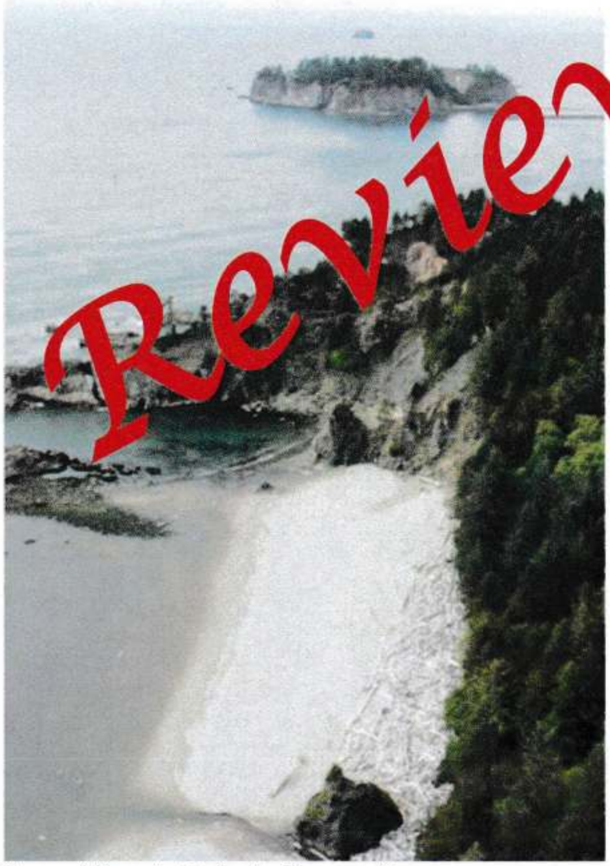
Quileute
NATION

2023 Hazard Mitigation Plan Update

Review Copy


Second Beach, Quileute Reservation
Photo by Katie Krueger

Bridgeview Consulting, LLC
915 No. Laurel Lane | Tacoma, WA
98406 | 253.301.1330

NOVEMBER 2023

Prepared for:
Quileute Nation
PO Box 279
La Push, WA 98350

Prepared by:

Bridgeview Consulting, LLC

915 No. Laurel Lane
Tacoma, WA 98406
Tel 253.301.1330

Quileute Nation
Hazard Mitigation Plan
TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

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 several editions of the Mitigation Planning and Review 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 2017 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 Quileute Nation has developed its 2023 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 Quileute Nation 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 (2015), 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 2023 update.

For future planning purposes, the Hazard Mitigation Planning Team adopted July 1, 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.

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. 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 Clallam County, the county in which the Quileute own and maintain 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.

This page intentionally left blank.

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. 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 Quileute Nation (hereinafter may be referenced as Tribe or Nation, or "QN") 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 Quileute Nation'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 QN developed their first Hazard Mitigation Plan in 2008 as a stand-alone plan. That document was updated and finalized in 2015. This document serves as the update to the 2015 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 2023 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 2015 Hazard Mitigation Plan

Since the 2015 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 13 identifies the current status of the strategies contained in the previous plan. The 2015 plan maintenance strategy identified an Annual Review Questionnaire emailed to all planning team members as its method of tracking project completion and identification of hazard impact. Such did not occur due to staffing levels and workloads, as well as COVID response and operations. The Tribe, however, does feel that a similar strategy will remain 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's HMP Project Manager will continue to work with the Tribal Council in the continued quest to reduce the risk and vulnerability to the Quileute Peoples, maintaining responsibility for the continued update of the HMP.

In addition to implementation of some of the 2015 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 Culture Historic Resource Protection, 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 for relocation of those areas of the Reservation that are within high hazard areas;

- Regularly acquiring 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 or restoring salmon (and other natural) habitats;
- Utilizing building materials and standards based on recommended codes and their ability to reduce risk;
- Implementing program management for freshwater and ocean fisheries, and wildlife and cultural resource protection.
- Overall assessment of the communities' usage of new construction to determine if multiple purposes exist, which, when fully operational, can be used for multiple purposes (e.g., a shelter or community resilience center which can also serve as a gym); and
- During planning stages, projected development includes prioritizing mitigation efforts based on impact (positive and negative), such as the project's proximity to the tsunami inundation zone, 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 Quileute Nation 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 13.

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. The Tribe has previously utilized Stafford Act grant funds when eligible, as well as public assistance and individual assistance grants as a result of disaster incidents, as applicable. It has also previously been awarded a Congressional Earmark for help in the relocation of the Tribe out of the hazard area. It is the intent of the Tribe to pursue grant opportunities in the future to assist in mitigating 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) (including 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	☑	☐
Bureau of Indian Affairs (Climate and Relocation)	BIA	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 Quileute Nation 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. This includes 2 CFR 200 and 3002. To ensure compliance, the Quileute Nation, 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 Quileute Nation, no matter their location. This includes all fee and trust lands, as well as those areas associated with the Tribe's Usual and Accustomed areas. These areas are inclusively referred to as the tribal planning area. Unique to the Quileute Reservation are properties (including private residences and businesses), which are owned by non-tribal members.

1.3 WHO WILL BENEFIT FROM THIS PLAN?

All tribal citizens and businesses 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 2015 AND 2023 PLAN UPDATE

Significant differences exist between the 2015 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 have 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 2015 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. 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 122. 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 13. The previous goals and objectives were reviewed and updated during the January 2023 Kick-Off Meeting.

Specific strategies and action items identified previously have been discussed in detail in Chapter 13. Those strategies carried over to the 2023 plan are indicated as such, and new strategies and action items are identified. Specific focus was placed on new construction, as the Tribe is actively expanding into new areas since completion of the 2015 plan. The methodology used for prioritization of strategies has also been modified, complying with FEMA's requirements. Additional items which reflect differences between the previous and current plan update are referenced throughout the plan itself where appropriate and significant.

This page intentionally left blank.

CHAPTER 2.
PLANNING PROCESS

2.1 PLANNING RESOURCE ORGANIZATION

The process followed to develop the Quileute Nation'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 2023 Hazard Mitigation Plan

This planning effort was funded through a FEMA FY 2020 BRIC grant, with a 90/10 split. The Tribe is considered an impoverished community. The Quileute Nation did not participate in the development of the Clallam County Hazard Mitigation Plan. This document constitutes a Tribal Hazard Mitigation Plan for the Quileute Nation (QN).

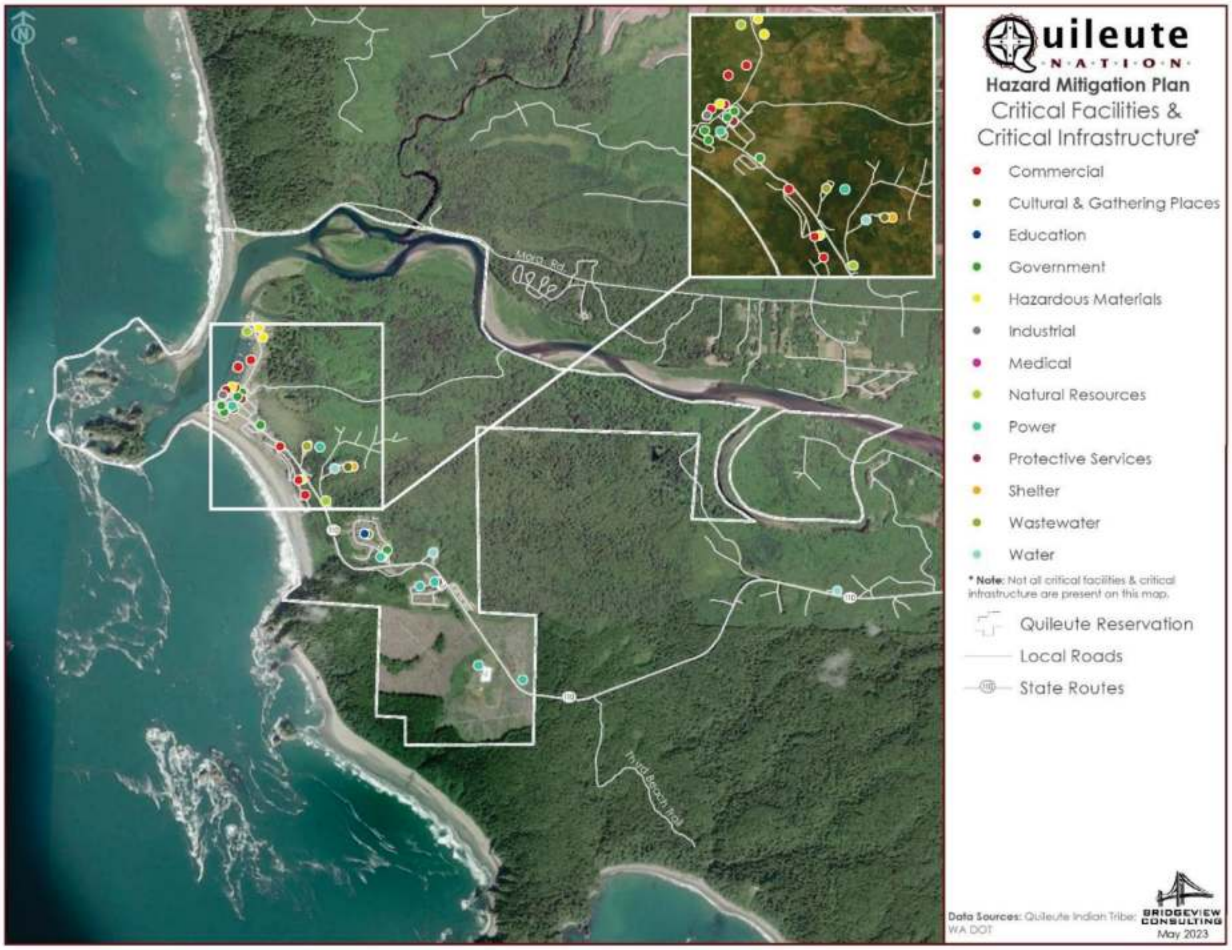


Figure 2-1 Quileute Indian Reservation

2.2 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 Planning Team) made up of various Tribal staff and citizens was formed to 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 QN 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, Larry Burtness.

The Planning Team agreed to meet as needed throughout the course of the plan's development. 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 January 2023 through the plan's completion, soliciting subject matter expertise from team members as needed depending on the issue being addressed. Table 2-1 lists the members of the team and the planning tasks they supported.

TABLE 2-1
PLANNING TEAM MEMBERSHIP

Name	Position	Planning Task
Larry Burtness	Project Manager / Planning Department	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. Burtness also conducted regular briefings to council and others on the scope and project, and conducted public outreach during the planning process. Mr. Burtness conducted plan review during drafting stages, as well as during final review prior to plan going public. Tasks completed also include identification of assets included in the risk assessment; historic hazard data regarding impact on the tribe; assisting with the capability assessment; and provided information on various other on-going planning efforts for the QN. Mr. Burtness was a planning team member for the various prior editions of the HMP.
Annie Foster	Grant Manager / Planning Department	Attended meetings; provided hazard (and other) data from various sources; assisted with data gathering; coordinated information between other tribal and outside entities; assisted with plan review; regularly participated in all meetings during the update process; assisted with various public outreach presentations of plan; provided information concerning risk; assisted with identification of assets to be included in risk assessment; provided historic hazard data on impact to the tribe; assisted with capability assessment; provided information on the long-range and strategic plans of the QN; provided information concerning several existing plans in place; conducted review of the draft hazard profiles and draft plan once complete.
Sgt. Kevin Harris	Tribal Police Department	Serves as Tribe's Emergency Manager; provided historic hazard and general information; assisted with plan reviews; attended public outreach events.
Nellie Ratliff	Enrollment Specialist	Provided population and enrollment data; provided information and input on various elements of the plan.
Garrett Rasmussen	TWF Program Manager and 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.

TABLE 2-1
PLANNING TEAM MEMBERSHIP

Name	Position	Planning Task
Various	Department of Natural Resources	Provided general information on the QN, including historical information on hazards, provided information on the natural resources of the tribe, including the fish hatchery information, etc. Also provided information on tribal capabilities and the current existing plans in place; reviewed risk assessment and draft plan once completed.
Page Foster Andrea Coberly Sheri Crippen Stephanie Doebbler	Quileute Tribal School District	Provided information on academia on the Reservation, including attendance, staffing and vulnerable populations; potential isolation issues. Reviewed plan at various stages.
	Website (Communications) Coordinator	Assisted with public outreach; IT and Website Developer; distributed materials via website and social media.
Annie Foster	Social Media Coordinator	Assisted with posting data, notifications, and information to social media accounts for the Tribe.
Beverly O'Dea,	Bridgeview Consulting, LLC	Project Manager and Lead Planner
Cathy Walker	Bridgeview Consulting, LLC	Senior GIS Analyst

2.2.1 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, invited to participate in the plan development process, or were kept apprised of plan development milestones. These notifications took place via email, personal contact, or telephonic contact. In addition, they provided relevant data to the various components of the plan, conducted review and provided in-put on the risk assessment, and completed the review of the draft plan.
    - FEMA Region X – various personnel
    - Clallam County Emergency Management
    - Chip Keen, Lead Commissioner, Clallam County Fire Protection District 6
    - Hoh Tribe, Robert Smith, Executive Director

  - Quinault Tribe, Faith Webster, Senior Planner
  - Washington State Department of Natural Resources (various divisions)
  - Washington State Department of Ecology (various divisions)

  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 information concerning draft review, as well as a link to download the plan if desired.

- **Social Media —**In addition to the above, the Tribe distributes information regularly 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 and other community events.

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

TABLE 2-2
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
WA DNR		Landslide and Tsunami Data
WA DOE	Diane Fowler, Community Right to Know Coordinator	Reporting Hazmat sites in Jefferson County
	Jerry Franklin	RiskMap Coordinator
USGS		Earthquake and Volcano Data

2.2.2 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:

- 2015 Quileute Hazard Mitigation Plan
- Climate Change Vulnerability Assessment for the Treaty of Olympia Tribes (2016)
- Climate Plan for the Quileute Tribe of the Quileute Reservation (2017)
- 2020 Clallam County Hazard Mitigation Plan
- Clallam County RiskMap Data (2013-present)
- Quillayute River Restoration – Reach 3 Environmental Assessment (2021)
- State of Washington Enhanced Multi-Hazard Mitigation Plan (2018)
- Washington Department of Ecology Hazardous Materials Annual Report for Clallam County

- Various papers and studies concerning the impacts of climate change
- Interpretive Map Series: Earthquake Hazard Maps, Tsunami, and Seismic Risk Assessment for Washington

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.

2.2.3 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 remote Tribe, involvement from the general public was 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 Tribal contractors. 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 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 existing 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 allowed involvement from individuals who are not Tribal, but have relevant knowledge of the Tribe gained through their employment. 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 the Tribe's Communications personnel to assist with the distribution of mitigation-related information and efforts on the Tribe's website and various social media sources.
- Utilize existing distribution lists to disseminate and capture relevant information. These lists historically have reached both tribal and non-tribal citizens living on the Reservation.
- Identify and involve planning area stakeholders (non-tribal).

Planning Team Input

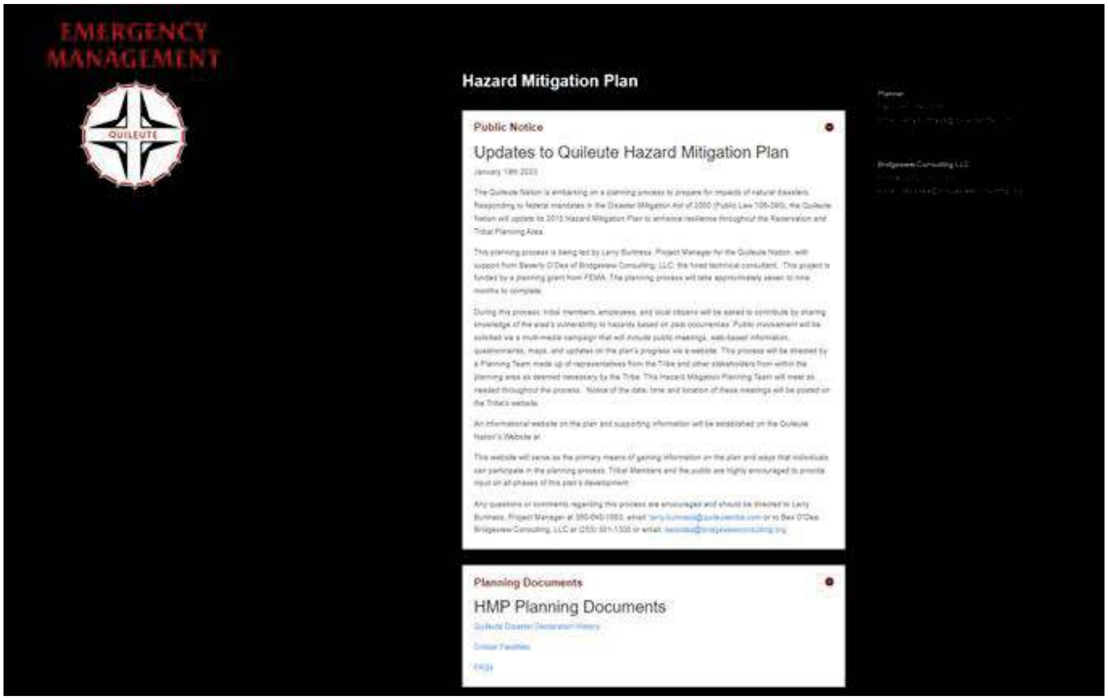
The majority of all of the members of the Planning Team live or work in the planning area. The make-up of the Planning Team proved to be integral in the success of this planning effort, as a representative from many tribal departments were represented. This helped to add a historical perspective to this team that was valuable in identifying direction for the plan development process, as well as providing departmental and programmatic efforts ongoing, which directly influence mitigation efforts.

COVID Response

Occurring simultaneous with this plan development, the COVID-19 Pandemic was continuing, with Tribal Nations continuing to be extremely hard-hit – the QN being no exception. Response to the Pandemic did impact the ability to develop this plan to an extent, in some instances delaying the ability to meet. As such, more telephonic meetings occurred, with the Tribe's Planning Team members attending additional smaller meetings / information gathering sessions as possible with respect to individuals working at home and individuals exposed. The QN relied heavily on the use of existing Council Meetings, the internet, email distribution lists, and existing meetings to capture and disburse relevant data.

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 2-2).



Hazard Mitigation Plan

Public Notice

Updates to Quileute Hazard Mitigation Plan

January 19th 2023

The Quileute Nation is embarking on a planning process to prepare for impacts of natural disasters. Responding to federal mandates in the Disaster Mitigation Act of 2000 (Public Law 106-390), the Quileute Nation will update its 2015 Hazard Mitigation Plan to enhance resilience throughout the Reservation and Tribal Planning Area.

This planning process is being led by Larry Burtness, Project Manager for the Quileute Nation, with support from Beverly O'Dea of Bridgeview Consulting, LLC, the hired technical consultant. This project is funded by a planning grant from FEMA. The planning process will take approximately seven to nine months to complete.

During this process, tribal members, employees, and local citizens will be asked to contribute by sharing knowledge of the area's vulnerability to hazards based on past occurrences. Public involvement will be solicited via a multi-media campaign that will include public meetings, web-based information, questionnaires, maps, and updates on the plan's progress via a website. This process will be directed by a Planning Team made up of representatives from the Tribe and other stakeholders from within the planning area as deemed necessary by the Tribe. This Hazard Mitigation Planning Team will meet as needed throughout the process. Notice of the date, time and location of these meetings will be posted on the Tribe's website.

An informational website on the plan and supporting information will be established on the Quileute Nation's Website at:

This website will serve as the primary means of gaining information on the plan and ways that individuals can participate in the planning process. Tribal Members and the public are highly encouraged to provide input on all phases of this plan's development.

Any questions or comments regarding this process are encouraged and should be directed to Larry Burtness, Project Manager at [illegible], email: [illegible] or to Bev O'Dea, Bridgeview Consulting, LLC at [illegible] or email: [illegible]

Planning Documents

HMP Planning Documents

Quileute Disaster Declaration History

Critical Facilities

FAQs

Figure 2-2 Hazard Mitigation Plan Information and Links

Survey Results

(To be completed: This is a holding spot for the survey results, which will provide additional QN data. This information will be inserted when the survey is closed, after the public review period to allow citizens a chance to provide comments and information).

Public Meetings

Large public gatherings were limited due in part to COVID and other on-going health concerns, as well as the remoteness of the Reservation itself, with reliance on existing meetings proving to be valuable for information exchange. Announcement of the planning process and additional hazard-related general information was distributed during the Tribe's Annual General Meeting occurring on January 19 and 20, 2023. During that meeting, attendees were invited to take the on-line survey (laptops available for use), as well as provide any information they deemed necessary to the process, and ask any relevant questions. Various mitigation strategies, such as the relocation project of the Tribe, were also discussed in detail during the meeting.

The Tribe also conducted public outreach events via the internet and web. The use of existing meetings were both in person and virtual, and included department meetings, regularly scheduled Tribal Council meetings, and various other meetings, such as the May 2023 Health Fair at which the planning team provided risk information and data, as well as general information on the planning process itself (see Figure 2-3). 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. The hazard profiles and risk assessment findings were also published on the Tribe's website once completed, asking for citizen review and comments. Notice of the completion of the risk portion of the process was disseminated in the same manner as other significant events or information exchanges occurring on the QN, utilizing the same email distribution lists. A hard copy of the risk analysis was also printed and made available at the planning office for anyone wishing to review the hardcopy format of the information.

Quileute Health Center
Presents

Save the date for

THE
2023
HEALTH FAIR

RSVP to the
number/email below ASAP

May 25TH 2023

Please let us know if you are needing a full/half table as well if electricity is needed for you! More information to come; any questions please call 360-374-7764/4159 or email medical.assistant@quileutetribe.com/ yvonne.davis@quileutetribe.com, thank you!

Figure 2-3 Health Fair Flyer

Public outreach events included presentations by several planning team members to different groups, with Planning Team Members available to answer questions, as well as providing email addresses to which questions and comments could also be directed. The Planning Team also distributed flyers, providing information on the project and the hazards of concern. 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, including at the Senior Center during Elder's lunch distribution and recreational efforts, and various Youth events, all of which included the availability of handouts. Comments received during outreach events were reviewed and vetted through the Planning Team Members, and data incorporated as appropriate.

Once completed, the initial draft plan was distributed to the Planning Team Members beginning October 27, 2023. After comments and information gathered during the internal review process were incorporated, the Public Draft of the plan was available for review by all Tribal citizens and staff as defined by the QN's defined public.

Notice of its availability was provided through multiple sources, including the November 8, 2023 Move to Higher Ground Community Project Update and Community Open House, website postings, and various email distribution lists, including surrounding municipalities and other tribes.

The Planning Team also printed multiple copies of the plan, which were available at several different locations for review if anyone wanted to review a hard copy of the plan. The draft plan was available from November 8, 2020 – November 28, 2020. No comments were received.

QUILEUTE DAYS

July 14—16, 2023

FRIDAY July 14TH

1 PM	**Traditional Dances**—Aka'lat
2 PM	**Royalty**—Aka'lat
3 PM	**Boxing** —Aka'lat
4 PM	**Cornhole**—Oceanside Resort
5 PM	**Youth Softball**— Youth Softball Field (All Weekend)
6 PM	**Adult Softball**—Adult Softball Field (All Weekend)
	Traditional Stick games Bone Hog— Aka'lat
10 PM	**Street Dance with DJ Camello**—Main Street

SATURDAY July 15TH

11 AM	**Outboard Canoe Races**—Quillayute River
12 PM	**Parade**—Quileute Natural Resources (Line up at 10 AM, Judging at 11 AM)
1 PM	**Traditional Fish Bake**— Main Street
2 PM	**Horseshoe Tournament**—Adult Softball Field
	Kids Zone—Old Community Center
	Traditional Stick games Tournament—Aka'lat
4 PM	**Kids Race Competition**—Main Street
6 PM	**Talent Show**—Main Street
8 PM	**Live Music**—Main Street
10 PM	**Fireworks**—Point
	Street Dance with DJ Camello—Main Street

SUNDAY July 16TH

11 AM	**Outboard Canoe Races**—Quillayute River
3 PM	**Adult/Youth Softball Championships**

For More Information
Please visit: quileutenation.org

- Vendor App
- Parade App
- Activities

Questions?

Email:
events@quileutetribe.com

Cell:
360.640.3297

The final public meeting was held on December 7, 2023, during which time the plan was presented to the Tribal Council, and at which time the Council approved and adopted the plan. The Tribe elected to adopt the plan prior to submission. The Resolution executed by Council allowed for modifications resulting from FEMA review without the need to re-adopt the plan as is their prerogative. The Council elected this method due to the holiday season approaching and limited council meetings, as well as upcoming council elections, which would delay adoption. Additional specific details of outreach events are identified in Table 2-2.

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 Tribal Council, a member of the planning team, regularly 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.

2.2.4 Plan Development Chronology/Milestones

Table 2-3 summarizes some of the important milestones in the development of the plan, including public outreach events.

TABLE 2-3
PLAN DEVELOPMENT MILESTONES

Date	Group	Description
2022		
October	Initiate consultant procurement	Seek a planning expert to facilitate the process
Nov/Dec	Select Bridgeview Consulting, LLC to facilitate plan development	Facilitation contractor secured
2023		
Jan	Kick-Off Meeting Website Launched	Identified process for plan development and FEMA requirements; identified additional Planning Team members; began review of existing plan and existing documentation supporting effort (e.g., studies, other planning documents, etc.), and identified areas of change within the new plan. Distributed sample Goals and Objectives (approved), defined "Public" for this update cycle, as well as critical facilities; confirmed Hazards of Concern. Identified public outreach strategy for presentation, utilizing existing Facebook and email distribution lists, which reach tribal and non-tribal citizens, among other avenues.
Jan	Initial Public Outreach	Website launched identifying project; Frequently Asked Questioned posted to website, Press Release prepared and distributed. Notice distributed on EM Facebook page, an Email blast to all tribal government employees and Tribal businesses. Announced project during the Annual General Meeting occurring January 19 - 20, 2023, inviting participants and identified hazards of concern and previous disaster impact data. Discussed existing strategy in place for relocation of Tribal facilities outside of hazard zones.
Jan	Survey Launched	Deployed Survey via web, developed posters with survey address, which was included in materials distributed during Annual General Meeting. Email distributions were also made to tribal citizens, staff and tribal enterprises.
Jan	Planning Meeting	Continued data capturing re: hazard impact; review of existing plans, studies, etc.
Feb	Flyer	Notice of the planning process and survey was distributed via a flyer distributed with all Elders' lunches.
March	Planning Meeting	Data capture re: land use development; Tribal roadways; historic impact from hazard events; discussions regarding grant opportunities and beginning phases of strategy development.

TABLE 2-3
PLAN DEVELOPMENT MILESTONES

Date	Group	Description
April	Planning Meeting	Planning meeting re: map layout and approval; call for photographs from previous events; discussion re: NFIP flood maps; discussion re: previous hazard impacts; discussion re: age of structures.
May 12	Planning Meeting	Internal review of risk assessment and methodology used to conduct the analysis; confirmation of risk analysis and ranking; strategy development; identified method for prioritization; confirm public outreach for presentation of risk via profiles on Tribe's website and at Safety Fair. Planning Team Members and Tribal staff provide information regarding strategies for inclusion in the HMP update and status of previous strategies.
May 25	Public Outreach Event	During Safety Fair, HMP Project Manager distributed maps and hazard profiles for review and comment; booth established with risk data available for review; hazard profiles printed in their entirety and available for review by Tribal Members, staff, and local citizens in attendance. Approximately 200 people attended the week-long event.
May	Planning Meeting	Capabilities assessment discussed; various tables distributed to capture current capabilities information. Tribal Project Manager took lead to capture data from various departments and personnel as appropriate, conducting one-on-one meetings.
June	Planning Meeting	Data capture of various planning information; discussed plan maintenance process.
July 14-16	Quileute Days	Various risk and HMP data was available for review and comment by attendees of the three-day event. Handouts provided; survey distributed in hard copy and available via computer.
Sept	Planning Meeting	Discussed strategy development and status of previous strategies.
Oct 27	Planning Team	Internal review of draft HMP by Planning Team Members.
Nov 8	Tribal Community	Public review of Draft Plan begins; announced at November meeting; Project Manager Larry Burtness again presented information on the planning process, the findings of the hazards of concern, and provided an opportunity for questions/answers. He announced that hard copies were printed and made available at the November meeting, and also at various locations on the Reservation. The draft plan was also posted to the Tribe's Mitigation Website, with notice distributed via email distribution to tribal citizens and tribal staff.
Nov 28	Public Review Period Ends	Public review period of Draft plan closed. Comments received reviewed by planning team and incorporated as appropriate

TABLE 2-3
PLAN DEVELOPMENT MILESTONES

Date	Group	Description
December 7, 2023	Public Outreach – Presentation of Final Plan made at Tribal Council, Adoption	Final public meeting on Plan presented at Tribal Council Meeting. Tribal Council adopted the plan as written, allowing for modifications require by FEMA without need to re-adopt. Resolution forwarded to FEMA.
December 11, 2023	Plan Submittal	Plan submitted to FEMA Region X for review.
	Plan Approval	Final plan approved by FEMA

This page intentionally left blank.

