Indian Nation Fire official reported that at approximately 5:20 AM he came upon 10 downed trees (1-2.5 feet in diameter) across Moclips Highway (S-26) at approximately mile marker 18. No injuries or other impacts were reported. Tornadoes occurring in Grays Harbor can impact the Hoh Reservation indirectly due to road closures.

Figure 10-15 KIRO 7 Weather Map March 19, 2021

The most recent tornado event occurred on March 19, 2021, when tornado warnings were issued for Jefferson County and much of the Olympic Peninsula (see Figure 10-14 and Figure 10-15). The event included large hail and significant thunderstorms. Figure 10-16 identifies some additional tornadoes occurring within the state between the period 1950-2022.

TABLE 10-1.
SEVERE WEATHER EVENTS IMPACTING PLANNING AREA SINCE 1960 – OLD PLAN

Date	Type	Deaths or Injuries	Property Damage
October 1962 Disaster 137	Windstorm	7 in Washington; 46 – combined all state's impacted	$235 million in property damage; 15 billion board feet of timber valued at $750 million
Description: *Most powerful non-tropical storm to impact lower 48 states. Impact felt in Washington, Oregon and California. Damaged over 50,000 buildings throughout regions impacted. Power in some areas out for 3+ weeks. Wind speeds ranged from 88 mph in Tacoma to 160 mph in Naselle, WA. There was extensive damage with power and telephone outages throughout the entire county. Trees were blown down in the North Beach area and the Markham Branch of the Northern Pacific Railroad was blocked. Many trees were blown down in Copalis beach and along the highway and the road was blocked from Montesano west to Grass Creek. An estimated 35 million board feet of timber was lost according to Wilton Vincent, Rayonier Land Department Manager. The Grays Harbor PUD facilities' damage was $50,000 with total damages in the county reported to be approximately 2.5 million dollars.*			
December 1964	Severe winter storm event	Unknown	Unknown
Description: *Cold wave, heavy snowfall and heavy rain.*			
December 1979 Disaster 612	Severe winter storm with heavy rains	Unknown	Unknown
Description: *Strong winds destroyed the Hood Canal Bridge, thereby isolating the Olympic Peninsula from the Kitsap Peninsula and roads leading to Tacoma and Seattle.*			
December 1990 (Disaster #896)	Severe winter storm, flood, snow and high winds	Unknown	$5.1 million combined in all 10 affected counties
Description: *Strong winds, snow fall and flooding affected 10 counties in Washington, including Jefferson County.*			
November 1995 DR 1079	Flooding, severe storm, thunderstorm	Unknown	Unknown
Description: *Heavy rains lead to flooding throughout the region.*			
Dec. 1996 – Jan. 1997 (Disaster #1159)	Severe winter storm, snow, freezing rain; high winds; landslides.	24 deaths statewide	Stafford Act assistance $83 million; SBA $31.7 million; total losses $140 million statewide
Description: *Saturated ground combined with snow, freezing rain, rain, rapid warming and high winds within a five-day period produced flooding and landslides. 37 counties were impacted with large power outages throughout the impacted counties.*			
June 1997	Severe storm	Unknown	Unknown
Description: *Heavy rains, thunderstorm, and wind event.*			
January 2006 Disaster 1641	Severe winter storm, flood, landslide, mudslide, tidal surge	Unknown	Unknown
Description: *Heavy rains, including tidal surge.*			
November 2006 (Disaster 1671)	Severe storms, flooding, landslides and mudslides	Unknown	PA program only available >$29.5 million for impacted communities, IA was >5.3 million for certain counties.

TABLE 10-1.
SEVERE WEATHER EVENTS IMPACTING PLANNING AREA SINCE 1960 – OLD PLAN

Date	Type	Deaths or Injuries	Property Damage
Description: A severe windstorm, including straight-line winds, impacted 13 counties (mostly in Western Washington) for the incident period November 2-11, 2006. (Declared December 2006.)			
December 2006 (Disaster 1682) (Jefferson County not declared)	Windstorm	15 deaths statewide	+$50 million statewide
Description: *The most powerful windstorm since the Inauguration Day Storm of 1993 slammed into Washington State with 90 MPH winds on the Coast, gusts up to 70 MPH in the Puget Sound basin, and peak winds well over 100 MPH along the Cascade Crest. Up to 1.5 million residents were without power for up to 11 days. While Jefferson County was not declared, the Hoh Tribe was impacted as a result of power outages (Clallam County PUD), and roadways in both Clallam and Grays Harbor Counties.*			
December 2007 (Disaster 1734)	Severe winter storm, snow, heavy rains, landslides, winds, tidal surge	Unknown	$201,216 for Jefferson County (March 2008)
Description: *Severe winter storm, including snow fall and heavy rains; winds ranged from 102 mps to 146 mp. Winds lasted 36 hours in some areas. Increased wave heights in some areas 44 to 48 feet offshore. After snowfall, near record temperatures and moist tropical air led to record rainfall, with reports indicating 100-year flood event.*			
January 2009 (Disaster #1817)	Severe Winter Storm, Landslides, Mudslides and Flooding	Unknown	$10 million statewide in Individual Assistance
Description: *Strong warm and very wet Pacific weather system brought high amounts of rainfall to Washington during 6-8 January 2009. Snow levels rose from low levels to between 6,000 and 8,000 feet, with strong westerly winds enhancing precipitation amounts in the mountains. Conditions from a mid-December through early January region-wide cold snap and associated heavy snow helped set the stage for flooding. This event produced avalanches in the mountains, caused more than 1,500 slides across the state, and resulted in structural damage to buildings from added snow load. All counties of Western Washington lowlands received 3-8 inches of rain. The National Weather Service issued flood warnings for 49 points across the state. Quillayute saw 2.88 inches on January 7, breaking the 2.39-inch record for the date set in 1983.*			
March 2009 (Disaster 1825)	Severe winter storm and record and near record snow	Unknown	PA program only available >$26 million for impacted communities, no IA.
Description: A severe winter storm with near-record snow blanketed the area. The incident period ran from December 12, 2008-January 5, 2009. (March 2009 declaration.)			
October 2015 (Disaster 4242)	Severe windstorm	Unknown	PA program only available >$6 million for impacted communities, no IA.
Description: A severe windstorm, including straight-line winds, impacted six counties in Western Washington on August 29, 2015. (October declaration.)			
December 2015 (Disaster 4253)	Severe winter storm, straight-line winds, flooding, landslides, mudslides and a Tornado.	Unknown	PA program only available, no IA.

TABLE 10-1.
SEVERE WEATHER EVENTS IMPACTING PLANNING AREA SINCE 1960 – OLD PLAN

Date	Type	Deaths or Injuries	Property Damage
Description: A severe windstorm, including straight-line winds, impacted several counties in Western Washington during the time period December 1-14, 2015. (Declared February 2016.) The Tribe was included under the County's disaster declaration. H&Q			
January 2016 (Disaster 4249)	Severe winter storm, straight-line winds, flooding, landslides and mudslides	Unknown	PA only >$25 million.
Description: Severe winter storm, including record and near record snowfall and heavy rains and winds during the period November 12-21, 2015. (Declared January 2016)			
December 2018 (Disaster 4418)	Severe winter storm, straight-line winds, flooding, landslides and mudslides	Unknown	PA program only available for >$12.6, no IA.
Description: Severe winter storm, including record and near record snowfall and heavy rains and winds during the period December 12-24, 2018. (Declared March 2019.)			
December 2020 (Disaster 4593)	Severe winter storm, straight-line winds, flooding, landslides and mudslides	Unknown	PA program only available >$6.2, no IA.
Description: Severe winter storm, including record and near record snowfall and heavy rains and winds. Incident period was December 29, 2020-January 16, 2021. (Declared April 2021.)			
December 2021 (Disaster 4650)	Severe winter storm, straight-line winds, flooding, landslides and mudslides	Unknown	PA program only available, no IA.
Description: Severe winter storm, including record and near record snowfall and heavy rains and winds. Incident period was December 26, 2021-January 15, 2022. (Declared March 2022.) The Hoh Tribe was declared separately. (Q)			

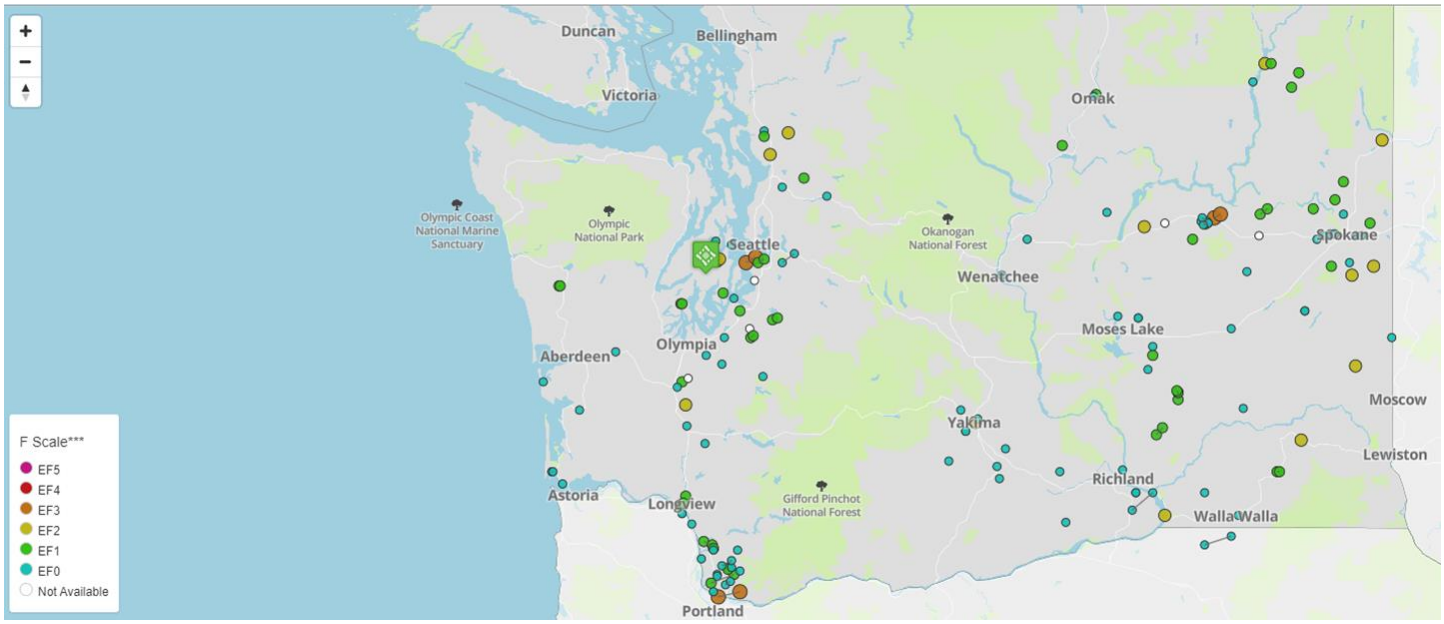


Figure 10-16 Tornado History in Washington 1950-2022

10.2.3 Severity

The most common problems associated with severe storms are immobility and loss of utilities. Roads become impassable due to flooding, downed trees, ice or snow, or a landslide, increasing the potential for injuries or death. Downed trees in the area do have the potential to impact ingress and egress to certain areas, and the Tribe does assist County and State personnel to help clear debris from the roadways as necessary after a weather event.

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 the tribal planning area. Physical damage to homes and facilities caused by wind do occur, although unless it is a significant windstorm, the impact is usually limited in nature. Only a few of the Tribal owned critical facilities have backup power generators. In addition, no residential structures in the area maintain generators, leaving the elderly and young citizens, and those citizens with disabilities more vulnerable to the impacts of power outages.

The strongest winds are generally from the south or southwest and occur during fall and winter, although severe windstorms are associated with summertime storms. In interior-facing valleys, wind velocities regularly reach 40 to 50 mph each winter, 75 to 90 mph a few times every, with some storms bringing winds in excess of 100 mph at least on an annual basis. The highest summer and lowest winter temperatures generally occur during periods of easterly winds.

Due to the limited amount of snow customarily received in the region, even a small accumulation of ice or snow on the roadways can, and has, caused havoc on transportation systems due to terrain, the level of experience of drivers to maneuver in snow and ice conditions. Snow melts in the mountains during spring and summer months regularly causes flooding on the Hoh River on the Reservation. Such events occur (almost) annually, and while more of a nuisance than a declared event, it does impact ingress and egress onto the reservation, as well as the ability of the Tribe to provide services to tribal members, such

as the medical or social services provided not only to Hoh Tribal Members, but to any federally recognized tribal member.

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 (such as the Forks bridge), 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.

Severe weather events can impact routine services throughout the planning area on which Tribal members rely. Businesses could be forced to close for an extended period, impacting availability of commodities. As a result of the heavily forested areas, debris accumulations would be high, causing additional difficulties with access along major arterials, 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).

In 2001, the NWS implemented a new wind chill temperature index designed to more accurately calculate how cold air feels on human skin. Figure 10-7 (above) illustrates the new wind chill temperature index.[16] 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).

10.2.4 Frequency

The severe weather events are often related to high winds and associated other winter storm-type events such as heavy rains and landslides, and occasionally snow. Severe storms (which include flooding) are the first-most declared event for the planning area. The Hoh experiences some form of a severe storm annually, although in most cases, such events do not always rise to the level of a declared disaster. While snow events do occur, they customarily are not significant, nor last for extended periods of time. For declared-level events, the Tribe experiences a significant severe storm every 6.18 years, with a probability of occurrence of 16.18 percent per year that such a significant event will occur.

[16] NWS, 2008

The National Weather Service reports that Washington state averages 2.5 tornadoes per year, which ranks in the bottom ten states.[17] 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

10.3 VULNERABILITY ASSESSMENT

10.3.1 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 than others. Therefore, preparedness plays a significant contributor in the resilience of the citizens to withstand such events.

Warning Time

Meteorologists can often predict the likelihood of some severe storms. In some cases, this can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm, and the rapid changes which can also occur significantly increasing the impact of a weather event.

10.3.2 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. During snow events, the Tribe becomes impacted due to school closures and employees who are unable to come to work due to the accumulation of snow on roadways, particularly in those areas with hills or steeper terrain. Resultant secondary impacts from power outages during cold weather event, when combined with the high population of elderly residents significantly impacts response capabilities and the risk factor

[17] http://mynorthwest.com/1220169/common-tornadoes-washington-state/

associated with such weather incidents. Within the densely wooded areas, increased fire danger during extreme heat conditions increases the likelihood of fire, which increases risk to human life.

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. Currently, the Hoh have approximately eight registered Tribal Citizens between the ages of 0-5 and 65 and over. Extreme temperature variations, either heat or cold, are of significant concern for both the elderly and the young, increasing vulnerability of those populations. Likewise, falling trees and debris could cause injury or death to citizens and visitors to the reservation.

The National Severe Storms Laboratory states that of injuries related to ice and snow:[18]

- 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.

Due to the somewhat limited roadways for ingress and egress via primary transportation routes, even minor incidents have the potential to impact the ability to travel throughout the area. Such issues are of concern as a result of the potentially limited access for evacuation purposes by first responder if vital Advanced Life Support is required, as well as for general evacuation purposes during a period where power is out, and individuals attempt to leave the area. In addition, the rural setting of the Hoh Reservation can increase impacts as the reservation is located at the furthest end of county public utilities. Oftentimes, this means that the reservation must wait longer for power restoration in the event of a storm. Historically, power has been restored within 48 hours.

In addition, the entire reservation population is dependent on well water, which must be pumped and a wastewater system which also utilize pumps. During power outages, many residents may be completely lacking drinking water or sewer services. When combined with flooding, which commonly occurs during a severe weather event, the likelihood of such ramifications increases.

10.3.3 Impact on Property

Loss estimations for severe weather hazards are not based on modeling utilizing damage functions, as no such functions have been generated. 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.

[18] http://www.nssl.noaa.gov/education/svrwx101/winter/

The Hoh Reservation, like most of western Washington, is vulnerable to high winds because of the climatic conditions and prevalence of 100 ft to 150 ft tall conifer trees. High winds weaken standing trees and structures weighted with snow or ice. Two predominating species, Douglas fir, which are planted extensively on the reservation as a timber crop and western hemlock have shallow later root systems with top heavy crown. These types of trees are particularly vulnerable to falling when soils are soaked from ongoing rainfall. Sustained high winds and gusts cause tress to sway significantly; repetitive swaying can weaken a tree's root hold in the saturated soils and force it to topple. Current estimations of crop value for trees on the existing reservation was not determined as part of this update, but the Planning Team members felt it would be significant. The Tribe is looking at the potential for establishing a more robust logging industry, and is currently working on a strategic business plan, which is anticipated to be completed within the next year.

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. For planning purposes, loss estimations for structure value only may exceeds $14.6 million.

10.3.4 Impact on Critical Facilities and Infrastructure

It should be assumed that all critical facilities are vulnerable to some degree, with older structures built pre-code being more susceptible to impact from a severe weather event. As many of the severe weather events include multiple hazards, information such as that identifying facilities exposed to flooding (see Flood profile) 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. With the Hoh Tribe, they are at the end of Clallam County PUD's utility lines, and any impact anywhere along the line causes power outages on the Reservation. It is uncommon for the Tribe to go more than a month without some power outage event not related to storms. Historically the outages have not lasted extremely long, but there have been events where power has been out for several days (into weeks).

In addition, power, phone, internet, water, and sewer systems may also not function properly during severe weather events. Cell towers may be damaged; landlines may be impacted via flood or landslide event. Power outages may impact wells and sewer systems. Primary water and sewer services to the reservation are provided by the Tribe itself, and include individual wells. The Tribe maintains one water storage tower, which distributes water to the existing Reservation. This is the same system which will be utilized for the Hoh Highlands area. The existing septic systems on the Reservation, which could be impacted by severe weather events, will be replaced once the Hoh Highlands has been developed. A power outage may impact the Tribe's ability to provide services on the existing Reservation, but as part of the future development, the Tribe anticipates installing generators to ensure more consistent operations of the water/septic systems in the Hoh Highlands area.

Roads may become impassable due to ice or snow or from secondary hazards such as landslides which occur off the Reservation, such as has previously occurred on several instances. 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 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, or areas where there is only one primary access route.

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 communications not only for households, but also public safety dispatching. Loss of electricity and phone connection would result in isolation because some residents will be unable to call for assistance, with cell phone operability weak in certain areas of the planning area.

10.3.5 Impact on Economy

Prolonged obstruction of major routes due to severe weather can disrupt employees' ability to get to work, as well as the shipment of goods and other commerce, both on and off the reservation.

Severe windstorms, downed trees, and ice can create serious impacts on power and above-ground communication lines, as well as negatively impacting the Tribe's timber crop, and the hatchery fish. Freezing rain/snow on power and communication lines can cause them to break, disrupting electricity and communication, further impacting business within the region, and potentially continuity of government operations.

All severe weather events have the potential to also impact tourism to the area. While limited in nature, there are several tribal members that own businesses reliant on tourists. Employees that currently live off the reservation have, on several occasions, not been able to report for duty at the Reservation due to impassable roadways.

10.3.6 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. The Tribe does maintain an active fish hatchery, which could also be potentially impacted by various severe weather events. Storm surges can erode riverbanks and redistribute sediment loads. Extreme heat can raise temperatures of rivers, impacting oxygen levels in the water, threatening aquatic life.

10.3.7 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) (U.S. EPA, 2013)."

The last several years (with particular attention to 2021 and statewide records) have seen record temperatures, with meteorologists predicting continued increase. 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. 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.

10.4 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 Tribe does have land use regulations in place, and does adhere to strict implementation of the International Building Codes as well as additional land use authority as established within the various jurisdictions in which non-trust properties are situated. 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, among others.

While under the Growth Management Act, public power utilities are required by law to supply safe, cost effective and equitable service to everyone in the service area requesting service, most lines in the area are above-ground, causing them to be more susceptible to high winds or other severe weather hazards. However, growth management is also a constraint, which could possibly lead to increased outages or even potential shortages, as while most new development expects access to electricity, they do not want to be in close proximity to substations. The political difficulty in sighting these substations makes it difficult for the utility to keep up with regional growth. The Tribe does not generate its own power, although some facilities do have generators for emergency use. As such, the Tribe must rely on public infrastructure to provide this to them. With the development of the Hoh Highlands area, all power line on the Reservation will be underground, to help mitigate, at least on the Reservation, the impact from wind on power lines. The Tribe does believe that this new construction will help reduce the impact of severe weather events on all new facilities.

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. In addition to the local land use authority, the Hoh must also address Federal land use requirements for any projects funded with federal dollars. That, when coupled with the land use tools currently in place, the Tribe will be well-equipped to deal with future growth and the associated impacts of severe weather. Since completion of the last plan,

the Tribe has conducted mitigation activities that have reduced the Impact of the severe weather hazard, particularly when flooding is a component of the severe weather event. A new water tower was constructed outside of the flood zone, and built to meet both current seismic and wind standards. Likewise, a new wastewater treatment plant was constructed, which was built to withstand the increased flood risk many times associated with a severe weather event. That facility included upgraded measures to ensure no contamination during flood events, while also ensuring continued operations.