CHAPTER 3.
QUILEUTE NATION PROFILE

3.1 HISTORY AND GOVERNMENT

The Constitution and By-Laws of the Quileute Tribe (1936) and their Corporate Charter issued by the Secretary of the Interior in 1937, recognized and established the sovereignty of the Quileute people as a self-governing political unit within the United States with the inherent right to govern and deal with other tribes and nations on a government-to-government basis.

The Quileute Tribal Council is the governing body of the Quileute Tribe, per Article III of its Constitution. It consists of five elected members, each of whom serves staggered three-year terms. From within, the elected members select a Chair, a Vice-Chair, a Secretary, and a Treasurer. Other officers and committees may be appointed as needed. Council seats up for election are voted upon in a General Council meeting of enrolled members, each January. Besides the Constitution, by-laws and ordinances Quileute Tribal Council provide additional direction on tribal governance.

Tribal operations consist of the following areas: Administration, Natural Resources, Human Services, Education Department, Health Services, Tribal Court, and Public Works. Enterprises include the Oceanside Resort, the Marina, Lonesome Creek Store, and the Ki'tla Center (storage facilities and office and retail spaces).

The QN 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, and Youth Programs. The Tribe also has a Natural Resources Department, which establishes annual fishing rules and regulations within the U&A.

3.1.1 Defining the Planning Area

The Quileute Nation (QN) is a self-governing Treaty Tribe. The Plan covers all lands owned and operated by the QN, whether fee or trust. The planning area also includes those areas utilized and established as the Usual and Accustomed areas, ensuring 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 QN Reservation as established, 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. Tribal-owned land mass is not contiguous, with non-tribal members owning properties and businesses which abut tribal lands. Those lands are not specifically analyzed for hazard impact in this process.

The Quileute Indian Reservation (QIR) is located on the farthest northwest corner of the contiguous United States. The Olympic Peninsula is bound on the west by the Pacific Ocean, on the north by the Strait of Juan de Fuca, and on the west by Puget Sound. Figure 2-1 illustrates the Reservation and tribally owned properties in relation to the surrounding area.

The peninsula is bisected north to south by the Olympic Mountains, the highest point being Mount Olympus at 7,962 feet. A significant portion of the range is covered by glaciers and year-round snow fields at elevations as low as 5,000 feet. The Hoh Rainforest covers much of the peninsula and is one of the few temperate rainforests on Earth. With an average of 142 inches of rainfall each year, this area is the wettest place in the lower 48 states. Vegetation of the Reservation is typical for the rainforest, giant evergreens - cedar, spruce, hemlock, and fir. Wooded wetlands cover the surroundings of the Quillayute River and nearby tributaries. Flooding is a perennial challenge.

The Quileute Reservation is located on the western edge of Clallam County, Washington. The county covers 2,670 square miles. The Quileute Reservation is approximately 2.5 square miles. Quileute ceded lands, also known as Usual and Accustomed Area (U&A), are 1,498,000 acres or 2,341 square miles, including 40 miles west into the Pacific Ocean. Immediately bordering the Quileute Reservation, the Olympic National Park covers 523 square miles of the county. An additional 124 square miles is covered by the Olympic National Forest.

The Reservation is remote and isolated. Traveling from the north or south end of the Peninsula by US101 to Forks, it is served by a single two-lane road, SR110, for 15 miles west to La Push. Both US101 and SR110 are frequently impassable during winter storms and flooding events. The nearest town for groceries, fuel, hospital care, and minor services is Forks, 15 miles east of La Push, (where SR110 intersects with US101). Port Angeles, the county seat and largest city, is 65 miles northeast of La Push.

Figure 3-1 Quileute Nation Reservation and Tribal Owned Lands

3.1.2 Usual and Accustomed Fishing Areas

The QN is heavily dependent economically, culturally, and spiritually upon natural resources found within the Nation’s Usual and Accustomed (U&A) hunting, fishing, and gathering area.

3.2 CLIMATE

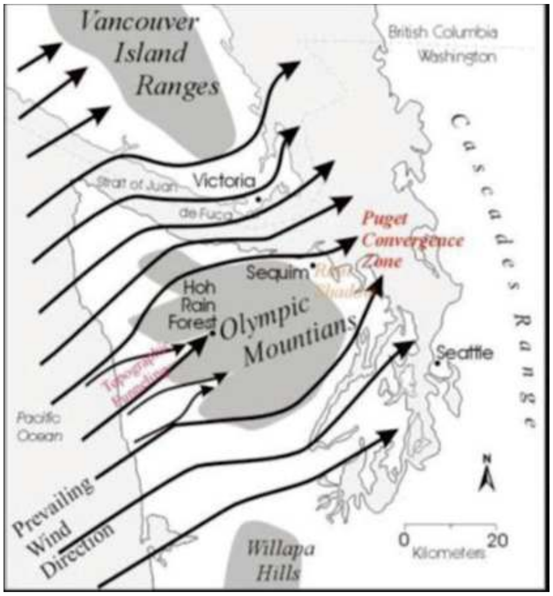


Figure 3-2 Prevailing Wind Directions

The western Olympic Peninsula along the coast has an oceanic climate (Koeppen Climate Classification System), which is characterized and controlled by temperature that is somewhat moderated by proximity to a large water body (the Pacific Ocean) and by moisture-laden air moving inland from the ocean, and resulting high volumes of rainfall falling along the western slope of the Olympic Peninsula (see Figure 3-2).

Summers customarily are cool and comparatively dry and winters are mild, wet and cloudy. The average number of clear or only partly cloudy days each month varies from four to eight in winter, eight to 15 in spring and fall, and 15 to 20 in summer. The percent of possible sunshine received each month ranges from approximately 25 percent in winter to 60 percent in summer. In the interior valleys, measurable rainfall is recorded on 150 days each year and recorded on 190 days in the mountains and along the coast. Thunderstorms over the lower elevations occur on four to eight days each year and over the mountains on seven to 15 days.

During July and August, the driest months, it is not unusual for two to four weeks to pass with only a few showers; however, in December and January, the wettest months, precipitation is frequently recorded on 20 to 25 days or more each month. The range in annual precipitation is from approximately 20 inches in an area northeast of the Olympic Mountains to 150 inches along the southwestern slopes of these mountains. Snowfall is light in the lower elevations and heavy in the mountains.

During the wet season, rainfall is usually a light to moderate intensity and continuous over a period of time rather than heavy downpours for brief periods. The heavier intensity rainfall occurs along the windward slopes of the mountains.

During the latter half of the summer and early fall, the lower valleys are sometimes filled with fog or low clouds until noon, while at the same time, the higher elevations are sunny. The strongest winds are generally from the south or southwest and occur during the late fall and winter. In the interior valleys, wind velocities can be expected to reach 40 to 50 mph each winter, with some events peaking at 75 to 90 mph. The highest summer and lowest winter temperatures are usually recorded during periods of easterly winds. The total evaporation for the warm season, May through September, as measured by a National Weather Service evaporation pan at Seattle, is 25 Inches with an average of seven inches in July.

3.2.1 Climate Change

Environmental pressures likely tied to climate change have diminished the tribe's traditional food sources, at times pushing some species below harvestable levels, including salmonids whose migration cycles have been disrupted by changes in snowfall patterns. Other problems have arisen as a result of shifts in precipitation and average temperatures, storm intensity, and changing marine chemistry. They include an increase in flooding and shoreline erosion; higher risk of wildfires in and around tribal land; an invasion of non-native plant species such as Scotch Broom and knotweed, which supplant native forbs on which elk and deer feed; and weakened shells in mollusks and possibly other marine invertebrates as ocean pH levels rise. As climate change continues to impact the Quileute community, tribal members are rethinking not only their means of sustenance but their geographic location.

"The fishery is the tribe's lifeblood," says Katie Krueger, Environmental Policy Analyst/Lawyer with the Quileute Tribe’s Natural Resources Department. That resource has been stressed from several angles: Salmonid species that spawn throughout four rivers in the Quillayute River Basin have diminished in recent years, some species crashing in 2015. Decreasing average snowfall in the Olympic Mountains has reduced summer flows but increased winter flows where salmonids spawn and their fry develop before their journey to the sea. During the 2015 crash Quileute tribal members, with help from salmonid co-manager Washington state, were forced to sandbag a riverbed to raise the water level sufficiently for chinook salmon to reach their spawning grounds (Pacific Northwest - The Quileute Tribe: Navigating a Sea of Change).[1]

Based on the 2016 Climate Plan developed for the QN, this means that for the QN, “climate will change in ways for the Quileute that may require new choices and changes from some cherished traditions, especially certain presently available foods. There will be some loss of coastal lowland, although not immediately. There may be increased violent weather. Protective infrastructure may need to be developed. Some independence from neighboring services may be advisable. However, in light of so many uncertainties regarding the timing and degree of change, it is important to develop a process for addressing the changes.”[2] As climate change progresses, monitoring climate and maintaining regular weather records and data will become increasingly important to track local changes.

3.3 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.

---

[1] Northern Arizona University. Accessed 5 April 2023. Available at: Tribes: Northwest - Tribes & Climate Change (nau.edu)

[2] Climate Plan for the Quileute Tribe of the Quileute Reservation (2016). Accessed 11 April 2023. Available oneline at: Microsoft Word - April 2017 UPDATE to Sept. 2016 CLIMATE PLAN FOR THE QUILEUTE TRIBE - Copy (quileutenation.org)

3.3.1 Tribal Enrollment

Based on Quileute Reservation Census Data[3], there are approximately 455 individuals living on the Reservation (both tribal and non-tribal), although that number is low when consideration is given that many families are multi-generational within the same household. Enrollment data identifies a tribal population as of January 2023 in excess of 841 enrolled members.

The QN do anticipate a continued increase in population, with more tribal citizens returning to the area once the new areas have been developed, and there is increased housing available. Currently, there are many families on the waiting list to move onto the Reservation.

For planning purposes, the sum of 150 housing units, and 3.5 people per household was utilized to identify potential population impact based on 2020 Census data, for an estimated 525 individuals. The residential structures are a combination of individually owned residences (which may be non-tribal), tribal owned/rented/emergency housing structures, and residential structures owned by tribal members, but for which the Tribe maintains the land. The La Push Coast Guard Station has approximately 30 assigned members.

3.3.2 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 (2020), the median age distribution on the Reservation is 31.6 years.[4] Based on Census data, approximately 59 residents are over 65, with approximately 44 children 5 years of age or under. There are 111 residents under the age of 18 years.

3.3.3 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

---

[3] Census Data. Accessed 1 Feb. 2023. Available at: [My Tribal Area (census.gov)](#)

[4] Census Report. Accessed 2 Feb. 2023. Available at: [Quileute Reservation - Profile data - Census Reporter](#)

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 (various sources) identifies the median household income on the Reservation to be $29,500 (2021 figures), with $69,021 being the median household income within the State of Washington, and $60,044 being the median household income in Clallam County.[5]

3.3.4 Disabled Populations

The 2020 U.S. Census Bureau estimated 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 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.

3.3.5 Economy

Traditional Quileute economic activities centered on the productive land the Quileute People inhabited. Its economy continues to rely heavily on ecotourism and the service industries, which remain the most prominent source of income for the QN. Throughout the years, focuses have shifted due to external influences, but today, the Quileute People are committed to a value-added model of resource management.

Tribal governments have the authority to operate Tribal-owned businesses, which in turn generate revenues for governmental services, provide jobs, and develop natural resources. This model also allows entrepreneurial Tribal members to work together to benefit from economies of scale and to have access to capital resources that they may not otherwise have had access.

The QN have demonstrated success in the tourism and hospitality sectors, their primary economic strategy. Opportunities for expanding Tribal involvement in the fishing industry have also increased. In 2014, the Tribe expanded its Oceanside Resort, which includes 71 rooms, including a mix of cabins and

---

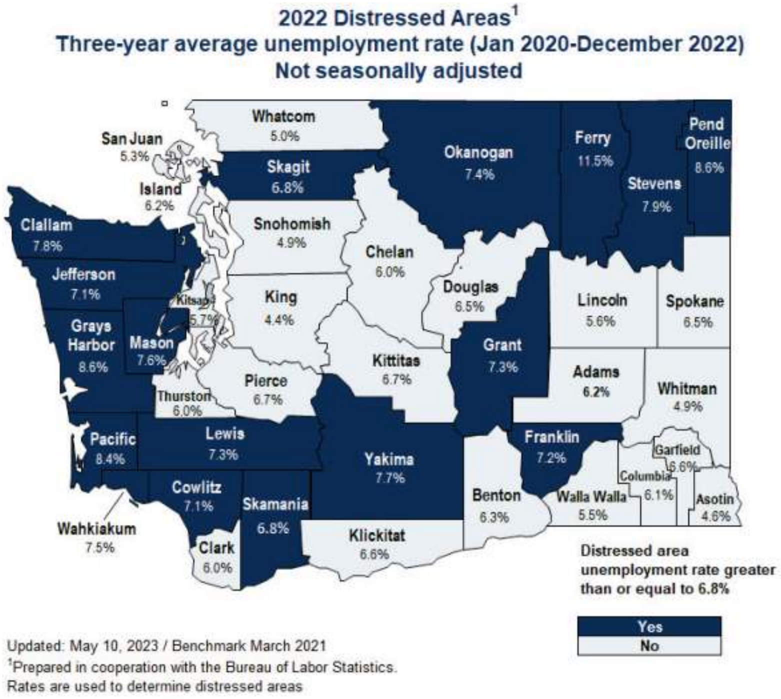
[5] US Census Quick Facts – Clallam County (2022) [U.S. Census Bureau QuickFacts: Clallam County, Washington; United States]

motel units, a convenience store, and an RV Park. The Tribe also owns the only marina between Neah Bay and West Port. The Quileute Harbor Marina is capable of handling as many as 60 vessels up to 50 feet in length. However, the Marina is subjected to high wave action from several directions in spite of a major breakwater that was built by the Army Corps of Engineers. It is also frequently damaged by storms, requiring regular and extensive maintenance.

The QN retain a significant number of tribal staff employed by Tribal government in various disciplines and sectors, which help manage governmental operations, health, wellness, safety, courts, land use development, and natural resources, among its other business ventures.

Washington State Employment Security Department, in conjunction with the federal Bureau of Labor Statistics annually compiles 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. As of this update, Clallam County, the county in which the Reservation is located, is considered a distressed area, with 7.8 percent of its population unemployed (see Figure 3-3).[6]

The Tribe feels that the percentage of unemployed on the Reservation is much higher than indicated within the area of Clallam County. The Tribe does qualify as a small, impoverished community based on Federal standards.



2022 Distressed Areas[1]
Three-year average unemployment rate (Jan 2020-December 2022)
Not seasonally adjusted

Updated: May 10, 2023 / Benchmark March 2021
[1]Prepared in cooperation with the Bureau of Labor Statistics.
Rates are used to determine distressed areas

Figure 3-3 Washington State 2022 Distressed Areas

---

[6] Washington State Employment Security Department – Distressed Areas List (2022). Accessed 26 Oct. 2023. Available online at: ESDWAGOV - Distressed areas list

3.4 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.

Emergency declarations are more limited in scope and without the long-term federal recovery programs of a presidential major disaster declaration. Generally, federal assistance and funding are provided to meet a specific emergency need or to help prevent a major disaster from occurring.

Fire Management Assistance declarations (44 CFR 204.21) are ones for which FEMA approves declarations for fire management assistance when a fire constitutes a major disaster, based on the following criteria:

- Threat to lives and improved property, including threats to critical facilities and critical watershed areas
- Availability of state and local firefighting resources
- High fire danger conditions, as indicated by nationally accepted indices such as the National Fire Danger Ratings System
- Potential major economic impact.

Table 3-1 identifies all Federal Disaster Declarations which have occurred on the QN since 1957 for which presidential disaster declarations were issued, or in the case of fire, where the fire management was issued. This includes disasters occurring in Clallam County as previous records did not identify the QN separately. A total of 26 disasters have occurred (two for COVID).

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 QN for many events. The QN have identified the capture of such loss data as a strategy for future planning efforts, as well as to support grant opportunities.

TABLE 3-1
QUILEUTE NATION AND CLALLAM COUNTY
DISASTER DECLARATION HISTORY
1957-2022

Disaster Number	Declaration Date	Incident Type	Title	Incident Begin Date	Incident End Date
4650	3/29/2022	Flood	Severe Winter Storms, Snowstorms, Straight-line Winds	12/26/2021	1/15/2022
4635*	1/5/2022	Flood	Severe Storms, Straight-Line Winds, Flooding, Landslides, and Mudslides	11/05/2021	12/02/2021
4593	4/8/2021	Severe Winter Storm	Severe Winter Storm, Straight-line Winds, Flooding, Landslides and Mudslides	12/29/2020	1/16/2021
4481* (2)	3/22/2020	Biological / Pandemic	COVID-19 Pandemic	1/20/2020	On-going
4418	3/4/2019	Severe Winter Storm	Severe Winter Storms, Straight-line Winds, Flooding, Landslides, Mudslides, Tornado	12/10/2018	12/24/2018
4253	2/2/2016	Flood	Severe Winter Storm, Straight-Line Winds, Flooding, Landslides, Mudslides	12/1/2015	12/14/2015
4249	1/15/2016	Severe Storm	Severe Storms, Straight-Line Winds, Flooding, Landslides, and Mudslides	11/12/2015	11/21/2015
4242	10/15/2015	Severe Storm(s)	Severe Windstorm	8/29/2015	8/29/2015
4056	3/5/2012	Severe Storm(s)	Severe Winter Storm, Flooding, Landslides, and Mudslides	1/14/2012	1/23/2012
1825	3/2/2009	Severe Storm(s)	Severe Winter Storm, Record and Near Record Snow	12/12/2008	1/5/2009
1817	1/30/2009	Flood	Severe Winter Storm, Landslides, Mudslides, and Flooding	1/6/2009	1/16/2009
1734	12/8/2007	Severe Storm(s)	Severe Storms, Flooding, Landslides, and Mudslides	12/1/2007	12/17/2007

TABLE 3-1
QUILEUTE NATION AND CLALLAM COUNTY
DISASTER DECLARATION HISTORY
1957-2022

Disaster Number	Declaration Date	Incident Type	Title	Incident Begin Date	Incident End Date
1682	2/14/2007	Severe Storm(s)	Severe Winter Storm, Landslides, and Mudslides	12/14/2006	12/15/2006
1641	5/17/2006	Severe Storm(s)	Severe Storms, Flooding, Tidal Surge, Landslides, and Mudslides	1/27/2006	2/4/2006
1499	11/7/2003	Severe Storm(s)	Severe Storms and Flooding	10/15/2003	10/23/2003
1361	3/1/2001	Earthquake	Earthquake	2/28/2001	3/16/2001
1172	4/2/1997	Flood	Heavy Rains, Snow Melt, Flooding, Land and Mudslides	3/18/1997	3/28/1997
1159	1/17/1997	Severe Storm(s)	Severe Winter Storms, Land and Mudslides, Flooding	12/26/1996	2/10/1997
1079	1/3/1996	Severe Storm(s)	Severe Storms, High Wind, and Flooding	11/7/1995	12/18/1995
1037	8/2/1994	Fishing Losses	The El Nino (The Salmon Industry)	5/1/1994	10/31/1994
883	11/26/1990	Flood	Severe Storms, Flooding	11/9/1990	12/20/1990
757	2/15/1986	Flood	Severe Storms, Flooding	1/16/1986	1/19/1986
623	5/21/1980	Volcano	Volcanic Eruption, Mt. St. Helens	5/21/1980	5/21/1980
612	12/31/1979	Flood	Storms, High Tides, Mudslides, Flooding	12/31/1979	12/31/1979
EMERGENCY DECLARATIONS					
3227	9/7/2005	Coastal Storm	Hurricane Katrina Evacuation	8/29/2005	10/1/2005
* Indicates Direct FEMA Declaration to the Quileute Tribe					

The most common disasters to occur are severe storms and flooding. Those hazards 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 3-2. These are 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 3-2
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	0	1	0	0	0	0	0	0	0	2	3	**8**	79, 86, 90, 97, 09, 15, 21(x2)	2	8	12.3
Severe Storm (including Wind)	2	0	0	0	0	0	0	1	0	1	3	6	**13**	95, 96, 03, 06 (x2), 07, 08, 12, 15 (x2), 18, 20, 22	1	5	20
TOTAL	**4**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**5**	**9**	**21**				

Based on FEMA designation and dates.

3.5 LAND USE AND DEVELOPMENT TRENDS

The Quileute Reservation is defined by the Quillayute River on the north, Olympic National Park on the eastern and southern boundaries, and the Pacific Ocean on the western shore. Tribal lands include both fee and trust lands, with some residential structures owned by non-tribal members, while the land remains in the ownership of the QN.

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 update its existing Tribal Code to ensure the most current codes are in place.

The Tribal Planning Area consists of three primary areas of land development - the traditional village located in lower elevation at the mouth of the Quillayute River, upland development including new land acquired through recent legislation, and purchased land closer in proximity to Forks and Highway 101. The Forks area is identified as a major economic target for the QN.

Acquired since completion of the last plan is the Riverview RV Park, which is a 32-acre area approximately six miles from the existing Reservation boundary. At present, there are six small homes on the land. Two of those structures were recently completed by the QN to provide housing for medical and other essential personnel as the Tribe continues to expand and grow.

The Tribe also acquired approximately 55 acres on the east side of Hermison Road (one-half mile from the existing Reservation). At present, there is a house, two garages, and an implement shed. This location supports health clinic activities.

The oldest existing development is along the beach, known as the lower village, with newer development in more elevated areas adjacent to La Push Road. The rest of the tribal lands are predominantly open wetlands and forest. There is no land use development plan in place for the lower village area. Limited new construction occurs in this area, mostly in the form of repair and maintenance.

Since completion of the last plan, the QN removed the old gym and community center which was in the lower reservation. A new accounting center was completed in 2022, which is a single-story modular structure, designed to the geotechnical issues surrounding the Reservation, which is subject to liquefaction. The removal of the older structures did reduce the vulnerability associated with those structures to the Tribe, and it is felt that with the geotechnical enhancements to the accounting center, its construction did not increase the vulnerability due to the enhanced construction methods imposed.

The Tribe has committed to tourism as their number one economic development strategy, a decision reflected throughout the Olympic Peninsula, particularly in light of the purchase of the new land in the Forks area. The Village of La Push itself is designated as a tourist destination in the Olympic Peninsula Region. In conjunction with that, the Marina and store, which serves as a critical economic hub for the QN, is scheduled for remodel and enhancements during the life cycle of this plan (as funding allows). Those enhancements will include a fuel system upgrade, reducing the level of vulnerability due to the replacement of the older storage tanks for fuel and diesel.

The QN have developed a Master Plan for the area, for the *Move to Higher Ground* initiative, which encompasses 285 acres of land falling outside of the Tsunami and Flood Hazard areas. The land was acquired in 2012, with the first project completed on the land – a school, completed and opened in 2022. With completion of the school, vulnerability to students and staff was reduced as a result of the new construction, as the old school fell within both the tsunami and flood inundation areas. The new school is removed from the vulnerable areas, decreasing the risk for the students and staff. The QN is currently in the process of establishing Phase 2 measures for the initiative.

There is one primary access road servicing the new area, with utilities - water, power, wastewater, constructed over the course of the last four years. The school was constructed with grant funds received in 2016 and built to the highest standards in place at the time of construction. At present, while the area is designated for new development, such will occur only as funding becomes available.

More recently, the Tribe received a Congressional Earmark (2022), which was utilized to develop a new water system, which provides water to the new school and will further service the relocation initiative when such occurs.

Since completion of the last plan, the QN also completed a million-dollar project to prevent erosion on Thunder Field, which is adjacent to the Quillayute River. The project included building log jams to support additional restoration work occurring in the area.

Within the next year, the QN, in conjunction with the U.S. Army Corps of Engineers (USACE), will enhance and repair the existing one mile-long and 12’ high dike currently off-shore of the Reservation, which helps mitigates the ocean waive action from engulfing the Reservation. Approximately 300-yards of the existing dike collapsed. That area will be the focus of the USACE project.

The QN is also currently seeking a permit with USACE to complete necessary repairs and maintenance to the Quileute Marina to upgrade and replace the wood docks and creosote pilings, replacing utility lines, upgrading the fuel system, and dredging maintenance. This project is set to be complete in 2024.

All of the structures completed since the last plan provide critical services for the Tribe and have had no negative hazard impact resulting from their construction.

Homeownership consists of individual (fee and trust), BIA, and HUD housing (including rentals) located on the Reservation. The QN is unique in that residential structures can be distributed through estates to non-tribal members; however, the land remains in the ownership of the QN.

The Tribe estimates that there are approximately 150 housing structures throughout the area, approximately 60 owned by non-tribal members. Of the residential structures, approximately one-fourth are located in the lower village. The remaining units are located upland mostly in three developments - Quileute Heights (51 units), Ravens Crest (36 units), and Ravens Crest II (8 units). Ravens Crest II has space allotted for a community garden and is one of the newer developments, having been completed in 2014. The Quileute Housing Authority office and Health Clinic are located at the entrance of Quileute Heights. There remains a large demand for new housing on the reservation for returning tribal members, service providers, and employees. Two 50-acre parcels are set aside for housing development on newly obtained land.

Overlooking the Pacific Ocean is the Tribe’s flagship enterprise, the Oceanside Resort, a destination for tourists and Olympic National Park recreational users. The resort operates 71 rooms and 66 RV campsites. The lower village land use designation will be for expanded enterprise and day use facilities.

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.

For future development, the QN plans to continue targeting sustainable development where suitable infrastructure can be guaranteed and where reasonable precautions can be taken to protect the sites from the adverse conditions of natural disasters while protecting the natural environment from damage.

For new construction, the following underlying principles 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, and civic facilities essential to the daily life of the Tribe while keeping cultural resources and cultural heritage intact.
- Encourage development of tribal centers that combine housing, commercial, office park and public uses in designated mixed-use areas, while preserving the locations of culturally sensitive areas.

- 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.
- 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.

Permitting and Enforcement

The QN fully complies 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 to ensure compliance with all established building, plumbing, electrical (etc.) codes in place, which are regularly updated to maintain compliance. Appropriate building setbacks and restrictions in high-hazard areas are enforced.

At present, all new buildings are required to be built to existing International Building Code (IBC) standards. The QN 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 continue to 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

As indicated above, future development during the life cycle of this plan may include housing, governmental structures (including essential facilities), and economic expansion. With development of the *Move to Higher Ground* initiative, the following are under review for future development as funding becomes available (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.

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, relocation of portions of the reservation which include previously flooded buildings, and forest practices which will enhance the economic industry for the QN while also sustaining those areas for future generations. Additional projects are further discussed in Chapter 13.

3.5.2 Critical Facilities and Infrastructure

Figure 3-4 Wellness Center

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, hotel, fish hatchery, and administrative offices that provide essential services or are primary to the economy or the culture of the Quileute Nation or its Peoples.
- Emergency response facilities needed for disaster response and recovery, including, but not limited to: public safety buildings; emergency services buildings; emergency operations centers; emergency supply storage facilities; public works facilities; emergency shelter(s), and tribally owned residential structures.
- Tribal medical and health clinics or facilities used during both emergency response, or in the normal course of business.
- Tribal facilities that may be used to house or shelter disaster victims, schools, day cares, gymnasiums, churches, senior or community centers, or facilities that have large kitchen areas to provide emergency feeding services.
- Tribal owned utilities and infrastructure vital to maintaining or restoring normal services to the areas damaged by the disaster such as power lines, roads, public works facilities, communication hubs, water, and wastewater facilities, etc.
- Community gathering places, including culturally significant areas, parks, community centers, gymnasiums, and meeting halls.
- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic, and/or water-reactive materials (e.g., hazmat sites).
- Cultural sites or facilities that are vitally important to maintaining the Tribe's cultural history, language, and traditions, such as burial grounds, archaeological sites, and artifact storage facilities.

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 ~54 structures, including culturally significant structures, emergency shelters and evacuation sites, and governmental structures, among others. The Tribe does own several structures which are located outside of the study region of the QN Reservation.

Residential structures were not included in this assessment as there is a mix of tribal and non-tribal residential structures scattered throughout the Reservation, as well as non-tribal commercial/business structures. For planning purposes, the Planning Team estimates approximately 150 residential structures scattered throughout the area, with ~3.5 persons per household. This equates to a total of ~525 individuals at risk to the hazards of concern, plus staff and visitors to the various hotel, restaurant, and tourist establishments. The tribe does not have a detailed accounting of the number of individuals frequenting the various enterprises.

The critical facilities list of structures is not provided within this document and is considered confidential in nature. The Tribe will continue to rely on the Clallam County Hazard Mitigation Plan to identify critical or essential facilities which are not owned or managed by the QN which are at risk to the hazards of concern.

The Quileute Water System (PWSS ID#105300016) is owned and operated by the Quileute Tribal Council. This system provides approximately 85,000 gallons of water per day to around 200 customers in the La Push, WA area. The Quileute Water System consists of two production wells, standard associated well machinery, three concrete reservoirs (100,000 g, 190,000 g, 110,000g), and 15 miles of buried water mains. The system is operated and managed by five certified operators, two of which are tribal members. A new 190 gallon steel tank was installed in the Move to Higher Ground development in 2022.

Quileute water source comes from two wells (69 and 71 feet) located in the Three Rivers area. The largest reservoir, 190,000 gallons, is located at Steep Hill. The 100,000-gallon reservoir is behind a locked gate in the recycling area. The 110,000-gallon reservoir is located on Cemetery Road behind the old Coast Guard Housing. All reservoirs are locked to public access. The tanks located on Cemetery Road and behind the recycling area have sensors that are monitored from the Public Works Office. The water consumption rate leveled out at 85,000 gallons per year and has capacity to meet future community development needs.

For emergency management planning purposes, general building and residential structure values were not included in this assessment due to limited data available. As such, only critical facilities were identified and included for this plan update. Based on the list established, it is estimated that structure value for the identified critical facilities is in excess of $74 million. That figure does not include potential revenues generated by the commercial or business structures, or inventory. Table 3-3 and Figure 3-5 illustrate the critical facilities for the QN.

TABLE 3-3
CRITICAL FACILITIES

Critical Facility Type	Count	Building Values (Combined)
Commercial (includes docks)	8	5,000,000
Cultural (Cemetery)	1	10,000
Generators/Power	8	925,000
Government/Administration	6	6,000,000
Hazmat (Tribal Owned gas stations)	2	790,000
Industrial	1	800,000
Medical	4	2,954,000
Natural Resources (Fisheries/Hatcheries)	4	1,360,000
Protective	7	1,540,000
Schools / Education (Daycare, Head Start)	3	47,307,060
Shelters, Gym, Gathering Structures	4	3,810,000
Water	5	1,900,000
Wastewater	1	900,000
Totals	**54**	**73,296,060**

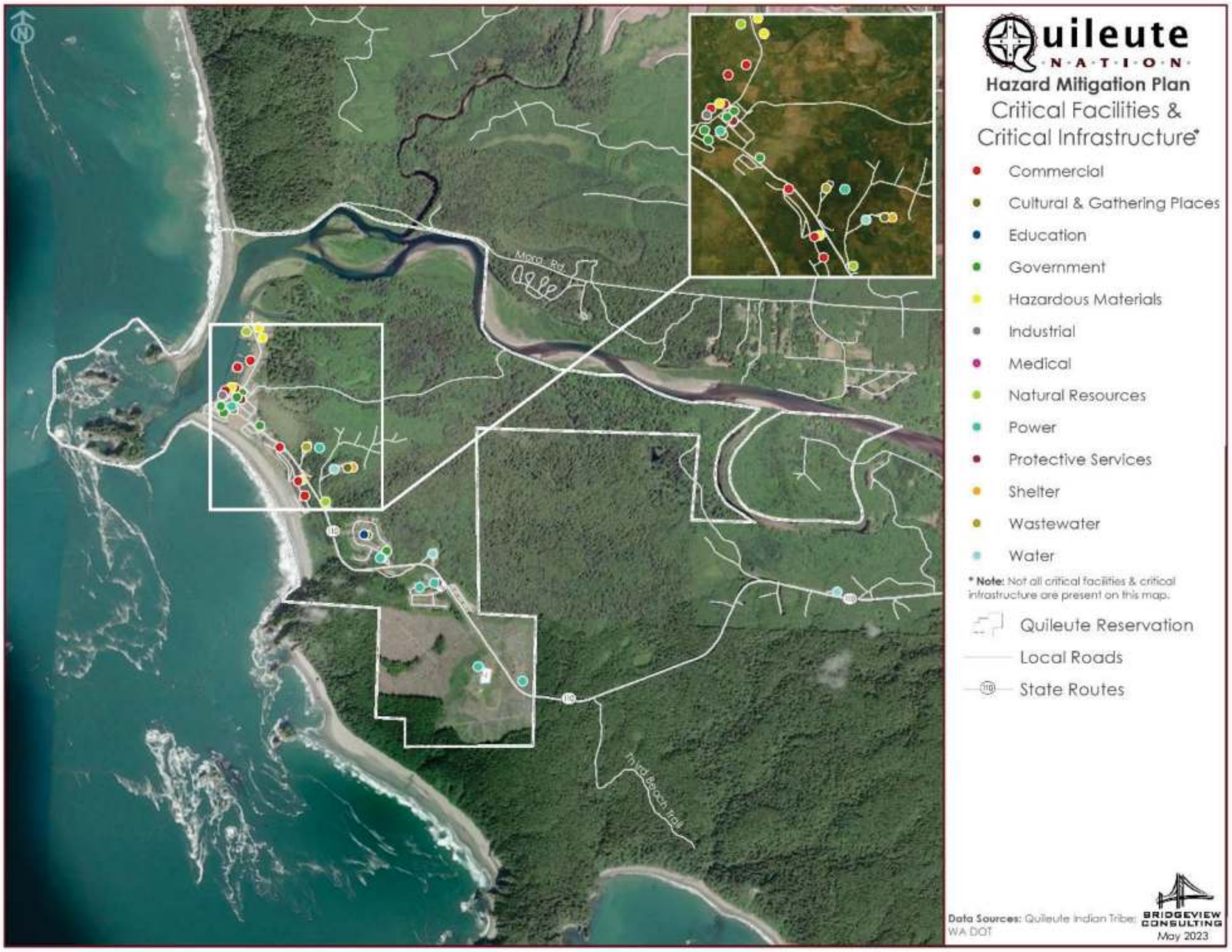


Figure 3-5 QN Critical Facilities & Infrastructure

3.5.3 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 QN has acquired several of its structures from the Coast Guard, as well as other sources. In many instances, the actual year of construction is unknown, but the Nation is aware that some of the structures were built around 1930. Figure 3-5 illustrates (among other areas) a portion of the QN, including the two structures built in ~1930.

Figure 3-6 Navy Collection of WWII Photographs (1944)

Review of structure data identifies the following:

- At least two structures were built in the 1930-1940 time period; one serves as the old school administration building, and the other is the River's Edge Restaurant. One of the buildings is scheduled to be removed during the life cycle of the plan.
- Several tribal enterprises were built in the 1970-1980 timeframe.
- The Tribal Administration Office was acquired in 1977.
- Three of the medical structures are newer (post-2000), the fourth pre-1990, but all assumably built to higher codes.
- Educational facilities are newer, the most recent – the Quileute Tribal School, constructed in 2022 in the area identified for relocation of the Reservation, out of the Tsunami Inundation Zone.
- Four shelter or gathering centers have all been built to newer codes, with the Akalat Gym being the oldest, acquired in 1998.
- Fish hatchery structures were built in acquired post 1997, with one structure built in ~2000, and the hatchery boat storage facilities built in 2022, all when more stringent building codes were in effect.
- There are several modular/metal buildings on the QN.
- The majority of the water storage tanks were built 2020 and are steel tanks.
- Two fueling stations are on the Reservation, the Marina and the Lonesome Creek Fueling Station; the Coast Guard Station also maintains a supply of fuel, but is not owned by the QN.
- Eight of the structures are equipped with diesel powered generators; estimated value of those generators is approximately $1 million.

- The newest structure to have been built since completion of the last plan was completed in 2022 – the Quileute Tribal School.

Construction Materials

- The majority of structures are wood framed; there are several newer metal buildings.
- The water towers and wastewater treatment plants are constructed of heavy, non-combustible materials, with the towers themselves being steel tanks, built to newer standards.

3.5.4 Transportation

Transportation on the Reservation includes roads owned by the Tribe, the BIA, Clallam County, and the Washington State Department of Transportation – WSDOT. Tribal roads are the internal roads that serve the housing projects, the parking lots near the marina, and some side streets, making up a small percentage of the road system serving the reservation. The County owns La Push Road, the main road that leads from the entry of the reservation to the waterfront. The State owns the only road that provides egress and ingress to the reservation, SR 110, from US101 to the entry of La Push. It is a 15-mile 2-lane corridor with narrow shoulders.

There continues to be serious and chronic flooding on SR 110 at MP 8 that poses severe threats during winter storms. Water reaches 3 to 4 feet deep at this site. There is significant loss of productivity for the QN as a result of the road closures, approximated at $30,000-$50,000 per day due to Tribe’s 285 employees being unable to work, and when offices must be closed.

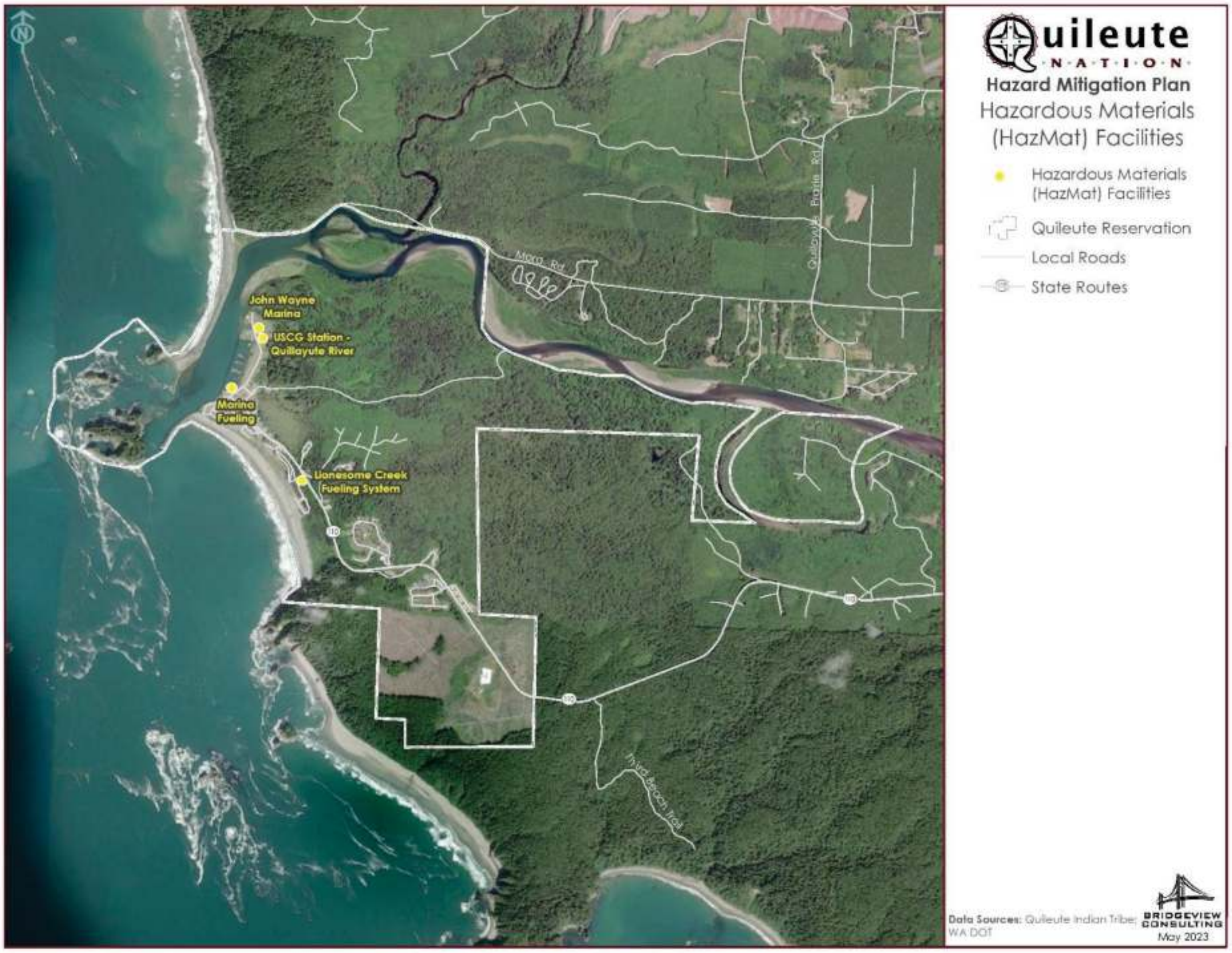
Other areas of concern include a potential landslide on La Push Road at Lonesome Creek. If the bluff were to slide onto the road due to saturated soil or due to earth shaking, the lower village would be isolated, as this is the only road in or out. Thunder Road is also seriously deteriorated. Thunder Road is the historic trail to La Push, according to the 1997 Cultural Resources Survey, and connects the lower village to Thunder Field and can serve as an exit route in the case of a road closure due to landslides or downed trees along the main road out of town during a disaster event along the waterfront.

Road closures pose a significant safety hazard as anyone with a health problem cannot travel to obtain medical care, and emergency response vehicles cannot cross the roadways.

The Tribe and Clallam County also operate public transportation services between the town of Forks and La Push. The Tribe operates a shuttle service with an average of 3700 passenger trips a year. While operations are currently suspended, they are expected to resume within the life cycle of this plan. Clallam Transit operates a bus three times daily, a service that is utilized by several tribal employees. The Tribe has access to several buses and vans.

3.5.5 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. Figure 3-7 identifies the location of potential hazmat sites on and within five miles of the Reservation. The planning area has two tribal-owned hazardous material sites (fueling stations) on the Reservation, as well as maintaining ownership of generators powered by diesel (not pictured). There are also additional hazardous material sites in proximity to the Reservation as identified in Washington State Department of Ecology's Hazardous Materials Annual Report (2022), including at the Coast Guard Station and John Wayne Marina in Clallam County. There are four tribal assets and two areas of cultural significance (Lonesome Creek and La Push), which are located within the tidal reach and are vulnerable to a potential vessel incident.



Data Sources: Quileute Indian Tribe; WA DOT

May 2023

Figure 3-7 Hazardous Materials Facilities (WA DOE, 2023)

This page intentionally left blank.

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 QN utilizes and has regularly adopted the most currently building code standards in place.
Floodplain Ordinance				The Tribe is part of the NFIP and does have land use development regulations which restrict building in the floodplain.
Stormwater Management	Y	Y	Y	
Shoreline Management Plan	Y			
Land Use Development Code	Y			Permitting and regulations for the Reservation.
Growth Management	Y			The Tribe has established areas for development which have been updated as new land mass is acquired. 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 a benefit to both the environment and the residents of the QN.
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 administer programs and provide direct medical services of varying types. The QN also works with Clallam County and State Dept. of Health to provide various types of health campaigns.

TABLE 4-1 LEGAL AND REGULATORY CAPABILITY				
	Tribal Authority or Program in Place	Other Jurisdictional Plan or Program in Place	State Mandated	Comments
Climate Change Adaptation	Y		Y	The Tribe is actively engaged in various climate change issues, having previously completed a Climate Study (utilized in this planning process) with two surrounding tribes – the Hoh and the Quinault. The Tribe has had a practice of purchasing surrounding lands, many of 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.
QN Natural Resource Management	Y			Used by the Natural Resources to manage QN forests, fish and wildlife habitat, and mineral lands.
Environmental Protection	Y			Tribal programs as well as EPA regulated programs.
Planning Documents				
Improvement Plan	Y			Improvement plans via Transportation Plans, Economic Development, and Natural Resources (among others) exist for developed areas, and several undeveloped parcels. There are currently multiple plans in place for the redevelopment of high-hazard areas of the Reservation.

TABLE 4-1
LEGAL AND REGULATORY CAPABILITY

	Tribal Authority or Program in Place	Other Jurisdictional Plan or Program in Place	State Mandated	Comments
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 or removal of existing structures.
Habitat Conservation or Clean-Up Plans	Y			Wildlife trafficking is growing at an alarming rate worldwide and threatens an increasing variety of terrestrial, freshwater, and marine species. A high demand exists for some of the species that occur within the QNR including, but not limited to bald eagles, black bear gall bladders, and elk and deer velvet antlers. The QNR also maintain climate change plans, air/water quality monitoring, and shoreline protection plans, among others.
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.
Response/Recovery Planning				
Comprehensive Emergency Management Plan / Emergency Operations Plan	Y			
Post-Disaster Recovery Plan	N			The Tribe has various plans in place to address disaster impact, but no specific recovery plan.

TABLE 4-1
LEGAL AND REGULATORY CAPABILITY

	Tribal Authority or Program in Place	Other Jurisdictional Plan or Program in Place	State Mandated	Comments
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.
Maintenance programs to reduce risk (e.g., tree trimming, clearing drainage systems, chipping, etc.)	Y			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	Planning Department, Natural Resources, Environmental, Economic Development and Contracted Services
Professionals trained in building or infrastructure construction practices (building officials, fire inspectors, etc.)	Yes	Planning Department, Housing Manager, and County/State Resources as requested.
Engineers or inspectors specializing in construction practices?	Yes	Housing Manager and Contracted Services
Planners or engineers with an understanding of natural hazards	Yes	Planning Department, Housing Manager, Environmental Manager, Public Works Officer, also under Contracted Services as needed.
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	Yes	Various
Emergency Manager	Yes	Designated Emergency Manager
Grant writers	Yes	On staff
Warning Systems/Services	Yes	Sirens and evacuation signage, including through State.
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.

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 (B&O, Lodging, Fish, Gas)	Yes
4. User Fees for Water, Sewer, Gas or Electric Service	Yes
5. State-Sponsored Grant Programs	Yes
6. Bureau of Indian Affairs Sponsored Grant	Yes
7. Indian Health Services Grant	Yes
8. U.S. Dept. of Agriculture, Rural Development Agency	Yes
9. U.S. Environmental Protection Agency	Yes
10. U.S. Fire Administration	Yes
11. Tribal Homeland Security Grants	Yes
12. Stafford Act Grants	Yes
13. 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
Fire Safe Councils or Fire Wise Community	N	
Chipper program	Y	
Defensible space inspections program	Y	The QN is actively engaged in forest management practices.
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 QN 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 QN 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.

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 QN 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 QN 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 QN are undertaking also coincide with the following state and local planning initiatives:

- International and Washington State Building Code
- Washington State Enhanced Hazard Mitigation Plan
- Clallam County Hazard Mitigation Plan
- Climate Change Adaptation Planning

4.1.3 General Public Safety Information

Emergency Management:

The QN does have a designated 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 QN has adopted the National Incident Management System (NIMS) as its operating structure for emergency events.

Schools, Community Centers, and Shelters:

There is a newly constructed tribal school (2022) which is located outside of the tsunami inundation zone. The Tribe does maintain Childcare/Head Start facilities. The Gym/Community Centers serve as gathering places for Tribal citizens and could be utilized as emergency shelters as needed to provide services to both tribal members and other citizens in the area should a disaster or significant event occur. With potential isolation occurring should a major roadway providing ingress and egress fail, utilization of these structures will be significant to ensure the safety of citizens and employees.

Disaster Declaration Policy:

The QN 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 QN 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 tribal personnel trained for a Hazmat response, and the Tribe does not have any capacity in this regard. They do work closely with the local Coast Guard Station, and rely on local fire agencies, WSP, and WA DOE for hazmat response and cleanup.

Law Enforcement, Corrections, and Gaming Enforcement

The Tribe does have the Quileute Nation Police Department for enforcement of Tribal Criminal Code and Natural Resources Enforcement Officers, which extends throughout the U&A. The Tribe does not have a jail facility but has a Memorandum of Agreement with Forks to provide jail services.

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 / Social Services:

The QN do have a Fire Department and recently obtained a mobile Emergency Medical Trailer to provide emergency medical services, but the services are limited in nature (non-surgical). There is no hospital on the Reservation, the nearest facility being 65 miles northeast of La Push in Port Angeles. Travel time to the nearest hospital takes approximately 45-50 minutes each way. The Tribe does provide some medical services and has established health care centers located in various locations on the Reservation. Significant social services are provided by the QN to its citizens, including a senior lunch program.

This page intentionally left blank.

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.

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 2015 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 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 starting point. The list of hazards was felt to be consistent with the previous plan, with slight modifications to the grouping of the hazards (e.g., 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)
- 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 122 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 2023 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

Rating	Magnitude	Percentage of People and Property Affected
		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 12 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

The QN utilized this effort to develop a new critical facilities layer which was utilized to identify potential loss data to include exposure and vulnerability to the critical infrastructure identified during this process. GIS building data utilizing detailed structure information for tribal facilities, which was utilized in GIS. Building information was developed using best available Tribal data, including building address points, aerial imagery, and Tribal staff resources. Building and content replacement values were estimated using values from various sources, including valuation by Tribe staff and insurance coverage data, which identified replacement values, years built, construction type, etc.. In some instances, estimations were made where missing data existed. In some instances, where content value was missing, the value was based on one-half of building value, which is an acceptable practice for these planning purposes.

Hazus Application for This Plan

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

- **Flood**— Analysis was based on current FEMA regulatory 100- and 500-year flood hazard data, to include a proprietary study completed by FEMA for the QN.
- **Earthquake**—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 (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.

GIS Application

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:

> **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, 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.*
>
> **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.
>
> **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.*

This page intentionally left blank.

CHAPTER 6.
EARTHQUAKE

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

DEFINITIONS

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

Epicenter—The point on the earth's surface directly above the hypocenter of an earthquake. The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth.

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

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

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

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

6.1 GENERAL BACKGROUND

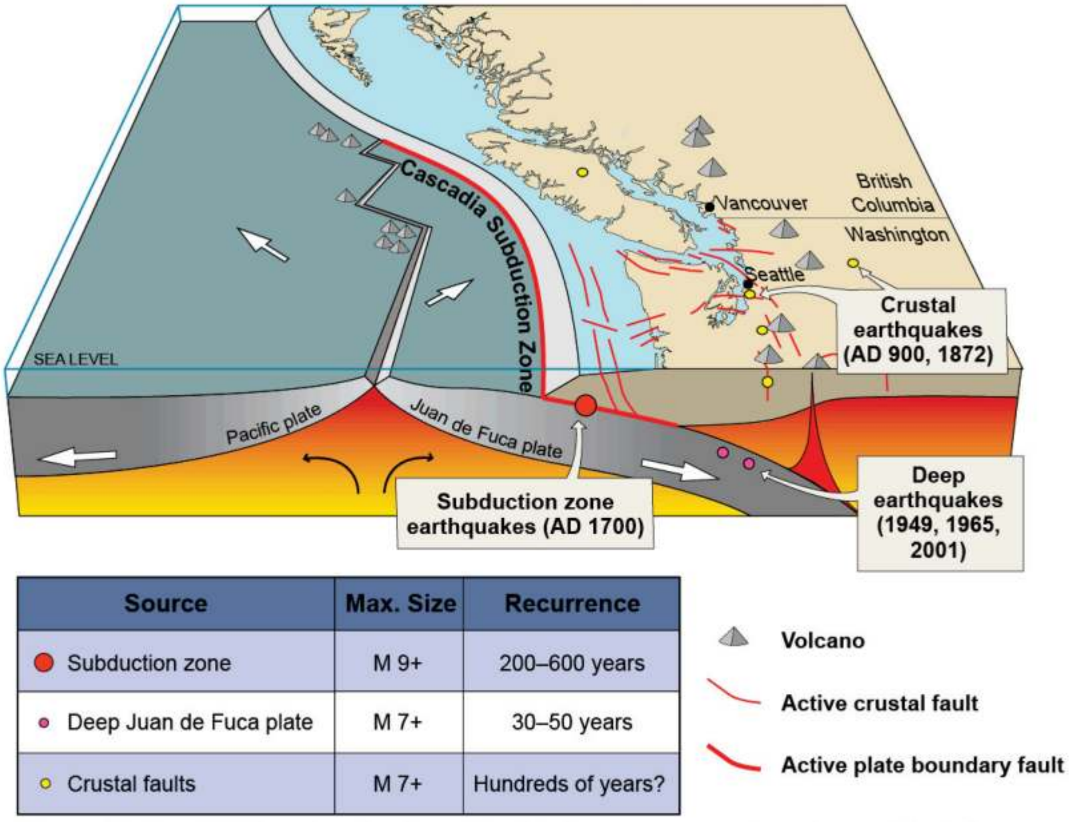
Most destructive quakes are caused by dislocations of the crust. The crust may first bend and then, when the stress exceeds the strength of the rocks, break and snap to a new position. In the process of breaking, vibrations called "seismic waves" are generated. These waves travel outward from the source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

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

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

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

It is generally agreed that three source zones exist for Pacific Northwest quakes: a shallow (crustal) zone; the Cascadia Subduction Zone; and a deep, intraplate "Benioff" zone. These are shown in Figure 6-1. More than 90 percent of Pacific Northwest earthquakes occur along the boundary between the Juan de Fuca plate and the North American plate.



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

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

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

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

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

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

6.2 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 6-1 presents a classification of earthquakes according to their magnitude.

TABLE 6-1
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 6-2 compares the moment magnitude scale to the modified Mercalli intensity scale.

TABLE 6-2
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 6-2 illustrates the USGS's analysis identifying earthquake hazard areas/levels nationwide. Figure 6-3 illustrates the PGA that Washington State can expect (most current available showing PGA as of 2023 update).[7]

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.

---

[7] USGS. Accessed 4 April 2023. Available at: https://earthquake.usgs.gov/earthquakes/search/

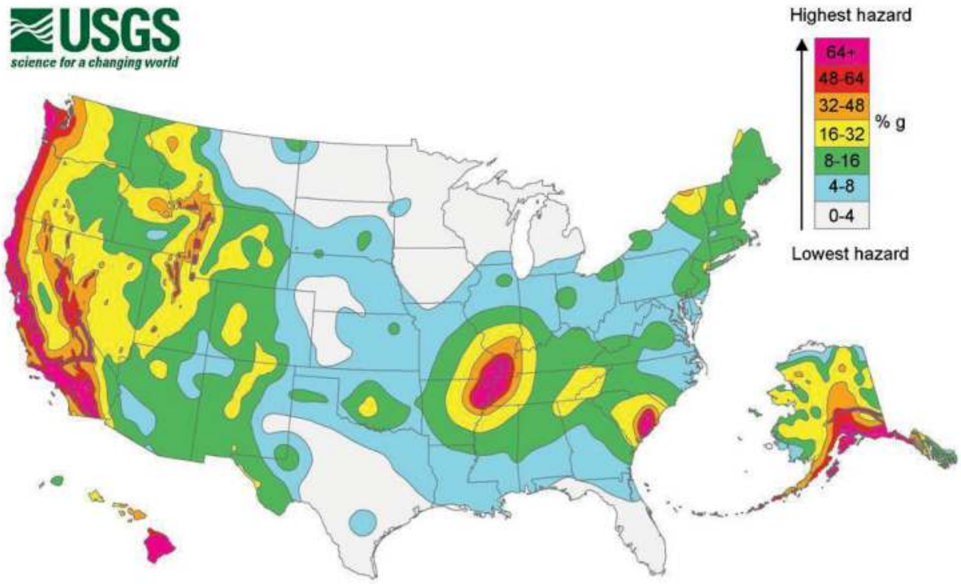


Figure 6-2 USGS Ranked Earthquake Hazard Areas Nationwide (2022)

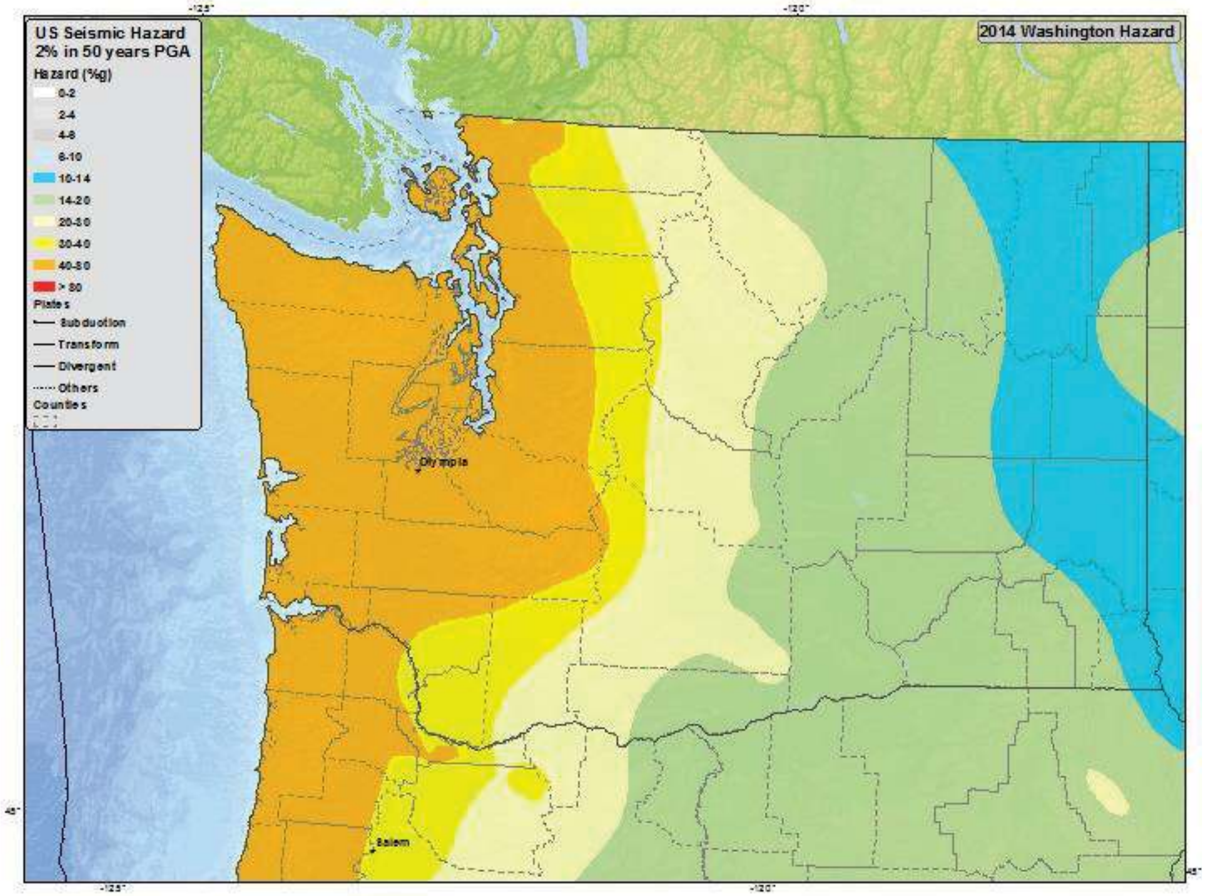


Figure 6-3 USGS PGA for Washington State (2014)

PGA is the basis of seismic design categories that are included in building codes such as the International Building Code (see Figure 6-4).[8] 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 6-3 identifies damage potential and perceived shaking by PGA factors, compared to the Mercalli scale.