10.5 ISSUES

Important issues associated with a severe weather in the planning area include the following:

- Older building stock in the planning area are built to low code standards or none at all. These structures could be highly vulnerable to severe weather events such as windstorms. While some structures owned by the Hoh are newer (post-1975), and built to higher code standards, tribal citizens living throughout the planning area could be impacted as a result of the lower building code standards in their residential structures. This is particularly true since several structures within the existing flood zone of the Tribe have been previously flooded, with structural integrity potentially compromised. Due to the lack of infrastructure in other areas of the Reservation, no options for rebuilding outside of the flood zone were possible until the Hoh Highlands project is completed.
- Redundancy of power supply must be evaluated and increased planning-region wide in order to understand the vulnerabilities more fully in this area. As the local PUDs replace power lines, consideration should be given to placing the lines underground to make them less vulnerable.
- The capacity for backup power generation should be enhanced, especially in areas of potential isolation due to impact on major thoroughfares or evacuation routes, or structures which ensure continuity of government.
- Isolated population centers could exist if roadways are impacted.
- Climate change will increase the frequency and magnitude of winter flooding or storm surges, thus exacerbating severe winter events, while also increasing the potential for .

10.6 IMPACT AND RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from a severe weather event throughout the area is highly likely, but the impact is more limited when removing resulting flood events from the severe weather category.

The entire area experiences some severe storm or weather event annually, with 11 events occurring since 1953. FEMA has identified Severe Storm/Weather as the number one hazard impacting the area.

When severe weather events occur, the storms do have the ability to impact the area, posing a danger to life and property, as well as possibly causing economic losses. While snow and ice do occur, impact and duration are somewhat limited, reducing life safety dangers as advanced warning many times allow residents to take precautionary measures (extra food, not driving, etc.).

Wind is a very significant factor, which can cause power outages, as well as impacting transportation for both citizens and goods/supply chain. While the local PUD/utilities maintain excellent records for low incidents of long-term power outages, the possibility does exist. Historically, severe weather events that occur are of a relatively short duration, with more localized impacts, and thankfully, power outages have not been for extended periods of time, but shorter in duration and is something to which Tribal Members have become accustomed to deal with when it occurs. However, it does impact the ability to carry out normal functions, including governmental operations. There are also health-related issues if power outages last beyond a day. While the Tribe does not experience extremely cold or hot temperatures with any great frequency, it does occur. There are no portable generators, or generators in enough buildings that could be utilized for cooling or heating facilities. There is also concern of a power outage impacting the hatcheries, which rely on power to maintain fish tanks, etc. The new public safety building in the Hoh Highlands has been identified as the Tribe's future shelter/resilience center to ensure citizens (both tribal and non-tribal) are provided care and resources (as available).

Based on the potential impact, the Planning Team determined the CPRI score to be 3.35, with overall vulnerability determined to be a high level.

CHAPTER 11.
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.

11.1 GENERAL BACKGROUND

11.1.1 Physical Characteristics of Tsunamis

All waves, including tsunamis, are defined by the following characteristics (see Figure 11-1; Earth Science, 2012):

- **Wavelength** is defined as the distance between two identical points on a wave (i.e., between wave crests or wave troughs). Normal ocean waves have wavelengths of about 300 feet. Tsunamis have much longer wavelengths, up to 300 miles.
- **Wave height** is the distance between the trough of a wave and its crest or peak.
- **Wave amplitude** is the height of the wave above the still water line; usually this is equal to ½ the wave height. Tsunamis can have variable wave height and amplitude that depends on water depth.
- **Wave frequency or period** is the amount of time it takes for one full wavelength to pass a stationary point.
- **Wave velocity** is the speed of a wave. It is equal to the wavelength divided by the wave period. Velocities of normal ocean waves are about 55 mph while tsunamis have velocities up to 600 mph (about as fast as jet airplanes).

Tsunamis are different from the waves most of us have observed on the beach, which are caused by the wind blowing across the ocean's surface. Wind-generated waves usually have periods of 5 to 20 seconds and a wavelength of 300 to 600 feet. A tsunami can have a period in the range of 10 minutes to 2 hours and wavelengths greater than 300 miles. Tsunamis are shallow-water waves, which are waves with very small ratios of water depth to wavelength.

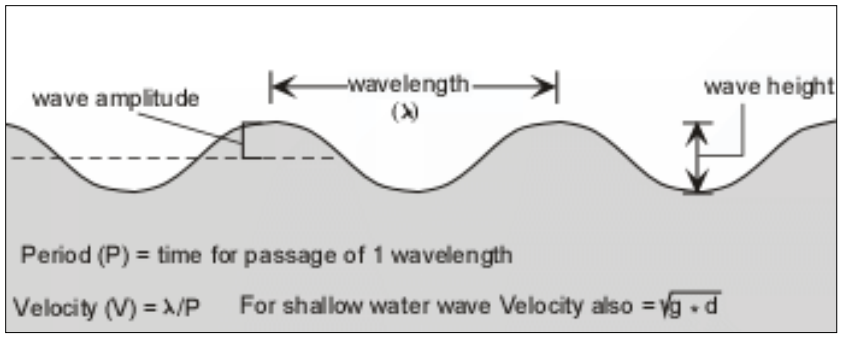


Figure 11-1 Physical Characteristics of Waves

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 11-2; 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.

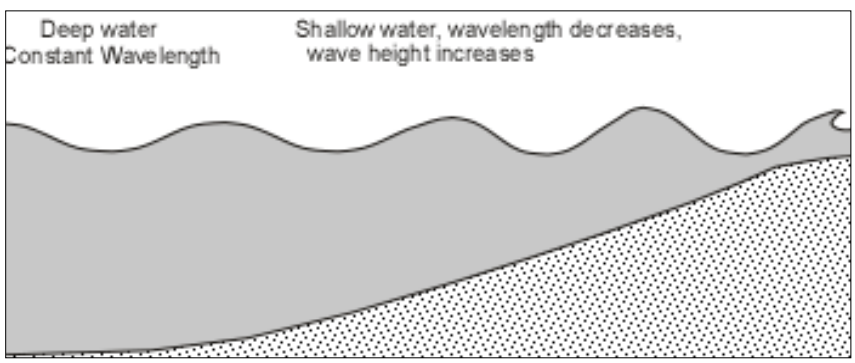


Figure 11-2 Change in Wave Behavior with Reduced Water Depth

Because of this "shoaling" effect, a tsunami that was imperceptible in deep water may grow to have wave heights of several meters. As a tsunami enters the shoaling waters near a coastline, its speed diminishes, its wavelength decreases, and its height increases greatly. The first wave usually is not the largest. Several larger and more destructive waves often follow. As tsunamis reach the shoreline, they may take the form of a fast-rising tide, a cresting wave, or a bore (a large, turbulent wall-like wave). The bore phenomenon resembles a step-like change in water level that advances rapidly (from 10 to 60 miles per hour).

The configuration of the coastline, the shape of the ocean floor, and the characteristics of advancing waves play roles in the destructiveness of tsunamis. Offshore canyons can focus tsunami wave energy and islands can filter the energy. The orientation of the coastline determines whether the waves strike head-on or are refracted from other parts of the coastline. A wave may be small at one point on a coast and much larger at other points. Bays, sounds, inlets, rivers, streams, offshore canyons, islands, and flood control channels

may cause various effects that alter the level of damage. It has been estimated, for example, that a tsunami wave entering a flood control channel could reach a mile or more inland, especially if it enters at high tide.

The first indication of a tsunami to reach land may be a trough—called a drawdown—rather than a wave crest. The water along the shoreline recedes dramatically, exposing normally submerged areas. Drawdown is followed immediately by the crest of the wave, which can catch people observing the drawdown off guard. Rapid drawdown can create strong currents in harbor inlets and channels that can severely damage coastal structures due to erosive scour around piers and pilings. As the water's surface drops, piers can be damaged by boats or ships straining at or breaking their mooring lines. The vessels can overturn or sink due to strong currents, collisions with other objects, or impact with the harbor bottom.

Conversely, the first indication of a tsunami may be a rise in water level. The advancing tsunami may initially resemble a strong surge increasing the sea level like the rising tide, but the tsunami surge rises faster and does not stop at the shoreline. Even if the wave height appears to be small, 3 to 6 feet for example, the strength of the accompanying surge can be deadly. Waist-high surges can cause strong currents that float cars, small structures, and other debris. Boats and debris are often carried inland by the surge and left stranded when the water recedes.

When the crest of the wave hits, sea level rises (called run-up). Run-up is usually expressed in height above normal high tide. Run-ups from the same tsunami can vary with the shape of the coastline. One coastal area may see no damaging wave activity while in another area destructive waves can be large and violent. The flooding of an area can extend inland by 1,000 feet or more, covering large areas of land with water and debris. Tsunami waves tend to carry loose objects and people out to sea when they retreat. Tsunamis may reach a vertical height onshore above sea level, called a run-up height, of 100 feet.

At some locations, the advancing turbulent wave front will be the most destructive part of the wave. In other situations, the greatest damage will be caused by the outflow of water back to the sea between crests, sweeping all before it and undermining roads, buildings, bulkheads, and other structures. This outflow action can carry enormous amounts of highly damaging debris with it, resulting in further destruction. Ships and boats, unless moved away from shore, may be dashed against breakwaters, wharves, and other craft, or be washed ashore and left grounded after the withdrawal of the seawater.

Because the wavelengths and velocities of tsunamis are large, their period is also large. It may take several hours for successive crests to reach the shore. (For a tsunami with a wavelength of 125 miles traveling at 470 mph, the wave period is about 16 minutes). Thus, people are not safe after the passage of the first large wave, but must wait several hours for all waves to pass. The first wave may not be the largest in the series of waves. For example, in several recent tsunamis, the first, third, and fifth waves were the largest.

11.2 HAZARD PROFILE

11.2.1 Extent and Location

Tsunamis affecting Washington may be induced by local geologic events or earthquakes at a considerable distance, such as in Alaska or South America. Approximately 80 percent of tsunamis originate in the Pacific Ocean and can strike distant coastal areas in a matter of hours, such as the 2011 earthquake and ensuing tsunami occurring in Japan which impacted Washington's coastlines, including within the planning area.

Most recorded tsunamis affecting the Pacific Northwest originated in the Gulf of Alaska. The landslide-generated tsunami in Lituya Bay, Alaska in 1958 produced a 200-foot-high wave. There is also geological evidence of significant impacts from tsunamis originating along the Cascadia subduction zone, which extends from Cape Mendocino, California to the Queen Charlotte Islands in British Columbia.

The Washington Department of Natural Resources (WDNR) has mapped the tsunami risk zone along Washington's coastline, identifying the various depths shown on Figure 11-3 (WDNR, 2000). Due to the size of the map(s), details are difficult to read and are for illustrative purposes only. Reviewers wishing direct access and additional available data may wish to check WDNR's website directly. The data is available at Tsunamis | WA – DNR The anticipated depth data on the Hoh Reservation is illustrated in Figure 11-4.

Figure 11-5 illustrates the FEMA defined inundation areas as identified in the RiskMap Assessment (2019) based on a M9.0 Cascadia Subduction Zone earthquake. Pursuant to that study, FEMA has identified all structures on the reservation falling within the tsunami hazard zone, further confirmed during this risk assessment process.

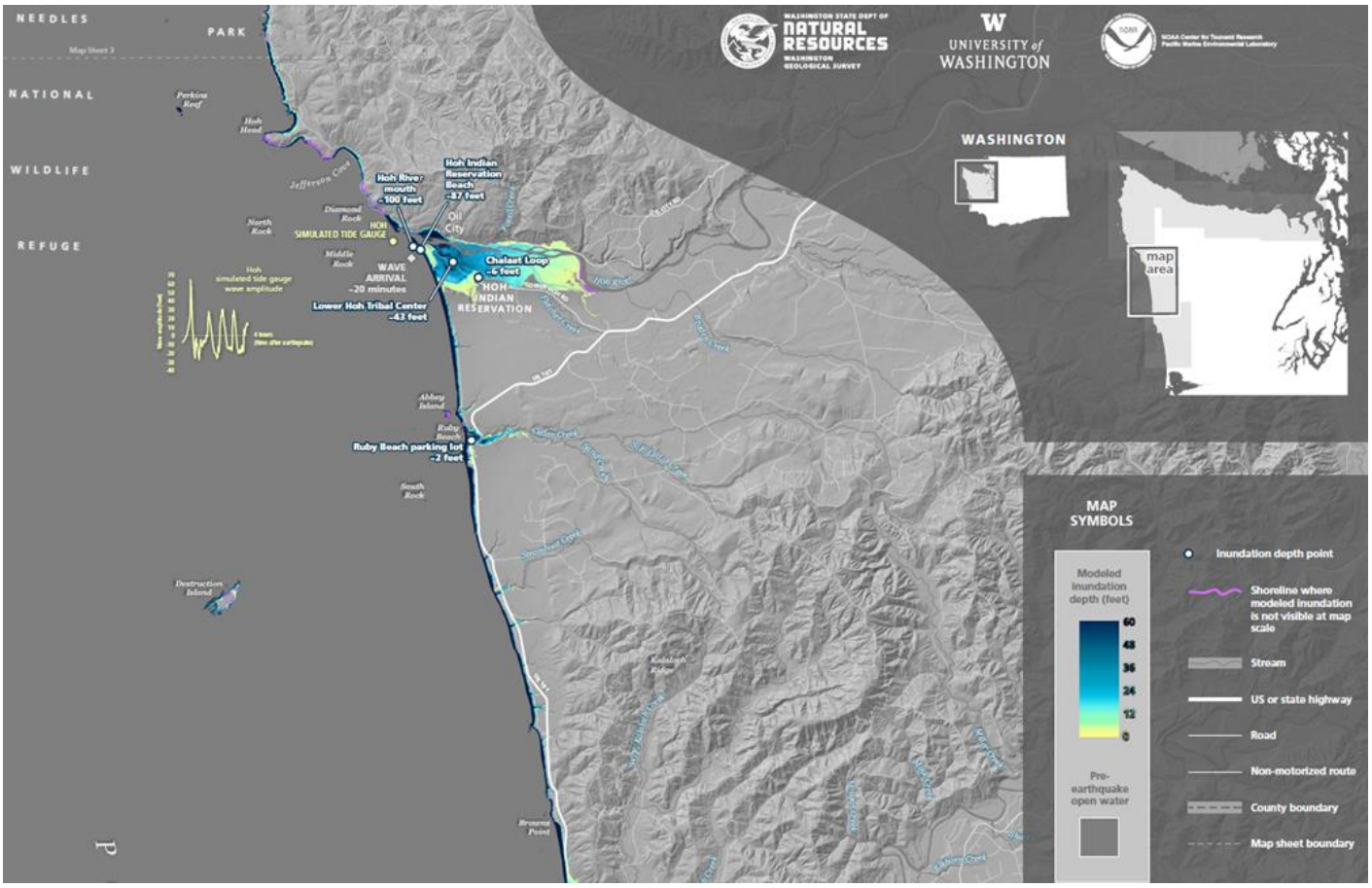


Figure 11-3 Tsunami Inundation Depth (WDNR, 2000)

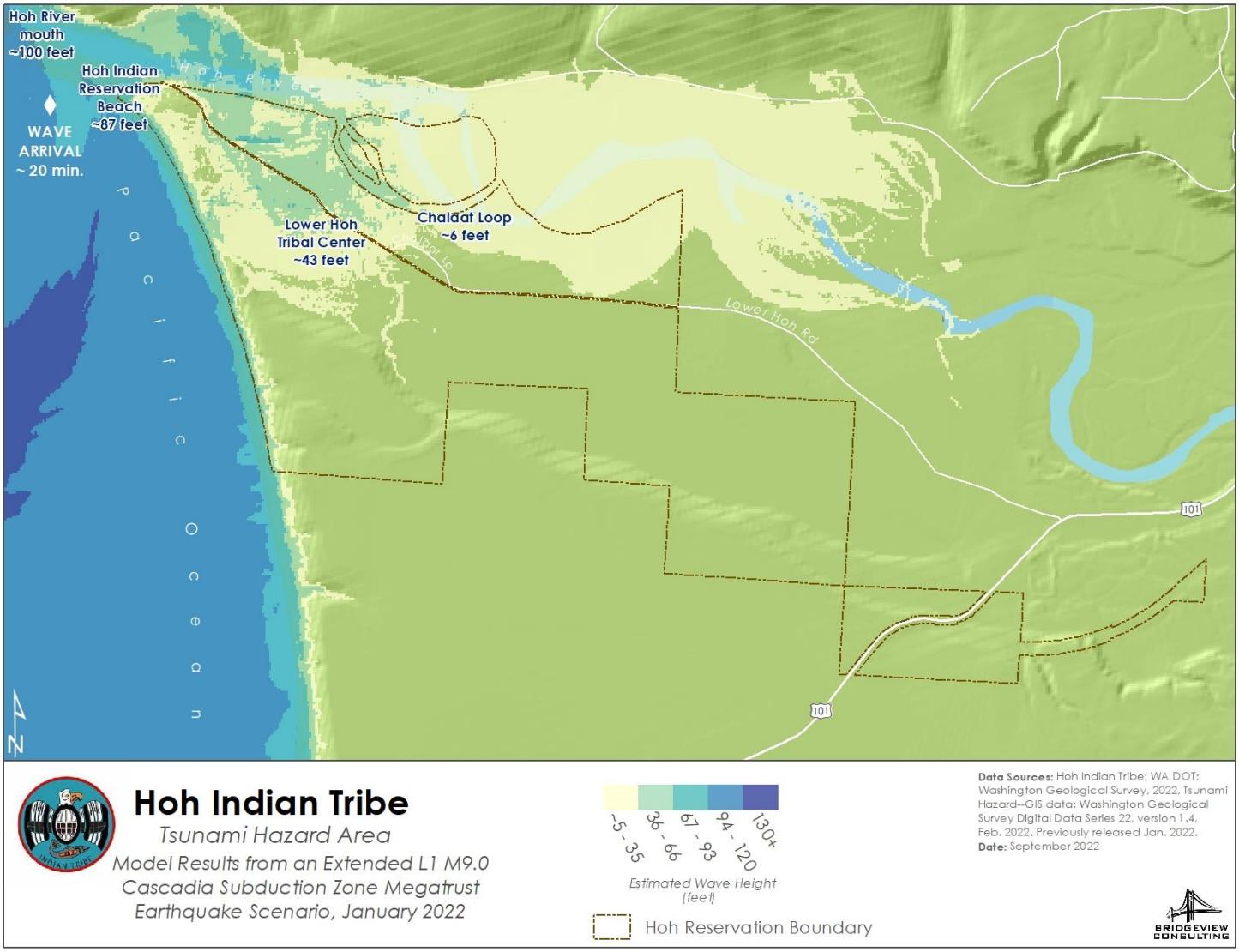


Figure 11-4 Tsunami Inundation Depth on Hoh Reservation

Figure 11-5 Tsunami Inundation Zone Resulting from Cascadia Earthquake (FEMA, RiskMap 2019)

11.2.2 Previous Occurrences

According to data captured from NOAA, SHELDUS and historical records, the coastal areas of Washington have been impacted previously by distant tsunami wave events.

- The 1964 Magnitude-9.2 earthquake in Prince William Sound, Alaska 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. Damages to roads and bridges alone were estimated at $80,000 (1964 figures). Wave heights along the Washington coastline were 1.5 feet at the mouth of the Hoh River; 5 feet in La Push; 10 feet in Ocean Shores; 23 feet in Taholah; 11 feet in Moclips, and 2 feet in Neah Bay (Sokolowski, undated). At Ocean City, 5- to 6-foot tsunami waves collapsed the bridge over the Copalis River. Wave heights at Moclips, Sea View, La Push and Wreck Creek reached an estimated 11, 12, 5, 7, and 15 feet, respectively.[19]
- The Magnitude 8.3 earthquake which occurred near Kuril Island northeast of Japan caused Tsunami waves at Westport to rise to .16 feet.
- 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

[19] Western Seismic Policy Council 1964 Alaska Tsunami - Western States Seismic Policy Council (wsspc.org)

5.5 inches in Westport, 7.5 inches in Port Angeles, 8.5 inches in La Push, and 9 inches in Neah Bay. (NOAA, 2011).

- The March 2011 tsunami that resulted from a Magnitude-9.0 earthquake in Japan caused increased wave heights along the California, Oregon and Washington coastlines. Major declarations were issued in California and Oregon, but Washington sustained much less damage. Washington coastline wave heights above sea level were reported at La Push at 28 inches; Port Angeles at 23 inches; Westport at 18 inches; Toke Point at 13 inches; Port Townsend at 6 inches; and Neah Bay at 17 inches. No significant damage was reported, but this incident had the potential to be much worse. The surrounding tribes, counties, and municipalities worked closely with the Pacific Marine Environmental Laboratory and the West Coast and Alaska Tsunami Warning Center, who provided wave predictions for coastal areas.
- 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 .04 and Westport .08.[20]

11.2.3 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.[21] 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.

[20] NOAA National Centers for Environmental Information Accessed 18 Aug 2022. Available online at: National Centers for Environmental Information (NCEI) (noaa.gov)

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

A Cascadia Subduction Zone earthquake is expected to lower the ground surface along the coast of Washington. Flooding of areas less than six (6) feet (1.8 m) above tide stage is expected shortly after the earthquake, rendering evacuation time even shorter for people on beaches (discussed further below). Maximum flooding depth, velocity, and extent will depend greatly on the tide height at the time of the tsunami arrival.

11.2.4 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.[22] 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.

11.3 VULNERABILITY ASSESSMENT

11.3.1 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 which is expected to occur along many miles of coastline will result in long-term inundation (Gica, 2014). Short-term inundation is expected to be caused by the generated tsunami waves. The long-term inundation is generated by co-seismic displacement.