---

[8] Source: fema_hazard_maps_western-map_graphic.jpg

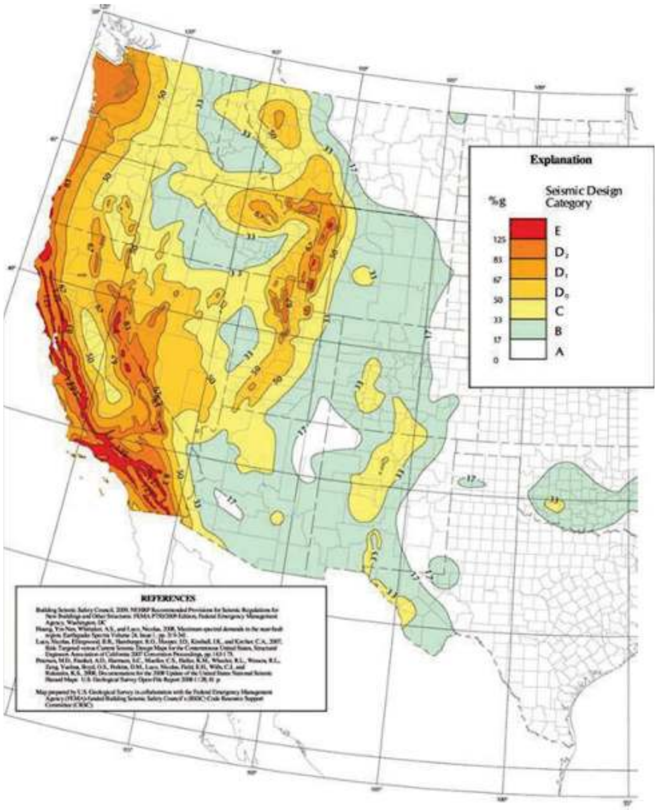


Figure 6-4 USGS Seismic Design Category (2020)

TABLE 6-3
COMPARISON OF MERCALLI SCALE AND PEAK GROUND ACCELERATION

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

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

6.3 EFFECT OF SOIL TYPES

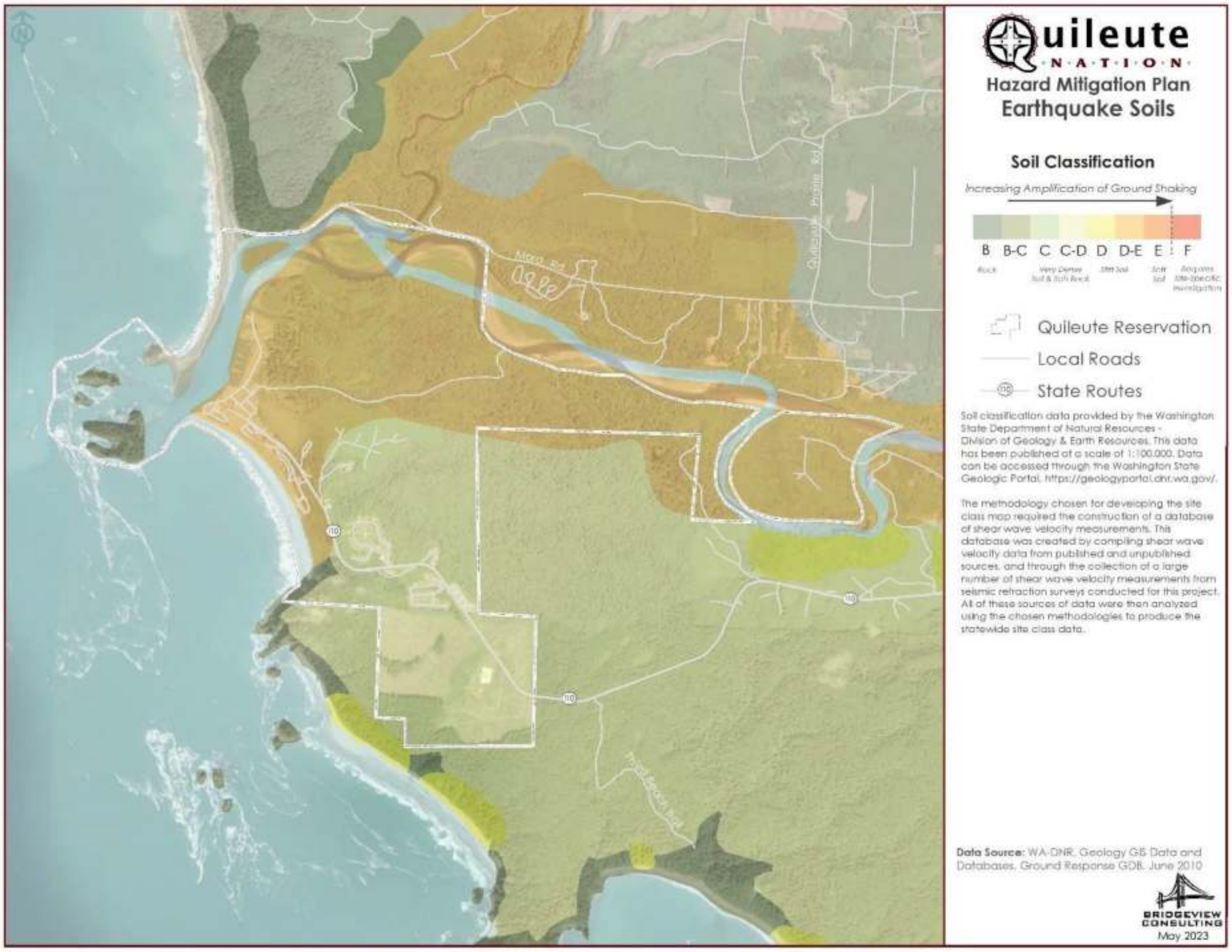
Liquefaction is a secondary effect of an earthquake in which soils lose their shear strength and flow or behave as liquid, thereby damaging structures that derive their support from the soil. Liquefaction generally occurs in soft, unconsolidated sedimentary soils. The National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics to identify areas subject to liquefaction. Table 6-4 identifies NEHRP soil classifications and identifies by acre(s) the types of soils on tribal reservation 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 6-5 identifies the number and types of tribal-owned structures within each soil classification. Figure 6-5 illustrates the areas in which the soil classifications are situated (inclusive of all lands within the Reservation boundary, regardless of ownership).

TABLE 6-4
TYPES OF NEHRP SOILS ON RESERVATION

NEHRP Soil Type	Description	QN Reservation Soils Type (in acres)
A	Hard Rock	0.00
B	Firm to Hard Rock	53.04
C	Dense Soil/Soft Rock	43.43
D	Stiff Soil	661.64
E	Soft Clays	1,415.73
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 m thick)	0

TABLE 6-5
QUILEUTE NATION CRITICAL FACILITIES / INFRASTRUCTURE IN NEHRP SOIL CLASSIFICATIONS

NEHRP Soil Type	Description	Government Function	Hazardous Materials	Medical / Health Care	Protective Services/Generators	Residential	Schools	Shelter/Gathering	Commercial	Industrial	Communications	Cultural	Natural Resources	Water	Wastewater	Total
A	Hard Rock	0	0	0	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	0	0	**0**
C	Dense Soil/Soft Rock	0	0	2	1	0	0	0	1	0	0	0	1	0	0	**5**
D	Stiff Soil (includes five emergency generators)	1	0	1	10	0	3	3	0	0	0	1	1	4	0	**24**
E	Soft Clays (includes three emergency generators)	5	2	1	4	0	0	1	7	1	0	0	2	1	1	**25**
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 m thick)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**



Soil classification data provided by the Washington State Department of Natural Resources - Division of Geology & Earth Resources. This data has been published at a scale of 1:100,000. Data can be accessed through the Washington State Geologic Portal, https://geologyportal.dnr.wa.gov/.

The methodology chosen for developing the site class map required the construction of a database of shear wave velocity measurements. This database was created by compiling shear wave velocity data from published and unpublished sources, and through the collection of a large number of shear wave velocity measurements from seismic refraction surveys conducted for this project. All of these sources of data were then analyzed using the chosen methodologies to produce the statewide site class data.

Data Source: WA-DNR, Geology GIS Data and Databases, Ground Response GDB, June 2010

Figure 6-5 NEHRP Soil Classifications on Reservation

6.3.1 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.

6.4 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 by 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.

6.4.1 Extent and Location

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

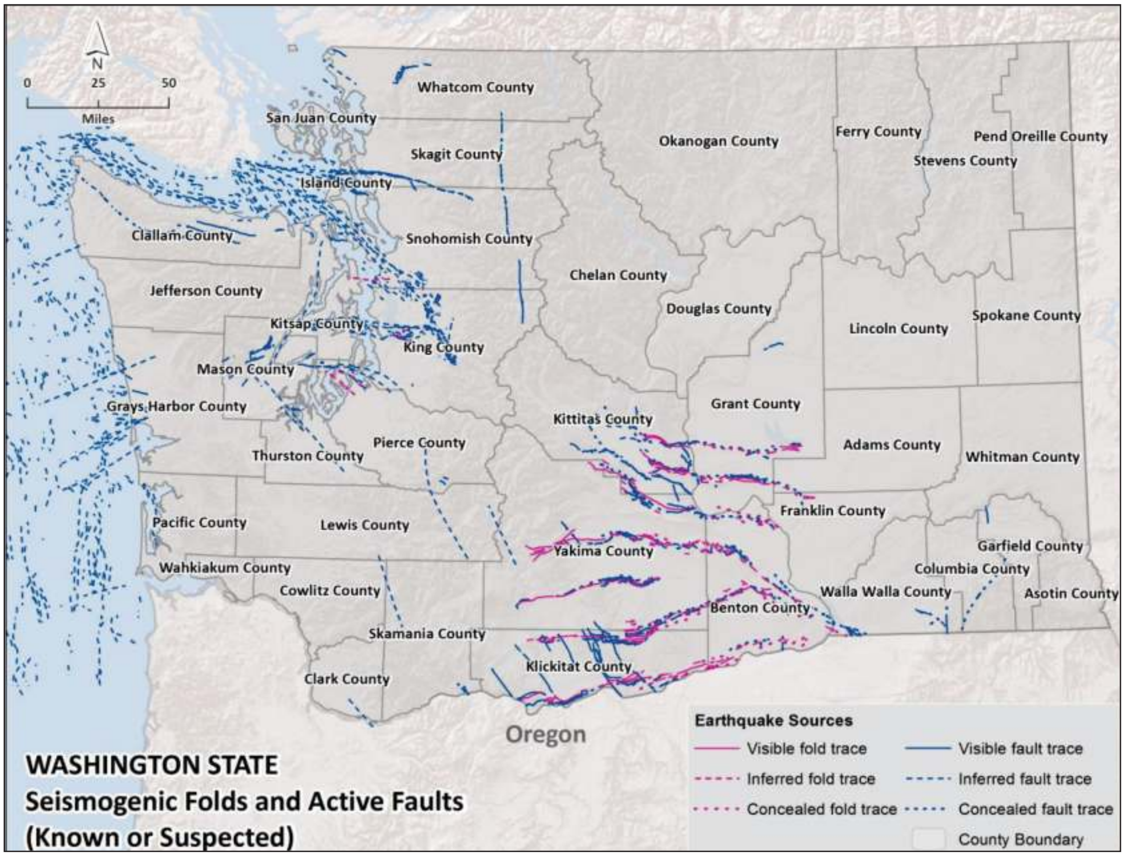


Figure 6-6 Washington State Seismogenic Folds and Active Faults

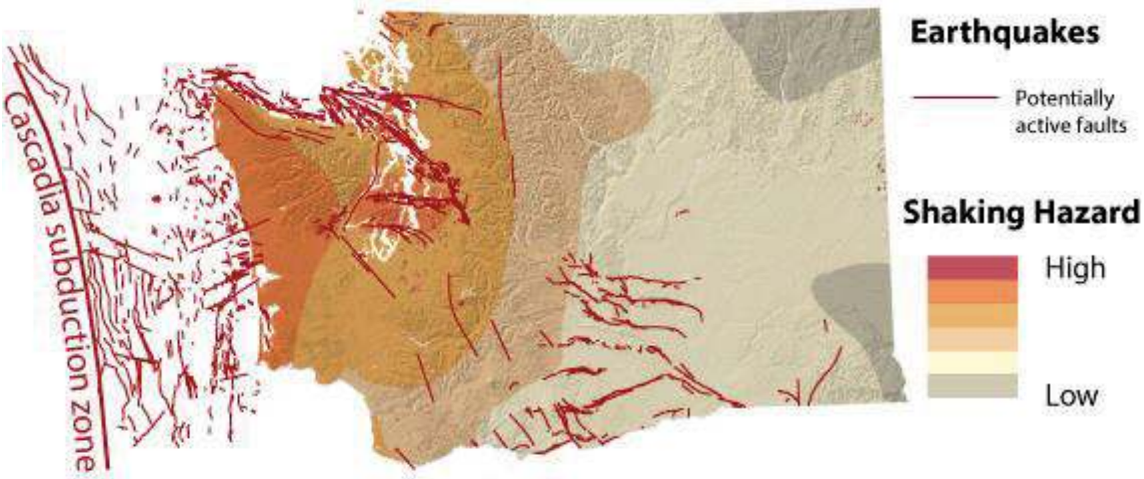


Figure 6-7 Washington State Earthquakes and Faults with Shaking Hazard

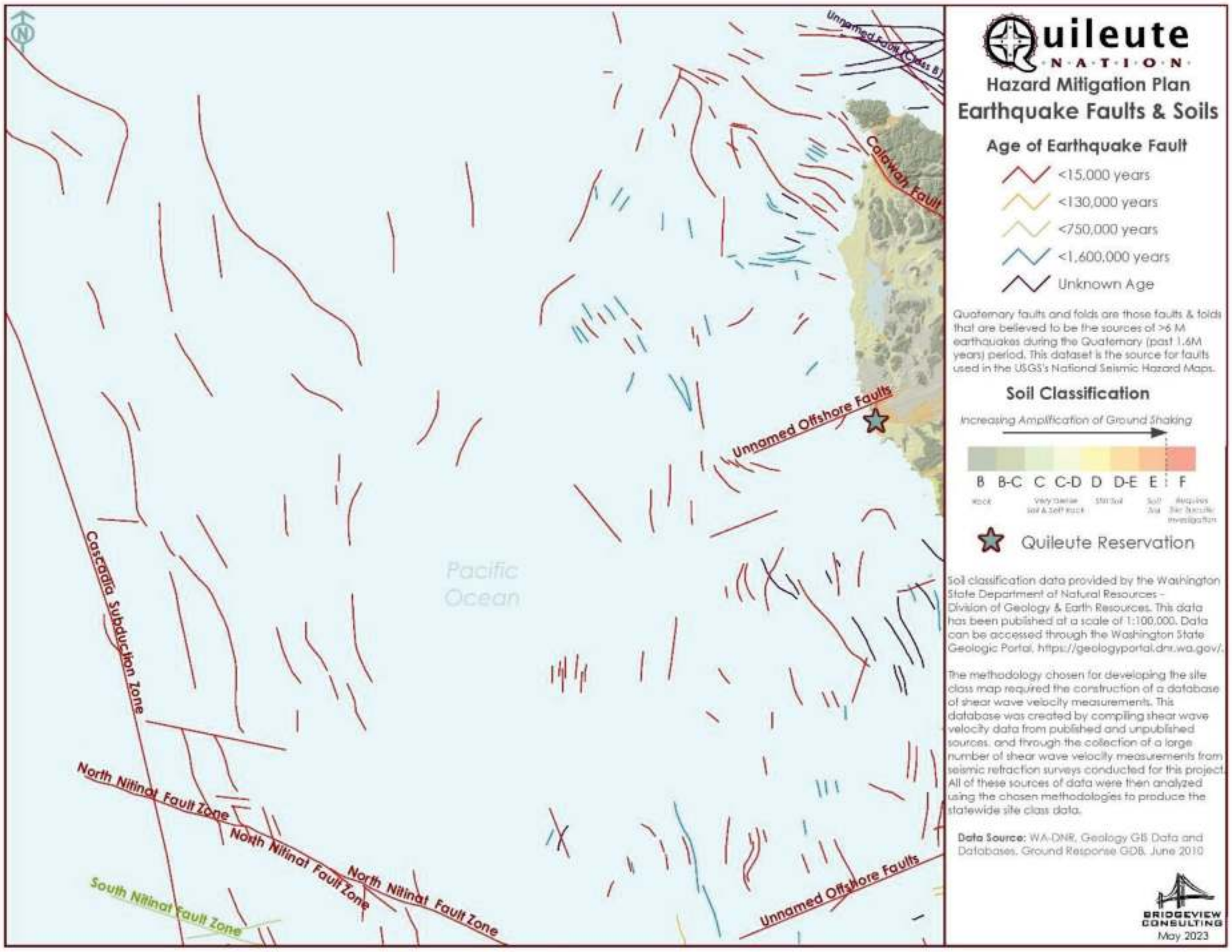


Figure 6-8 Faults On and Around Quileute Nation

As Figure 6-8 indicates, there are a number of faults running on or near the QR, the primary of which is the Cascadia Subduction Zone, approximately 83 miles offshore of the QR. 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. Ground shaking from earthquakes on shallow faults typically last from 20 to 60 seconds and are localized to the source. The Tribe does not have earthquake monitors located on the Reservation, which could give up to 40 seconds advanced notice of a quake occurring. While 40 seconds is only a fraction of time, it would allow some emergency and safety precautions to occur. In addition to the direct impact of injured and structure damage, due to limited roadways in the area, should an earthquake occur on any of the existing faults in the surrounding communities, there would be impact to the QN with respect to supply chain issues and evacuation, among others.

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

Additional information on the Earthquake Hazard Program is available at: Earthquake Hazards Program | U.S. Geological Survey (usgs.gov)

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

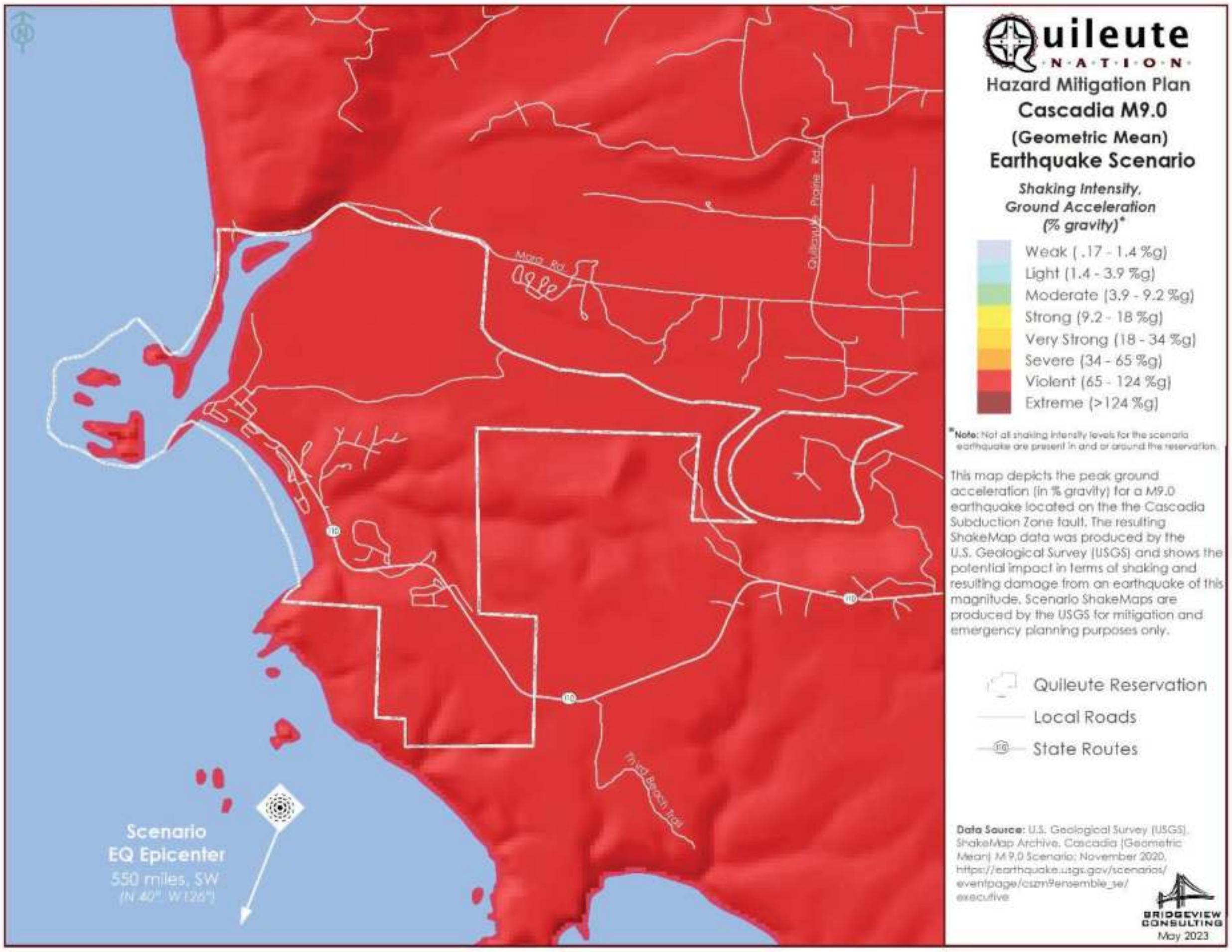
A shake map is a representation of ground shaking produced by an earthquake (Peak Ground Acceleration). The information it presents is different from the earthquake magnitude and epicenter that are released after an earthquake because shake maps focus on the ground shaking resulting from the earthquake, 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 6-9 illustrates the shaking intensity.



*Note: Not all shaking intensity levels for the scenario earthquake are present in and or around the reservation.

This map depicts the peak ground acceleration (in % gravity) for a M9.0 earthquake located on the the Cascadia Subduction Zone fault. The resulting ShakeMap data was produced by the U.S. Geological Survey (USGS) and shows the potential impact in terms of shaking and resulting damage from an earthquake of this magnitude. Scenario ShakeMaps are produced by the USGS for mitigation and emergency planning purposes only.

Data Source: U.S. Geological Survey (USGS), ShakeMap Archive, Cascadia (Geometric Mean) M 9.0 Scenario; November 2020, https://earthquake.usgs.gov/scenarios/eventpage/cszm9ensemble_se/executive

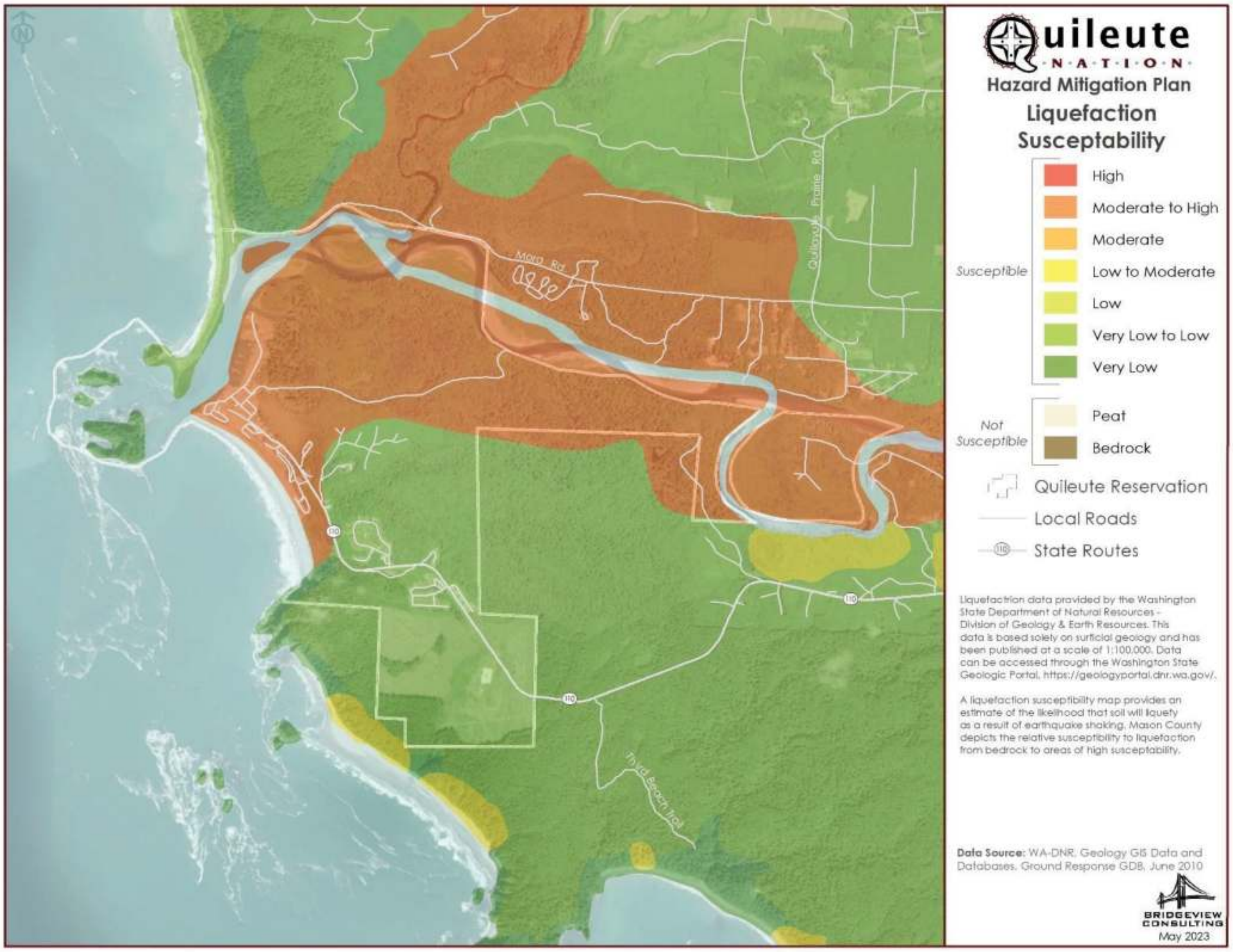
Figure 6-9 Cascadia M9.0 Earthquake Scenario Modified Mercalli Shaking Intensity

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 6-5 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 6-6 identifies the number of acres of liquefiable soil within the Reservation boundary. Figure 6-10 illustrates liquefaction susceptibility in the surrounding areas where tribal structures are located.