Studies based on scenarios developed by PMEL and NOAA have illustrated extensive inundation in the Ocean Shores and Westport peninsulas, which are heavily populated annually by tourists. Evacuation from these areas would impact major transportation corridors in the area, and deplete emergency resources.

Extensive flooding from the tsunami hazard is primarily caused by the initial and largest tsunami wave that hits the coasts. Later waves are also deemed damaging, with some amplitudes almost matching the initial one and occurring hours after the earthquake. Results indicate that not only are the tsunami waves high, but maximum current speed values are also high. 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 die out (Gica, 2014). Wave height also varies by study, with some indicating the first waves measuring in excess of 11 m in elevation, traveling at speeds from 3 m/second to 8 m/second, with maximum speeds reaching 12 m/second (Gica, 2014).

Aside from the tremendous hydraulic force of the tsunami waves themselves, floating debris carried by a tsunami can endanger human lives and batter inland structures. Ships moored at piers and in harbors often are swamped and sunk or are left battered and stranded high on the shore. Breakwaters and piers

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

collapse, sometimes because of scouring actions that sweep away their foundation material and sometimes because of the sheer impact of the waves. Railroad yards and oil tanks situated near the waterfront are particularly vulnerable. Oil fires frequently result and are spread by the waves.

Warning Time

Typical signs of a tsunami hazard are earthquakes and/or sudden and unexpected rise or fall in coastal water. The large waves are often preceded by coastal flooding and followed by a quick recession of the water. Tsunamis are difficult to detect in the open ocean, with waves less than 3 feet high. The tsunami's size and speed, as well as the coastal area's form and depth, affect the impact of a tsunami. In general, scientists believe it requires an earthquake of at least a magnitude 7 to produce a tsunami. Figure 11-6 illustrates typical time for a tsunami to travel across the Pacific Ocean, based on the 1964 Alaska and 1960 Chile earthquakes and resulting tsunamis.

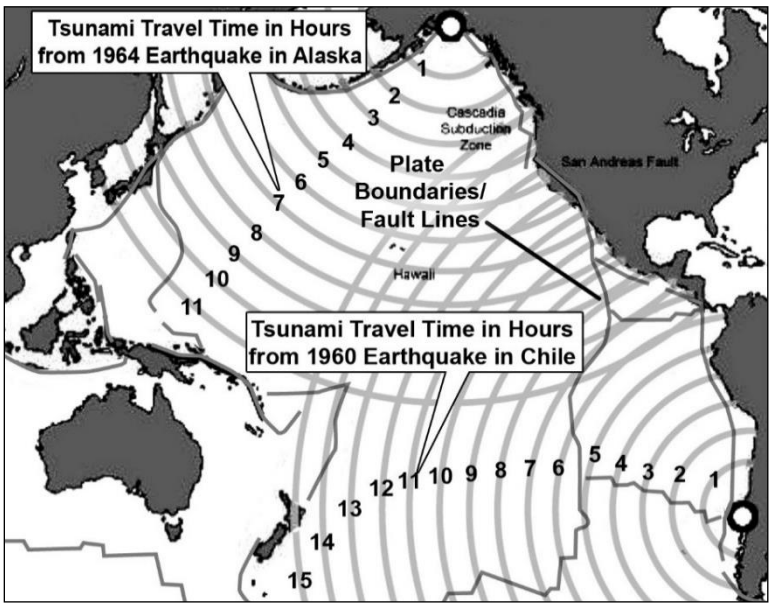


Figure 11-6 Tsunami Travel Times in the Pacific Ocean

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 13 outer coastal communities in Washington extremely vulnerable to significant loss of life from such an incident. 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 initial 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. Grays Harbor County was successful in constructing our nation's first vertical evacuation at the Ocosta School – Project Safe Haven. Shoalwater Bay Tribe, in 2022, also completed a vertical evacuation project in conjunction with parking garage at the casino on the Reservation. The Hoh Tribe has identified a walking trail from the shores of the Pacific Ocean along to Hoh River to the new location in the Hoh Highlands as an option for tsunami evacuation in its immediate vicinity.

The arrival time and duration of flooding are key factors to be considered in evacuation strategies. For locations on the outer coast, the first wave crest is generally predicted to arrive between 25 and 40 minutes after the earthquake (Gica, 2014). Review of WDNR data indicate an estimated arrival time of 20 minutes for the Hoh Reservation. 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 coast, with some models predicting a 3.0 meter (~9.8 feet) subsidence. Flooding of areas less than six (6) feet above tide stage is expected a short time after the initial earthquake. This will effectively render evacuation times short not only for people on the beach, but also along coastal roadways, including major highways traversing the coastline.

Pacific Tsunami Warning System

The Pacific Tsunami Warning System evolved from a program initiated in 1946. It is a cooperative effort involving multiple countries with numerous seismic stations, water level stations, and information distribution centers whose purpose is to disseminate information of possible or approaching tsunami waves. The National Weather Service operates two regional information distribution centers. One is located in Ewa Beach, Hawaii, and the other is in Palmer, Alaska. The Ewa Beach center also serves as an administrative hub for the system. When a Pacific basin earthquake of magnitude 6.5 or greater occurs, the following sequence of actions begins:

- Data is interpolated to determine epicenter and magnitude of the event.
- If the event is magnitude 7.5 or greater and located at sea, a TSUNAMI WATCH is issued.
- Participating tide stations in the earthquake area are requested to monitor their gages. If unusual tide levels are noted, the tsunami watch is upgraded to a TSUNAMI WARNING.
- Tsunami travel times are calculated, and the warning is transmitted to the disseminating agencies and thus relayed to the public.
- The Ewa Beach center will cancel the watch or warning if reports from the stations indicate that no tsunami was generated or that the tsunami was inconsequential.

All-Hazard Alert Broadcasting Network

All-Hazard Alert Broadcast (AHAB) sirens have been installed along much of the Washington coast to provide warnings of tsunamis to outdoor populations. The system provides rapid alert to citizens and

visitors who are in the hazard zone, giving advanced warning for evacuation. The Tribe does have an AHAB siren on the Reservation.

Deep-Ocean Assessment and Reporting of Tsunamis

NOAA's Deep-ocean Assessment and Reporting of Tsunamis system (see Figure 11-7) collects data that is relayed to the Pacific Tsunami Warning Center. These units generate computer models that predict tsunami arrival, usually within minutes of the arrival time. This information is relayed in real time. This system is not considered to be as effective for communities close to the tsunami because the first wave would arrive before the data were processed and analyzed. In this case, strong ground shaking would provide the first warning of a potential tsunami.

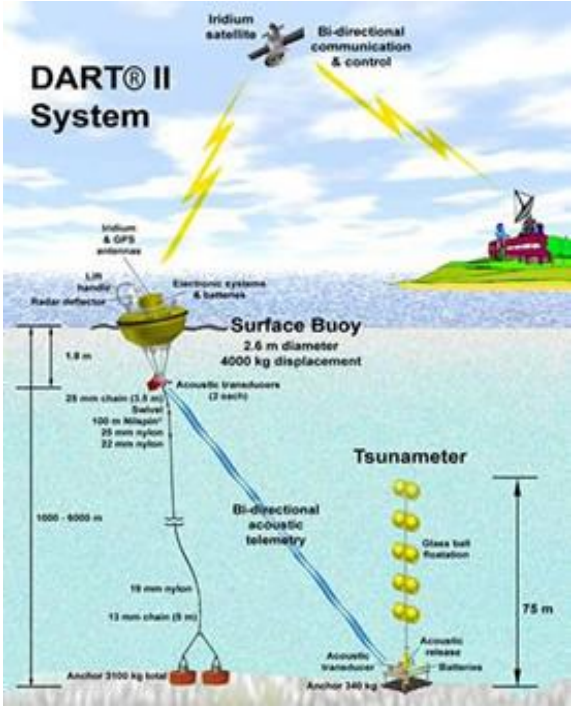


Figure 11-7 Deep-Ocean Assessment and Reporting of Tsunamis System (DART)

11.3.2 Impact on Life, Health, and Safety

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 as the Hoh Reservation is in a low-lying coastal area on the mouth of the Hoh River, where it opens into the Pacific Ocean.

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?

Given its proximity to the coastline, the entire population of the Hoh Tribe, as well as any guests and visitors or individuals utilizing any services provided by the Tribe are exposed to Tsunami Inundation. Once moved to the Hoh Highlands area, this number will be reduced as residential structures are moved outside of the inundation zone to the new residential area. It should also be noted that while the entire

population is exposed to the inundation area, there is also impact from the preceding earthquake event which triggers the tsunami. Any injuries sustained as a result of the earthquake will further impact the ability to evacuate.

The area as a whole has a very high population of tourists, which stay in local hotel and motels, and utilize the many trails in the area. The Tribe itself also has tourists utilizing fishing excursions operated by the Tribal members. Those population numbers are not factored into the population impacted due to the many variables.

Depending on the season, the large numbers of visitors and tourists that may be in the area will increase response requirements by first responders, limiting availability for incident response on the Reservation. Those visitors and tourists will also require some type of educational outreach with respect to what to do and where to go if an earthquake and tsunami occur. With roadways impacted, those tourists trapped in the area will seek support from the closest available source, which may fall upon the Tribe (if it maintains the ability to offer such assistance).

Due to the potential for individuals to be trapped in the area, the Tribe is looking at a potential mitigation project in conjunction with the Park Service to develop an evacuation trail from the existing Reservation to the upper Hoh Highlands area, adjoining the trails in the Olympic National Park to provide a means of evacuation to a cleared area. The Tribe has also identified as a potential strategy the development of an emergency shelter location (also utilized as a resilience center) by expansion of the new Public Safety Building in the Hoh Highlands area, as well as establishing both “dry camp” and “hook-up” (with power, water and sewer) type areas in the Hoh Highlands to support evacuees who are in the area, whether tribal or non-tribal. Sections of open land in the new Hoh Highlands area are also identified as potential medical evacuation sites.

11.3.3 Impact on Property

All structures along beaches, low-lying coastal areas, tidal flats and river deltas would be vulnerable to a tsunami. For the Hoh Tribe, this impact could include all 53 structures (all types) on the Reservation, totaling ~$14.6 million structure value.

The impact of the waves and the scouring associated with debris that may be carried in the water to more distant locations and could be further 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 Tribe has few structures which store chemicals, those most common being household-type chemicals. There are five 500-gallon propane tanks at various locations throughout the Reservation, along with limited amounts of chlorine for water purification. Limited gas/diesel is on site, mostly for lawn maintenance equipment.

11.3.4 Impact on Critical Facilities and Infrastructure

Roads 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.

All critical facilities in the lower portion of the Reservation are exposed to the tsunami hazard. Based on FEMA's 2019 RiskMap Report, all fall within the Tsunami Inundation Zone. Table 11-1 identifies the types of critical facilities owned by the Tribe. The exception to this would be the new water storage facility and the new public safety structure located in the new Hoh Highlands; however, the tsunami in other areas would still potentially impact those structures by cutting off ingress/egress, as well as power.

Table 11-1
Critical Facilities Exposed to Tsunami Hazard

Facility Type Identified	Number Identified
Commercial	8
Government/Administration	8
Hazmat (Tribal Owned gas station currently fuel tank empty)	1
Medical	1
Protective	4
Residential	25
Schools (Daycare, Head Start)	1
Shelters (Gym)	1
Transportation (bridges)	0
Water (value includes two underground wells; no structures)	3
Wastewater	1
Totals	**53**

Roads and Bridges

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 highways and roadways will be impacted by tsunami events, due to their proximity to the coastline along the entire length of the County, with Highway 101 being the primary route.

Likewise, bridges will also be impacted. While there are many state and county owned bridges in the area which have the potential to impact evacuation, of significant concern is the Forks Bridge located in Jefferson County. Forks is the nearest town to the Reservation. It is also the area in which tribal members not living on the Reservation, and the majority of tribal employees, reside. Highway 101, on which the Forks Bridge is situated, would also be the most likely direction/roadway that tourists would take for evacuation. Highway 101 is the only access roadway which connects to the Lower Hoh Road, which is the only main road providing ingress and egress to the Reservation, and is approximately 2 miles in length. Based on FEMA's RiskMap report, Lower Hoh Road will be impassable during 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.

11.3.5 Impact on Economy

All structures on the Hoh Reservation will be impacted by a tsunami, including both governmental structures and residences. The loss of those structures to the Tribe would be devastating, and potentially beyond the ability of the Tribe to rebuild within a reasonable timeframe. Such an event will also impact the ability of tribal government to function, further impacting tribal economy.

Hoh Tribal members that have tourist-related businesses, such as fishing charters, or those that sell handmade products would also be significantly impacted by a tsunami. In addition, much of Jefferson County's businesses are related to tourism, highly dependent on the millions of visitors to the area annually. Many tribal members are dependent on those industries as their source of income. Tribal members not living on the Reservation but working for the Tribe would not be able to travel to/from work, with lost income.

In general, coastal communities with port facilities, fishing fleets and public utilities, etc., are often the backbone of the economy of affected areas, and these are the resources that generally receive the most severe damage. Until debris can be cleared and infrastructure rebuilt, 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 remoteness of the Reservation and the impact to roadways, supply chain disruption will be impact everyone. With limited resources available, and access impacted, waterway or air-drop deliveries may be the only option to get supplies to the Reservation, increasing the associated costs.

A tsunami would also damage economically important natural resources, such as crab, clams, salmon and other fish, and outdoor recreation areas. Likewise, forestlands, which are a large part of the County's land use and economy, would also be impacted with loss of revenue and destruction of businesses for future growth of the area. The Tribe is looking at some level of forest management during the life cycle of this plan, which may include the thinning of forest stock, providing an economic benefit either for the Tribe by the sale of the trees, or for use by tribal members.

The inundation zone for the planning region is significant and would have a devastating impact on the planning region's economy as a whole. 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. That loss at the county level would impact employment for tribal members, as well as limiting available resources. 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, and the travel time associated with loss of the transportation infrastructure.

11.3.6 Impact on Environment

The vulnerability of agricultural and aquatic habit and associated ecosystems would be highest in low-lying areas close to the coastline, such as the Hoh Reservation. Areas near gas stations, industrial areas and Tier II facilities would be vulnerable due to potential contamination from hazardous materials. Such contamination would not need to occur in the immediate area, as wave action would distribute the hazardous materials. In addition, aquatic species such as those attached to debris from the Japan tsunami were brought to the Washington Coastline. These invasive species represent a significant environmental impact.

Tsunami waves can carry destructive debris and pollutants that can have devastating impacts on all facets of the environment. Millions of dollars spent on habitat restoration and conservation in the planning area could be wiped out by one significant tsunami. There are currently no tools available to measure these impacts. However, it is conceivable that the potential financial impact of a tsunami event on the environment could equal or exceed the impact on property.

11.3.7 Impact from Climate Change

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 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. With the potential for a Cascadia Subduction Zone earthquake lowering the coastline, climate change impact on a tsunami will mean higher wave height travelling further inland.

11.3.8 Future Development Trends

With tsunami wave heights estimated to reach as high as ~100 feet at the mouth of the Hoh River, ~87 feet at the Hoh Reservation Beach, and ~43 feet at the Tribal Center as a result of a Cascadia Subduction Zone earthquake, standard floodplain development regulation would not provide adequate risk protection for new development. The planning area also has a significant amount of bluffs and steep hillsides as well, which would be impacted as a result of wave activity. Roadways will also be impacted, restricting access to and from the Reservation. As a result, the Hoh Tribe has elected to move the Reservation to the new Hoh Highlands area, which is, at its lowest point, in excess of 160 feet above sea level, and outside of the tsunami inundation zone. Until that total relocation occurs, the Tribe is restricting development on the existing Reservation boundary to only replacement of immediately critical infrastructure, such as the wastewater treatment facility that was constructed as replacement for the failing system. In anticipation of the relocation, when the Tribe was forced to replace its failing water system, it did elect to incur the additional expense and relocate the new storage tank and system in the Hoh Highlands area.

11.4 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). Depending on the epicenter of the earthquake, only minutes will exist before waves begin to reach the mouth of the Hoh River. Based on scenario modeling by WA DNR, residents can expect waves to reach their boundaries within 20 minutes of a Cascadia Subduction Zone earthquake. 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:

- With the high number of tourists visiting the area, and the limited roadways providing evacuation, designated foot trails leading outside of the tsunami inundation zone need to be constructed which join the existing Reservation through the Olympic National Forest to the new Hoh Highlands area.

- To measure and evaluate the probable impacts of tsunamis, new hazard mapping needs to be created based on probabilistic scenarios likely to occur for the County. The science and technology in this field are emerging. For tsunami hazard mitigation programs to be effective, probabilistic tsunami mapping will need to be a key component, with updated occurring as new data emerges. FEMA just recently completed such studies in 2019; however, that data will continue to be enhanced using Hazus as time progresses. Regular updates should continue to occur.

- Some limitations associated with data relating to building codes, guidelines and building records provides limited information with respect to the impacts of tsunamis on structures.

- As tsunami warning technologies evolve, the tsunami warning capability within the planning area will need to be enhanced to provide the highest degree of warning to planning partners with tsunami risk exposure. Funding for weather radios, additional sirens, or notification systems which will be strategically located will allow for advanced warning in areas of concern.

- Elevated tsunami evacuation points throughout the area of inundation need to be constructed, which will require additional funding sources.

- With climate change, the issue of sea level rise is 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.

11.1 IMPACT AND 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 highly likely, with widespread catastrophic impact with respect to geographic extent. Wave height is estimated to be ~100 feet at the mouth of the Hoh River and ~43 feet at the Tribal Center. The entire Reservation and all structures will be impacted. The age of the building stock and previous impact from flood events has left many structures weakened. While there area has experienced

tsunami impact historically, those incidents have occurred infrequently. However, due to the fact that we are well over-due for a Cascadia-type earthquake event, which undoubtedly will generate a significant tsunami within the entire region from Canada to California, the probability of occurrence is high. Implementation of mitigation strategies sites will help protect some lives, but not all. Relocation to the Hoh Highlands area is the only certain way to help reduce the impact on tribal citizens living on the Reservation.

Based on the potential impact, the Planning Team determined the CPRI score to be 3.5, with overall vulnerability determined to be high.

CHAPTER 12.
WILDFIRE

A wildfire is any uncontrolled fire occurring on undeveloped land that requires fire suppression. Wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use, and arson. The wildfire season in Washington usually begins in April, picks up in early July, and generally ends in late September; however, wildfires have occurred every month of the year. Drought, snowpack, and local weather conditions can expand the length of the fire season.

People start most wildfires; major causes include arson, recreational fires that get out of control, smoker carelessness, debris burning, and children playing with fire. Wildfires started by lightning burn more state-protected acreage than any other cause. Fires during the early and late shoulders of the fire season usually are associated with human-caused fires; fires during the peak period of July, August and early September often are related to thunderstorms and lightning strikes.

While the Tribe currently is not practicing controlled burns, over the course of the lifecycle of this plan, the Tribe may utilize this method to care for its natural areas. The Tribe may also to again work with the Center for Natural Lands Management to help identify areas which would benefit environmentally from such practices, and to learn appropriate applications of controlled burns.

12.1 GENERAL BACKGROUND

Wildland-Urban Interface Areas

The wildland urban interface (WUI) is the area where development meets wildland areas. This can mean structures built in or near natural forests, or areas next to active timber and rangelands. The federal definition of a WUI community is an area where development densities are at least three residential, business, or public building structures per acre. For less developed areas, the wildland-intermix community has development densities of at least one structure per 40 acres. Table 12-1 identifies the Wildland Urban Interface Acres within the reservation boundary.

DEFINITIONS

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

Firestorm—A fire that expands to cover a large area, often more than a square mile. A firestorm usually occurs when many individual fires grow together into one. The involved area becomes so hot that all combustible materials ignite, even if they are not exposed to direct flame. Temperatures may exceed 1000°C. Superheated air and hot gases of combustion rise over the fire zone, drawing surface winds in from all sides, often at velocities approaching 50 miles per hour. Although firestorms seldom spread because of the inward direction of the winds, once started there is no known way of stopping them. Within the area of the fire, lethal concentrations of carbon monoxide are present; combined with the intense heat, this poses a serious life threat to responding fire forces. In very large events, the rising column of heated air and combustion gases carries enough soot and particulate matter into the upper atmosphere to cause cloud nucleation, creating a locally intense thunderstorm and the hazard of lightning strikes.

Interface Area—An area susceptible to wildfires and where wildland vegetation and urban or suburban development occur together. An example would be smaller urban areas and dispersed rural housing in forested areas.

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

TABLE 12-1.
WA-DNR WILDLAND URBAN INTERFACE ACRES WITHIN RESERVATION BOUNDARY

Jurisdiction	Non-Vegetated					Intermix				Interface				Other			
	Non-Vegetated Uninhabited	Non-Vegetated Very Low Structure Density	Non-Vegetated Low Structure Density	Non-Vegetated Medium Structure Density	Non-Vegetated High Structure Density	Intermix Very Low Structure Density	Intermix Low Structure Density	Intermix Medium Structure Density	Intermix High Structure Density	Interface Very Low Structure Density	Interface Low Structure Density	Interface Medium Structure Density	Interface High Structure Density	Vegetated Uninhabited	Long-term Non-Buildable Areas	Water	Total
Hoh Indian Reservation	0	0	0	0	0	56.46	33.15	60.61	0	0	0	0	0	725.95	5.39	31.02	912.58

In 2001, Congress mandated the establishment of a Federal Register which identifies all urban wildland interface communities within the vicinity of Federal lands, including Indian trust and restricted lands that are at high-risk from wildfire. The list assimilated information provided from States and Tribes, and is intended to identify those communities considered at risk. Review of the Federal Registry list does not identify the Hoh Reservation as being considered a community at risk; however, there are portions of Jefferson County that are identified.