TABLE 6-6
ACRES OF LIQUEFACTION SUSCEPTIBILITY ON RESERVATION

Liquefaction Susceptibility Classification	Quileute Reservation
High	0.00
Moderate to High	1,108.29
Moderate	0.00
Low to Moderate	0.01
Low	0.00
Very Low to Low	0.00
Very Low	705.05
Not Susceptible to Liquefaction	
Bedrock	53.04
Peat	0.00
Water	307.45



Liquefaction data provided by the Washington State Department of Natural Resources - Division of Geology & Earth Resources. This data is based solely on surficial geology and has been published at a scale of 1:100,000. Data can be accessed through the Washington State Geologic Portal, https://geologyportal.dnr.wa.gov/.

A liquefaction susceptibility map provides an estimate of the likelihood that soil will liquefy as a result of earthquake shaking. Mason County depicts the relative susceptibility to liquefaction from bedrock to areas of high susceptability.

Data Source: WA-DNR, Geology GIS Data and Databases, Ground Response GDB, June 2010

Figure 6-10 Liquefaction Susceptibility Zones Within Reservation Boundary

6.5 PREVIOUS OCCURRENCES

Although earthquakes have been reported in Clallam County, no earthquake creating major damage has been definitively identified on the Reservation prior to the advent of the Puget Sound Seismic Network in 1969.

The most recent significant earthquake to impact the region 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. Table 6-7 lists past seismic events that have affected the Puget Sound area. [9,10] The QN

---

[9] WADNR Earthquake Energy and Frequency. Accessed 10 May 2023. Available online at: https://www.dnr.wa.gov/pictures/ger/ger_hazards_eq_mag_freq_1140.png?ahvn0n

[10] PNSN, 2022

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 damage, surrounding counties' roadways leading into the planning area were impacted.

For the QN Reservation, the largest earthquake threat would likely be from a Cascadia Subduction Zone earthquake. 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.

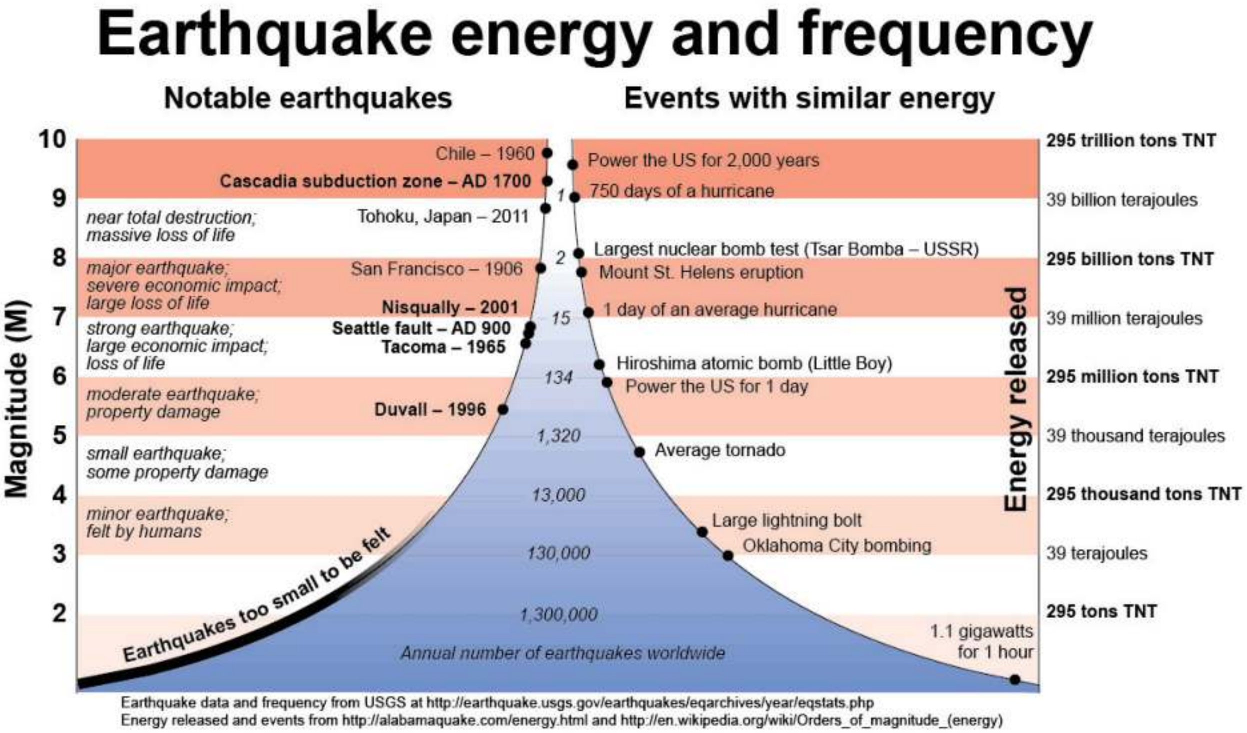
TABLE 6-7
HISTORICAL EARTHQUAKES IMPACTING THE PLANNING AREA

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
2/14/1981	5.5	Mt. St. Helens
6/8/1980	4.2	Blyn
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

TABLE 6-7
HISTORICAL EARTHQUAKES IMPACTING THE PLANNING AREA

Year	Magnitude	Epicenter
4/30/1882	5.8	Olympia area
12/15/1872	6.8	Pacific Coast

Source: Pacific Northwest Seismic Network



Earthquake data and frequency from USGS at http://earthquake.usgs.gov/earthquakes/eqarchives/year/eqstats.php
Energy released and events from http://alabamaquake.com/energy.html and http://en.wikipedia.org/wiki/Orders_of_magnitude_(energy)

Figure 6-11 Earthquake Energy and Frequency

6.5.1 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. Figure 6-11 (above) illustrates the energy and frequency associated with some of the historical earthquakes occurring.

USGS ground motion maps based on current information about fault zones show the PGA that has a certain probability (2 or 10 percent) of being exceeded in a 50-year period. The PGA is measured in %g. Figure 6-12 shows the PGA with a 2 percent exceedance chance in 50 years in Washington.

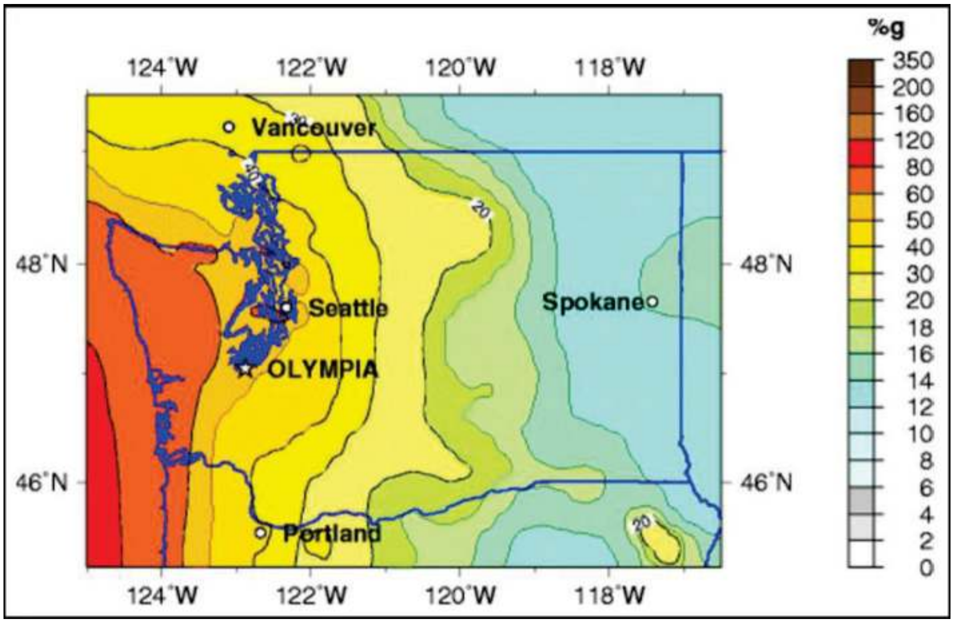


Figure 6-12 PGA with 2-Percent Probability of Exceedance in 50 Years, Northwest Region

For the QN, 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 6-13 illustrates the potential peak ground velocities for such an event (Frankel, 2018).

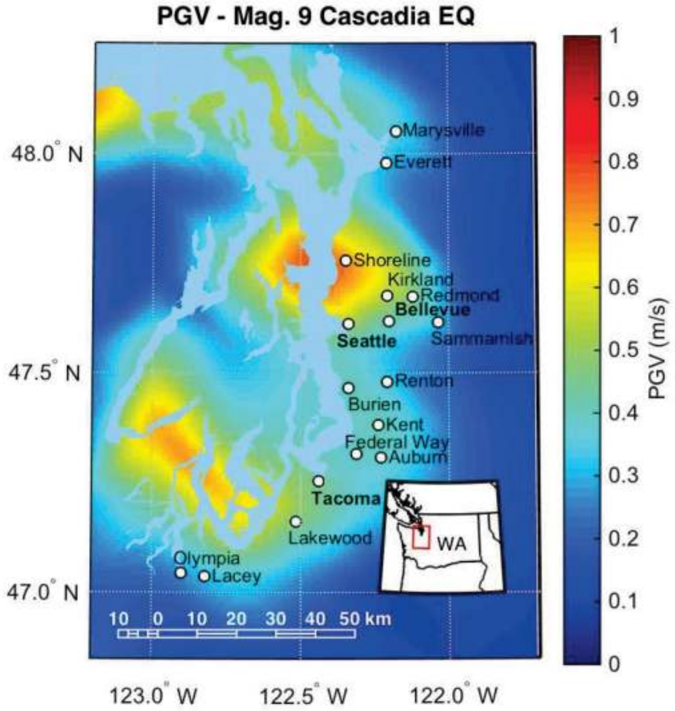


Figure 6-13 Estimated Peak Ground Velocities - M9.0 Cascadia Subduction Zone Earthquake

6.5.2 Frequency

Scientists are currently developing methods to more accurately determine when an earthquake will occur, determining the probability of an earthquake in a given period using 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.

6.6 VULNERABILITY ASSESSMENT

6.6.1 Overview

Several faults within the planning region have the potential to cause impact. The Cascadia Subduction Zone fault is approximately 83 miles offshore to the Reservation. There are several additional faults along the coastal areas of Clallam County which would also have the potential to impact Tribe, including potential tsunami wave impact and impact to major roadways used for ingress and egress, 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 or air 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. These do not have to be in the immediate vicinity to cause concern or issues.
- 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 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 someone to get under a desk, step away from a hazardous material they are working with, or shut down equipment. As indicated, there are no such monitors on the QN Reservation.

6.6.2 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. The Tribe identifies ~525 individuals living on the Reservation, not inclusive of guests, visitors, and employees. Additional consideration would also include individuals seeking services or referrals for health and other services which the QN provide.

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, approximately 59 residents are over 65, with 44 children 5 years of age or under. This does not include additional family members which may be visiting Tribal Members or living within multi-generational houses.

Also for consideration would be the number of tourists traveling to the ocean beaches or to the Olympic National Park and Forest, which would travel in direct proximity to the Reservation. The Olympic National Park estimates over 3 million people visit the area annually (2019 count). The Tribe also has a robust tourism industry, including the hotel, restaurant, RV park, a marina which provides fishing excursions, and other enterprises that draw large populations to the Reservation. While statistically not identified, it is estimated that this number could exceed over a hundred thousand guests monthly traveling to or through the area during peak seasons that would be vulnerable.

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 have its own police and fire services, but also rely on the local municipalities to provide mutual aid should resource requests exceed QN capacity; however, with all of the surrounding areas also impacted should a significant earthquake occur, mutual aid would be very limited.

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 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.

6.6.3 Impact on Property

All structures owned by the Tribe are at some risk to impact from earthquake. The current plan includes ~54 critical facilities analyzed during this assessment, with a potential of an additional 150 residential structures. Total critical facilities' value is approximately $74 million dollars. Due to the area of impact and the proximity to a fault or epicenter location, all structures could be impacted. This update did not review the general building stock due to ownership, focusing only on tribal owned critical assets.

Building Age

Chapter 3, Section 3.5.3 identifies the age of structures owned by the QN which were included in this update. While older structures have an increased impact potential, for the QN, 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 anticipated development occurring as a result of the *Move to Higher Ground* initiative, as development occurs, the older structures on the lower portion of the Reservation will be removed as they are replaced in the new area. The newest structure, the school, was completed in 2022 along with the Tribe's new water system. The QN 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 QN 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 1974, so it is assumed that buildings in the planning area built after 1974 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.

6.6.4 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 distribution of structures owned by the QN 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 information 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. Section 3.5.3 discusses the age of the structures, as well as the applicable building code standards.

Of the 54 structures identified:

- 25 (including generators) are in a moderate to high liquefaction susceptibility zone (EQ Soil Type E)
- 29 are in the very low liquefaction susceptibility zone (soil types C and D)

Earthquakes may trigger fires, dock/dam/levee/dike/seawall 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.

Earthquakes can also cause disruption to communications, electrical power, wastewater and potable water services and supplies. Such disruptions should be expected. In the event of a major earthquake, areas lying within the floodplain are susceptible to liquefaction. 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 along the roadways.

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. There are also forestry roads, which could be used for evacuation purposes during an earthquake and potential ensuing tsunami, but those roadways could also be impacted by debris and potential flooding.

The Tribe has previously experienced isolation as a result of roadways being impacted by flood events on a fairly regular basis (at least 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 in surrounding counties 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. The Tribe works in unison with the federal, state and local municipal road maintenance personnel to maintain roadways in good repair. Closure of major arterials would 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.

6.6.5 Impact on Economy

Economic losses sustained as a result of an earthquake include damage to the marinas, buildings, including the cost of structural and non-structural damage, damage to contents, and loss of inventory, loss of wages, and loss of income. Structure value for the QN for its 54 critical facilities assessed in this plan update are approximately $74 million, not inclusive of content value. This is also not inclusive of additional structures owned by the QN not considered critical infrastructure or structures which would be impacted.

The QN does have several significantly large businesses which currently operate both on and off the Reservation, employing hundreds of personnel, both tribal and non-tribal. Economic impact would also include loss to the various business ventures owned and operated by individual tribal members. The value of economic loss cannot be identified in this assessment but is anticipated to rise to several hundreds of thousands of dollars per month. The Tribe also has 22 acres in Forks, which is identified as an area for major economic development. Impact to the Forks Bridge leading into Forks would significantly impact the economy of those businesses. The Bogachiel River Bridge would also be at risk, which would also jeopardize the water main traveling along the bridge and Highway 110 near Three Rivers.

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.

6.6.6 Impact on Environment

Earthquake-induced landslides up or down-stream of rivers or streams can significantly impact habitat on the QN 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 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. The Tribe does have fueling stations, both commercial at the marina and for tribal vehicles, which could be impacted. There is also a storage of chemicals utilized for various purposes by the Tribe (e.g., chemicals for the hatchery, etc.). Several of the residential structures (both tribal and non-tribal) also maintain propane tanks. Due to the nature of the hatcheries, as the Tribe relocates to higher grounds, the hatcheries will remain in their current location to allow access to the river and proximity to the ocean.

6.6.7 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.

6.7 FUTURE DEVELOPMENT TRENDS

The QN 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 Move to Higher Ground initiative, new structures are built to the current standards in place at the time of construction, with the older structures on the lower reservation removed over time as they are replaced, 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.

Construction which has occurred since completion of the last plan include the school (2022), water system and tower (2022), marina update (2014 plus annual update), and accounting center (2022) have been built to higher standards. Several of the older structures have been removed when the newer structures are completed, such as the old gym and community center. All new structures have not only been built to existing earthquake standards, but are also outside of the tsunami inundation zone, which is a secondary hazard associated with earthquakes.

The soils in the various areas of construction are also different in some instances, providing greater support with respect to liquefaction that exists on the lower portions of the reservation, which is in very close proximity to both the coastline and the various riverbeds. The Tribe does not feel that the development which 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 and replaced in areas outside the hazard zones, or enhanced to the newer building code standards.

6.8 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. Warning systems in place could give approximately 40 seconds notice that a major earthquake is about to occur. While this would not provide adequate time for preparation, it would provide limited time to turn off machinery or seek cover, at the least. Earthquakes of M6 or higher would lead to massive structural failure of property on NEHRP C, D, E, and F soils. Seawalls, dikes, 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 QN 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.

6.9 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 QN would be impacted to some degree, with newer structures theoretically sustaining less damage as a result of more stringent building codes in place. The Nation lacks redundant water supply systems in certain areas, which is something that has previously been identified as a mitigation strategy. Several structures also lack generators. The existing seawall, while updated in certain parts, is of concern for failure as a result of an earthquake.

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 (Clallam County). Municipalities within the surrounding counties (Jefferson, Grays Harbor, and Kitsap Counties) have a large number of older structures, particularly in the downtown hub areas. As some tribal members live in the surrounding counties, 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 large town, and the response capabilities both by the tribe itself, or through services provided by Clallam or Jefferson Counties, or other local service provider (e.g., fire districts).
- While the Tribe maintains law enforcement and fire response, they are of limited size, particularly when considering the potential number of individuals needing assistance or medical care. 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, and medical services.

- With the potential of a Cascadia event generating a significant tsunami wave, 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 QN Reservation within 10 minutes based on WA DNR's analysis (WA DNR, 2022).
- The structural integrity of the Forks and Bogachiel bridges and other major 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 remaining roadways at a standstill. Should a Cascadia event occur during a summertime month when a high number of tourists are in the area, resources and supplies (including medical) throughout the entire region would be significantly taxed in addition to roadway congestion.
- 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 7.
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.

7.1 GENERAL BACKGROUND

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

- Riverine flooding, including overflow from a river channel, flash floods, alluvial fan floods, dam-break floods and ice jam floods;
- 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 Reservation)
- Sea level rise;
- King/High Tides; and
- Climate Change.

7.1.1 On-Going Study and Efforts

Concurrent with this plan update, Clallam County is in the process of a RiskMap project and new flood maps. The study includes conducting a review/analysis of the best available data to identify specific flooding sources, relative magnitudes, and their pathways. When completed, the results of the study will provide specific recommendations for improving flood protection and resiliency, both in the long- and short-term, as well as providing flood impact data. That data will develop additional mitigation strategies, which the QN can utilize to reduce the impacts of flooding. Preliminary maps were issued in 2019.

As the scope of the study by FEMA includes a detailed analysis, for purposes of this update, due to the time constraints associated with the Congressional Earmark and utilization of those funds, the planning team elected to utilize existing data developed by FEMA for the QN with the intent of meeting HMP requirements, allowing this plan to be completed more expeditiously. Once the final FEMA study is completed, the QN will utilize that data to update this flood chapter to provide a better understanding of the potential impacts of flood on the QN Reservation, as well as potentially updating the mitigation strategies to incorporate new projects.

Also ongoing as of this update is a continued effort for the Quillayute River Restoration project which is attempting to provide alternative methods of redirecting the Quillayute River away from its previous river channel, which, if it resumes the old channel, would inundate and flood the village in La Push.

The Quileute Tribe has been awarded federal and state funding to construct a habitat restoration and bank stabilization project on the Quillayute River. The proposed project would take place partly on Tribal Trust Indian land and partly within Olympic National Park.[11]

The Tribe also has various climate change analysis ongoing in an effort to assist with potential impacts associated with increased flooding as it relates to climate change, expanding erosion, and impact to the survival of various salmon species native to the Reservation.

Commencing in September 2023, the USACE will begin repairs on the Quillayute Sea Dike. The Dike is vital to supporting the Coast Guard Station on the Quillayute River, as well as protecting the marina and community located on the QN Reservation. Figure 7-1 and Figure 7-2 illustrate the project area and dike.

The dike protects the Quillayute River Navigation Channel by reducing incoming wave transmissions. This protection is critical because damage from waves and/or current forces the dike has experienced over its lifetime has made it undersized and no longer able to provide the needed protection to the community. The project will restore the dike structure to its authorized height 8 feet above mean lower low water within the approved in-water work window Sept. 1, 2023, through March 1, 2024. This work window is also beneficial because wave and tide conditions are favorable.[12]

---

[11] Further information available at Quillayute River Restoration - Reach 3 Environmental Assessment (quileutenation.org) Accessed 10 April 2023.

[12] US Army (2023). Accessed 13 April 2023. Available online at: Corps of Engineers dike repairs will protect 800-year-old fishing village | Article | The United States Army

Figure 7-1 Quillayute Estuary in Marina and Waterfront Area of La Push

Figure 7-2 Portion of Quillayute Sea Dike in La Push

7.1.2 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, ice/debris jam floods, and floods associated with local drainage or high groundwater. On the QN, the two primary types of flooding to occur include coastal and riverine, although others have also occurred.

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.

Shallow

Shallow floods may include urban flooding, areas with gentle slopes and no defined channels with an average depth limited to 3.0 feet or less, or flat areas along riverbanks which may covered for days after a flood event.

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, 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 areas of the Reservation. 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.

Ice/Debris Jam Flooding

Floating debris or ice accumulates at a natural or man-made obstruction in rivers and restricts the flow of water, causing it to leave the bank-full width of the river and spill onto the flood plain and beyond. This flood type is common along rivers in response to the steep canyon walls geographically arranged to receive heavy rains from the ocean while large organic matter in the form of trees and roots is transported downstream. Both of these long river systems transport significant amounts of large organic debris through the river systems on their way to the ocean.

7.1.3 Measuring Floods and Floodplains

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

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

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

- Major Flooding—Extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations.

7.1.4 Flood Insurance Rate Maps

According to FEMA, flood hazard areas are defined as areas that are shown to be inundated by a flood of a given magnitude on a map (see Figure 7-3). These areas are determined using statistical analyses of records of river flow, storm tides, and rainfall; information obtained through consultation with the community; floodplain topographic surveys; and hydrologic and hydraulic analyses. Three primary areas make up the flood hazard area: the floodplains, floodways, and floodway fringes. Figure 7-4 depicts the relationship among the various designations, collectively referred to as the special flood hazard area. Figure 7-5 identifies the coastal flood zones.

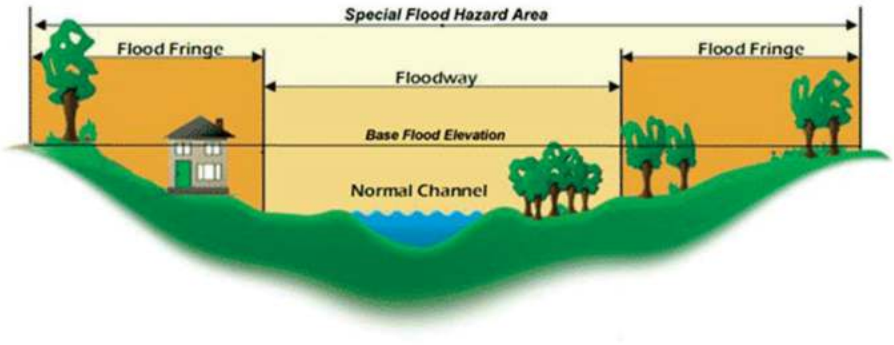
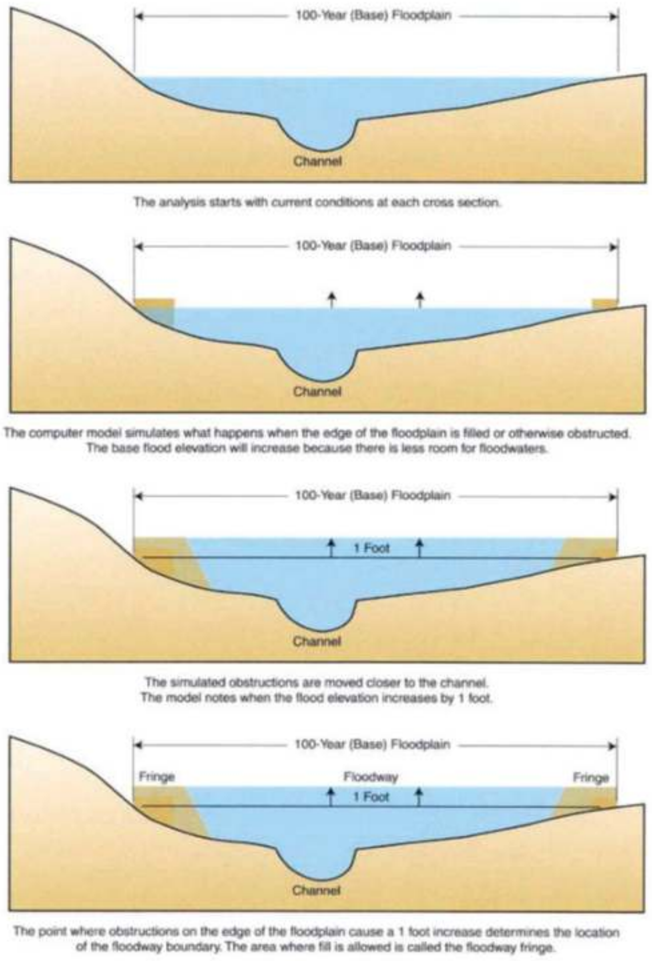


Figure 7-3 Flood Hazard Area Referred to as a Floodplain



The analysis starts with current conditions at each cross section.

The computer model simulates what happens when the edge of the floodplain is filled or otherwise obstructed. The base flood elevation will increase because there is less room for floodwaters.

The simulated obstructions are moved closer to the channel. The model notes when the flood elevation increases by 1 foot.

The point where obstructions on the edge of the floodplain cause a 1 foot increase determines the location of the floodway boundary. The area where fill is allowed is called the floodway fringe.

Figure 7-4 Special Flood Hazard Area

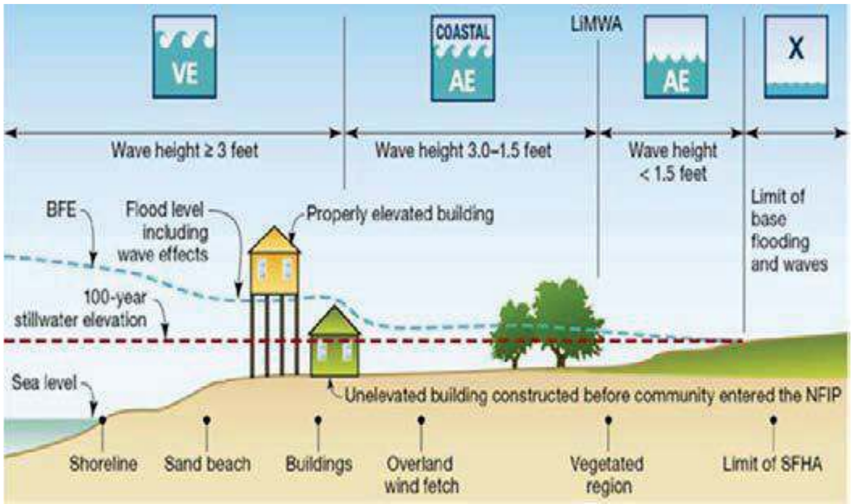


Figure 7-5 Coastal Zones Graphic

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 7-1 identifies the various rate map zones.

<table>
<tr><th colspan="2">TABLE 7-1
FLOOD INSURANCE RATE MAP ZONES</th></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td>Zone</td><td>Description</td></tr>
<tr><td>B and X (shaded)</td><td>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.</td></tr>
<tr><td>C and X (unshaded)</td><td>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 levees from 100-year flood.</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td>Zone</td><td>Description</td></tr>
<tr><td>A</td><td>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.</td></tr>
<tr><td>AE</td><td>The base floodplain where base flood elevations are provided. AE Zones are now used on new format FIRMs instead of A1-A30 Zones.</td></tr>
<tr><td>A1-30
(old map format)</td><td>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.)</td></tr>
<tr><td>AH</td><td>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.</td></tr>
<tr><td>AO</td><td>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.</td></tr>
<tr><td>AR</td><td>Areas with a temporarily increased flood risk due to the building or restoration of a flood control system (such as a levee or a dam). Mandatory flood insurance purchase requirements will apply,</td></tr>
</table>

TABLE 7-1
FLOOD INSURANCE RATE MAP ZONES

	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 - a statistical tool used to define the probability that a certain river discharge 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 7-2
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%

7.1.5 National Flood Insurance Program (NFIP)

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

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

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

- New buildings and those undergoing substantial improvements must, at a minimum, be elevated to protect against damage by the 100-year flood.
- New floodplain development must not aggravate existing flood problems or increase damage to other properties.

- New floodplain development must exercise a reasonable and prudent effort to reduce its adverse impacts on threatened salmonid species.