When identifying areas of fire concern, in addition to the Federal Register, the Washington Department of Natural Resources and its federal partners, including the U.S. Forest Service, also determine communities at risk based on fire behavior potential, fire protection capability, and risk to social, cultural and community resources. These risk factors include areas with fire history, the type and density of vegetative fuels, extreme weather conditions, topography, number and density of structures and their distance from fuels, location of municipal watersheds, and likely loss of housing or business. The criteria for making these determinations are the same as those used in the National Fire Protection Association's *NFPA 299 Standard for Protection of Life and Property from Wildfire*, and is discussed in some detail below for further clarification. Figure 12-2 identifies those areas of risk on the Hoh Reservation as identified by U.S. Forest Service – Wildfire Risk to Communities dataset.[23] Figure 12-2 identifies the Wildland Urban Interface Areas. Table 12-2 identifies the number of structures within each of the various interface zones.

[23]USDA, USFS (2022). Wildfire Risk to Communities. Accessed Sept. 2022. Available at: Wildfire Risk to Communities

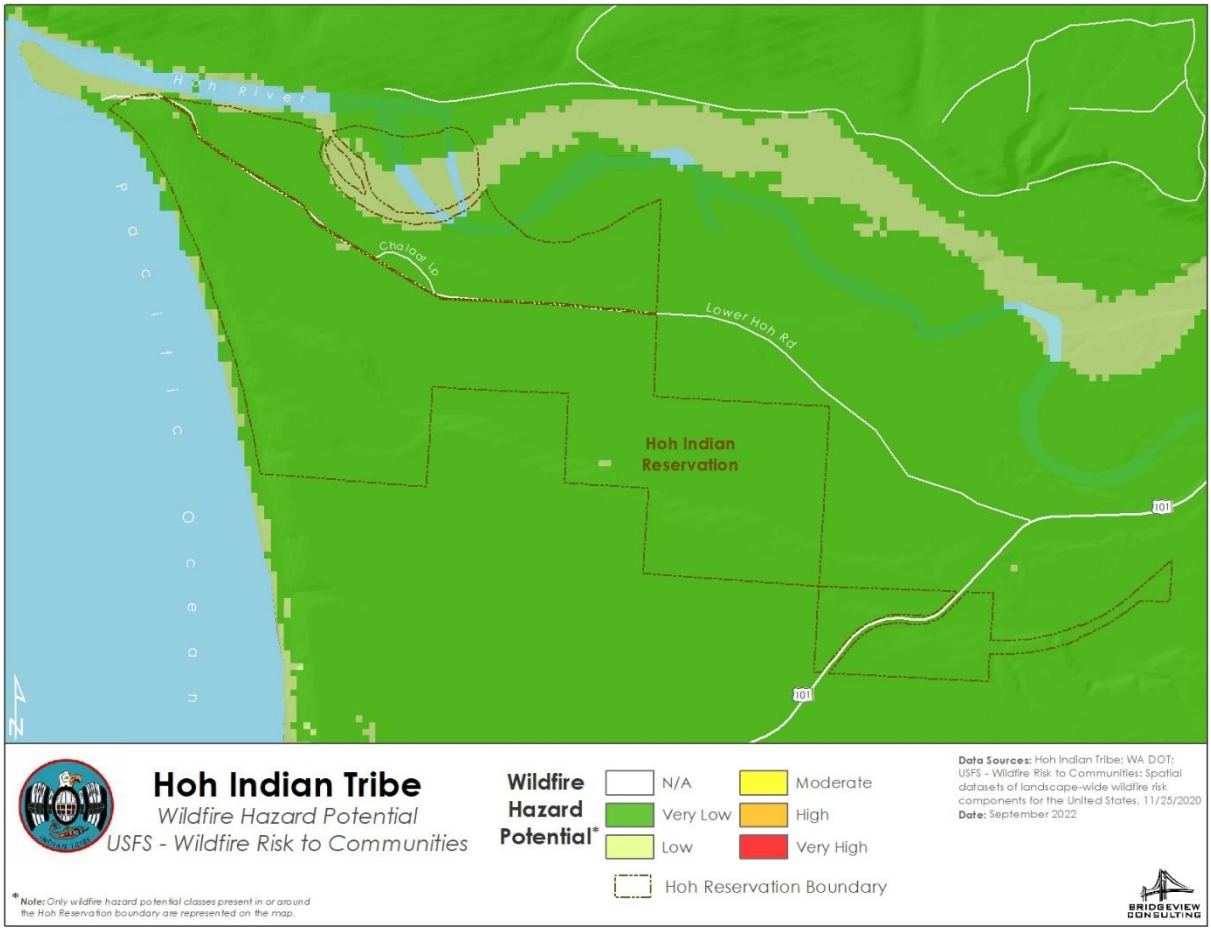


Figure 12-1 Wildfire Risk to Communities

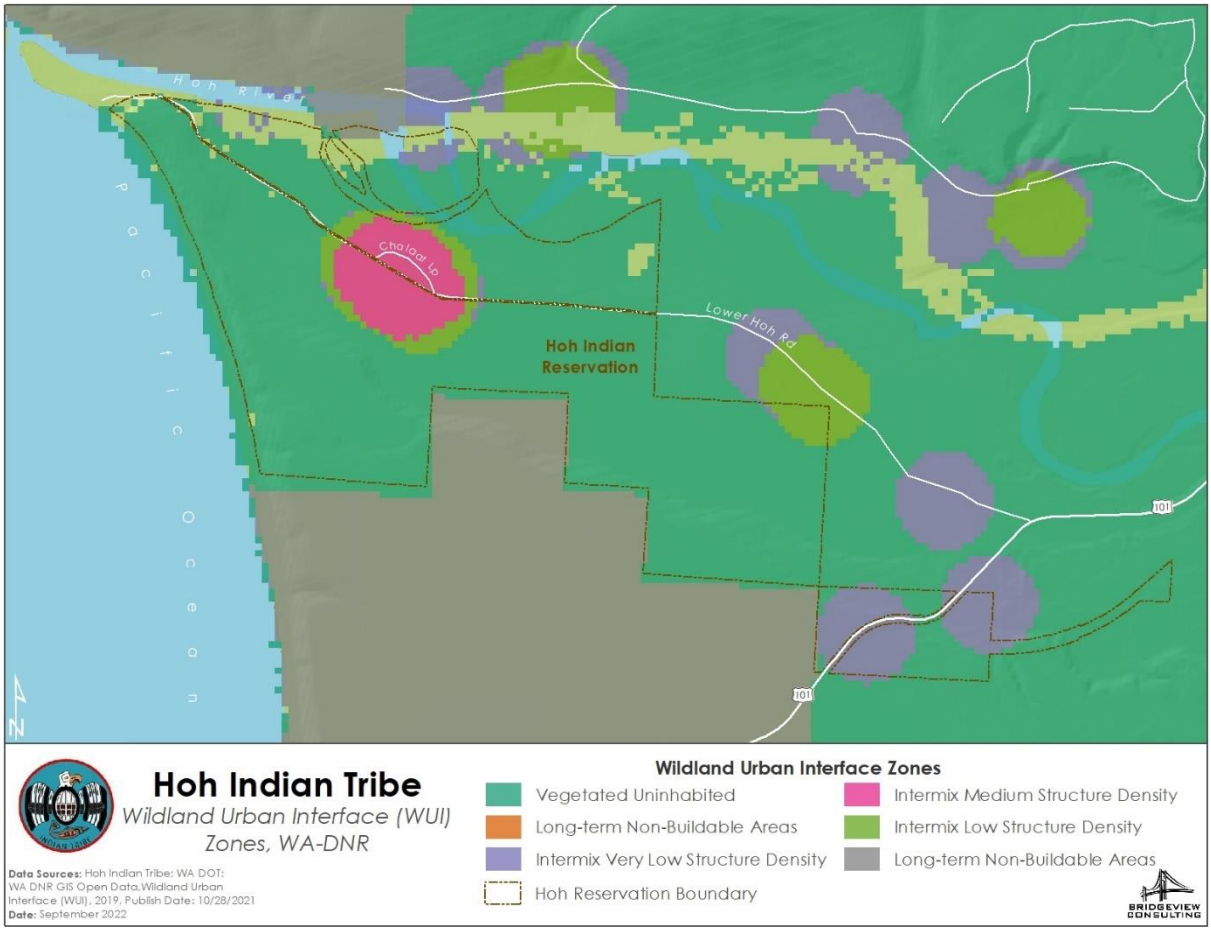


Figure 12-2 Wildland Urban Interface Communities
Source: Washington State Department of Natural Resources, 2022

TABLE 12-2
CRITICAL FACILITIES/ INFRASTRUCTURE WITHIN WA-DNR WILDLAND URBAN INTERFACE ZONES

Critical Facilities/Critical Infrastructure	Non-Vegetated					Intermix				Interface				Other			
	Non-Vegetated Uninhabited	Non-Vegetated Very Low Structure Density	Non-Vegetated Low Structure Density	Non-Vegetated Medium Structure Density	Non-Vegetated High Structure Density	Intermix Very Low Structure Density	Intermix Low Structure Density	Intermix Medium Structure Density	Intermix High Structure Density	Interface Very Low Structure Density	Interface Low Structure Density	Interface Medium Structure Density	Interface High Structure Density	Vegetated Uninhabited	Long-term Non-Buildable Areas	Water	Total
Government Function	0	0	0	0	0	0	2	1	0	0	0	1	0	4	0	0	**8**
Medical	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**1**
Hazardous Materials	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**1**
Protective Services	0	0	0	0	0	0	1	1	0	0	0	0	0	2	0	0	**4**
Schools	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**1**
Shelter	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	**1**
Commercial	0	0	0	0	0	0	0	4	0	0	0	0	0	4	0	0	**8**
Water	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	**3**
Wastewater	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	**1**
Residential	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	**25**
TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**9**	**0**	**0**	**0**	**1**	**0**	**40**	**0**	**0**	**53**

12.1.1 Wildfire Behavior

The wildfire triangle illustrated to the right (DeSisto et al., 2009) is a simple graphic used in wildland firefighter training courses to illustrate how the environment affects fire behavior. Each point of the triangle represents one of three main factors that drive wildfire behavior: weather, vegetation type (which firefighters refer to as "fuels"), and topography. The sides represent the interplay between the factors. For example, drier and warmer weather combined with dense fuel loads (e.g., logging slash) and steeper slopes will cause more hazardous fire behavior than light fuels (e.g., short grass fields) on flat ground.

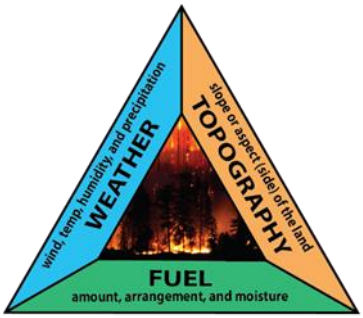


Figure 12-3 Wildfire Behavior Triangle

The following are key factors affecting wildfire behavior:

- **Fuel**—Lighter fuels such as grasses, leaves and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs and trunks take longer to warm and ignite. Snags and hazard trees—those that are diseased, dying, or dead—are larger but less prolific west of the Cascades than east of the Cascades. In 2002, about 1.8 million acres of the state's 21 million acres of forestland contained trees killed or defoliated by forest insects and diseases.

- **Weather**— Relevant weather conditions include temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount and duration, and the stability of the atmosphere. Of particular importance for wildfire activity are wind and thunderstorms:

    - Strong, dry winds produce extreme fire conditions. Such winds generally reach peak velocities during the night and early morning hours. East wind events can persist up to 48 hours, with wind speed reaching 60 miles per hour. Being a coastal community, Grays Harbor County experiences significant winds on a fairly regular basis during all times of the year.

    - The thunderstorm season typically begins in June with wet storms, and turns dry with little or no precipitation reaching the ground as the season progresses into July and August.

- **Topography—**Topography includes slope, elevation and aspect. The topography of a region influences the amount and moisture of fuel; the impact of weather conditions such as temperature and wind; potential barriers to fire spread, such as highways and lakes; and elevation and slope of land forms (fire spreads more easily uphill than downhill).

- **Time of Day**—A fire's peak burning period generally is between 1 p.m. and 6 p.m.

- **Forest Practices**—In densely forested areas, stands of mixed conifer and hardwood stands that have experienced thinning or clear-cut provide an opportunity for rapidly spreading, high-intensity fires that are sustained until a break in fuel is encountered.

Fires can be categorized by their fuel types as follows:

- **Smoldering**—Involves the slow combustion of surface fuels without generating flame, spreading slowly and steadily. Smoldering fires can linger for days or weeks after flaring has ceased, resulting in potential large quantities of fuel consumed. They heat the duff and mineral layers, affecting the roots, seeds, and plant stems in the ground. These are most common in peat bogs, but are not exclusive to that vegetation.

- **Crawling**—Surface fires that consume low-lying grass, forest litter and debris.

- **Ladder**—Fires that consume material between low-level vegetation or forest floor debris and tree canopies, such as small trees, low branches, vines, and invasive plants.

- **Crown**—Fires that consume low-level surface fuels, transition to ladder fuels, and also consume suspended materials at the canopy level. These fires can spread rapidly through the top of a forest canopy, burning entire trees, and can be extremely dangerous (sometimes referred to as a "Firestorm").

Wildfires may spread by jumping or spotting, as burning materials are carried by wind or firestorm conditions. Burning materials can also jump over roadways, rivers, or even firebreaks and start distant fires. Updraft caused by large wildfire events draws air from surrounding area, and these self-generated winds can also lead to the phenomenon known as a firestorm.

12.1.2 Wildfire Impact

Short-term loss caused by a wildfire can include the destruction of timber, wildlife habitat, scenic vistas, and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and destruction of cultural and economic resources and community infrastructure. Vulnerability to flooding increases due to the destruction of watersheds. The potential for significant damage to life and property exists in WUI areas, where development is adjacent to densely vegetated areas (DeSisto et al., 2009). The planning area as a whole is very rural in nature, with the majority of housing in the area being on the Reservation, and a few non-tribal residential structures scattered through the area off the Reservation. The Reservation does border areas that have a high rate of tourism, including camping, which could increase wildfire danger with respect to campfires.

Forestlands in the planning area are susceptible to disturbances such as logging slash accumulation, forest debris due to weather damage, and periods of drought and high temperature. Forest debris from western red cedar, western hemlock, and Sitka spruce can be especially problematic and at risk to wildfires when slash is accumulated on the forest floor, because such debris resists deterioration. When ignited, these fuels can be explosive and serve as ladder fuels carrying fire from the surface to the canopy.

12.1.3 Identifying Wildfire Risk

Risk to communities is generally determined by the number, size and types of wildfires that have historically affected an area; topography; fuel and weather; suppression capability of local and regional resources; where and what types of structures are in the WUI; and what types of pre-fire mitigation activities have been completed. Identifying areas most at risk to fire or predicting the course a fire will take requires precise science by subject matter experts. The following data sets are most useful in assessing risk in the area:

- **Topography (slope and aspect) and Vegetation (fire fuels)**—These are two of the most important factors driving wildfire behavior.
- **Weather**—Regional and microclimate variations can strongly influence wildfire behavior. Because of unique geographic features, weather can vary from one neighborhood to another, leading to very different wildfire behavior.
- **Critical Facilities/Asset Location**—A spatial inventory of assets—including homes, roads, fire stations, and natural resources that need protection—in relation to wildfire hazard helps prioritize protection and mitigation efforts.

12.1.4 Secondary Hazards

Wildfires can generate a range of secondary effects, which in some cases may cause more widespread and prolonged damage than the fire itself. Fires can cause direct economic losses in the reduction of harvestable timber and indirect economic losses in reduced tourism. Wildfires cause the contamination of reservoirs, destroy transmission lines, and contribute to flooding. They strip slopes of vegetation, exposing them to greater amounts of runoff. This in turn can weaken soils and cause failures on slopes. Major landslides can occur several years after a wildfire. Most wildfires burn hot and for long durations that can bake soils, especially those high in clay content, thus increasing the imperviousness of the ground. This increases the runoff generated by storm events, thus increasing the chance of flooding.

12.2 HAZARD PROFILE

12.2.1 Extent and Location

Given its rural land use complexity, densely wooded areas, and its proximity to the various large park systems (both federal and state), the entire region is susceptible to impact from wildfire, either as a direct result, or as a secondary result from health or economic impact.

12.2.2 Previous Occurrences

Wildfire causes are highly variable and dependent upon many factors, including the general weather patterns of the region. Within the Hoh Rainforest ecosystem, the forestlands are susceptible to forest disturbance patterns such as logging slash accumulation, weather damage caused forest debris, and to a lesser degree, periods of prolonged drought and high temperatures. Forest debris from western red cedar, western hemlock, and Sitka spruce can be especially problematic and at risk to wildfires when slash is accumulated on the forest floor because of the tendency to resist deterioration. When ignited, these fuels

can be explosive and provide ladder fuels that transition from the surface fire to a crown fire rapidly. According to the U.S. Department of Agriculture (2022) and U.S. Forest Service, the Hoh Reservation's exposure to ignition is predominantly related to direct sources, such as adjacent flammable vegetation.[24]

Evidence from tree rings indicates that much of the north, east and south sides of the Olympic Peninsula burned during episodes of drought about 300-500 years ago. Analysis of fire scarred trees indicates that another cycle of prehistoric fires burned many east side watersheds about 250 years ago. The relatively dry east side of the peninsula shows evidence of more frequent and larger fires than the wet west side.[25]

Fires historically burn on a fairly regular cycle, recycling carbon and nutrients stored in the ecosystem, and strongly affecting the species within the ecosystem. The burning cycle in western Washington is estimated to be every 100 to 150 years. Controlled burns have also been conducted because the fire cycle is an important aspect of management for many ecosystems. These are not considered hazards unless they get out of control.

Currently the extent to which the Hoh Indian Tribe used fire on the Olympic Peninsula is largely unknown. Government Lands Office maps of the late 1800's show locations of many burned areas along the coastal strip, and it has been hypothesized that coastal tribes burned to clear land, improve game habitat, expose root crops and maintain cranberry and bracken fern in selected sites. It is possible that the small "prairies" near the coast were created or improved by such burning, but no conclusive evidence has been found to date. At present, the Tribe does not practice prescribed burns.

According to FEMA's website, the Reservation has received no disaster declarations for fire. None of Washington State's most significant wildland fires have occurred on the Hoh Reservation or Jefferson County, although smaller fires have occurred in the region. Table 12-2 identifies some of the recorded information of fires occurring in the planning area.

TABLE 12-3.
RECORD OF FIRE IN OR NEAR THE PLANNING AREA

Date	Cause	Total Area in Acres within Planning Zone	Duration of Fire in Days
10/6/1972	Debris Burn	<1	2
7/8/1975	Camper	<1	2
9/27/1975	Camper	<1	2
8/7/1978	Lightning Strike	1,050	7
7/21/1980	Arson	<1	1
7/5/1991	Camper	<1	1

[24] USDA (2022). Wildfire Risk to Communities. Accessed 25 August 2022. Available online at Wildfire Risk to Communities

[25] Olympic National Park. Fire History. Accessed 30 August 2022. Available online at: Fire History - Olympic National Park (U.S. National Park Service) (nps.gov)

7/28/1999	Children playing with fire	<1	2
8/31/2002	Camper	.5	1
6/27/2006	Controlled Burn	<1	2

The Hoh Fire (highlighted in Table 12-2), which occurred in 1978, burned approximately 1,050 acres of land within the Hoh Watershed. Started by lightning on a steep south-facing slope, it smoldered and crept on the ground until hot east winds started. The east winds dried out the fuels, causing the fire to burn hotter and ignite the tree crowns. The flames did not stop spreading until the winds died two days later. Although fire crews were immediately dispatched to the fire when it was discovered on August 7th , the fire was not contained until August 14th .

Review of Jefferson County's available HIVA (pre-2012) indicates that the County has sustained seven fires since 1900, as follows:

- 1902—Green Mountain Fire
- 1918—Dosewallips & Duckabush Fires
- 1924-1925—Green Mountain, Mt. Zion, Snow Creek Fires
- 1929—Interorrem Fire-9,000 acres
- 1961—Mt. Bretherton Fire
- 1978—Hoh Fire-1050 Acres
- 1981—Chimney Peak Fire

The Tribe has not experienced any significant fires since completion of the 2012 Hazard Mitigation Plan; however, with climate change, it is anticipated that the wildfire risk will increase.

Lightning Fires

Lightning-caused fires have accounted for approximately half of the ignitions and two thirds of the burned acreage at Olympic National Park since it was established in 1938. Natural fire occurrence is directly related, but not proportional, to lightning incidence levels. It is rare for a summer to pass without at least one period of lightning activity. Lightning incidence is greatest during July and August, though storms capable of igniting fires have occurred from early spring to mid-October. Lightning storms generally track across the park in a southwest to northeast direction. The greatest numbers of ground strikes have been recorded in the upper Quinault, Elwha, and Skokomish River drainages. The majority of subsequent fires have developed in the Elwha River drainage and Hurricane Ridge area. However, isolated lightning storms have occurred over all areas of the park, including the coastal strip.

Lightning storms are typically followed by light to moderate amounts of precipitation. The rainfall may extinguish the fires, while high fuel moisture inhibits spread. However, prolonged periods of warm, dry weather, especially in combination with east winds, often reveal numerous latent "sleepers." The Hoh Fire (1978) was discovered 13 days following known ignition and the Chimney Fire (1981) 23 days after probable ignition.