NFIP Status and Severe Loss/Repetitive Loss Properties

The QN is a member of the NFIP, Community Number 530335. The Tribe does have regulatory authority within its land use planning which regulates development to IBC standards. The Tribe has FEMA-developed flood maps (2019). That data has been used to project the floodplain areas in this plan. The Tribe has four policies in force as of April 2023, valued at $538,000 of insurance in force.

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 QN, as appropriate, will continue to work with the state in its endeavor to reduce impact from flooding within the tribal planning area. At the QN's election, this may include seeking opportunities for mitigation funds under the various Stafford Act Grant Programs.

- The Tribe has no repetitive flood claims under FEMA.

Tribal Repetitive Loss Strategy:

The QN 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 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 QN.

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.

- The QN has no severe repetitive loss properties.

The Community Rating System

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

- The QN is not a CRS Community.

7.2 HAZARD PROFILE

7.2.1 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, but nonetheless significantly impacting the Reservation. Flooding is most often due to riverine or coastal flooding. Riverine flooding is customarily caused by increased levels of precipitation, or snow melt occurring, causing the river to overflow onto its banks and surrounding area. Coastal flooding is most often caused by severe storms and storm surge from the ocean, particularly when accompanied by king tides.

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 waterbodies traveling through the Reservation. The Tribe is partially protected by a USACE sea dike and jetty, constructed to dissipate wave action or ocean swell to help protect the Tribe’s marina and the existing USCG station, as well as the La Push flood berm, which helps reduce the frequency of flooding in La Push.

The primary river in the area is the Quillayute River, which has historically, and continues to threaten to flip its banks back into an old channel between river miles 2 and 3. Should this occur, the water of the river will flow directly towards the lower portion of the Quileute Village of La Push. The Quillayute River is fed by four major tributaries (Dickey River, Sol Duc River, Bogachiel River, and Calawah River) and has a total watershed area of 627 square miles. The river is tidally influenced by Smith Slough.

Local flooding regularly blocks access to the primary highway (101 and 110) providing ingress and egress to the reservation, which leads to the closest hospital, approximately 65 miles away. Thunder Road is a 1.2-mile-long gravel-surfaced road that leads from the village of La Push to Thunder Field, a vital access point along the left bank of the Quillayute River used for tribal fishing access, hunting, gathering, ceremonies, and recreation. Mora Road runs along the north side of the river and provides public access to Olympic National Park at Mora Campground and Rialto Beach (see Figure 7-6). Mora Road is also an important access route to tribal land north of the Quillayute River, and it facilitates dredging and jetty maintenance activities that are critical for the safety of La Push and the continued operation of the marina and USCG station.

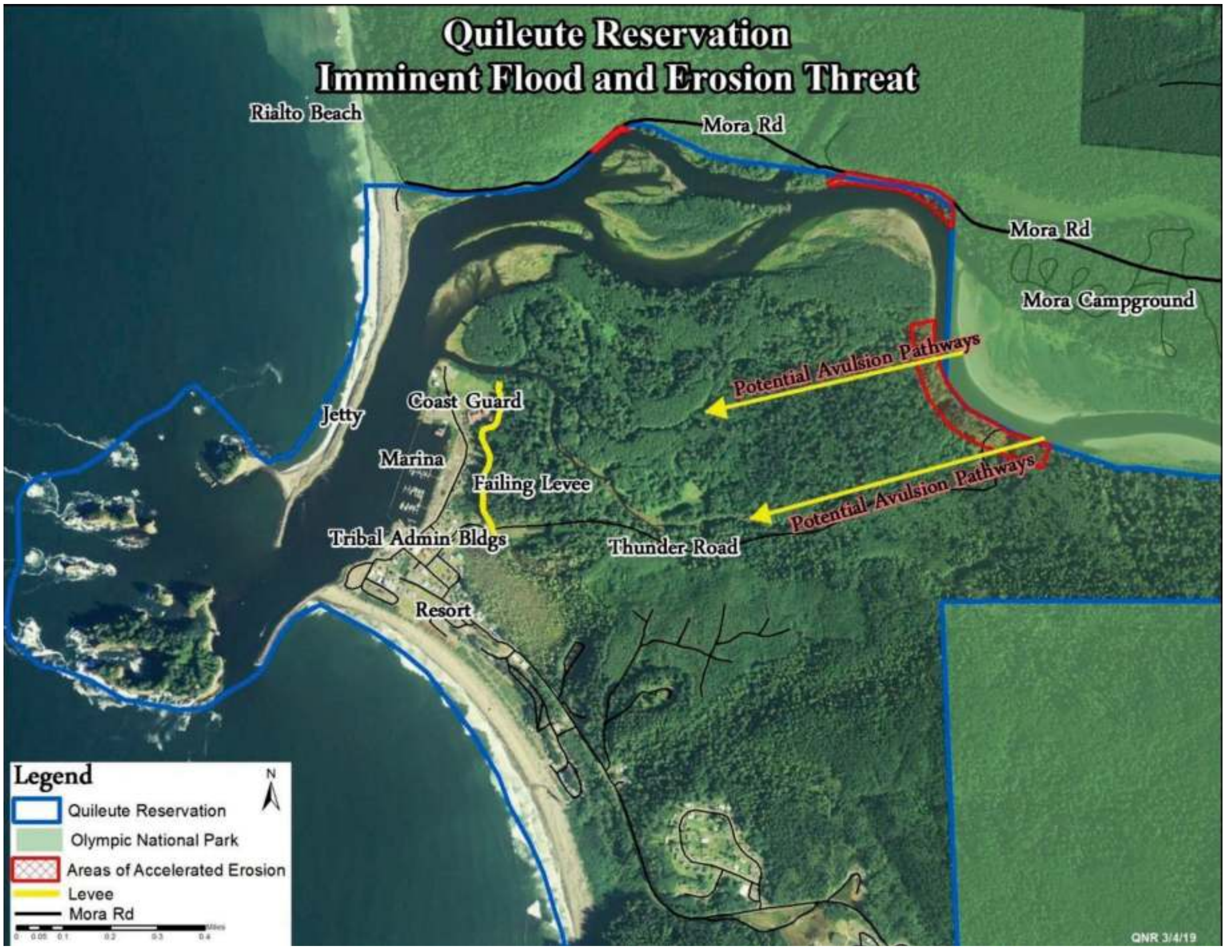


Figure 7-6 Potential Flood Threat on the Quileute Reservation
(Image Credit – Quileute Tribe)

Figure 7-7 October 2003 Flooding of the Quillayute River

Tribal members have noted that over the course of time, storm events which have caused flooding have grown more intense, eroding the shoreline and damaged the tribe's protective jetty. USACE has previously performed emergency repairs on the jetty, and also periodically dredges the water courses at the mouth of the Quillayute River to maintain the navigation channel.

Figure 7-7 illustrates the impact from the October 2003 Flooding of the Quillayute River into Smith Slough, flowing into the Quileute Village of La Push.

At present, much of the reservation land mass falls within the 100-year flood zone or the coastal flood zone; however, structure impact based on FEMA's RiskMap study of the identified 100-year flood zone is limited. The Tribe, from experience, does not agree with FEMA's determination, and does feel like there are additional areas which are frequently flooded which are not identified in the NFIP maps.

Causes of Flooding

All of the rivers and streams on the Reservation carry tremendous volumes 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 rivers and streams running through the Reservation have greater 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 induce or increase flooding. River floods occur most often when winter storms bring heavy rains from the southwest, or during a rain-snow event, with temperatures rising quickly melting accumulated snow.

Because the Reservation is bordered by the Pacific Ocean with the mouth of the Quillayute 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 rivers to rise and flooding portions of the Reservation.

Warning

The ability of weather forecasters to provide early warning to citizens when significant weather-related events are to occur does provide residents with early warning to prepare (including the potential to evacuate) prior to the weather system arriving. Due to the geologic and physical environment of the Reservation, areas 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 are blocked by floodwaters, causing people to be unable to engage in normal activities of traversing roadways, and causing isolation of the area.

FEMA Flood Maps

FEMA previously performed a Flood Insurance Study (FIS) for Clallam County since completion of the last plan; however, the QN has not yet adopted the maps. For purposes of this plan update, the 100-year floodplain generated by FEMA has been utilized in this analysis, as has the 500-year analysis. The various flood zones associated with the study are illustrated in Figure 7-8. As indicated, these maps may be updated once FEMA's FIS study is completed.

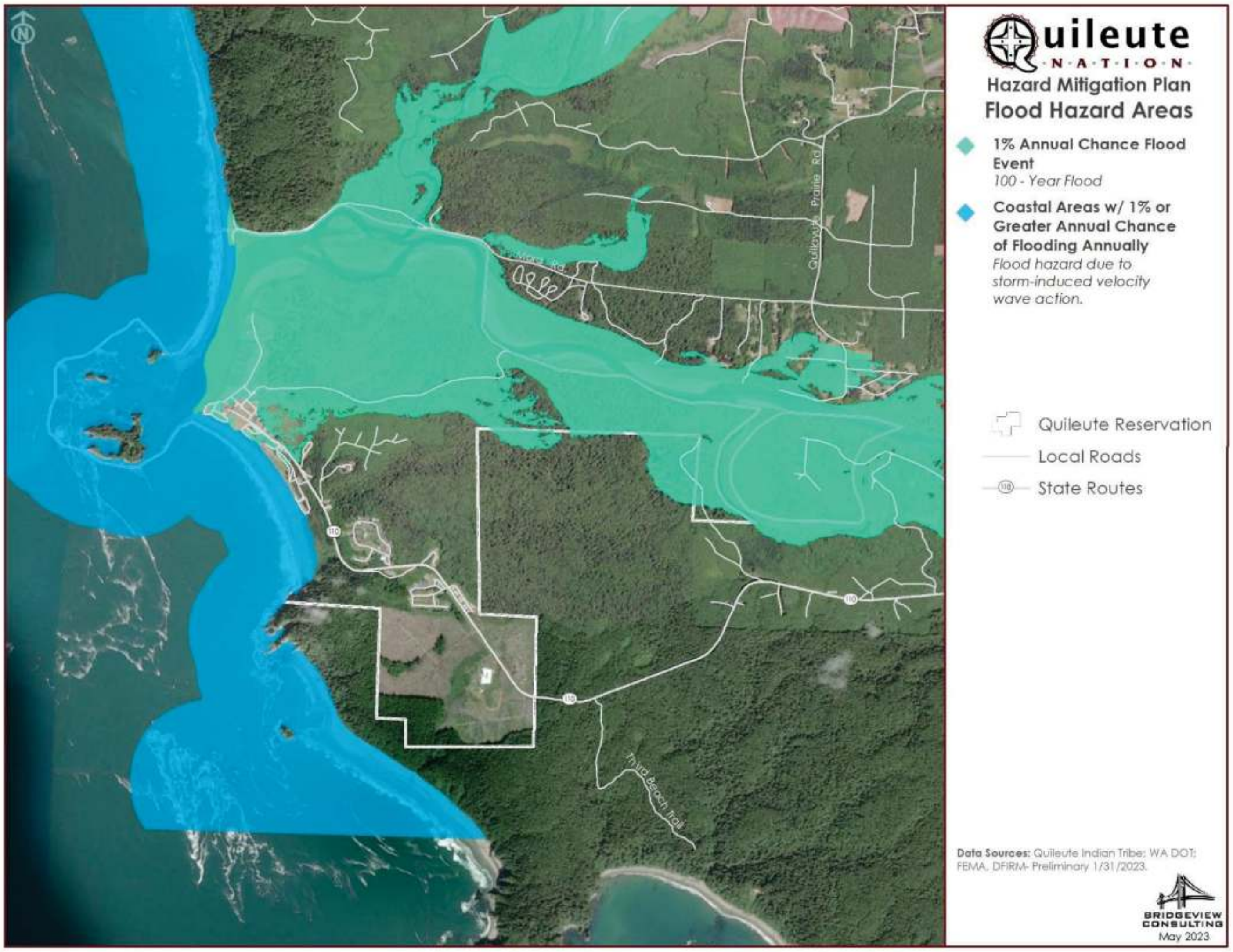


Figure 7-8 QN Flood Hazard Areas

7.2.2 Previous Occurrences

Flooding has a long history on the Reservation. Major floods in the planning area have resulted from intense rainstorms customarily between October and March. The months highest in number for declared flood events are December (three events), November and January (two events each), and March (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 December to 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 the water levels on the river to rise, flooding the Reservation. Review of existing data does illustrate high tides associated with flooding or severe storm events occurring with some frequency during December and May.

Floods on the Reservation have damaged governmental structures, roads (particularly SR110) and bridges (Bogachiel River Bridge on SR110 – both abutments and bridge deck, and the Forks Bridge), eroded public and private properties, and regularly interrupted transportation. Road and bridge washouts near the Reservation and elsewhere in Clallam and Jefferson Counties in recent years have isolated portions of the Reservation. Rising waters on the rivers have also necessitated sandbagging and other emergency measures (USACE repairs to the sea dike and jetty) for areas impacted.

As identified in Chapter 3, Section 3.5 – Major Past Hazard Events Table, the planning area has received eight flood-typed disaster declarations in Clallam County. Because limited data is available for the QN independent of County data, such was used to populate this data. At present, the dollar value of property damage on the Reservation is unknown. In the future, the Tribe may begin a system for maintaining historical data specific to the Reservation.

7.2.3 Severity

The severity of a flood depends not only on the amount of water that accumulates in a period of time, but also on the land's ability to manage this water. One element is the size of rivers and streams 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 gauge data which is available real-time for viewing. Figure 7-9 through Figure 7-11 illustrate the type of data available from the USGS.[13] There are several gauges providing data for the area of the QN. Readers may elect to obtain data on stream gauges directly from the USGS at: Quillayute River at River Mile 6.2 - USGS Water Data for the Nation

---

[13] USGS WaterWatch -- Streamflow conditions

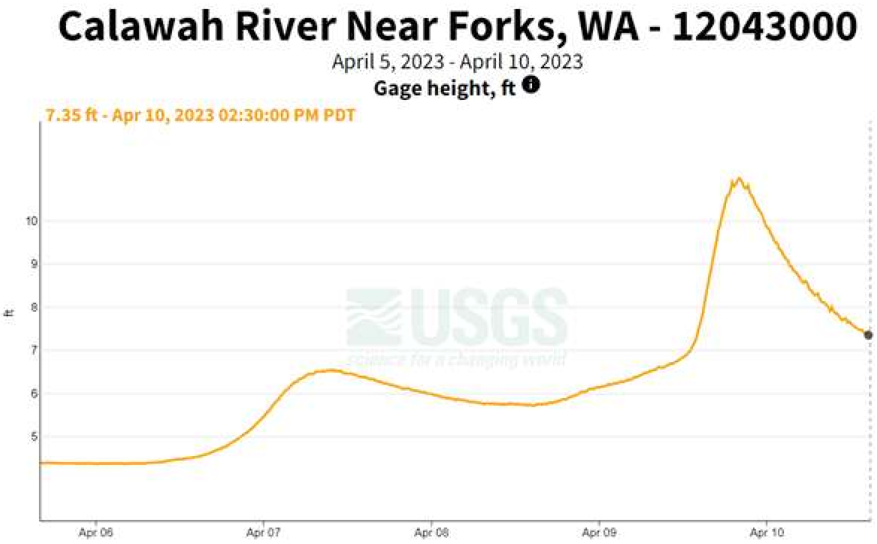


Figure 7-9 Sample Calawah River Near Forks USGS Gauge Data

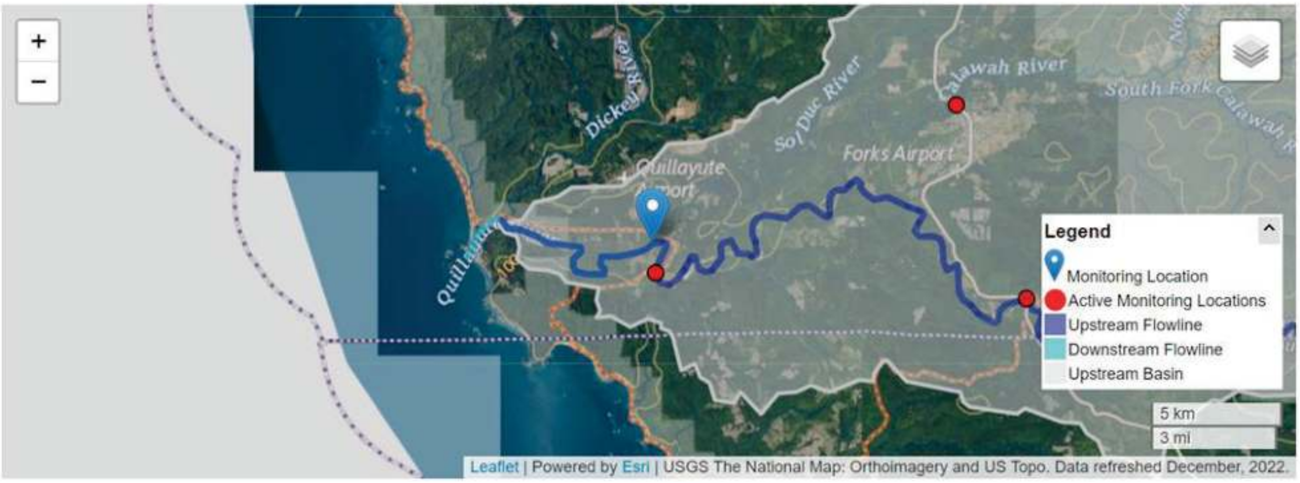
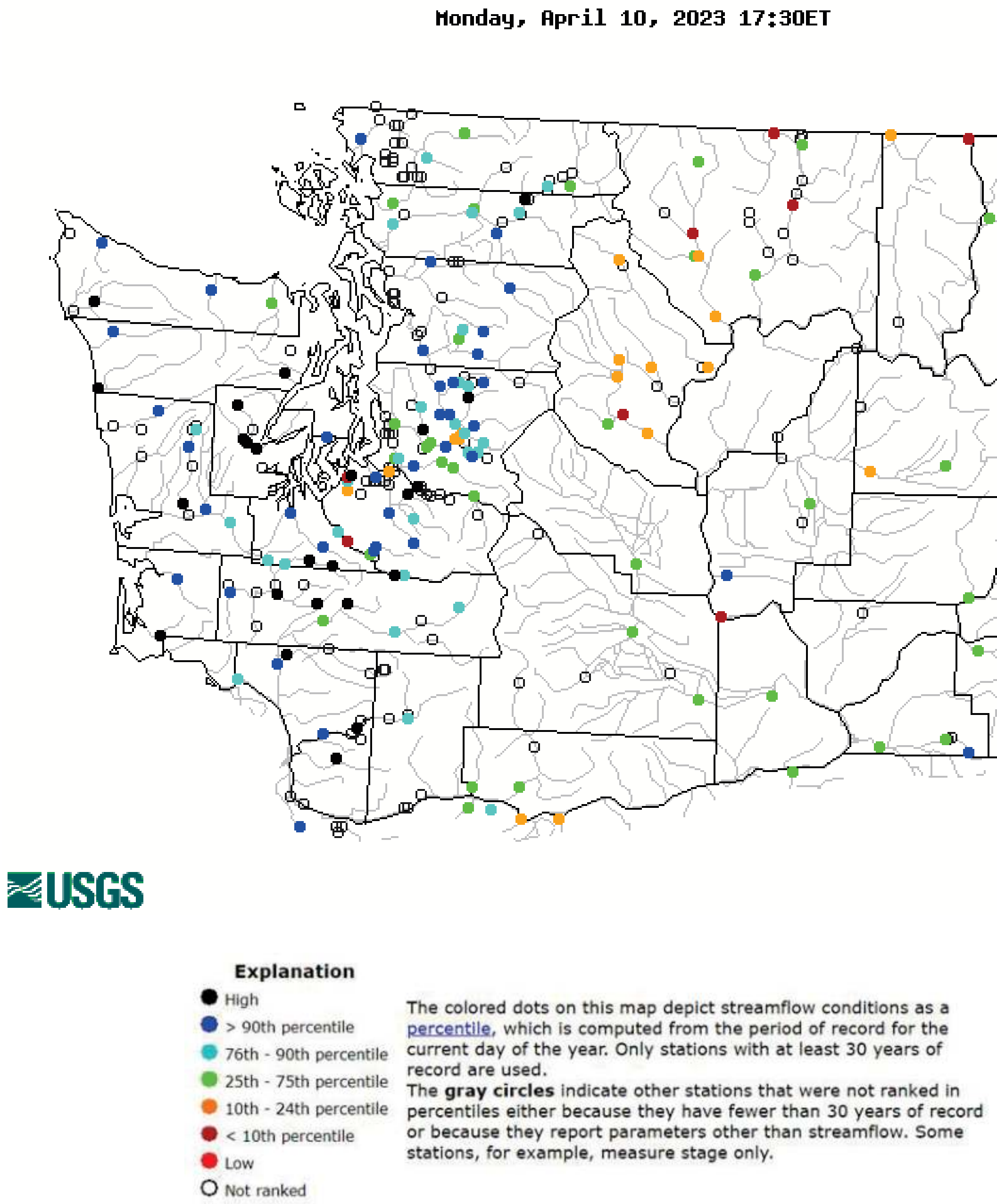


Figure 7-10 Stream Gauge Monitoring Data



Explanation

- ● High
- ● > 90th percentile
- ● 76th - 90th percentile
- ● 25th - 75th percentile
- ● 10th - 24th percentile
- ● < 10th percentile
- ● Low
- ○ Not ranked

The colored dots on this map depict streamflow conditions as a percentile, which is computed from the period of record for the current day of the year. Only stations with at least 30 years of record are used.
The **gray circles** indicate other stations that were not ranked in percentiles either because they have fewer than 30 years of record or because they report parameters other than streamflow. Some stations, for example, measure stage only.

Figure 7-11 USGS Stream Flow Data for April 10, 2023

Floods that result from rainfall on frozen ground in the winter, or rainfall associated with a warm, regional frontal system that rapidly melts snow at low and intermediate altitudes (rain-on-snow), can be the most severe. Both of these situations quickly introduce large quantities of water into the stream channel system, easily overloading its capacity.

On small drainages, the most severe floods are usually a result of rainfall on frozen ground but moderate quantities of warm rainfall on a snowpack, especially for one or more days, can also result in rapid runoff and flooding in streams and small rivers. Although meteorological conditions favorable for short-duration warm rainfall are common, conditions for long-duration warm rainfall are relatively rare. Occasionally, however, the polar front becomes situated along a line from Hawaii through Oregon and Washington causing warm, moist, unstable air to move into the region. Most winter floods develop under these conditions.

7.2.4 Frequency

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

As indicated, the Reservation is subject to flooding (of some degree) several times annually. The frequency of flooding is caused by the unique geologic and physical environment of the Reservation. While the minor floods occur primarily along only certain areas of the Reservation, the impacts can be significant, flooding buildings, homes, and impacting evacuation routes. This is particularly true when high tides and storms occur simultaneously. Although many of these events are minor, these smaller events tend to limit access to areas of the Reservation, causing isolation and disrupting services.

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 SR 110 has historically occurred every eight years. Severe storms that also include flooding occur approximately every five years. The planning area has sustained eight declared *Flood* incidents during the period 1957-2022, not inclusive of *Severe Storm/Weather* incidents which also include an element of flood. There are an additional 13 Severe Storm incidents that include some level of flooding. The “normal” flood season of October through April in Western Washington appears to be fairly consistent with respect to the rivers in the Reservation, with the latest flood disaster event being recorded in March.

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 QN to help reduce the impact of flooding as previously indicated by the various restoration projects underway. In many cases, these actions were funded or developed by the Nation.

7.3 VULNERABILITY ASSESSMENT

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

7.3.1 Overview

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

7.3.2 Impact on Life, Health, and Safety

The impact of flooding on life, health, and safety is dependent upon several factors, including the severity of the event and whether or not adequate warning time is provided to residents. The QN has not experienced the loss of life as a result of highwater levels on the Reservation.

Exposure to life, health, and safety customarily represents the population living or working in or near floodplain areas that could be impacted should a flood event occur. Currently, there are approximately 525 tribal members living on the reservation with additional family members regularly visiting, and Coast Guard service members also living in the area. The Tribe also has a large number of employees and staff, which fluctuate seasonally.

Much of the Reservation land mass falls within the 100- year flood zone or areas subject to coastal flooding, with the majority of the structures analyzed for this HMP outside of the 100-year flood zone, including the new school which opened for service in 2023. There are no structures currently identified as being within the 500-year flood zone.

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 QN 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 for the QN, drawing a fairly large population annually. Also for consideration are the millions of people annually visiting the Olympic Peninsula (based on Olympic National Park estimations). 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 QN or not. All of these individuals would also be exposed to the flood hazard as a result of inundation, flooding, and potential isolation during flood events, even those more minor in nature.

With the opening of the new school, there are also both tribal and non-tribal members in attendance. There are a total of approximately 91 students and staff that live off of the Reservation (based on 2022 enrollment) that are at the school daily, in addition to tribal students that attend the school that live on the reservation.

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 living on the Reservation, but such does not account for the transitory population also disadvantaged that may be in the area when a flood event occurs.

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. 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 which close transportation routes, there potentially could be a significant number of individuals impacted.

7.3.3 Impact on Property

Based on analysis for this 2023 update, there are 10 structures that fall within the 100-year floodplain. Of the tribal-owned residential structures, 25 fell within the 100-year flood zone based on the 2015 HMP. As indicated, based on FEMA's data, there are no structures which fall within the 500-year flood zone (or VE Flood Zone).

The Tribe has initiated removal and/or restoration of some frequently flooded structures on tribal lands which were subject to impact from floods. Such activities have been extremely important to the Nation in protecting its lands and the environment. The Tribe is also in the initial phases of redevelopment of structures with the *Move to Higher Grounds* initiative, which is out of the floodplain. Once structures are replaced in the upper portion, the properties on the lower portion of the Reservation in the flood zone may be removed.

7.3.4 Impact on Critical Facilities and Infrastructure

As indicated, 54 tribal-owned critical facilities were identified for this plan update which are considered critical in nature. Table 7-3 identifies the impact to the critical facilities which fall within the 100-year flood zone.

In addition to the facilities impacted, the majority of all roadways both on the reservation and leading to the reservation are regularly inundated to different depths, causing isolation, with flood waters in some instances rising to six feet (2015 HMP). Such has been the case many times historically on the reservation.

TABLE 7-3
IMPACT TO CRITICAL FACILITIES

Critical Facilities in the 100-Year Flood Hazard Area													
Government Function	Medical	Protective Services	Hazardous Materials	Schools	Shelter	Industrial	Commercial	Communications	Water	Wastewater	Natural Resources	Cultural	**Total**
3	**1**	**0**	**1**	**0**	**0**	**1**	**4**	**0**	**0**	**0**	**0**	**0**	**10**

7.3.5 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 the Nation and those individual tribal members which operate businesses. In the case of the QN, over the course of the lifecycle of this plan, with the *Move to Higher Grounds* initiative and the purchase of the business center in Forks, the Nation will also be establishing different types of businesses. Flooding would have the potential to impact revenue generated by the Nation, particularly if roadways leading into the tribal planning area as a whole were 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 Nation's economic loss, Tribal citizens would also be impacted due to loss of income for those that work at non-tribal owned businesses if the roadways were impassable, and they could not get to their employment venues.

7.3.6 Impact on Environment

Flooding is a natural event, and floodplains provide many natural and beneficial functions. Nonetheless, with human development factored in, flooding can impact the environment in negative ways. Because they border water bodies, floodplains have historically been popular sites to establish settlements. Human activities tend to concentrate in floodplains for a number of reasons: water is readily available; land is fertile and suitable for agriculture, farming, or forestry; 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 also has significant impact on migrating fish, which can be washed onto roadways or over levees, with no possibility of escape, or the chemicals or pollutants can wash into rivers and streams, killing the fish and their food supplies. It also significantly disrupts spawning areas. The Quileute enhance diminished salmon stocks through their own Lonesome Creek Hatchery in La Push, and share operations of the Bogachiel and Sol Duc Hatchery with the state (see Figure 7-12). Flooding has the potential to significantly impact operations and the release of stock.

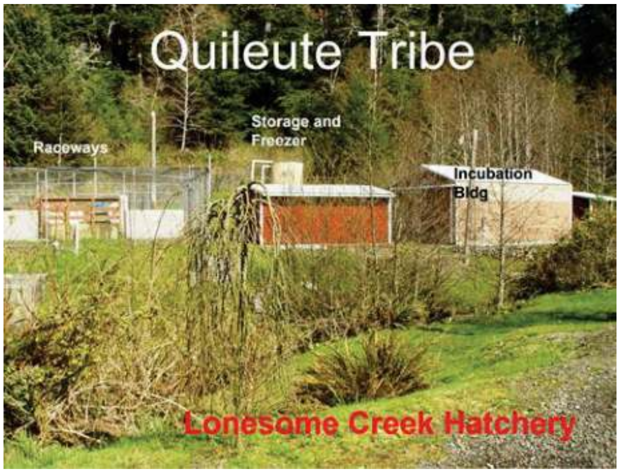


Figure 7-12 Lonesome Creek Hatchery

Keeping the marina open is a challenge because of the heavy sediment load carried by the Quillayute River and its four tributaries. This is particularly true during flood events, or during times when there is significant precipitation or snowmelt. The Nation works with various federal and state agencies to assure dredging can continue and the marina can remain operating for fishers and the US Coast Guard.