While most lightning fires are less than a quarter acre in size, occasional large fires during dry periods account for most of the burned acreage. Large lightning fires include the 1978 Hoh Fire, the 1981Chimney Fire, and the most recent 2009 Heatwave Complex fires.

Fire Causes

According to Washington State Department of Natural Resources (DNR), review of the 2021 fire season reports:[26]

- A total 674,249 acres burned statewide;
- 88% (1,640 total) of Washington wildfires were human-caused;
- 12% (232 total) of Washington wildfires were lightning-caused;
- 44 Washington fires met the large fire criteria- described as fires larger than 1,000 acres in the western United States; and
- Burning a total 107,118 acres, the Schneider Spring fires was the state's largest wildfire for the year.

Based on DNR data, the 10-year averages for fire causes are:

- 73.4% human;
- 16.6% lightning; and
- 10% undetermined.

12.2.3 Severity

In 2021, Washington state recorded the hottest and driest year on record. In addition to the heat wave in June, which recorded triple-digit temperatures throughout Washington, state officials noted that the intense heat throughout July and August often made wildfires harder to manage. Officials anticipated that as the state is likely to encounter more of the extreme weather experienced in 2021, future wildfires would in turn be more frequent and more destructive. Despite severe heat and drought-like conditions, the 2021 wildfire season was in fact not as devastating with human and property loss as prior years. This was credited to the state's ability to respond to wildfires more rapidly due, in part, to the passage of HB 1168, which committed funding annually for the next four biennial budgets to boost wildfire response and accelerate forest restoration. These investments helped the Department of Natural Resources address fires swiftly and attack smaller fires earlier to prevent many of them from growing into large-scale wildfires, which proved to reduce impact from wildfires.

For the Hoh Tribe, the severity of the fire would be dependent on the existing conditions in place at the time of the fire, and the available of fire resources. The Tribe does not have a fire department, and relies on the surrounding communities to provide such services. Arrival time for fire response is 45 minutes at

[26] Washington Forest Protection Association. 2021 Wildfire Season Summary. Accessed 29 August 2022. Available at 2021 wildfire season summary – Washington Forest Protection Association (wfpa.org)

a minimum. This would allow significant time for any wildfire to spread, increasing the severity of the fire if conditions are optimal.

Potential losses from wildfire include human life, structures and other improvements, and natural resources. Smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations such as children, the elderly and those with respiratory and cardiovascular diseases. Wildfire may also threaten the health and safety of those fighting the fires. Wildfire can lead to ancillary impacts such as landslides in steep ravine areas and flooding due to the impacts of silt in local watersheds. A large-scale wildfire would destroy timber, equipment, and the natural habitat for generations.

Extreme fires, when they occur, are characterized by more intense heat and preheating of surrounding fuels, stronger flame runs, potential tree crowning, increased likelihood of significant spot fires, and fire-induced weather (e.g., strong winds, lightning cells). Extreme fire behavior is significantly more difficult to combat and suppress, and can drastically increase the threat to homes and communities.

Review of U.S. Forest Service data indicates that while the Reservation has a low probability of fires impacting its lands (U.S. Forest Service 2022), the populated areas of the Hoh Reservation have, on average, a 38 percent greater level of risk than other tribal areas (and counties) in the state.[27]

Due to many years of fire suppression, logging, and other human activities, the forests and rangelands have changed, increasing fire severity. Much of the lands surrounding the Reservation are historic logging areas. Areas that historically once experienced frequent, low-severity wildfires now burn with much greater intensity due to the build-up of understory brush and trees. At times, this equates to fires which are larger and more severe, killing the trees and vegetation at all levels, and spreading much more quickly. The combination of steep slopes, canyons, open rangeland, and fuel type have a history and potential for fast moving and fast spreading wildfires.

12.2.4 Frequency

As previously indicated, none of Washington State's most significant wildfires have occurred in the planning area, although smaller fires have occurred in the region annually. Fires historically burn on a regular cycle, recycling carbon and nutrients stored in the ecosystem, and strongly affecting species within the ecosystem. The burning cycle in western Washington is approximately every 100 to 150 years.

Historically, drought patterns are related to large-scale climate patterns in the Pacific and Atlantic oceans. The El Niño–Southern Oscillation varies on a 5- to 7-year cycle, the Pacific Decadal Oscillation varies on a 20- to 30-year cycle, and the Atlantic Multidecadal Oscillation varies on a 65- to 80-year cycle. As these large-scale ocean climate patterns vary in relation to each other, drought conditions in the U.S. shift from region to region. El Niño years bring drier conditions to the Pacific Northwest and more fires.

[27] Ibid.

Historic Fire Regime

Many ecosystems are adapted to historical patterns of fire. These patterns, called "fire regimes," include temporal attributes (e.g., frequency and seasonality), spatial attributes (e.g., size and spatial complexity), and magnitude attributes (e.g., intensity and severity), each of which have ranges of natural variability. A fire regime refers to the frequency and intensity of natural fires occurring in various ecosystem types. Alterations of historical fire regimes and vegetation dynamics have occurred in many landscapes in the U.S., including the planning area through the combined influence of land management practices, fire exclusion, insect and disease outbreaks, climate change, and the invasion of non-native plant species. Anthropogenic influences to wildfire occurrence have been witnessed through arson, incidental ignition from industry (e.g., logging, railroad, sporting activities), and other factors. Likewise, wildfire abatement practices have reduced the spread of wildfires after ignition.

The LANDFIRE Project produces maps of simulated historical fire regimes and vegetation conditions using the LANDSUM landscape succession and disturbance dynamics model. The LANDFIRE Project also produces maps of current vegetation and measurements of current vegetation departure from simulated historical reference conditions. These maps support fire and landscape management planning outlined in the goals of the National Fire Plan, Federal Wildland Fire Management Policy, and the Healthy Forests Restoration Act.

The simulated historical mean fire return interval data layer quantifies the average number of years between fires under the presumed historical fire regime. This data is derived from simulations using LANDSUM. LANDSUM simulates fire dynamics as a function of vegetation dynamics, topography, and spatial context, in addition to variability introduced by dynamic wind direction and speed, frequency of extremely dry years, and landscape-level fire characteristics.

The historical fire regime groups simulated in LANDFIRE categorize mean fire return interval and fire severities into five regimes defined in the Interagency Fire Regime Condition Class Guidebook:

- Regime 1: 0-35 year frequency, low to mixed severity
- Regime II: 0-35 year frequency, replacement severity
- Regime III: 35-200 year frequency, low to mixed severity
- Regime IV: 35-200 year frequency, replacement severity
- Regime V: 200+ year frequency, any severity

Large wildfires have historically been infrequent in the coastal regions of the Pacific Northwest. While fires have occurred in the planning area, due to firefighting efforts, many have been contained with limited impact on acreage burned. All lands owned by the Hoh Tribe fall within Fire Regime V, with a 200+ year frequency.

Mean Fire Return Interval (MFRI) layer quantifies the average period between fires under the presumed historical fire regime. MFRI is intended to describe one component of historical fire regime characteristics. LANDFIRE's MFRI for acres within the Reservation boundary and off-reservation owned lands are identified in Table 12-4 and Figure 12-4.

TABLE 12-4 MEAN FIRE RETURN INTERVAL BY ACRES								
Jurisdiction	**6-10 Years**	**71-80 Years**	**201-300 Years**	**301-500 Years**	**501-1000 Years**	**Water**	**Barren**	**Indeterminate Fire Regime Characteristics**
Hoh Indian Reservation	0.00	0.00	0.00	6.71	817.05	36.55	4.09	44.76

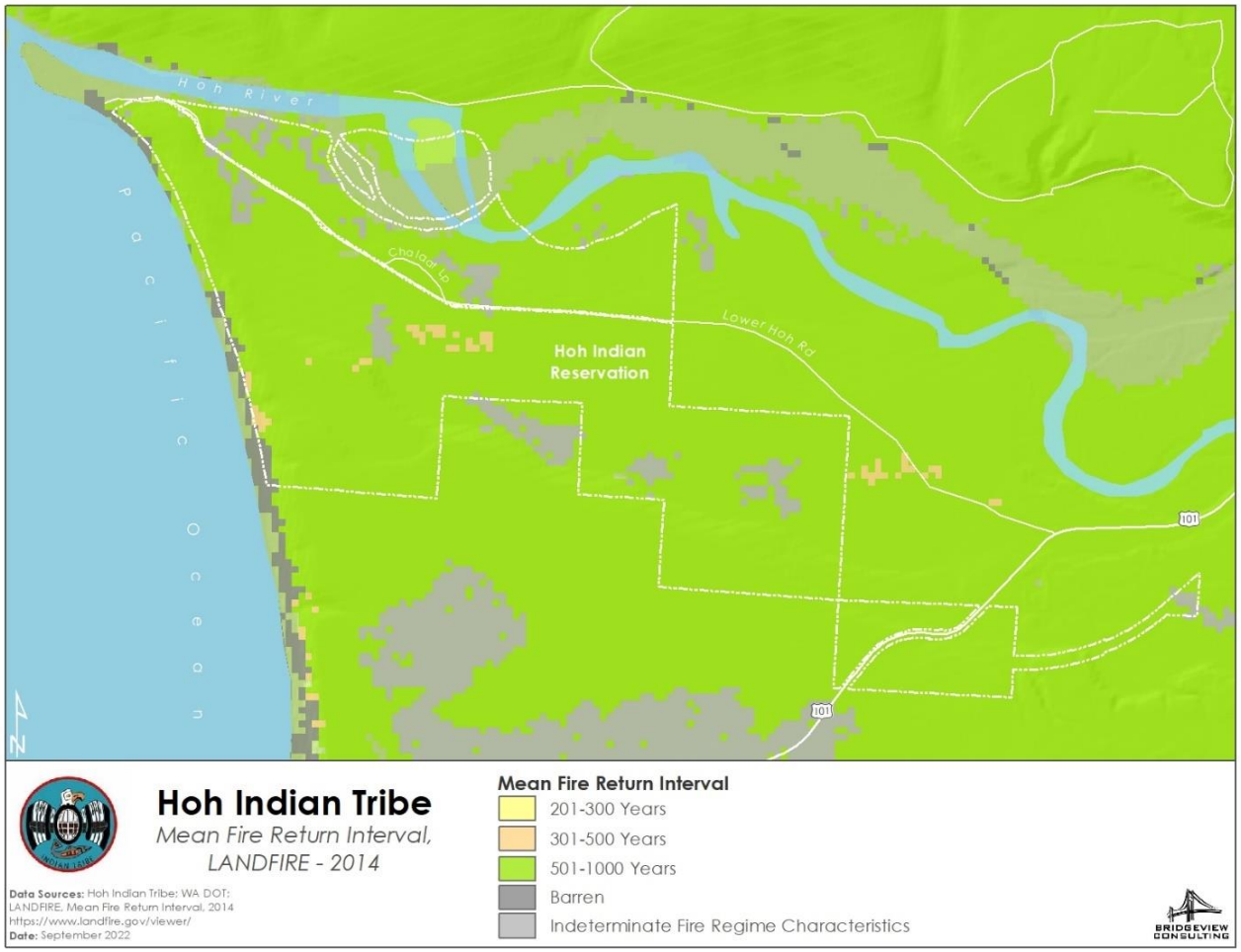


Figure 12-4 Mean Fire Return Interval

Certain types of vegetations, or fuels respond differently in fire situations, with some more easily ignitable, and others which burn more quickly than others. Historically, grasses burn more quickly, and spread fires to shrubs and timber.

The existing LANDFIRE Vegetation Condition Class (VCC) is identified in Table 12-4 and Figure 12-5. VCC represents a simple categorization of the associated Vegetation Departure (VDEP) layer and indicates the general level to which current vegetation is different from the simulated historical vegetation. The classes of variation range are low, medium, and high. The variation of vegetation class directly influences fire.

TABLE 12-5 LANDFIRE – VEGATION CONDITION CLASS (VCC)													
	Vegetation Condition Class							*Non-Burnable Classes*					
Jurisdiction	***Vegetation Condition Class 1A***	***Vegetation Condition Class 1B***	***Vegetation Condition Class 2A***	***Vegetation Condition Class 2B***	***Vegetation Condition Class 3A***	**Burnable Urban**	**Burnable Agriculture**	**Non-Burnable Urban**	**Non-Burnable Agriculture**	**Urban**	**Barren**	**Water**	**Total**
Hoh Indian Reservation	0.00	0.00	41.86	252.58	524.73	0.00	0.22	0.00	0.00	73.44	4.76	8.20	905.79

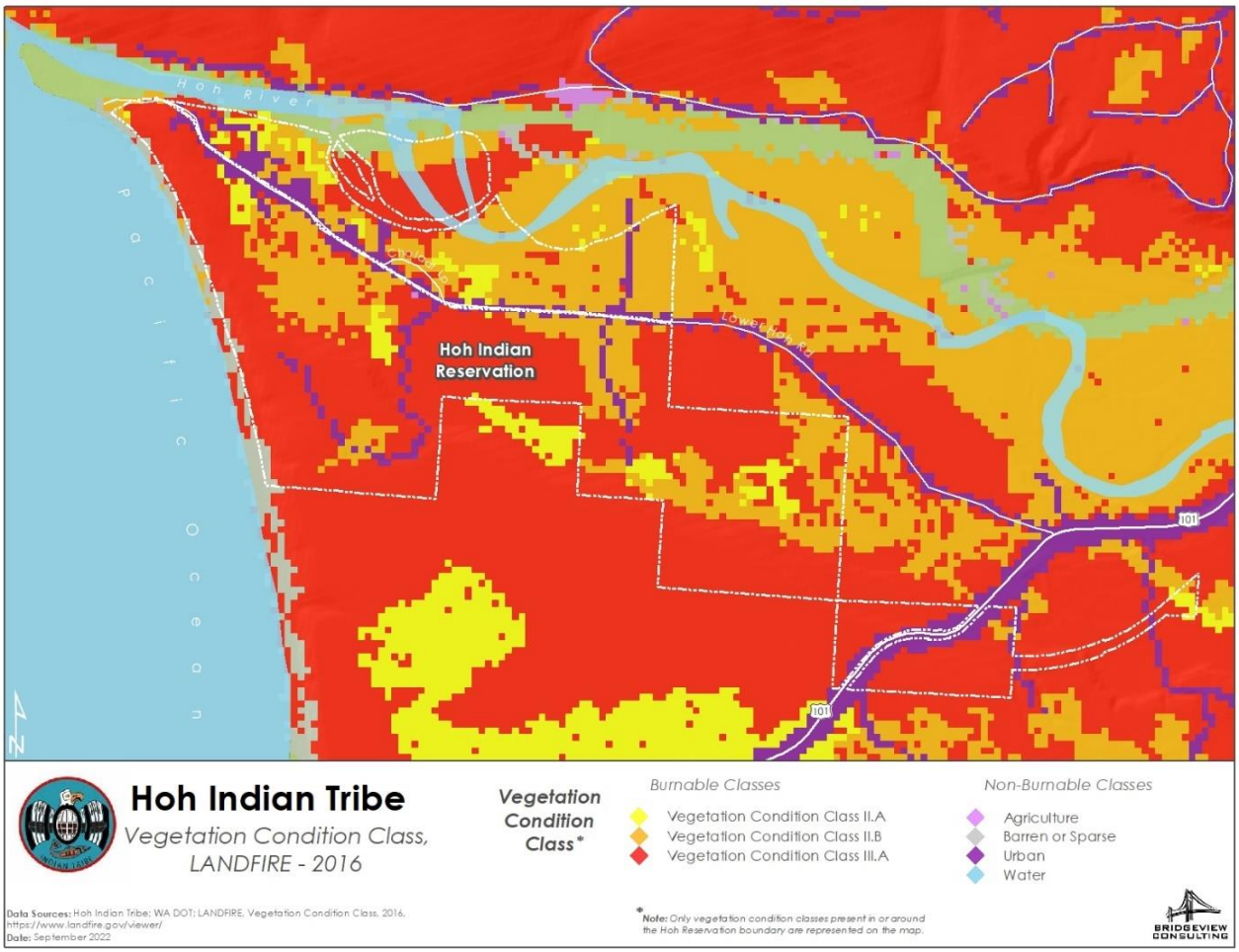


Figure 12-5 LANDFIRE Vegetation Condition Class

12.3 VULNERABILITY ASSESSMENT

12.3.1 Overview

Structures, above-ground infrastructure, critical facilities, and natural environments are all vulnerable to the wildfire hazard. Communities can reduce their risk to homes by reducing wildfire likelihood, wildfire intensity, exposure, and susceptibility. For example, fuel treatments may reduce wildfire likelihood or intensity, exposure may be reduced through land use planning tools, and susceptibility may be reduced by mitigating the home ignition zone, home hardening, and land use planning tools.

Warning Time

Understanding the relationship between weather, potential fire activity, and geographical features enhances the ability to prepare for the potential of wildfire events. This knowledge, when paired with emergency planning and appropriate mitigation measures, creates a safer environment.

Statistically, we know that wildfires are often caused by humans, intentionally or accidentally. Dry seasons and droughts are factors that greatly increase fire likelihood. Dry lightning may trigger wildfires. Severe weather can be predicted, so special attention can be paid during weather events that may include lightning. Reliable National Weather Service lightning warnings are available on average 24 to 48 hours prior to a significant electrical storm. Since fireworks often cause brush fires, extra diligence is warranted around the Fourth of July when the use of fireworks is highest.

Wildfire studies can analyze weather data to assist firefighters in understanding the relationship between weather patterns and potential fire behavior. Fire forecasting examines similarities between historical fire weather and existing weather and climate values. These studies have determined that for areas such as this study region, any combination of two of the following factors can create more intense and potentially destructive fire behavior, known as extreme fire behavior:

- Sustained winds from the east
- Relative humidity less than 40 percent
- Temperature greater than 72º Fahrenheit
- Periods without precipitation greater than 14 days in duration
- 1,000-hour fuel moisture less than 17 percent.

If a fire breaks out and spreads rapidly, residents may need to evacuate within a short timeframe. A fire's peak burning period generally is between 1 p.m. and 6 p.m. In normal situations, fire alerting would commence quickly, helping to reduce the risk. However, in more remote locations, or in areas where cell phone services are sporadic at times, warning time and calls for assistance may be reduced. The Tribe does not have its own fire service, and relies on Jefferson County to provide firefighting services. On average, fire response agencies in the area take approximately 45 minutes.

12.3.2 Impact on Life, Health, and Safety

There are no recorded fatalities from wildfire in the planning area or on the reservation. The data and maps used in the analysis show areas of relative importance in determining fire risk, though they do not provide sufficient data for an exact statistical estimation of exposed populations. We do know that the Tribe currently has approximately 125 +/- tribal members living (or family members visiting) on the reservation daily, as well as tribal staff that work on the Reservation.

Also for consideration in determining impact to life, health and safety are the daily visitors and staff at the various tourist attractions in the area, which cannot be determined with certainty. With Highway 101 being a major thoroughfare along the entire coastline, that will also increase the potential population at risk. An exact number of the population vulnerable to impact from fire is difficult to determine due to the high number of variables that impact fire scenarios.

Smoke generated by wildfire consists of visible and invisible emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, nitrogen oxides), and toxics (formaldehyde, benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather. Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility. Smoke and air pollution from wildfires can be a severe health hazard, especially for sensitive populations, including children, the elderly and those with respiratory and cardiovascular diseases. We know that smoke can travel for miles, and one does not necessarily need to me in the immediate area of the fire to be impacted by such. Based on 2020 Census data, approximately eight residents are under 5 years of age, with four residents over the age of 65, further increasing the potential impact on the fire hazard. Wildfire also threatens the health and safety of those fighting fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke.

12.3.3 Impact on Property

Property damage from wildfires can be severe and can significantly alter entire communities. Currently, placement of residential structures are primarily within one roadway (Chaalet). The majority of all buildings presently on the reservation are pre-1980's, built from wood, with wood frames and with shingle roofs – all combustible materials. Many of the buildings have been previously flooded, many of those with minimal repairs completed after the flood event. The probability of increased dry rot is high, making the wood structure even more of a fire fuel.

Also taken into account is the proximity to the Olympic National Park, which hosts campsites with fire pits, and the fact that four of the last nine fires occurring within the planning region have been caused by campfires. Those factors, when added to the fact that there are no available firefighting services in close proximity to the Reservation, increases significantly the percentage of population exposed to the impacts from fire on the Reservation, although an actual statistical percentage cannot be determined.

Additional concerns to consider which are highly variable include the general weather patterns of the region. Within the Hoh Rain Forest ecosystem, the forestlands are susceptible to forest disturbance patterns such as logging slash accumulation, weather damage caused forest debris, and periods of

prolonged drought and high temperatures. Forest debris from western redcedar, western hemlock, and Sitka spruce can be especially problematic and at risk to wildfires when slash is accumulated on the forest floor because of the tendency to resist deterioration. When ignited, these fuels can be explosive and provide ladder fuels that transition from the surface fire to a crown fire rapidly. Two of the last nine fires occurring within the planning region have occurred from contained debris burns.

Property damage from wildfires can be severe and can significantly alter entire communities. As a result of the lack of fire management or suppression activities on the Reservation, at present time, 100% of the structures on the planning area of the Reservation is at risk to fire.

The probability of occurrence of a fire based on historic events appears to be relatively low, with a low return interval. Nine fires have occurred in a 50-year timeframe, which averages to a fire every 5.6 years. Review of the historic fire data illustrates that seven of the nine fires which occurred did so pre-2000. All but one of the fires burned less than one acre of land. For additional consideration, the planning team also reviewed the condition of the current structures, their close proximity to one another, potential climate change impacts, and the potential exposure to the structures on the Reservation should a fire occur. With that in mind, the potential impact is considered medium to high on the current Reservation, but that will hopefully change in the Hoh Highlands, where the tribe anticipates incorporating fire resistant materials and additional wildfire mitigation efforts (e.g., concrete siding, covered eves, non-combustible roofs, defensible space, etc.).

12.3.4 Impact on Critical Facilities and Infrastructure

Critical facilities of wood frame construction are especially vulnerable during wildfire events. In the event of wildfire, there would likely be high damage to most infrastructure on the Reservation due to its age and building type. Most roads and railroads would be without damage except in the worst scenarios. Fueling stations could be significantly impacted, and while the Tribe currently has a fueling station, it does not contain any fuel, meaning the Tribe would have to travel a significant distance to obtain fuel for vehicles, heating/cooling, etc. Power lines are also significantly at risk from wildfire because most poles are made of wood and susceptible to burning. All power coming to the Reservation are above-ground poles, and would be impacted. Within the new Hoh Highlands area, the power will be underground, thereby reducing impact on the actual Reservation, but not the poles owned by Clallam County PUD. Fires can also create conditions that block or prevent access and can isolate residents and emergency service providers. Wildfire in the planning area could also impact wood-structured bridges, peers, and docks, which are utilized to moor watercraft, launch search and rescue vessels, or fishing vessels.

All structures on the Reservation fall into Fire Regime 5.

Hazardous Material Involved Fire Impact on Critical Facilities and Infrastructure

Currently there are no registered Tier II hazardous material containment sites on the Reservation, with no sites in close proximity (based on 2021 reporting to Washington State Dept. of Ecology).

During a wildfire event, hazardous material storage containers could rupture due to excessive heat and act as fuel for the fire, causing rapid spreading and escalating the fire to unmanageable levels. In addition, the materials could leak into surrounding areas, saturating soils and seeping into surface waters, having a disastrous effect on the environment.

12.3.5 Impact on Economy

The economy of the Tribe is largely dependent on governmental operations/functions, with limited entertainment (fishing excursions) and other businesses conducted by tribal members. Much of the population is employed in Forks, or other areas. A large-scale wildfire could destroy structures and equipment. The economy could suffer both from lost revenue and tax base, but also with respect to employees' potential loss of income returning into the neighboring communities as well. Tourism would also be impacted, as wildfire impact on the economy can be far reaching, ranging from damage to transportation routes to non-use of park facilities and campsites, to loss of structures influencing lost revenue by requiring replacement of structures. Secondary impacts include erosion on burned slopes leading to runoff and contributing to flooding, landslides, and impacts to salmon-bearing streams.

12.3.6 Impact on Environment

Fire is a natural and critical ecosystem process in most terrestrial ecosystems, dictating in part the types, structure, and spatial extent of native vegetation. However, wildfires can cause severe environmental impacts:

- Damaged Fisheries—Critical fisheries can suffer from increased water temperatures, sedimentation, and changes in water quality. The Tribe has an active hatchery, which releases approximately 80,000 fish annually into the neighboring waters.

- Soil Erosion—The protective covering provided by foliage and dead organic matter is removed, leaving the soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitats.

- Spread of Invasive Plant Species—Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control.

- Disease and Insect Infestations—Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees.

- Destroyed Endangered Species Habitat—Catastrophic fires can have devastating consequences for endangered species.

- Soil Sterilization—Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost. It can take decades or even centuries for ecosystems to recover from a fire. Some fires burn so hot that they can sterilize the soil.

12.3.7 Impacts from Climate Change

Fire in western ecosystems is determined by climate variability, local topography, and human intervention. Climate change has the potential to affect multiple elements of 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. When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

Historically, drought patterns in the West are related to large-scale climate patterns in the Pacific and Atlantic oceans. The El Niño–Southern Oscillation in the Pacific varies on a 5- to 7-year cycle, the Pacific Decadal Oscillation varies on a 20- to 30-year cycle, and the Atlantic Multidecadal Oscillation varies on a 65- to 80-year cycle. As these large-scale ocean climate patterns vary in relation to each other, drought conditions in the U.S. shift from region to region. El Niño years bring drier conditions to the Pacific Northwest and more fires.

Climate scenarios project summer temperature increases between 2ºC and 5°C and precipitation decreases of up to 15 percent. The last two years have brought record-setting temperatures. Such conditions would exacerbate summer drought and further promote high-elevation wildfires, releasing stores of carbon and further contributing to the buildup of greenhouse gases. Forest response to increased atmospheric carbon dioxide—the so-called "fertilization effect"—could also contribute to more tree growth and, thus, more fuel for fires, but the effects of carbon dioxide on mature forests are still largely unknown. High carbon dioxide levels should enhance tree recovery after fire and young forest regrowth, as long as sufficient nutrients and soil moisture are available, although the latter is in question for many parts of the western United States because of climate change.

12.3.8 Future Development Trends

In an effort to reduce the impacts of wildfires on the Reservation, the Tribe plans on development in the Hoh Highlands area to be in a cluster format, which enhances the Tribe's ability to reduce and fight wildfires by use of landscaping that will reduce the spread of fire on the reservation. The Tribe will also be utilizing less-combustible materials than currently exist, and implement mitigation efforts such as smaller netting around eves to reduce in the intrusion of embers. Additionally, the Tribe completed a previous strategy for seismic retrofit of the existing water tower, while also enhancing the size of the existing pipes for increased flow specifically for firefighting purposes. This will enhance the Tribe's ability to fight fires with respect to existing structures, while also enhancing the ability to fight fires on the new structures. This is a significant endeavor on the part of the Tribe as presently, they have no firefighting capability on the Reservation, and Jefferson County fire has previously indicated they will not respond to any fires occurring on the Reservation.

The Tribe is optimistic that increased population growth and economic expansion will occur throughout the planning area. As areas become more urbanized, the potential exists that the fire risk may increase as urbanization tends to alter the natural fire regime, and the growth will expand the urbanized areas into undeveloped wildland areas. However, the Tribe feels that this expansion of the wildland-urban interface can be managed with strong land use and building codes such that it has in place, as do the neighboring counties.

A growing body of research suggests that "the only effective home protection treatment is treatment in, on, and around the house (see Figure 12-6); homeowners must be responsible for protecting that property" (Nowicki 2001, p. 1:3). U.S. Forest Service research scientist, Jack Cohen has stated that "home ignitions are not likely unless flames and firebrand ignitions occur within 40 meters [131 feet] of the structure; the WUI fire loss problem primarily depends on the home and its immediate site."

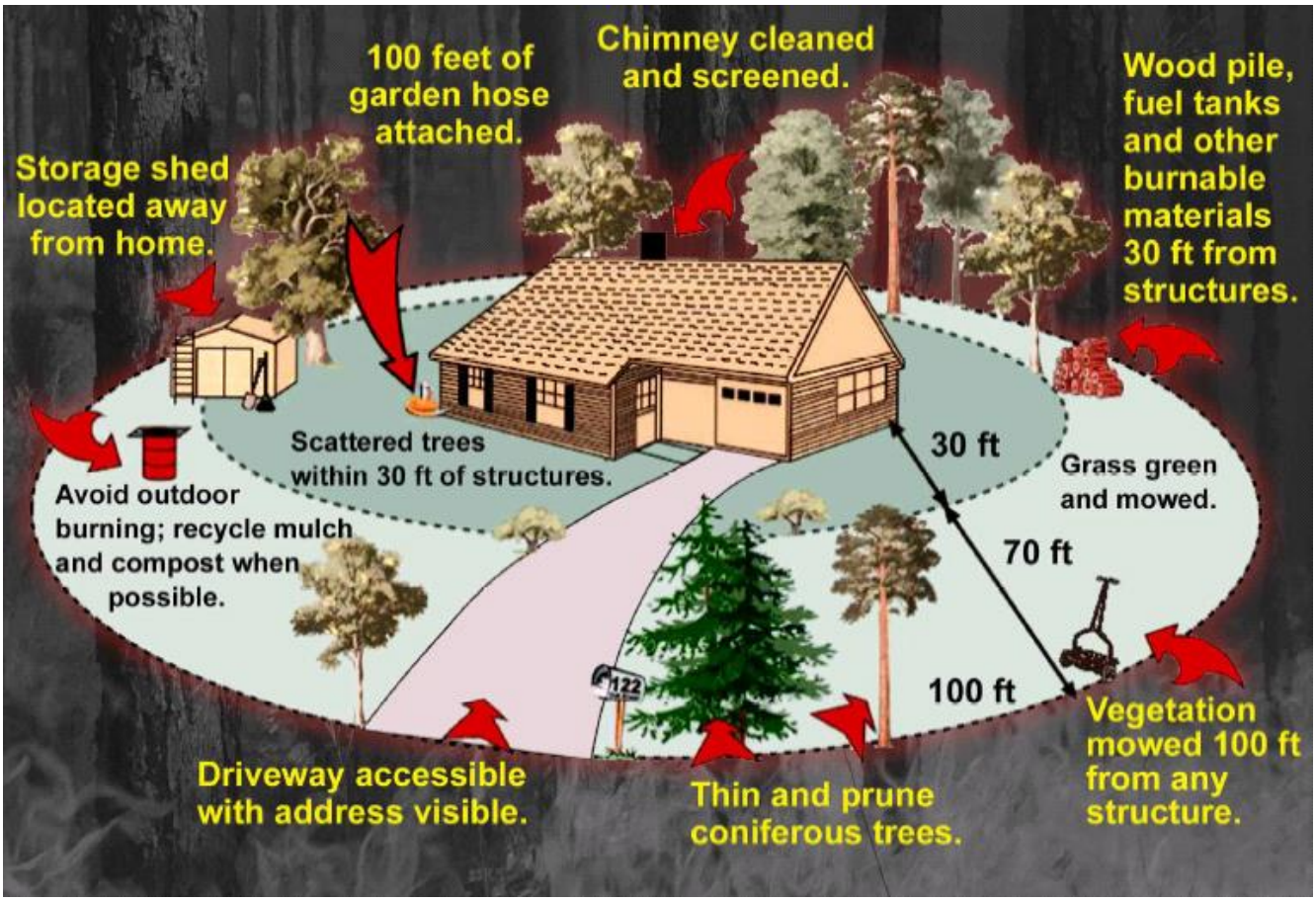


Figure 12-6 Measures to Protect Homes from Wildfire

12.3.9 Issues

The major issues for wildfire in the planning area are the following:

- The Tribe does not have its own fire department, and thus must rely on the surrounding municipalities to provide the service, causing increased response times.
- Public education and outreach to people living in or near the fire hazard zones should include information about and assistance with mitigation activities such as defensible space, and advance identification of evacuation routes and safe zones.
- Wildfires could cause landslides as a secondary natural hazard.

- Climate change will affect the wildfire hazard.
- Future growth into interface areas should continue to be managed.
- Vegetation management activities should include enhancement through expansion of target areas as well as additional resources.
- Building code standards need to be enhanced, including items such as residential sprinkler requirements and prohibitive combustible roof standards, among other construction mitigation opportunities available to help reduce fire combustion.
- Increased fire department water supply is needed in high-risk wildfire areas.
- Obtain and maintain certifications and qualifications for fire department personnel. Ensure that firefighters are trained in basic wildfire behavior, basic fire weather, and that company officers and chief level officers are trained in the wildland command and strike team leader level.

A worst-case scenario would include an active fire season throughout the American west such as has occurred over the last several years, spreading resources thin. Firefighting teams would be exhausted or unavailable. Many federal assets would be responding to other fires that started earlier in the season. While local fire districts would be extremely useful in the urban interface areas, they have limited wildfire capabilities or experience, and they would have a difficult time responding to the ignition zones. Even though the existence and spread of the fire is known, it may not be possible to respond to it adequately, so an initially manageable fire can become out of control before resources are dispatched.

To further complicate the problem, heavy rains could follow, causing flooding and landslides and releasing tons of sediment into rivers, permanently changing floodplains, and damaging sensitive habitat and riparian areas. Such a fire followed by rain could release millions of cubic yards of sediment into streams for years, creating new floodplains and changing existing ones. With the forests removed from the watershed, stream flows could easily double. Flood that could be expected every 50 years may occur every couple of years. With the streambeds unable to carry the increased discharge because of increased sediment, the floodplains and the flood elevations would increase.

12.4 IMPACT AND RESULTS

Due to its close proximity to the Olympic National Park, fire danger is of significant concern to the Tribe, although historical fire damage has been low. With the increase in popularity of tourists to the Olympic National Park, as well as the business development plan currently in place for tours to be conducted by members of the Hoh Tribe, there is an increase in concern for fire danger.

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from Wildfire throughout the area is likely, but the impact is more limited with respect to geographic extent. While the reservation itself has never experienced a wildfire within its boundary, the general planning area experiences some level of wildfire almost annually, but the acreage burned has, thankfully, been more limited in nature due in large part to response activities. The tribe has never lost a

structure due to wildfire, but the condition of many of the structures on the reservation is of concern should a fire occur.

For purposes of ranking, it is determined that potential impact to Tribal population due to fire is medium to high. This is due both to the potential isolation should a significant wildfire occur, as well as the potential impact from smoke and the elderly population of citizens living on the Reservation. As the tribe continues to develop its new acreage, it will take fire danger into consideration utilizing best practice construction standards and materials, to include landscaping and by establishing barriers around the proximity of the new facilities. This may also include air filtration systems in the new residences, once completed, to assist with smoke issues for the elderly.

The Tribe also does not have its own fire department, and therefore relies on outside agencies. While the services provided have been excellent, fire response does take a significant amount of time due to the remoteness of the Reservation. As the Tribe continues to grow and expand, it may be prudent for the Tribe to look at establishing a tribal fire department at some point in the future to help alleviate reliance on the current fire service providers.

Construction into the wildfire hazard areas undoubtedly will continue to expand, thereby increasing the risk of fires. Implementation of mitigation strategies which help reduce wildfire risk, such as landscaping regulations and mandatory sprinkler systems, could potentially help reduce the number of structures at risk. Based on the potential impact, the Planning Team determined the CPRI score to be 2.4, with overall vulnerability determined to be a medium level.

CHAPTER 13.
HAZARD RANKING

The risk ranking process conducted by Planning Team members assessed the probability of each hazard's occurrence, as well as its likely impact on the people, property, and economy of the planning area. Also of significant concern to the Tribe is the impact of these hazards on the environment, which factor was also taken into consideration during this plan update.

For some hazards, estimates of risk were generated with data from Hazus, using methodologies promoted by FEMA. For other hazards, citizens, and Planning Team members (who have an extensive historic perspective and knowledge base concerning the impact of hazards on the Tribe) provided invaluable information during this process. That information had a significant impact on the risk ranking process.

In ranking the hazards, the Planning Team completed a Calculated Priority Risk Index worksheet for each hazard (Figure 13-1). The Index examines the various criteria for each hazard (probability, magnitude/severity, geographic extent and location, warning time, and duration) as discussed in Chapter 5, defines a risk index for each criterion according at four levels (1-4), and then applies a weighting factor.

The result is a score that has been used to rank the hazards for the Tribe. Table 13-1 presents the results of the Calculated Priority Risk Index (CPRI) scoring for the hazards of concern. Once the hazard ranking was completed, the Planning Team also assigned an ordinal scale to identify the level of significance based on the CPRI score and rank, assigning a low-to-high rating of concern or significance. Those ratings are categorized into the following levels, with Table 13-2 presenting the overall results:

- 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.

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	

Figure 13-1 Calculated Priority Risk Index

TABLE 13-1
CALCULATED PRIORITY RANKING SCORES

Hazard	Probability	Magnitude and/or Severity	Geographic Extent and Location	Warning Time	Duration	Calculated Priority Risk Index Score
Drought	3	2	2	1	4	2.35
Earthquake	4	4	4	4	1	3.85
Flood	4	3	3	1	2	3.05
Landslide	3	2	2	4	2	2.70
Severe Weather	4	3	4	1	2	3.35
Tsunami	3	4	4	4	2	3.5
Wildfire	2	2	2	4	4	2.4

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 13-2
HAZARD RANKING

Hazard in Ranked Order	CPRI Score	Level of Concern and Significance
Earthquake	3.85	High
Tsunami	3.5	High
Severe Weather	3.35	High
Flood	3.05	High
Landslide	2.7	Medium
Wildfire	2.4	Medium
Drought	2.35	Low

CHAPTER 14.
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.

Once identified, the goals and objectives establish an overall mitigation strategy by which the Tribe will enhance resiliency of the planning area. When combined with the Risk Assessment data developed during this plan update, the Planning Team identified a set of mitigation action items (sometimes referred to as initiatives or strategies) which, when implemented, will help reduce the impact of the hazards on the Hoh Reservation.

14.1 GOALS AND OBJECTIVES

Hazard mitigation plans must identify goals and objectives for reducing long-term vulnerabilities to identified hazards (44 CFR Section 201.7I(3)(i)). In identifying the goals, the Planning Team reviewed the goals from the previous 2012 Hazard Mitigation Plan. During the June 29, 2022 Tribal Council Meeting, the Planning Team approved the goals as written, and deleted one objective (previously Objective 9), which dealt with enrollment in the NFIP. The remaining Objectives were confirmed. The 2022 Goals and Objectives are as follows:

1. Prevent future hazard-related losses of life and property.
2. Reduce the adverse impacts on the economy caused by natural disasters.
3. Encourage the development and implementation of long-term, cost-effective and environmentally sound mitigation projects.
4. Improve community emergency management capability (i.e., prepare, respond, recover, mitigate).
5. Promote a disaster-resistant and resilient community.
6. Preserve the cultural resources of the Hoh Indian Tribe.

TABLE 14-1
PROPOSED 2020 OBJECTIVES

Objective Number	Objective Statement	Goals for which it can be applied
O-1	Acquire (purchase), retrofit, or relocate structures in high hazard areas, including those known to be repetitively damaged.	1, 2, 3, 5, 6
O-2	Encourage open space uses in hazardous areas or ensure that if building occurs in these high-risk areas that it is done in such a way as to minimize risk.	1, 2, 5, 6

TABLE 14-1
PROPOSED 2020 OBJECTIVES

Objective Number	Objective Statement	Goals for which it can be applied
O-3	Utilize the best available data and science to continually improve understanding of the location and potential impacts of natural hazards.	1, 2, 4, 5, 6
O-4	Consider the impacts of natural hazards in all planning mechanisms that address current and future land uses on the Reservation.	1, 2, 3, 5, 6
O-5	Educate Reservation residents on the risk exposure to natural hazards and ways to increase the member's capability to prepare, respond, recover and mitigate the impacts of these events.	1, 2, 4, 5, 6
O-6	Increase resilience and the continuity of operations of identified critical facilities within the Reservation.	1, 2, 3, 4, 5, 6
O-7	Develop or improve emergency warning response and communication systems and evacuation procedures.	4
O-8	Provide/improve flood protection through various means, such as with flood control structures and drainage maintenance where appropriate and feasible.	1, 2, 3, 5, 6
O-9	Establish a partnership among all levels of Tribal departments, surrounding governments, adjoining communities and the business community to improve and implement methods to protect property.	1, 2, 4, 5, 6
O-10	Seek mitigation projects that provide the highest degree of natural-hazard protection at the least cost.	1, 3, 5, 6

14.2 MITIGATION ACTION ITEM IDENTIFICATION AND ANALYSIS

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

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

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

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

New to this planning effort was the use of FEMA's 2013 *Catalog of Mitigation Ideas,* which was presented to the Planning Team and served as the beginning point in the development of the Tribe's 2023 initiatives. The FEMA document includes a broad range of alternatives for consideration in the planning area, in compliance with 44 CFR (Section 201.7.c.3.ii). Many of the action items or initiatives can be applied to both existing structures and new construction, as identified below. The catalog provides a baseline of mitigation initiatives that are backed by a planning process, are consistent with the planning partners' goals and objectives, and are within the capabilities of the Tribe to implement.

Also new for this 2022 update, the Planning Team 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 (Tribal, 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 the type of mitigation activity involved (most of which also coincide with CRS activities):
  - **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.

- Benefit: By who the strategy benefits:
  - A specific structure or facility;
  - The Tribe (or local community);
  - County -level efforts;
  - Regional level benefits.

During development of these strategies, the initial starting point was review of the previous action items. As this current plan update is of a new format and organizational structure, the Planning Team elected to use this opportunity to modify the structure of the action items previously identified to eliminate those which are no longer relevant, combine the strategies as appropriate, and to reword existing strategies to make them more viable. Those projects which remain valid have been included within Table 14-2 and referenced as having been previously identified. The status of the previous action items is discussed in detail in Section 14.5 (Table 14-4).

In addition to the referenced *Catalog*, many of the hazard mitigation initiatives recommended in this plan were selected from among examples presented from other planning and strategic documents – integrating various planning efforts already in existence to the extent possible.