Floodplains can support ecosystems that are rich in quantity and diversity of plant and animal species. A floodplain can contain 100 or even 1,000 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.

7.3.7 Impact from Climate Change

Global climate change is expected to result in warmer and wetter winters and are projected to increase flooding frequency in most Western Washington river basins. Future floods are expected to exceed the capacity and protective abilities of many existing flood protection facilities, threatening lives, property, major transportation corridors, communities, and regional economic centers.

Based on a 2016 study completed for the Treaty of Olympia Tribes, for the QN, "[b]y the next century we can expect about one meter (39 inches,) of sea level rise but this is subject to change, based on the pace at which ice melts from glaciers and Antarctica. This should impact all low-lying coastal facilities and may cause salt-water intrusion into Smith Creek and Lonesome Creek, which our hatchery uses. It will also erode the dunes in front of our resort."[14]

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 in 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, dikes and levees, as well as the design of local wastewater treatment facilities and storm drains.

---

[14] Climate Change Vulnerability Assessment for the Treaty of Olympia Tribes. Accessed 11 April 2023. Available online at: [Microsoft Word - April 2017 UPDATE to Sept. 2016 CLIMATE PLAN FOR THE QUILEUTE TRIBE - Copy (quileutenation.org)]

Sea Level Rise

Sea level and temperature are interrelated. 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. 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. As indicated, based on a 2016 study completed for the Treaty of Olympia Tribes, it is anticipated that for the QN, an increase is sea level can be expected of approximately 39 inches.

7.4 FUTURE DEVELOPMENT TRENDS

The area in general is extremely rural, which does present drawbacks with respect to available resources and infrastructure. Development has affected the natural features of the land over time as the area has been developed from a wilderness setting 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 due to exposure of the older structures. Encroachment on floodplains by structures and fill material does reduce carrying capacity and increases flood heights and velocities. As indicated, the Nation does work with other state and federal agencies in an attempt to continue mitigating the flood issue, including the dredging of the Quillayute River to help reduce the flood impact.

The QN has established land use regulations, including a flood ordinance, and does have some NFIP flood policies in force. The Tribe is prepared to address flooding issues through various mitigation activities, including its restoration projects, and building outside of the floodplain when new construction occurs, such as in with the *Move to Higher Ground* initiative. 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 Nation deems appropriate, thereby decreasing the level vulnerability since completion of the last plan.

7.5 ISSUES

Significant portions of the QN 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 March/April. 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 various rivers' abilities 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.

7.6 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 several flood events annually, albeit not to the level of a disaster declaration. The area has been impacted a total of eight times for flood-typed events, and 13 times for severe weather events which include flooding since 1957 at the level to gain a federal disaster declaration. 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 QN 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. Flood events could also impact water quality, and water sources, impacting people and the natural resources of the QN. Of additional consideration are the Nation's 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 2.95 with overall vulnerability determined to be a high level.

CHAPTER 8.
LANDSLIDE

8.1 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.

8.2 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 8-1 through Figure 8-4. 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.

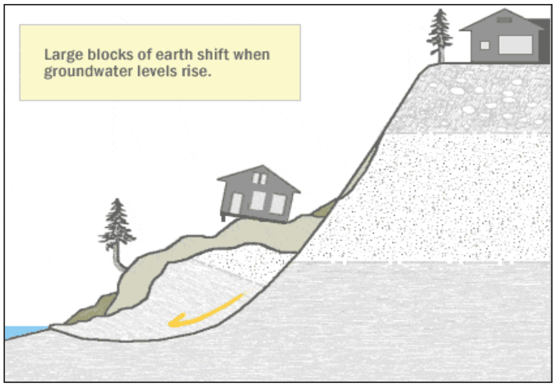


Figure 8-1. Deep Seated Slide

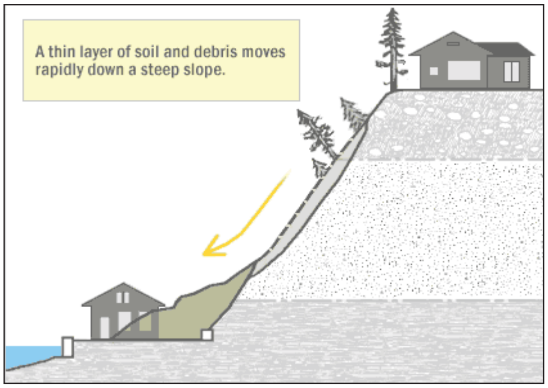


Figure 8-2. Shallow Colluvial Slide

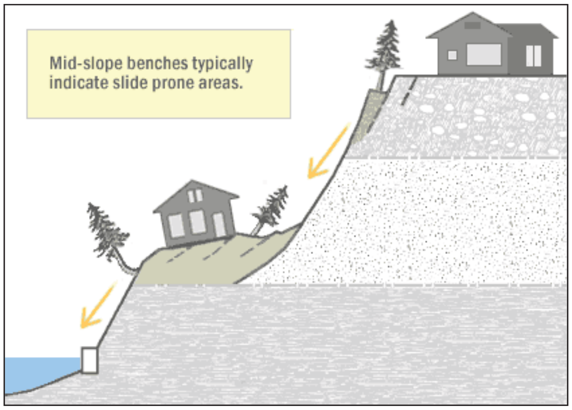


Figure 8-3. Bench Slide

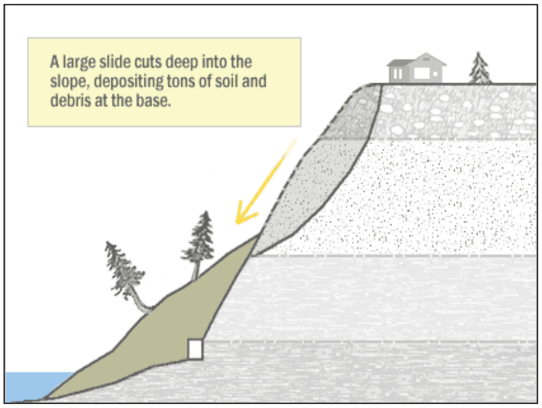


Figure 8-4. Large Slide

Slides and earth flows can pose serious hazard to life and property, particularly in hillside terrain. In some cases, they tend to move slowly, while in other cases, it is a sudden action. 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 devastating, causing loss of life or injuries, 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 wave action, 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 (and other) 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 slope 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.

Identification of Hazard Areas

Historical occurrences, combined with analysis of the slope and the type of soil, are the most effective indicator of areas at risk to landslide and the exposure vulnerable to landslide impact. 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).

The purpose of this planning document is not to conduct an assessment of the landslide danger or identification of the erosion hazard areas, as such process exceeds the purpose of this document and requires subject matter expertise by professionals in the field well beyond the scope of this planning effort. As such, information contained in this section should not be utilized for life safety purposes. No landslide or erosion hazard analysis was conducted, but rather, only reprojection of existing data. Additional publicly available landslide data is available at: http://www.dnr.wa.gov/programs-and-services/geology/geologic-hazards/landslides

8.2.2 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 may not be 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.

For the QN, review of existing data for this 2023 update and review of the Tribe's 2015 HMP indicates that there have been no landslides which have occurred on the Reservation, although landslides have been identified as part of the severe weather hazard impacting Clallam County, including the roadways providing ingress and egress to the Reservation.

While shorelines in general along the state's Pacific Coast have been identified in the State's HMP and by WDNR as being prone to landslides, including earthquake-induced landslides, the beach within the Reservation, with the exception of the two islands off the coast of the Reservation and the area below Lonesome Creek, tends to be flat (2015 QN HMP). There are sections of the Reservation's coastline that are susceptible to earthquake-induced landslides, as are the narrow strips of bluffs adjacent to Lonesome Creek and the east-facing bluffs of Akalat (James Island) and Little James Island.

There are some inland areas within the Reservation that are also at risk for landslides due to their slope, as are the hills adjacent to Highway 110 as it exits the Reservation. That area of Highway 110 has experienced frequent landslides and rock falls in the past. These hills are likely to experience landslides in the event of an earthquake in vicinity of the Reservation, or as a result of precipitation (snow or rain) or ice, among other causes.

As of this update, the QN continues to work with Washington State Department of Transportation (WSDOT) and Clallam County to identify potential alternatives should access become compromised, including the potential of a new, more stable roadway.

The recognition of ancient dormant mass movement sites is important in locating 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. In other cases, there are landslides that have been active for many years, and show no signs of stopping, continuing to increase in size. Figure 8-5 and Figure 8-6 identify landslide hazard areas in and around the QN Reservation.

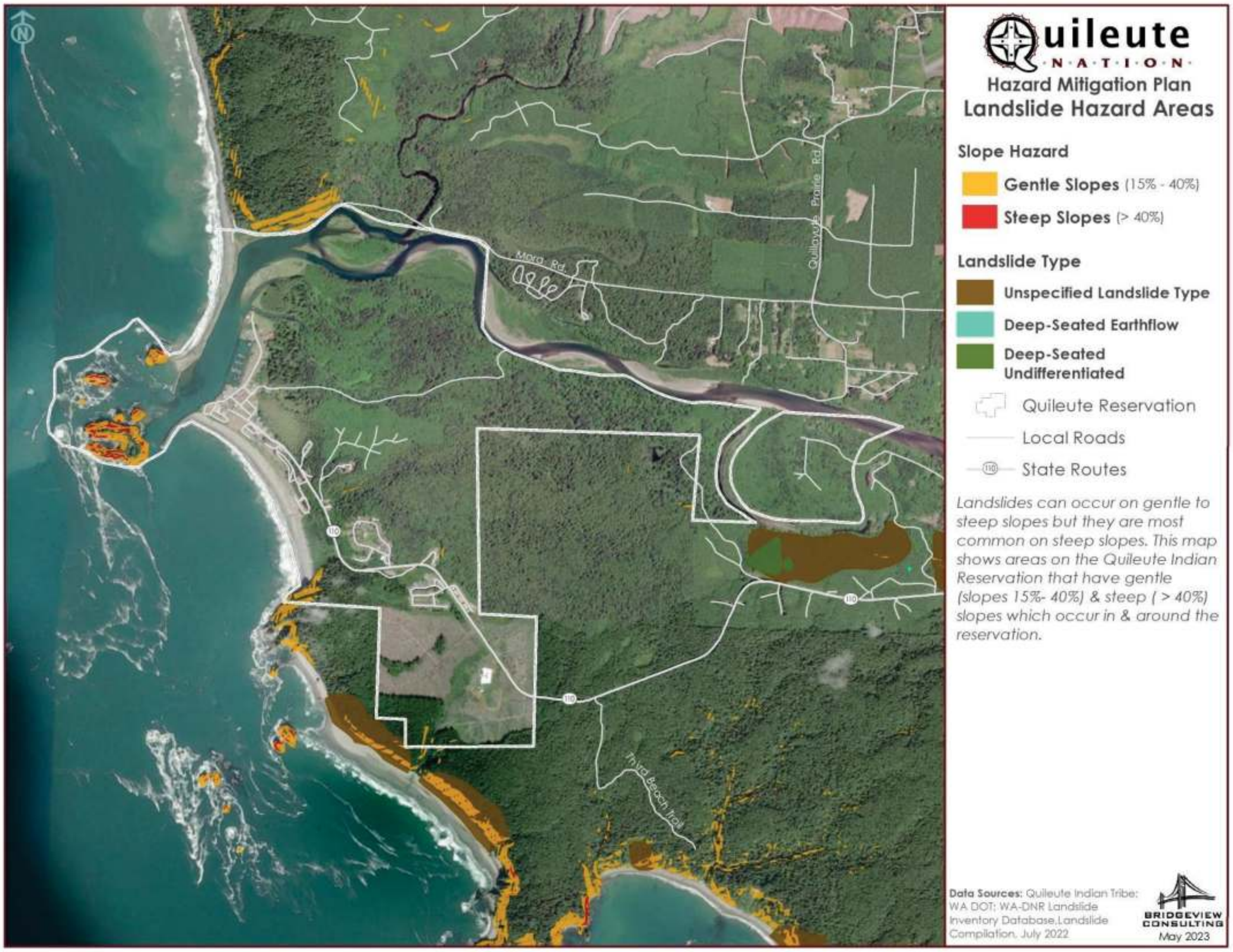


Figure 8-5 Landslide Hazard on the QN Reservation

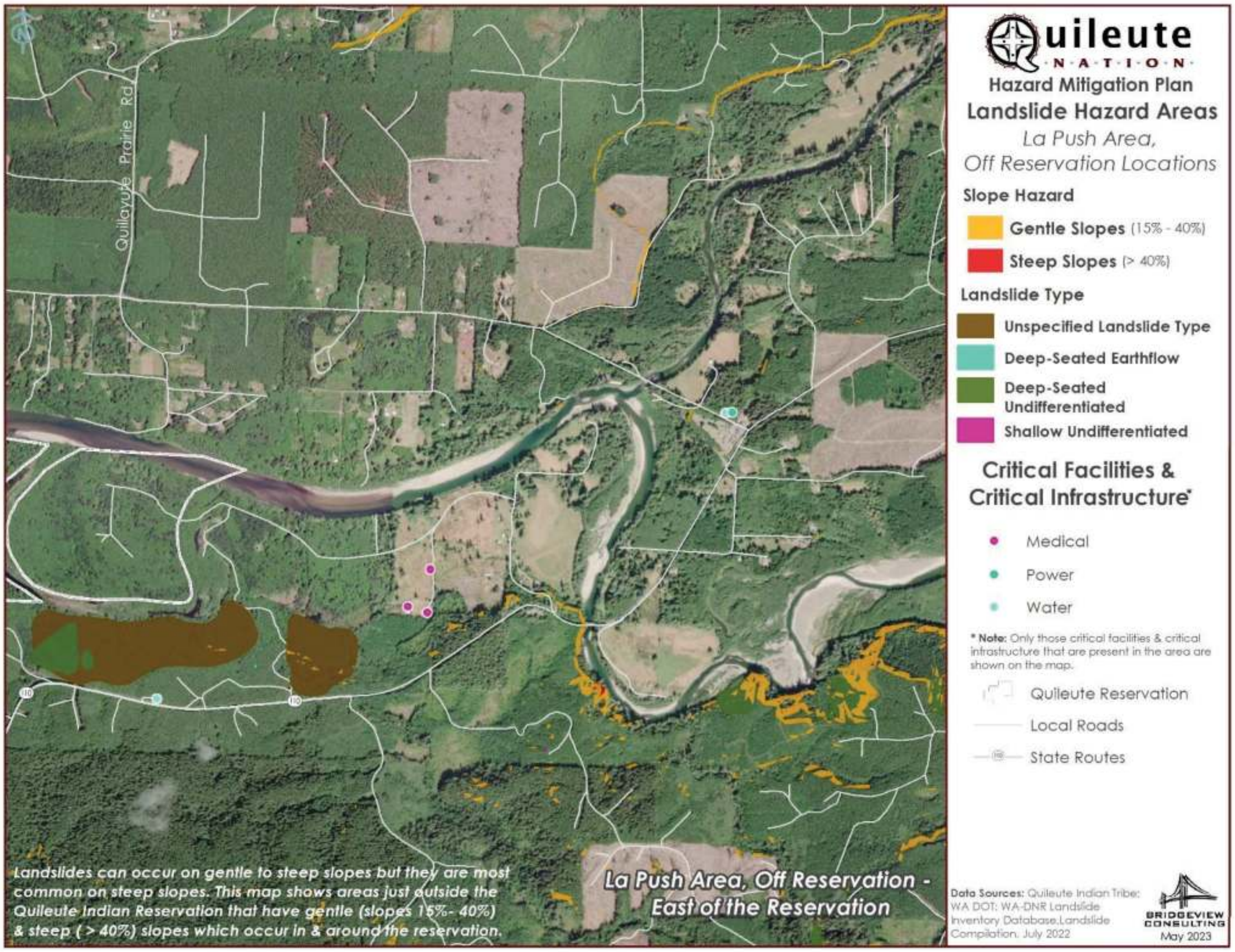


Figure 8-6 Landslide Hazard Areas Off Reservation

8.2.3 Previous Occurrences

There is little recorded information regarding any landslides specific to the Reservation itself, and the Tribe has limited records of damages sustained. The QN has not experienced a landslide occurring on the Reservation that has directly impacted individuals or structures; however, there are landslides occurring in surrounding areas which have impacted ingress and egress to the Reservation.

Chapter 3 identifies severe weather events including landslides which have occurred that have impacted Clallam County as a whole; however, the Tribe nor the County has ever received a disaster declaration for a landslide-typed event, but rather only in conjunction with a severe weather event. There are no recorded fatalities or injuries attributed to mass movement occurring on the Reservation.

8.2.4 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 the planning area 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. For the QN, this occurs several months out of the year.

Based on review of FEMA's National Risk Index, Clallam County has a very high risk base with respect to landslides.[15] However, there is no FEMA data specific to the QN, and it is unclear if the analysis includes the state highway system, or just incidents occurring in the County.

8.2.5 Frequency

Landslides are often triggered by other natural hazards such as earthquakes, severe storms, heavy rain, floods, or wildfires. As such, landslide frequency is often related to the frequency of these other hazards. Within the planning area, 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. Section 3, Tables 3-1 and 3-2 identify the severe storm and flood events occurring within the planning area. Since 1957, 21 disaster-declared events have occurred for flood and severe storm events, with the months of December (nine events) and January (four events) being the highest months with the number of occurrences.

8.3 VULNERABILITY ASSESSMENT

8.3.1 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

---

[15] FEMA National Risk Index. (2023). Accessed 14 April 2023. Available online at: Map | National Risk Index (fema.gov)

- 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.

8.3.2 Impact on Life, Health, and Safety

One of the most significant factors for the Reservation population is the potential landslide area cutting off ingress and egress, which has the potential to impact all Tribal members living or working on the Reservation, as well as any visitors who may be trapped on the Reservation should a landslide block any of the major arterials leading to the tribal planning area. This would include guests and visitors to the QN's enterprises, as well as the 90+ students and staff at the school, which are citizens that do not live on the Reservation but would be impacted.

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.

8.3.3 Impact on Property

Currently, none of the inhabited residences or public facilities on the Reservation are in a landslide prone area. However, 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.

8.3.4 Impact on Critical Facilities and Infrastructure

Of the 54 critical facilities analyzed for this risk assessment, none are in the immediate vicinity of a landslide prone area based on the identified landslide hazard area established by Washington State Department of Natural Resources. The water storage tank is within 500 feet of a potential landslide hazard area, and two structures (both emergency management storage structures) are within 1,000 feet of a slope area of 15-40 percent.

Throughout the immediate surrounding area (off tribal lands), several types of infrastructure are exposed to mass movements and highly susceptible to the landslide throughout both Clallam and Jefferson Counties. Impact to that infrastructure would pose a threat or increased vulnerability to the QN. 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 QN is extremely isolated. Impact to any of the major arterials in the area would have a negative impact for life safety purposes and the local economy.
- **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. Should impact occur to the Bogachiel or Forks Bridges, not only would traffic be impassable, but evacuation would be significantly impacted causing large detours, emergency response would be negatively impact, and acquisition of supplies would be impossible. Tribal water supplies which fall along Highway 110 near Three Rivers and the Bogachiel Bridge would also be impacted.
- **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 there are limited backup generators available, and even a minor power outage anywhere along the lines leading onto the reservation has the potential to last for extended periods of time. At present, the QN experience at least two power outages per month, many of which are not weather related. Thankfully, those have not lasted for excessive periods, but they do disrupt business operations, and the daily lives of tribal members With the anticipated new development, several governmental facilities, once completed, will also be equipped with generators to provide a source of power for use during emergencies.

8.3.5 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 a fish hatchery from which they annually release fish back into the rivers and streams. Due to the lifecycle of salmon (and others), impact in any given year from a landslide could have long-reaching impact to the QN.

8.3.6 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 QN 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.

8.4 FUTURE DEVELOPMENT TRENDS

The Tribe has experienced somewhat slow growth over the past 10 years with respect to increased housing available for tribal members, but has taken significant proactive steps to help stimulate growth on the Reservation. Specifically, in an effort to strengthen tribal resilience to flood and tsunami events, the Tribe has begun redevelopment through the *Move to Higher Grounds* initiative outside the hazard zones. The QN has also developed a business plan, which will provide for greater economic vitality by providing businesses that will stimulate the economy through retail sales and services. The Tribe is optimistic that sustained growth will return to the Reservation as its economy strengthens.

The Tribe Is equipped to handle future growth in the geologically hazardous areas. The Tribe has developed land use regulations that addresses the 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 regularly adopts the most current International Building Code (IBC) for all development, as it has historically done. With much of the funding for construction activities coming from HUD, BIA or other federal funds, such codes have always been utilized as required. This will enhance the resiliency of the Tribe with respect to development in hazard-prone areas.

8.5 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 impacted during high tides, particularly when such tides occur during storm events. Continued bank erosion will further exacerbate areas already experiencing landslide events, particularly along roadways and major thoroughfares.

Most mass movements would be isolated events affecting specific areas; however, given historic records, it is not without cause for concern that both private and public property, including infrastructure, would be affected, if not directly, than secondarily through isolation due to washed out roadways. Mass movements could also affect bridges that pass over landslide-prone ravines. Road obstructions caused by mass movements would create isolation problems for residents and businesses in developed areas, impacting emergency response capacity. 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 any of the major rivers or streams traveling through the Reservation, or any of its smaller tributaries. Should a landslide occur that impacts any of the rivers, 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, there are steep banks where the major rivers empty into the Pacific Ocean, and along the coastal areas where wave action occurs. Those areas are being impacted by coastal erosion, causing landslides as the ground continues to wash away. In those areas are 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.

8.6 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 is likely when including Clallam and Jefferson Counties. The planning area as a whole experiences some level of landslides annually, which can and have impacted ingress and egress to the Reservation. The coastal bluff areas and along the mouth of the river have some level of identifiable landslide risk. Climate change will only further exacerbate continued erosion due to increased storm surge, particularly when occurring simultaneous with high tides.

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 QN on the Reservation. 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, and impact to utility infrastructure, 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, with overall vulnerability determined to be a medium level.

CHAPTER 9.
SEVERE WEATHER

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

General severe weather covers wide geographic areas; localized severe weather affects more limited geographic areas. The severe weather event that most typically impacts the planning area is a damaging windstorm, which causes storm surges exacerbating coastal erosion. Flooding and erosion associated with severe weather are discussed in their respective hazard chapters. Snow historically does not accumulate in great amounts in the area, although even small amounts can impact the area through traffic-related issues and safety for citizens walking in areas of snow accumulation or ice. Excessive heat and cold, while they have occurred, are rare and the QN has never received a disaster declaration for either type of event.

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

During summer and fall, the circulation of air around a high-pressure area over the north Pacific brings a prevailing westerly and northwesterly flow of comparatively dry, cool, and stable air into the Pacific Northwest. As the air moves inland, it becomes warmer and drier, resulting in a dry season. In the winter and spring, the high pressure is further south, and low pressure prevails in the northeast Pacific. Circulation of air around both pressure centers bring 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.

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.

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 QR lies within the temperate rainforest and receives approximately 70-100 inches of precipitation along the coast and up to 150 inches of precipitation in the northeast mountainous regions (Treaty of Olympia Tribes, 2017). This amount of rainfall makes 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. The driest period is during the spring, when snowmelt runoff is the dominant source of water in the watershed. Since 2015, the QN has observed that September has been dryer than normal, with usual fall rains occurring later.

The Pacific Ocean does moderate temperatures in the area from extremes experienced in other parts of the state. Proximity to the ocean keeps the adjacent lands cool in the summer and relatively warm in the winter. Temperatures vary to some degree in the higher inland elevations with fewer extremes in the coastal lowlands. The average annual temperature is ~50°F; summers average ~59°F and winters average about 40°F. Summer temperatures rarely surpass 95°F. Winter temperatures can get cold (into the teens), but this occurs rarely. [16]

Winds have been recorded at and above 100 mph during the storm season, which normally occurs November through February. Coastal storm winds regularly top 40 mph. The annual peak speed of 55 mph can topple chimneys, utility lines, and trees. The entire county is vulnerable to windstorms, which has the ability to impact power on the QR. High winds are very commonplace along the coast. Due to its remote location, power outages occur more frequently than other parts of Clallam County, and customarily last longer than other areas closer to the population hubs.

Atmospheric Phenomenon

Atmospheric rivers (see Figure 9-1) 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

---

[16] Climate Forks - Washington and Weather averages Forks (usclimatedata.com)

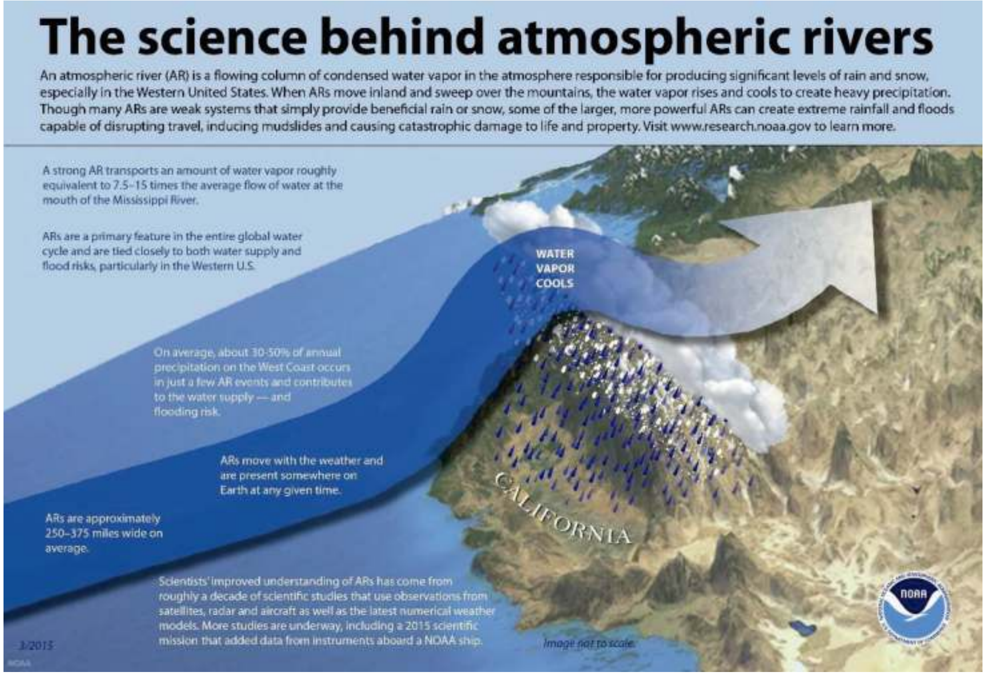
property. A well-known example is the “Pineapple Express,” a strong atmospheric river that is capable of bringing moisture from the tropics near Hawaii over to the U.S. West Coast. [17]

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 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.

---

[17] NOAA. What are atmospheric rivers? Accessed 4 April 2023. Available online at: https://www.noaa.gov/stories/what-are-atmospheric-rivers



The science behind atmospheric rivers

An atmospheric river (AR) is a flowing column of condensed water vapor in the atmosphere responsible for producing significant levels of rain and snow, especially in the Western United States. When ARs move inland and sweep over the mountains, the water vapor rises and cools to create heavy precipitation. Though many ARs are weak systems that simply provide beneficial rain or snow, some of the larger, more powerful ARs can create extreme rainfall and floods capable of disrupting travel, inducing mudslides and causing catastrophic damage to life and property. Visit www.research.noaa.gov to learn more.

A strong AR transports an amount of water vapor roughly equivalent to 7.5–15 times the average flow of water at the mouth of the Mississippi River.

ARs are a primary feature in the entire global water cycle and are tied closely to both water supply and flood risks, particularly in the Western U.S.

On average, about 30-50% of annual precipitation on the West Coast occurs in just a few AR events and contributes to the water supply — and flooding risk.

ARs move with the weather and are present somewhere on Earth at any given time.

ARs are approximately 250–375 miles wide on average.

Scientists' improved understanding of ARs has come from roughly a decade of scientific studies that use observations from satellites, radar and aircraft as well as the latest numerical weather models. More studies are underway, including a 2015 scientific mission that added data from instruments aboard a NOAA ship.