TABLE 14-2.
HAZARD MITIGATION ACTION PLAN MATRIX

Action Identified in Any Other Plan (Y or N)#	Applies to New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency (listed first) and others potentially involved	Estimated Cost	Sources of Funding	Timeline	Included in Previous HMP Yes/No	Initiative Type: Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources
S-1—Develop necessary emergency management and post-disaster action plans addressing hazards of concern. This may include a Comprehensive Emergency Management Plan, Evacuation Plan, Debris Management Plan, Damage Assessment Plan, Continuity of Operations Plan, a process for identifying cultural and historical data gathering, and grants management.									
N	New and existing	All Hazards	3, 4, 5, 6, 7	Police/ Emergency Management	Low	General Fund, FEMA BRIC, HMGP funds, EMPG funds, BIA funds,	Short-term	Y Re-written for 2022	All
S-2—Adopt the *Hoh Indian Tribe Hazard Mitigation Plan* as an element of any comprehensive plan that the Tribe will create to ensure linkage between the documents.									
Y	New and existing	All Hazards	1, 2, 3, 4, 5, 6	Planning/Land Use Office	Low	General Fund	Short-term	Y	Emergency Services, Property Protection, Prevention, Recovery, Structural Projects
S-3—Map the Hoh Indian Tribe floodplain using the best available data and generating a map-based product that will actively support hazard mitigation and land-use decision-making within the Reservation.									
N	New and existing	Flood	1, 2, 3, 4, 5	GIS	Medium	FEMA Risk Map program, LIDAR data	Short-term	Y	Emergency Services, Prevention, Structural Projects

TABLE 14-2.
HAZARD MITIGATION ACTION PLAN MATRIX

Action Identified in Any Other Plan (Y or N)#	Applies to New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency (listed first) and others potentially involved	Estimated Cost	Sources of Funding	Timeline	Included in Previous HMP Yes/No	Initiative Type: Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources
S-4—Develop regulatory authority to address land use development. This may include an ordinance to become compliant and a member in good standing under the National Flood Insurance program (NFIP).									
N	New and Existing	Flood	All	Planning/ Land Use Office, Tribal Government	Low	General Fund	Short-term, ongoing	Y Re-written for 2022	Protection, Prevention, Structural Project
S-5—Develop a Hoh Indian Tribe Stormwater Management plan prior to beginning development on Hoh Highlands.									
N	New and Existing	Flood, Severe Weather	1, 2, 3, 4, 5, 6,	Public Works	Mediu m	Stormwater Utility	Short-term	Y	Property Protection, Prevention
S-6—Consider a building setback/spacing requirement, landscaping, building codes, or other land use development for all new construction in areas deemed susceptible to wildfire exposure, which will help reduce the impacts from wildfire.									
N	New	Wildfire	1, 2, 3, 4, 5, 6, 7, 9, 10	Planning/ Land Use	Low	General Fund	Short-term	Y Re-written and expand-ed for 2022 update	Emergency Services, Property Protection, Prevention, Projects, Public Info., Natural Resources

TABLE 14-2.
HAZARD MITIGATION ACTION PLAN MATRIX

Action Identified in Any Other Plan (Y or N)#	Applies to New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency (listed first) and others potentially involved	Estimated Cost	Sources of Funding	Timeline	Included in Previous HMP Yes/No	Initiative Type: Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources
S-7— Work with the National Tsunami Hazard Mitigation Program and the Olympic National Parks Department to determine possible vertical evacuation sites for Tsunami hazard, as well as a trail from the old Reservation through the surrounding parks to the new Hoh Highlands area for evacuation purposes.									
N	New	Tsunami	All	Emergency Management, Public Works Department, Natural Resources Department, Washington Emergency Management Division	Low	General fund	Short-term	Y (Re-written)	Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources
S-8—Consider building codes that would harden new and existing structures from the potential impacts of earthquakes.									
N	New and existing	Earth-quake	1, 2, 3, 4, 5, 6, 9, 10,	Planning/ Land Use and Tribal Council	Low	General Fund	Short-term	Y	Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Natural Resources
S-9—Continue and/or enhance where feasible, the Tribe's ongoing drainage system maintenance program to reduce or minimize the impacts from stormwater flooding within the Reservation.									

TABLE 14-2.
HAZARD MITIGATION ACTION PLAN MATRIX

Action Identified in Any Other Plan (Y or N)#	Applies to New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency (listed first) and others potentially involved	Estimated Cost	Sources of Funding	Timeline	Included in Previous HMP Yes/No	Initiative Type: Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources
N	New and existing	Flood, Severe Weather	1, 2, 3, 4, 5, 6, 8, 9, 10	Public Works	Low	Land Use Permitting Fees, Grant Funds, General Funds, BIA	Short-term, ongoing	Y	Property Protection, Prevention, Recovery, Structural Projects, Natural Resources
S-10—Promote and increase inspections on Highway 101 along the Reservation to reduce risk from landslides and washouts. Work with Washington Department of Transportation and Jefferson County to identify areas along Highway 101 which require modification. Seek ways to improve slope stability and drainage, and/or seek funding to plan for and repair future slope failures to reduce the potential for isolation and to provide for additional access to the Reservation.									
N	New and Existing	Landslide	3, 4, 5, 6, 8, 9, 10	Public Works, WDOT, Jefferson County	High	General fund, WA DOT, BIA	Long-term	Y Re-written for 2022 Update	Emergency Services, Property Protection, Recovery, Structural Projects
S-11—Develop a public outreach strategy that maximizes the Tribe's capabilities through its ongoing programs that provide multiple messages that support all phases of emergency management, including the maintenance of a 7-day supply of food and water.									
N	New and Existing	All Hazards	1, 2, 3, 5, 9	Police (Emergency Management)	Low	Tribal General fund, FEMA HMGP	Short-Term Ongoing	y	Emergency Services, Prevention, Public Info.

TABLE 14-2.
HAZARD MITIGATION ACTION PLAN MATRIX

Action Identified in Any Other Plan (Y or N)#	Applies to New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency (listed first) and others potentially involved	Estimated Cost	Sources of Funding	Timeline	Included in Previous HMP Yes/No	Initiative Type: Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources
S-12—Continue to conduct vulnerability assessments of water and wastewater utilities for exposure to all identified hazards of concern. This effort may include engineers and various subject matter experts.									
Y	Existing	All Hazards	1, 3, 4, 6, 7	Public Works	High	FEMA Hazard Mitigation Grant funding	Short-term	Y Re-written for 2022 Update	Emergency Services, Property Protection, Structural Projects
S-13—Review utility designs and standards for safety and competence under natural and human caused disasters, utilizing information from this Hazard Mitigation Plan.									
N	New	All hazards	1, 2, 3, 4, 8, 9, 10	Public Works	Low	General Fund, Land Use Permit Fees, Grants, BIA	Short-Term, ongoing	Y	Emergency Services, Property Protection, Prevention, Recovery
S-14—Develop a Reservation-wide comprehensive education program to educate the Tribal members about the hazards of concern on the Reservation and about hazard mitigation opportunities.									
N	New and existing	All	1, 2, 3, 5, 10	Police/ Emergency Management Department	Low	General Fund, Grant funds when available	Short-term, ongoing	Y	Emergency Services, Prevention, Recovery, Public Info.
S-15— Seek funding for the placement of a new stream flow gauge at the Hoh Indian Tribe in the Hoh River that will accurately depict in channel flows at the Reservation during high water events.									

TABLE 14-2.
HAZARD MITIGATION ACTION PLAN MATRIX

Action Identified in Any Other Plan (Y or N)#	Applies to New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency (listed first) and others potentially involved	Estimated Cost	Sources of Funding	Timeline	Included in Previous HMP Yes/No	Initiative Type: Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources
N	New and existing	Flood	1, 3, 4, 5, 6 7, 9, 10	Public Works	High	National Weather Service Grants, USGS grants, Corps of Engineers	Long-term (depends on funding)	Y	Emergency Services, Property Protection, Prevention, Natural Resources
S-16—Develop a protocol for capturing data about damage occurring on the Reservation, including flood depths, dollar losses for all hazards impacting the Reservation, and the duration of impact from the event. This data should then be used to update the Tribe's Hazard Mitigation Plan.									
N	New and existing	All	1, 2, 3, 4, 5, 6, 8, 9, 10	Executive Director/ Public Works Department	Low	General Fund, FEMA grant programs	Short-term, development, long term maintenance	Y Re-written for 2022 Update	Emergency Services, Public Info., Recovery
S-17—Relocate public facilities that have been repeatedly flooded to areas outside of the floodplain area through acquisition projects funded by PDM and HMGP.									
N	Existing	Flood	1, 2, 3, 4, 5, 6, 8, 9, 10	Executive Director/ Tribal Government	High	General Fund, BRIC & HMGP Grants, HUD, BIA	Long-Term	Y	Emergency Services, Property Protection, Prevention, Recovery, Structural Projects
S-18—Relocate private residences that have been repeatedly flooded to areas outside of the floodplain through acquisition projects funded by BRIC and HMGP.									

TABLE 14-2.
HAZARD MITIGATION ACTION PLAN MATRIX

Action Identified in Any Other Plan (Y or N)#	Applies to New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency (listed first) and others potentially involved	Estimated Cost	Sources of Funding	Timeline	Included in Previous HMP Yes/No	Initiative Type: Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources
N	Existing	Flood	1, 2, 3, 4, 5, 6, 8, 9, 10	Housing	High	General Fund, Land Use Permit Fees, BRIC and HMGP Grants, HUD, BIA	Long-Term, depending on funding, ongoing	Y	Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Natural Resources
S-19—Seek alternative energy sources to support development in the Hoh Highlands area.									
N	New	All	1, 2, 3, 4, 5, 6, 7, 9, 10	Public Works Department and Natural Resources Department	High	General Fund, Land Use Permit Fees, BRIC & HMGP, BIA and HUD Grants	Long-Term	N	Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources
S-20 Consider establishing a fire department with appropriately trained EMTs or Paramedics on the Reservation to service both the Reservation and the areas immediately surrounding the Tribe.									

TABLE 14-2.
HAZARD MITIGATION ACTION PLAN MATRIX

Action Identified in Any Other Plan (Y or N)#	Applies to New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency (listed first) and others potentially involved	Estimated Cost	Sources of Funding	Timeline	Included in Previous HMP Yes/No	Initiative Type: Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources
N	New and Existing	All	All	Executive Director, Tribal Council	High	USDA Fire Grants	Long-term	N	Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources
S-21 Expand the existing Public Safety Facility to include alternative power sources, such as solar power, to enable the structure to be utilized during power outages associated with several of the hazards of concern. This includes expansion of the structure to be utilized as a resilience center for not only tribal but also other citizens living or traveling through the area that become isolated. The power source should be large enough to also provide power to camp sites for motorhomes or travel trailers.									
N	New	All	All	Executive Director, Tribal Council	High	US Dept. of Commerce, USDA, BIA	Long-term	N	Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources
S-22 Seek out grant funding and develop 10-15 camp sites which include power, water and sewer (or a general dump site) for use by citizens evacuating or isolated as a result of impact from a hazard of concern.									

TABLE 14-2.
HAZARD MITIGATION ACTION PLAN MATRIX

Action Identified in Any Other Plan (Y or N)#	Applies to New or Existing assets	Hazards Mitigated	Objectives Met	Lead Agency (listed first) and others potentially involved	Estimated Cost	Sources of Funding	Timeline	Included in Previous HMP Yes/No	Initiative Type: Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources
N	New	All	All	Executive Director, Tribal Council	High	BRIC, US Dept. of Commerce, BIA	Long-term	N	Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources

14.3 BENEFIT/COST REVIEW

Once established, the action plan must then be prioritized according to some form of a benefit/cost analysis of the proposed projects and their associated costs. The benefits of proposed projects were weighed against estimated costs as part of the project prioritization process. The benefit/cost analysis was not of the detailed variety required by FEMA for project grant eligibility under the Hazard Mitigation Grant Program (HMGP) and Building Resilient Infrastructure and Communities (BRIC) grant program. A less formal approach was used because some projects may not be implemented for up to 10 years, and associated costs and benefits could change dramatically in that time. Therefore, a review of the apparent benefits versus the apparent cost of each project was performed. Parameters were established for assigning subjective ratings (high, medium, and low) to the costs and benefits of these projects.

Cost ratings were defined as follows:

- **High**—Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds or grants).
- **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. If partial funding is available, or the project is a joint project with other agencies, *Partial* is also identified as an option.

- **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.

For many of the strategies identified in this action plan, the Tribe may seek financial assistance under the HMGP or BRIC 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 Tribe reserve the right to define "benefits" according to parameters that meet the goals and objectives of this plan.

14.4 ACTION PLAN PRIORITIZATION

Table 14-3 lists the priority of each initiative, using the same parameters used in selecting the initiatives. A qualitative benefit-cost review 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.

TABLE 14-3.
ACTION PLAN PRIORITIZATION

	No. of Objectives Met	Benefits	Costs	Benefits Equal or Exceed Costs (Y or N)	Grant-Eligible (Y or N)	Can Be Funded Under Existing Programs or Budgets (Y or N)	Priority
S-1	5	High	Low	Yes	Yes	Yes	High
S-2	6	High	Low	Yes	Yes	Yes	High
S-3	5	High	Medium	Yes	Yes	Yes	High
S-4	10	Medium	Low	Yes	No	Yes	High
S-5	6	Medium	Medium	Yes	No	Yes	High
S-6	3	Medium	Low	Yes	No	Yes	High
S-7	10	High	High	Yes	No	No	Medium
S-8	8	High	Low	Yes	No	Yes	High
S-9	9	High	High	Yes	Yes	No	High
S-10	6	High	High	Yes	No	Yes	High
S-11	5	High	Low	Yes	No	Yes	High
S-12	5	High	Medium	Yes	No	Yes	High
S-13	7	High	Low	Yes	No	Yes	High
S-14	5	High	Low	Yes	Yes	Yes	High
S-15	10	Medium	High	Yes	Yes	No	Medium
S-16	9	Medium	Low	Yes	No	Yes	High
S-17	9	High	High	Yes	Yes	Yes	High
S-18	9	High	High	Yes	Yes	Yes	High
S-19	9	High	High	Yes	Yes	No	High
S-20	10	High	High	Yes	Yes	No	High
S-21	10	High	High	Yes	Yes	No	High
S-22	10	High	High	Yes	Yes	No	High

14.5 2012 ACTION PLAN STATUS

In addition to establishing new action items for the 2022 update, a comprehensive review of the previous action plan was performed to determine which actions were completed, which should carry over to the updated plan, and which were no longer feasible and should be removed from the plan. Table 14-4 identifies the results of this review.

TABLE 14-4.
2022 STATUS OF 2011 HAZARD MITIGATION ACTION PLAN

		Current Status			
Mitigation Strategy	Project Status	Completed	Continual /Ongoing Nature	Removed -/No Longer Relevant / No Action Required / Normal Operations / Combined with another strategy	Carried Over
S-1—Develop a post-disaster action plan for all hazards of concern that addresses debris management, cultural/historical data gathering, substantial damage assessment, and grants management. This plan would be an appendix to the Tribe's Emergency Management Plan.	Carried over. The Tribe does have an emergency manager (co-responsibilities with the Police Chief) but has made minimal progress on development of emergency management plans, with the exception of this HMP update. This is still a valid project, and the Tribe will carry this over to the 2023 update.		X		X
S-2—Adopt the Hoh Indian Tribe Hazard Mitigation Plan as an element of any comprehensive plan that the Tribe will create to ensure linkage between the documents.	On-going/Carried Over. The Tribe has continued its effort in developing a comprehensive land use plan and does have areas identified for development or the type of use. This is evidenced by the development occurring in the Hoh Highlands Area, to which all tribal		X		X
S-3—Begin acquiring FEMA elevation certificates for all structures within the floodplain for which the Tribe does not currently have one in an effort to pursue potential acquisition of properties to relocate to higher ground out of floodplain	Completed. The Tribe has obtained a number of elevation certificates since completion of the last plan for some structures within the flood zone. At present, the Tribe is attempting to relocate the Reservation onto the new Hoh Highlands area, which is outside of the flood zone. New structures will be built to appropriate elevation (and other) standards. Due to the relocation, the Tribe will not continue to obtain elevation certificates on the existing buildings which are being rebuilt in the new area, with older structures removed when replaced outside of the flood zone.	X		X	

TABLE 14-4.
2022 STATUS OF 2011 HAZARD MITIGATION ACTION PLAN

		Current Status			
Mitigation Strategy	Project Status	Completed	Continual /Ongoing Nature	Removed -/No Longer Relevant / No Action Required / Normal Operations / Combined with another strategy	Carried Over
S-4—Pursue feasible, cost-effective, home elevation projects, targeting identified repetitive loss or frequently flooded properties on the Reservation.	On-going, but removed due to duplicity. The Tribe has obtained grant funding to develop the infrastructure necessary to relocate the tribal structures and residences outside of the flood and tsunami zones onto the Hoh Highlands. It is anticipated that this will be a five-year project to be able to rebuild all structures (based on available funding). This strategy is similar to other identified strategies and will combined.		X	X	X
S-5—Map the Hoh Indian Tribe floodplain using the best available data and generating a map-based product that will actively support hazard mitigation and land-use decision-making within the Reservation.	FEMA developed new flood maps under RiskMap in 2019, which were utilized for this HMP update. With the understanding of the potential flood and tsunami risk, the Tribe is relocating out of the mapped 100- and 500-year floodplain, and tsunami inundation zone. This strategy is on-going in nature to present risk to the citizens of the Reservation.	X	X		X
S-6—Consider a flood damage prevention ordinance to add language that will track substantial improvements and damage cumulatively, to leverage increased-cost-of-compliance opportunities for flood insurance policy holders.	The Tribe's current land use codes have a flood prevention ordinance which will be updated within the next year. At present, the Tribe has no existing NFIP policies in place, but will reconsider this opportunity in the future. This strategy will be removed as written and combined with similar strategies in the plan update.		X	X	
S-7—Considered adopting a regulatory freeboard standard for new construction to elevate homes for flooding.	The Tribe utilizes the most current land use development codes based on federal funding requirements and will be updating its land use code within the life cycle of this plan. This strategy will be combined with other similar strategies related to land use planning for future updates and eliminated as a separate strategy. (Removed)			X	

TABLE 14-4.
2022 STATUS OF 2011 HAZARD MITIGATION ACTION PLAN

		Current Status			
Mitigation Strategy	Project Status	Completed	Continual /Ongoing Nature	Removed -/No Longer Relevant / No Action Required / Normal Operations / Combined with another strategy	Carried Over
S-8—Develop regulatory authority to become compliant and a member in good standing under the National Flood Insurance program (NFIP)	On-Going. The Tribe does have regulatory in place which previously had met NFIP standards. At present the Tribe is in a Suspended Status due to the ordinance being outdated. Once the HMP is completed, the Tribe will work to review and update the Floodplain Ordinance as appropriate for the Tribe. Carried forward for 2022 Update.		X		X
S-9—Work toward enrollment in the Community Rating System (CRS) to lower insurance premiums.	The Tribe is not a CRS Community and does not have capacity to support this effort. As such, this strategy is removed.			X	
S-10—Develop a Hoh Indian Tribe Stormwater Management plan prior to beginning development on Hoh Highlands.	Carried Forward. The Tribe is in the beginning phases of development of the Hoh Highlands area, including stormwater management, which will be completed during the life cycle of this plan.				X
S-11 Consider building setback/spacing requirement for new construction in areas deemed susceptible to wildfire exposure.	On-Going. The Tribe is in the beginning phases of development of this project in the Hoh Highlands, including wildfire management, which will be completed during the life cycle of this plan. As structures continue to be built in the Hoh Highlands area, this policy will remain in force.		X		X
S-12—Join Firewise program by adopting Firewise policies in the management of the urban/wildland interface areas on the Reservation	Removed. The Tribe lacks the resources to dedicate to the Firewise Program; however, it will be utilizing wildfire mitigation efforts as it develops the new Hoh Highlands area, as the fire danger to the Tribe is anticipated to increase due to the area to which the tribe is relocating being more densely wooded than the coastline area where it is currently situated.			X	

TABLE 14-4.
2022 STATUS OF 2011 HAZARD MITIGATION ACTION PLAN

		Current Status			
Mitigation Strategy	Project Status	Completed	Continual /Ongoing Nature	Removed -/No Longer Relevant / No Action Required / Normal Operations / Combined with another strategy	Carried Over
S-13—Consider planting standards in wildland buffer areas to use only loose branching habits, non-resinous woody material, high moisture content leaves and limited seasonal dead debris and other varieties that possess fire resistive traits.	Removed. This strategy will be joined with other similar strategies for the 2022 plan. The tribe is currently in the development phase of the Hoh Highlands area. Planting standards will be a consideration as the area is developed. It is anticipated that the area will be built out to those standards by completion of the life cycle of this 2022 edition.			X	
S-14— Work with National Tsunami Hazard Mitigation Program in site determination for possible vertical evacuation for Tsunami hazard in coordination with the Safe Haven Program.	On-going. With the relocation of the Tribe, they continue to seek ways in which to provide a safe harbor for citizens to ensure their safety should a tsunami occur. The Tribe continues to be in conversations with the Park Service to develop a trail through the lower portion of the Reservation, continuing through Park's land, and onto the new Hoh Highlands area, which is outside of the tsunami inundation zone.		X		X
S-15—Consider building codes that would harden new and existing structures from the potential impacts of earthquakes.	Completed but On-Going. Tribe utilizes the most current building codes during development of its structures, such as the new Public Safety Building, the Water Treatment Plant, and the new Water Tower, all of which have been constructed to the most current building codes in place at the time of construction.	X	X		X
S-16—Conduct a seismic vulnerability study of identified critical facilities.	Removed. The Tribe is in the process of relocating (and ultimately removing) the structures on the current Reservation to the new Hoh Highlands area. As such, all of its structures will be built to the current seismic building code standards.			X	

TABLE 14-4.
2022 STATUS OF 2011 HAZARD MITIGATION ACTION PLAN

		Current Status			
Mitigation Strategy	Project Status	Completed	Continual /Ongoing Nature	Removed -/No Longer Relevant / No Action Required / Normal Operations / Combined with another strategy	Carried Over
S-17—Promote the structural and non-structural seismic retrofit of structures built before 1974 by a targeted outreach to the owners of these structures, including a tie-down program Reservation-wide.	Remove. The Tribe is in the process of relocating (and ultimately removing) the structures on the current Reservation to the new Hoh Highlands area. As such, all of its structures will be built to the current codes.			X	
S-18—Continue and/or enhance where feasible, the Tribe's ongoing drainage system maintenance program to reduce or minimize the impacts from stormwater flooding within the Reservation.	Carried forward. The Tribe is in the process of relocating (and ultimately removing) the structures on the current Reservation to the new Hoh Highlands area. Stormwater management will be implemented to utilize best practices, helping to ensure a reduced level of flood risk.				X
S-19—Promote and increase inspections on Highway 101 along the Reservation to reduce risk from landslides and washouts. Work with Washington Department of Transportation and Jefferson County to identify areas along Highway 101. Seek ways to improve slope stability and drainage, and/or seek funding to plan for and repair future slope failures to reduce the potential for isolation and to provide for additional access to the Reservation.	On-going. The Tribe has worked with Jefferson County on numerous occasions when issues along the roadways have occurred. As development in the Hoh Highlands occurs, the tribe will work with the county and state to ensure connections to the roadway are done appropriately to ensure bank stabilization and stormwater management.	X	X		X
S-20—Develop a public outreach strategy that maximizes the Tribe's capabilities through its ongoing programs that provide multiple messages that support all phases of emergency management, including the maintenance of a 7-day supply of food and water.	On-going. The Tribe has an emergency manager, filled by the current Police Chief as collateral duties. The Tribe continues to have regular outreach with tribal members concerning the hazards of concern, and self-preparedness. This includes during update of this HMP update. The Tribe will continue to provide hazard information and public outreach to help ensure continued self-reliance.		X		X

TABLE 14-4.
2022 STATUS OF 2011 HAZARD MITIGATION ACTION PLAN

		Current Status			
Mitigation Strategy	Project Status	Completed	Continual /Ongoing Nature	Removed -/No Longer Relevant / No Action Required / Normal Operations / Combined with another strategy	Carried Over
S-21—Prior to development on the newly acquired acreage, conduct a vulnerability assessment of water and wastewater utilities for exposure to all identified hazards of concern.	Completed. The Tribe is in the process of development of the critical infrastructure in the Hoh Highlands area. Water systems have been installed; wastewater plans are in place to be finalized in the next year.	X			
S-22—Review utility designs and standards for safety and competence under natural and human caused disasters, utilizing information from this Hazard Mitigation Plan.	Completed. The Tribe worked with Clallam County PUD to remove above-ground power lines onto the reservation in the area of the Hoh Highland, which is the area where the tribe will be relocated over the course of the next several years during the life cycle of this plan.	X	X		X
S-23—Develop a Reservation-wide comprehensive education program to educate the Tribal members about the hazards of concern on the Reservation and about hazard mitigation opportunities.	On-going in nature. The Tribe continues to disseminate hazard information to tribal members, including data developed through the HMP process, and also through other state and federal agency data, such as RiskMap, DOE and DNR hazard data.		X		X
S-24— Seek funding for the placement of a new stream flow gauge at the Hoh Indian Tribe in the Hoh River that will accurately depict in channel flows at the Reservation during high water events.	Carried Forward. No action completed since last plan, but this remains a viable strategy.				X
S-25 Assess potential debris accumulations, including debris flow from water channels in an effort to develop recovery and response plans.	On-going. No action was completed on this strategy, and the Tribe lacks capabilities to determine these amounts. While there have been incidents causing debris accumulations in the water channels, quantities have not been tracked. The Tribe will continue to work with and rely on USACE for assistance in this regard under technical assistance requests.		X	X	X

TABLE 14-4.
2022 STATUS OF 2011 HAZARD MITIGATION ACTION PLAN

		Current Status			
Mitigation Strategy	Project Status	Completed	Continual /Ongoing Nature	Removed -/No Longer Relevant / No Action Required / Normal Operations / Combined with another strategy	Carried Over
S-26—Participate in and support Jefferson County public outreach strategies to coordinate countywide efforts for public education programs credited under the CRS program, as well as self-sustainability (three days, three ways campaign) and emergency preparedness.	On-going. The Tribe continues to work with Jefferson County in its public outreach campaigns and does regularly participate in emergency management planning efforts; however, it is not a CRS community and does not anticipate seeking such status. As such, the CRS element of this strategy will be removed.	X	X	X	X
S-27— Work in coordination with FEMA to develop a detailed Flood Insurance Study to provide the Tribe with information concerning the floodplain currently on the Reservation. Once completed, review the flood profile in the mitigation plan to determine if the profile and areas of impact should be updated with the new data.	Completed/Removed. FEMA completed a flood study and updated flood maps in 2019. With the move of the Tribe to the Hoh Highlands (anticipated to be completed during the life cycle of this plan), tribal structures will be outside of the floodplain.	X		X	
S-28—Develop a protocol for capturing data about damage occurring on the Reservation, including flood depths, dollar losses for all hazards impacting the Reservation, and the duration of impact from the event. This data should then be used to update the Tribe's Hazard Mitigation Plan. The Tribe may elect to work with NOAA and become a member of the Yellow Jackets program.	Completed/On-Going. The Tribe has attempted to capture impact data from hazard events since completion of the last plan. That data, as applicable, has been included in this update. The Tribe will continue this effort.	X	X		X

TABLE 14-4.
2022 STATUS OF 2011 HAZARD MITIGATION ACTION PLAN

		Current Status			
Mitigation Strategy	Project Status	Completed	Continual /Ongoing Nature	Removed -/No Longer Relevant / No Action Required / Normal Operations / Combined with another strategy	Carried Over
S-29—Relocate public facilities that have been repeatedly flooded to areas outside of the floodplain area through acquisition projects funded by PDM and HMGP.	On-going. The tribe is in the process of developing the infrastructure necessary to relocate the tribe and tribal structures outside of the flood and tsunami inundation zones. Some infrastructure has been relocated (water tower, water treatment plant) The infrastructure portion of the development is anticipated to be complete by 2023-2024. Thereafter, the tribe will continue to move the structures.	X	X		X
S-30—Relocate private residences that have been repeatedly flooded to areas outside of the floodplain through acquisition projects funded by PDM and HMGP.	On-Going. The Tribe has been awarded a PDM grant for development of the infrastructure necessary to move residences. The Tribe will continue to seek grant funding to relocate residences outside of the hazard areas.				X
S-31-Work toward becoming a Storm Ready and Tsunami Ready community.	Carried Over. While the Tribe does feel this is a valuable program, they lack the staffing resources necessary to apply for and maintain the programs. However, it will keep the strategy in the plan as a viable option as staffing levels increase.			X	
S-32— Seismically retrofit existing water towers to reduce the potential for collapse during earthquake or significant flooding event, and enhance water lines for firefighting purposes. Once completed, the tower can be used to store water for firefighting on the Reservation.	Completed. The Tribe's water system was contaminated by inundation as a result of previous floods. In 2012, through assistance for BIH, the Tribe constructed a new water tower outside of the flood and tsunami inundation zone. That tower is also the primary source of water for the new Hoh Highlands area.	X			

TABLE 14-4.
2022 STATUS OF 2011 HAZARD MITIGATION ACTION PLAN

		Current Status			
Mitigation Strategy	Project Status	Completed	Continual /Ongoing Nature	Removed -/No Longer Relevant / No Action Required / Normal Operations / Combined with another strategy	Carried Over
S-33—As there are no alternative power sources available for development on the newly acquired acreage, seek out alternative energy source of power to enable relocation of structures in floodplain and tsunami inundation zone.	Removed. The Tribe is currently in the infrastructure development stages of the Hoh Highlands area, which includes power supplied by Clallam County PUD. The lines, once they reach the reservation, will be underground, and will include power and communications, thereby reducing the potential impact on the tribe during power outages. However, the Tribe will continue to seek alternate energy sources and is developing a new strategy for the 2022 update to address this effort.	X	X	X	

14.6 ADDITIONAL HAZARD MITIGATION PROJECTS AND EFFORTS

In addition to the above project status, the Tribe has also completed other mitigation-related efforts, including land use development trends which have reduced the impacts of various hazards of concern. Those projects include, but are not limited to:

- Wetland projects, which reduce impact from flooding.
- Fish Restoration Project.
- Establish and enforce a burn-bans on Tribal owned lands, reducing the risk of wildfire.
- For those projects off of the Reservation or on non-trust lands, establish a system whereby the Tribe's building ordinances are applied to ensure the highest level of integrity for construction.
- The Tribe also continues to work in partnership with a number of different agencies and organizations for various projects since completion of the Tribe's 2012 HMP, including with FEMA to ensure accurate flood maps for the area.

Department of Natural Resources

The Natural Resources Department is involved in environmental monitoring, protection, and restoration in marine, freshwater, and terrestrial environments. Projects include a wide range of activities from stormwater monitoring, plant and animal population studies and climate change analysis to full scale river restoration projects and debris removal. Staff use traditional ecological knowledge and insights from

Tribal citizens to influence its work to ensure availability of traditional use materials and native foods for current and future generations.

Policy Partnerships

The Tribe participates in several policy organizations aimed at protecting natural resources within the planning area, such as with FEMA and the various Flood Insurance Studies, as well as other studies. By collaborating with various stakeholders, the Tribe is able to increase support for projects restoring and preserving resources important to the Tribe.

Protection

In addition to restoring and acquiring parcels for conservation, the Tribe also works to protect properties outside of Tribal control by ensuring existing regulations are properly implemented and enforced. This involves collaboration and occasionally confrontation with a variety of local, state, and federal rule-makers and enforcers. Fish and wildlife know no jurisdictional boundaries; therefore, it is critical to protect the environment on and off Tribal land.

Conservation

Habitat restoration is critical to maintaining and enhancing cultural opportunities for Tribal citizens; however, projects on private land are often limited and have no guarantee of longevity. Thus, the Tribe has continued to focus on land acquisition as a means of habitat conservation. Benefits of an acquisition strategy for conservation include:

- Ensuring protection from development in perpetuity;
- Allows for larger scale restoration projects that would not otherwise be practical on occupied land (e.g., bank armoring removal, floodplain reconnection); and
- Provides exclusive access to Tribal citizens to exercise their cultural practices (depending on the funding source).

14.7 MITIGATION MEASURES AND PROJECT CLOSEOUT

Mitigation measures and project closeouts are the responsibility of the department identified in the actual strategy or identified by grant application. The Planning Team shall share information regarding projects as they are implemented and completed.

The Tribe is a small jurisdiction with limited staff. Initiation and submission of projects utilizing federal or state grant funds falls under the Tribe's Financial Office for monitoring, as well as the respective Department which the funds benefit, and Tribal Council for approval of grant submissions and acceptance. The process includes documents supporting the grant development and review process, assuring that grants submitted on behalf of Hoh Tribe by tribal staff or by intertribal consortia are duly authorized, meet a professional standard, and are consistent with tribal goals and objectives. The policy further assures that:

- The applying department has the legal authority to apply for assistance and the capability to ensure proper planning, management, and completion of the project, including funds sufficient to pay any matching share of the project.

- Authorized representatives of the funding agency will be granted access to and the right to examine all records related to the award.
- Federal and federally originating state grant funded projects will comply with all federal regulations, inclusive of personnel administration, non-discrimination and civil rights, labor standards, environmental standards, historic preservation, animal welfare, lobbying and political activities, drug-free workplace, maintenance of effort, and financial standards including audit and non-supplanting of funds.

The policy includes a process assuring departmental review, financial (budget) approval, approval of the Executive Director and approval by resolution of the Hoh Tribal Council.

Projects utilizing tribal funds are authorized through tribal authorization processes, which is similar to the Tribe's Grant Development and Review Policy and assures departmental review, financial (budget) approval, approval of the Executive Director, and approval by resolution of the Hoh Tribal Council.

Projects specific to the HMP mitigation strategies will be reviewed annually by the Planning Team and Executive Director.

CHAPTER 15.
IMPLEMENTATION AND MAINTENANCE

15.1 PLAN ADOPTION

A hazard mitigation plan must document that it has been formally adopted by the governing body of the jurisdiction requesting federal approval of the plan (44 CFR Section 201.7(c)(5)). DMA compliance and its benefits cannot be achieved until the plan is adopted. This plan was adopted by the Tribal Council in December 2022. A copy of the resolution is provided in Figure 15-1.

INSERT RESOLUTION WHEN COMPLETED

Insert Plan Adoption Resolution

Figure 15-1 Resolution Adopting Hazard Mitigation Plan

15.2 PLAN MAINTENANCE STRATEGY

A hazard mitigation plan must present a plan maintenance process that includes the following (44 CFR Section 201.7(c)(4)):

- A section describing the method and schedule for monitoring, evaluating, and updating the mitigation plan over a 5-year cycle; a system for monitoring implementation of mitigation measures and project closeouts.
- A system for reviewing progress on achieving goals, as well as specific activities and projects identified in the mitigation plan.
- A process by which Tribal governments incorporate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate.
- A discussion on how the community will continue public participation in the plan maintenance process.

This chapter details the formal process that will ensure that the Hazard Mitigation Plan remains an active and relevant document and that the Hoh Tribe maintain its eligibility for applicable funding sources. The plan maintenance process includes a schedule for monitoring and evaluating the plan annually and producing an updated plan 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.

15.2.1 Plan Implementation

The effectiveness of the hazard mitigation plan depends on its implementation and incorporation of its action items into existing local plans, policies, and programs. Together, the action items in the Plan provide a framework for activities that the Hoh Tribe can implement over the next five years. The Planning Team has established goals and objectives and has prioritized mitigation actions that will be implemented through existing plans, policies, and programs. Implementation of the long-term and short-term objectives/goals will be dependent on securing funding for each of the strategies identified in the plan. The Tribe will actively pursue a variety of funding opportunities identified in the various plans and prioritized by the various departments and programs under the direction of Hoh Tribal Council.

The Executive Director will have lead responsibility for overseeing the Plan implementation and maintenance strategy. Plan implementation and evaluation will be a shared responsibility among all departments and agencies identified as lead agencies in the mitigation action plan.

The implementation of all short-term mitigation actions will primarily be monitored by the Executive Director, or his designee, on an ongoing basis until implementation is complete, unless identified otherwise. Long-term actions being actively implemented will be monitored on an ongoing basis, or at

least annually as needed. Long-term actions planned for the future will be reviewed during plan updates every five years.

The system for reviewing progress on achieving goals, objectives, and specific actions included in the mitigation strategy will be based on a progress report of all objectives and actions. This progress report will be reviewed annually by the Executive Director. As described in the previous section, progress on mitigation actions will be described in an annual report to the Hoh Tribal Council and in the five-year update of the Hazard Mitigation Plan.

Project Tracking

In addition to the work products described in approved work plans for projects funded by FEMA's Building Resilient Infrastructure and Communities (BRIC) Program (previously Pre-Disaster Mitigation Grants), the Hazard Mitigation Grant Program, or other grant programs, quarterly or semi-annual (depending on reporting requirements of funding agencies) performance reports that identify accomplishments toward completing the work plan commitments, a discussion of the work performed for all work plan components, a discussion of any existing or potential problem areas that could affect project completion, budget status, and planned activities for the subsequent quarter (and/or annual and/biannual basis depending on the funding agency requirements and Tribal regulations) will be submitted to the funding agency by the assigned Project Manager and/or Grant Coordinator. The agency-specific final grant closeout documents will also be prepared by the appropriate tribal personnel at the conclusion of the performance period and submitted to the funding agency.

15.2.2 Planning Team

The existing Planning Team oversaw the development of the HMP and made recommendations on key elements of the plan, including the maintenance strategy. The principal role of the Planning Team in this plan maintenance strategy will be to review the annual progress report and provide input on possible enhancements to be considered at the next update. Future plan updates will be overseen by a Planning Team similar to the one that participated in this plan development process. As such, keeping an interim Planning Team intact will provide a head-start on the next plan. It will be the Planning Team's role to review the progress report in an effort to identify issues needing to be addressed by future plan updates.

15.2.3 Annual Progress Report

The minimum task of the ongoing annual Planning Team meeting 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 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.

The Planning Team has created a template for preparing a progress report (see Appendix B). The Planning Team will prepare a formal annual report on the progress of the plan that will be presented to Tribal Council during the reporting period.

Annual progress reporting is not a requirement specified under 44 CFR. However, it may enhance opportunities for funding. While failure to implement this component of the plan maintenance strategy will not jeopardize compliance under the DMA, it may jeopardize the opportunity to leverage funding opportunities with other agencies.

15.2.4 Plan Update

CFR 201.7 requires that tribal hazard mitigation plans be reviewed, revised if appropriate, and resubmitted for approval in order to remain eligible for benefits under the DMA (44 CFR, Section 201.7(d)(3)). The Hoh Tribe 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 five years based on the following triggers:

- A Presidential Disaster Declaration that impacts the planning area;
- A hazard event that causes loss of life; or
- New data becomes available which significantly changes the findings of the risk assessment.

It will not be the intent of future updates to develop a completely 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 plan 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 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.
- Tribal Council will adopt the updated plan.

15.2.5 Continuing Public Involvement

The public will continue to be apprised of the plan's progress through the Tribe's website and by providing copies of annual progress reports at various public outreach meetings, including the Hoh Tribe Annual

General Meeting. Copies of the plan will be shared with the various Tribal departments and tribal citizens as requested. Upon initiation of future update processes, a new public involvement strategy will be initiated based on guidance from a new Planning Team. This strategy will be based on the needs and capabilities of the Tribe at the time of the update. At a minimum, this strategy will include the use of social media tools, the Tribe's website, and also potentially utilizing media outlets within the planning area.

15.2.6 Incorporation into Other Planning Mechanisms

The information on hazard, risk, vulnerability, and mitigation contained in this plan is based on the best science and technology available at the time this plan was prepared. The Hoh Tribe, through its various on-going capital improvement projects has planned for the impact of natural hazards. The plan development process provided the opportunity to review and expand on policies in these planning mechanisms. The Emergency Operations Plan and development policies are complementary documents that work together to achieve the goal of reducing risk exposure.

The Tribe will create a linkage between the hazard mitigation plan and future land use plans by identifying a mitigation initiative as such and giving that initiative a high priority. Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan may include the following:

- FEMA Flood Insurance Studies
- Emergency response plans
- Capital improvement programs
- Tribal codes
- Community design guidelines
- Restoration plans
- Water-efficient landscape design guidelines
- Stormwater management programs
- Community Wildfire Protection Plans
- Vegetation Studies
- Transportation Plans
- Climate Adaptation Plans

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.

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APPENDIX A.
ACRONYMS AND DEFINITIONS

APPENDIX A.
ACRONYMS AND DEFINITIONS

ACRONYMS

CFR—Code of Federal Regulations

cfs—cubic feet per second

CIP—Capital Improvement Plan

CPRI – Calculated Priority Risk Ranking

CRS—Community Rating System

DFIRM—Digital Flood Insurance Rate Maps

DHS—Department of Homeland Security

DMA —Disaster Mitigation Act

EAP—Emergency Action Plan

EPA—U.S. Environmental Protection Agency

ESA—Endangered Species Act

FEMA—Federal Emergency Management Agency

FERC—Federal Energy Regulatory Commission

FIRM—Flood Insurance Rate Map

FIS—Flood Insurance Study

GIS—Geographic Information System

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

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

SFHA—Special Flood Hazard Area

SHELDUS—Special Hazard Events and Losses Database for the US

SPI—Standardized Precipitation Index

USGS—U.S. Geological Survey

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 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 man-made 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.

Calculated Priority Risk Index: The calculated priority risk index (CPRI) is the method utilized for the ranking of hazards. It is a calculation to sort the risks from highest to lowest by multiplying the scoring columns.

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.

For the purposes of this planning effort, the Planning Team elected to define all structures on the reservation, including culturally significant areas, as critical facilities due to the impact the loss of one structure would have on the Tribe.

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 are based on the methodology for each hazard as identified within this plan.

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 downgradient 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.

The Hoh Indian Tribe
2022 Hazard Mitigation Plan Update

APPENDIX B.
EXAMPLE PROGRESS REPORT

APPENDIX B.
EXAMPLE PROGRESS REPORT

The Hoh Indian Tribe
Hazard Mitigation Plan
Annual Progress Report

Reporting Period: *(Insert reporting period)*

Background: The Hoh Indian Tribe 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 of 2000 requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. To prepare the plan, the Tribe organized resources, assessed risks from natural hazards, developed planning goals and objectives, reviewed mitigation alternatives, and developed an action plan to address probable impacts from natural hazards. By completing this process, the Tribe 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 LINK

Summary Overview of the Plan's Progress: The performance period for the Hazard Mitigation Plan became effective on ____, 2022, 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 _____, 2027. As of this reporting period, the performance period for this plan is considered to be __% 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 Tribe's 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 Hoh Tribe. This report discusses the following:

- Natural hazard events that have occurred within the last year
- Changes in risk exposure within the planning area
- 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 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)	Timeline	Priority	Status	Status (X, O,✓)
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)	Timeline	Priority	Status	Status (X, O,✓)
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 Tribe's governing board and to local media outlets and the report is posted on the Tribe's Hazard Mitigation Plan website. Any questions or comments regarding the contents of this report should be directed to:*

Insert Contact Info Here