Figure 9-1 Atmospheric Rivers

9.1.2 Thunderstorms

A thunderstorm is a rain event that includes thunder and lightning. A thunderstorm is classified as “severe” when it contains one or more of the following: hail with a diameter of three-quarter inch or greater, winds gusting in excess of 50 knots (57.5 mph), or tornado. Thunderstorms have three stages (see Figure 9-2):

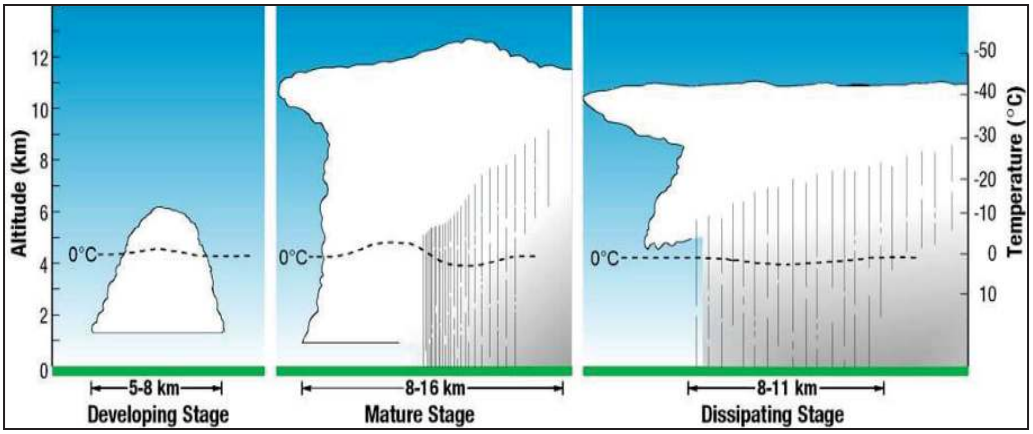


Figure 9-2 The Thunderstorm Life Cycle

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.

During 2022, NOAA reported 19 lightning related fatalities (see Figure 9-3). Based on review of data by the National Lightning Safety Council (2023), none of the fatalities occurred in Washington State (see Figure 9-4). Based on an analysis updated in 2022 by John Jensenius, Jr., of the National Lightning Safety Council, victims of lightning fatalities were again most often engaged in leisure activities, followed by work-related activities. Of the 19 fatalities, all but four were 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).

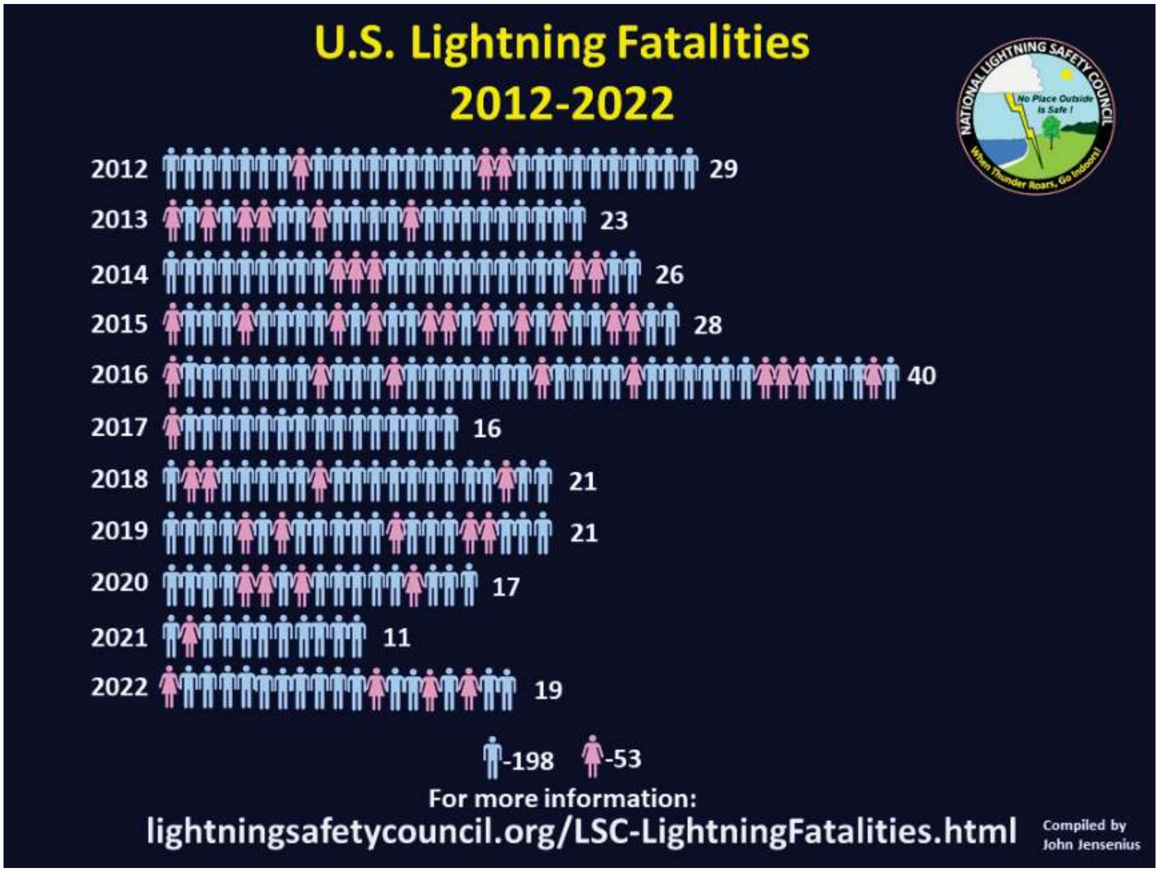


Figure 9-3 Lightning Fatality Statistics 2012-2022

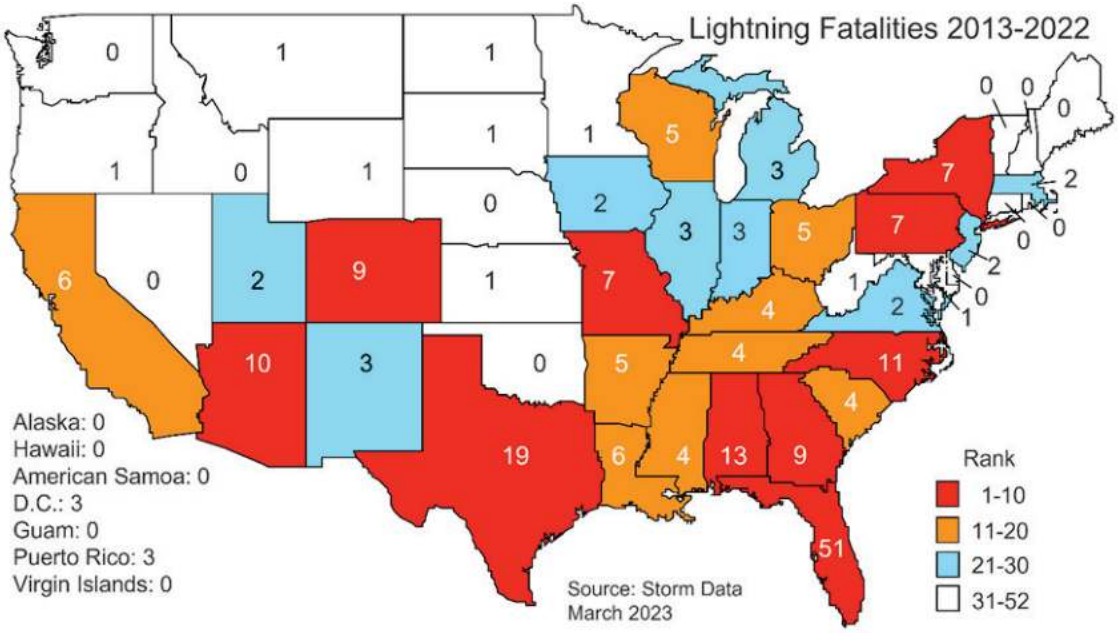


Figure 9-4 Lightning Fatalities by State

9.1.3 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 9-5. 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.

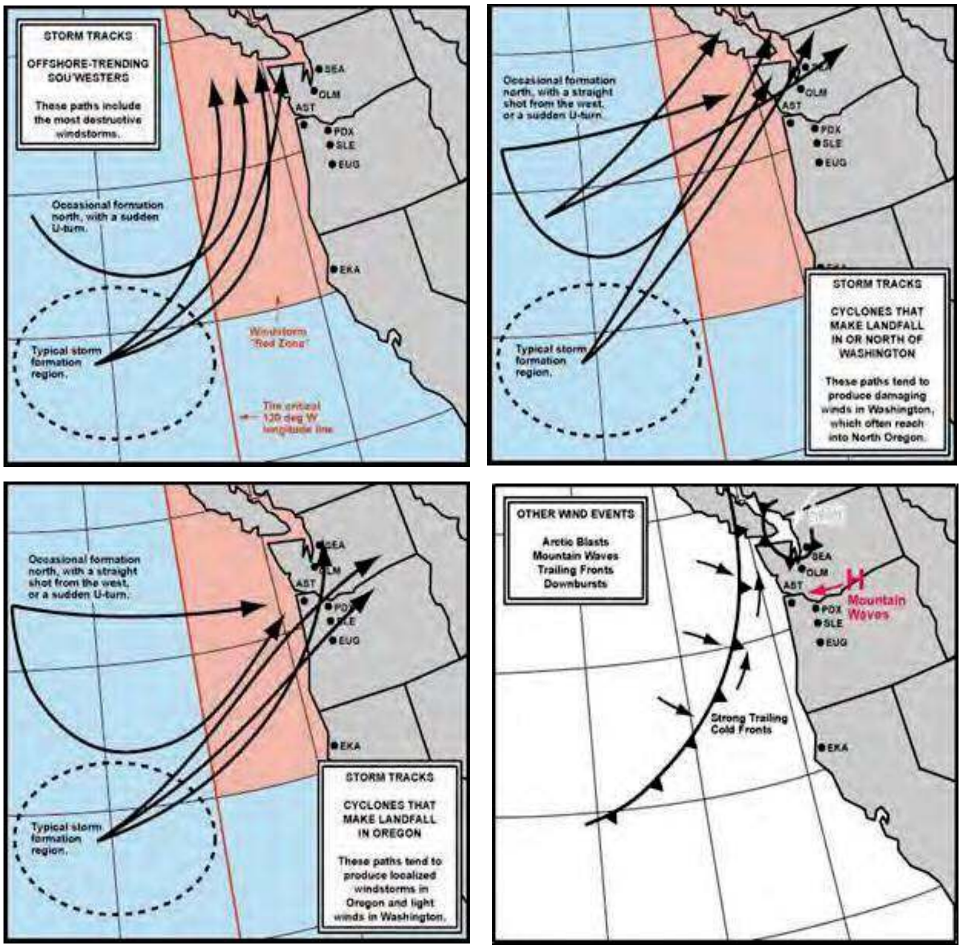
In contrast, easterly wind events are more limited. High pressure on the east side of the Cascade Mountain Range creates airflow over the peaks and passes, and through the funneling effect of the valleys, the wind increases dramatically in speed. As it descends into these valleys and then exits into 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.

Based on review of Clallam County Wind Zones, LaPush and Forks, the primary locations of the QN, windspeeds code design are for 130 and 120 MPH, respectively (Wind Zones C and D).[18] These zones were utilized to guide structure development beginning with the 2006 International Building Code, including those structures owned by QN. 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 the QN, 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 130 mph during the storm season, which normally occurs October through May. The highest summer and lowest winter temperatures generally occur during periods of easterly winds.

---

[18] Architectural / Engineering Design Standards (Wind, Snow & Seismic Zones) | Clallam County, WA (clallamcountywa.gov)



Source: Oregon Climate Service, 2015

Figure 9-5 Windstorm Tracks Impacting the Pacific Northwest

9.1.4 Hail Storms

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

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

9.1.5 Ice and Snow Storms

The National Weather Service defines an ice storm as a storm that results in the accumulation of at least 0.25 inches of ice on exposed surfaces. Ice storms occur when rain falls from a warm, moist, layer of atmosphere into a below freezing, drier layer near the ground. The rain freezes on contact with the cold ground and exposed surfaces, causing damage to trees, utility wires, and structures (see Figure 9-6).

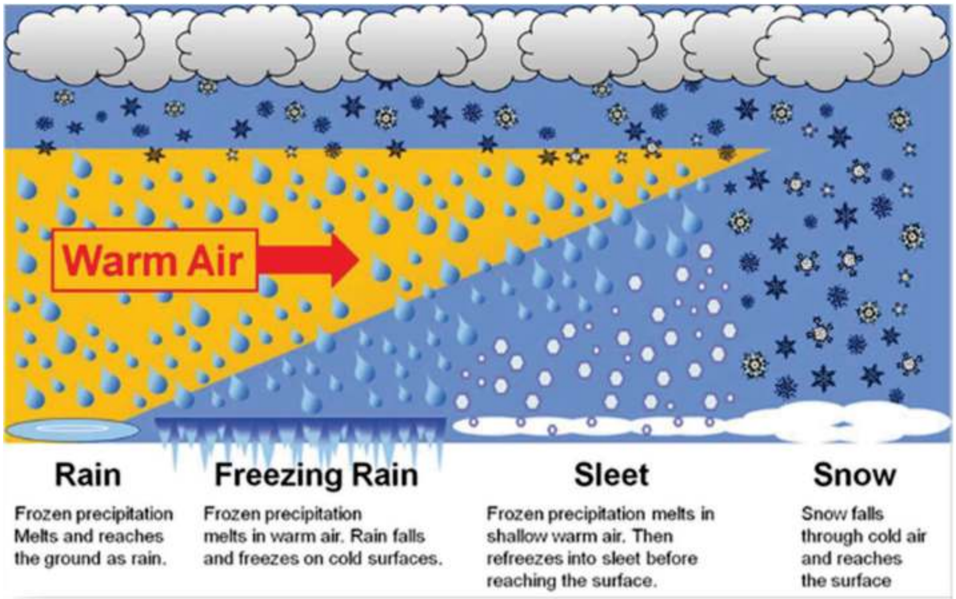


Figure 9-6 Types of Precipitation

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.

Depending on the type of snow falling (dry flakes versus heavy, wet flakes), the weight can exceed 10 pounds per square foot, which is significant when accumulations fall onto trees, electrical lines, or older structures built to lower snow-load capacities.

Significant snowfall does not customarily occur within the low-lying areas of the Reservation with any regularity; however, the upper areas of the reservation in higher elevations can and have experienced a greater amount of snow. When significant events occur, this has impacted rivers and streams in the area with increased snowmelt flowing in the rivers when temperatures rise.

Snowfall in the surrounding municipalities also impacts the QN with respect to power outages (with the weight of the snow impacting power lines or downing trees), increased motor vehicle accidents, and (limited) supply-chain issues. Travel restrictions also impact the economy of the Tribe, particularly for the tourism industries.

9.1.6 Extreme Temperatures

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

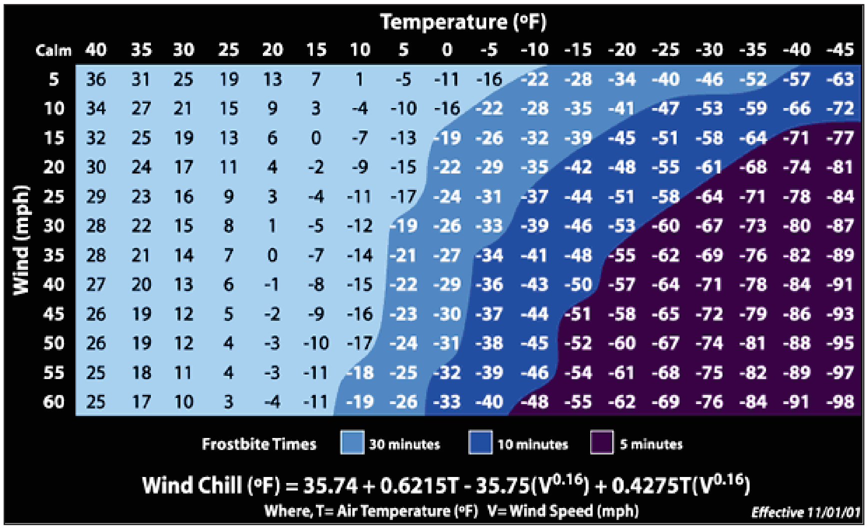
Extreme Cold

Extreme cold events occur when temperatures drop below normal in an area. In regions relatively unaccustomed to winter weather, near freezing temperatures are considered “extreme cold.” Extreme cold is often associated with severe winter storms and winds, which exacerbate the effects of cold temperatures by quickly depleting body heat, making it feel colder than temperatures indicate (wind chill). Figure 9-7 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 individuals 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.

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.



Temperature (°F)

Wind (mph)

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

Frostbite Times ▨ 30 minutes ▨ 10 minutes ▨ 5 minutes

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

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

Effective 11/01/01

Figure 9-7 NWS Wind Chill Index

Extreme Heat

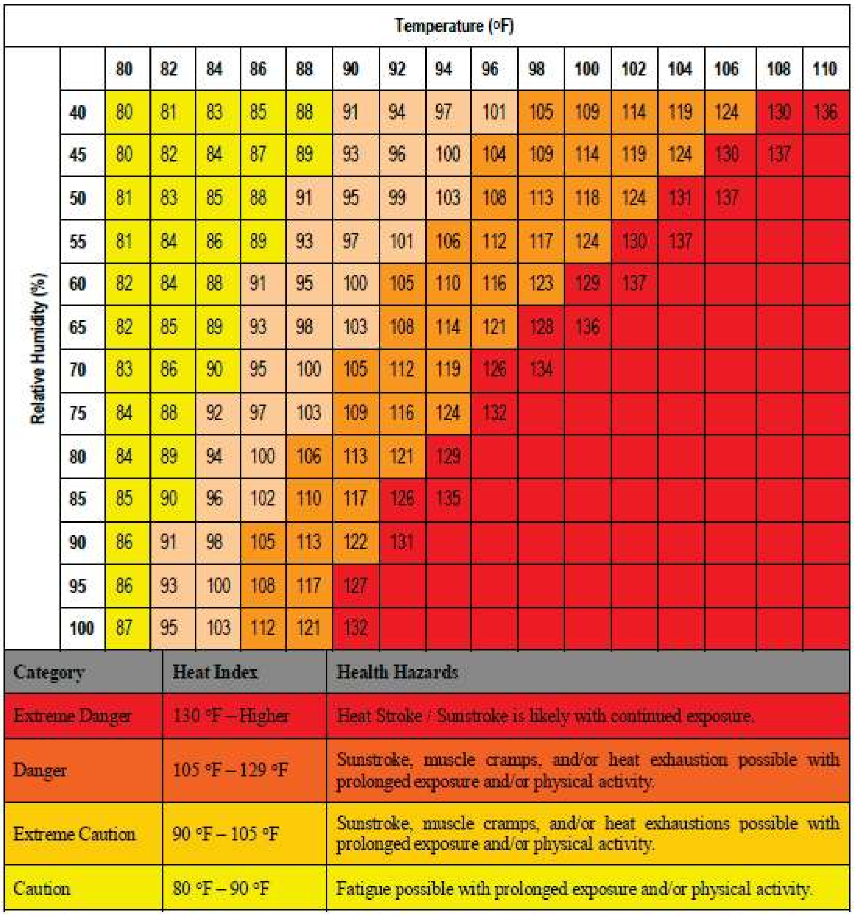
Temperatures 10 degrees or more above the average high temperature for the region lasting for days or weeks are defined as extreme heat (FEMA, 2022; CDC, 2017). An extended period of extreme heat of three or more consecutive days is typically called a heat wave and is often accompanied by high humidity. There is no universal definition of a heat wave because the term is relative to the usual weather in an area. The term heat wave is applied both to routine weather variations and to extraordinary spells of heat which may occur only once a century (Meehl and Tebaldi, 2004). A basic definition of a heat wave implies that it is an extended period of unusually high atmosphere-related heat stress, which causes temporary modifications in lifestyle and which may have adverse health consequences for the affected population (Robinson, 2000). Figure 9-8 identifies some of those consequences and associated temperatures. [19]

Certain populations are 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 9-9), pregnant woman, the homeless or poor, the overweight, and people with mental illnesses, disabilities, and chronic diseases.

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).

---

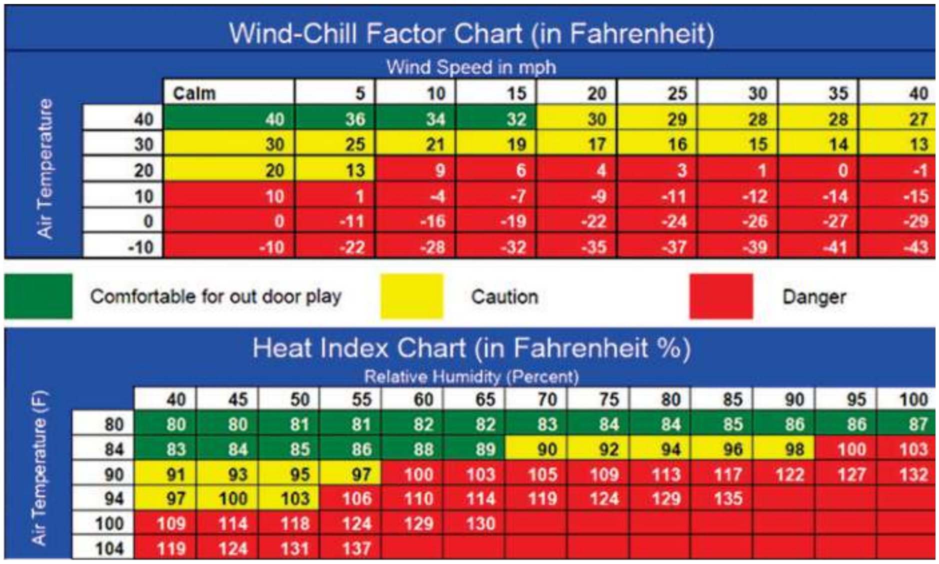
[19] NCDC, 2000



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

Category	Heat Index	Health Hazards
Extreme Danger	130 °F – Higher	Heat Stroke / Sunstroke is likely with continued exposure.
Danger	105 °F – 129 °F	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Extreme Caution	90 °F – 105 °F	Sunstroke, muscle cramps, and/or heat exhaustions possible with prolonged exposure and/or physical activity.
Caution	80 °F – 90 °F	Fatigue possible with prolonged exposure and/or physical activity.

Figure 9-8 Heat Stress Index



Wind-Chill Factor Chart (in Fahrenheit)

	Wind Speed in mph								
Air Temperature	Calm	5	10	15	20	25	30	35	40
40	40	36	34	32	30	29	28	28	27
30	30	25	21	19	17	16	15	14	13
20	20	13	9	6	4	3	1	0	-1
10	10	1	-4	-7	-9	-11	-12	-14	-15
0	0	-11	-16	-19	-22	-24	-26	-27	-29
-10	-10	-22	-28	-32	-35	-37	-39	-41	-43

🟩 Comfortable for out door play 🟨 Caution 🟥 Danger

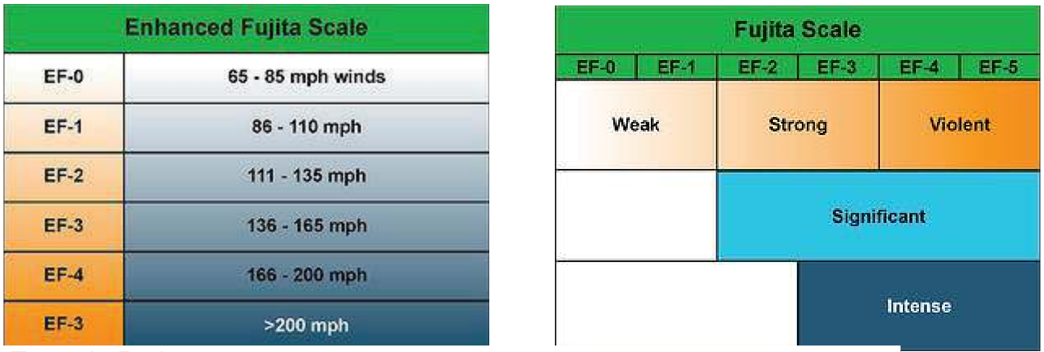
Heat Index Chart (in Fahrenheit %)

	Relative Humidity (Percent)												
Air Temperature (F)	40	45	50	55	60	65	70	75	80	85	90	95	100
80	80	80	81	81	82	82	83	84	84	85	86	86	87
84	83	84	85	86	88	89	90	92	94	96	98	100	103
90	91	93	95	97	100	103	105	109	113	117	122	127	132
94	97	100	103	106	110	114	119	124	129	135			
100	109	114	118	124	129	130							
104	119	124	131	137									

Figure 9-9 Heat and Wind Chill Index for Children

9.1.7 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 9-10 illustrates the two tornado rating scales.



Enhanced Fujita Scale	
EF-0	65 - 85 mph winds
EF-1	86 - 110 mph
EF-2	111 - 135 mph
EF-3	136 - 165 mph
EF-4	166 - 200 mph
EF-3	>200 mph

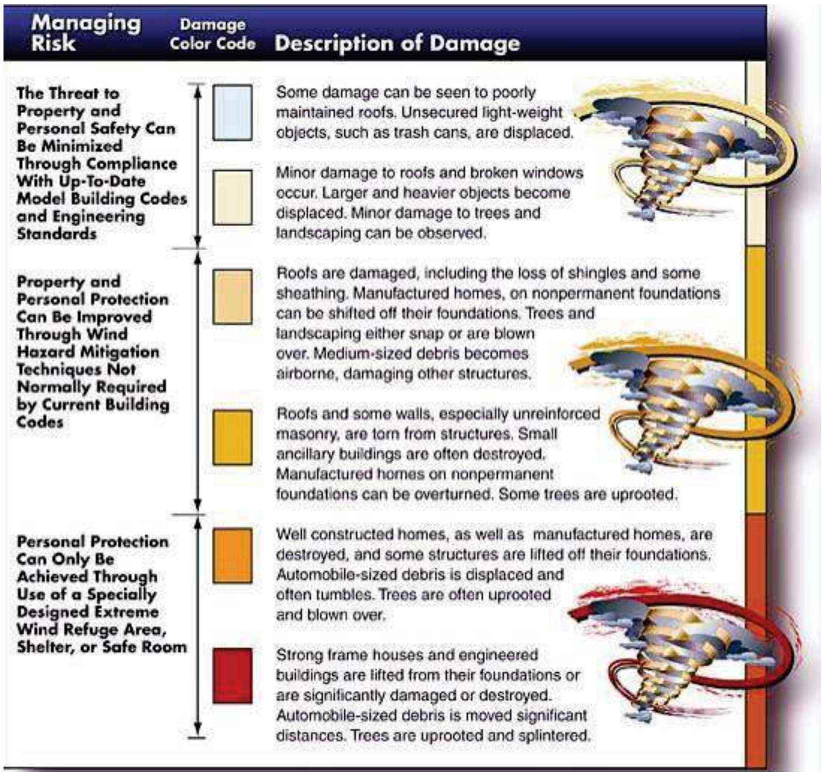
Figure 9-10 Tornado Ratings

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 9-11, 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 9-12, Washington has a low risk compared to states in the Midwestern and Southern U.S. Review of NOAA data does not identify any tornado events occurring during the period January 1, 2000 to May 2023. But while there have been no recorded events occurring, on March 19, 2021, the National Weather Service issued three tornado warnings for the areas of LaPush and the Quileute Reservation. While winds did increase and hail formed over some areas, no funnel was reported. The National Risk Index identifies a very low risk of a tornado event occurring in the area.[20]

---

[20] Tornado Hazard. National Risk Index. (2022). Accessed 4 April 2023. 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 9-11 Potential Impact and Damage from a Tornado

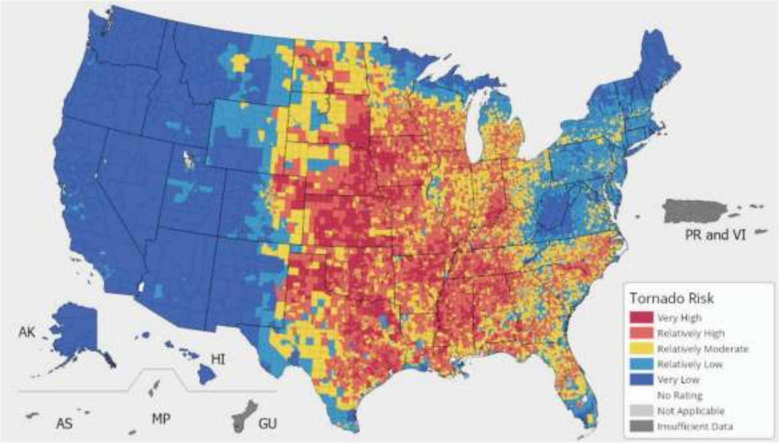
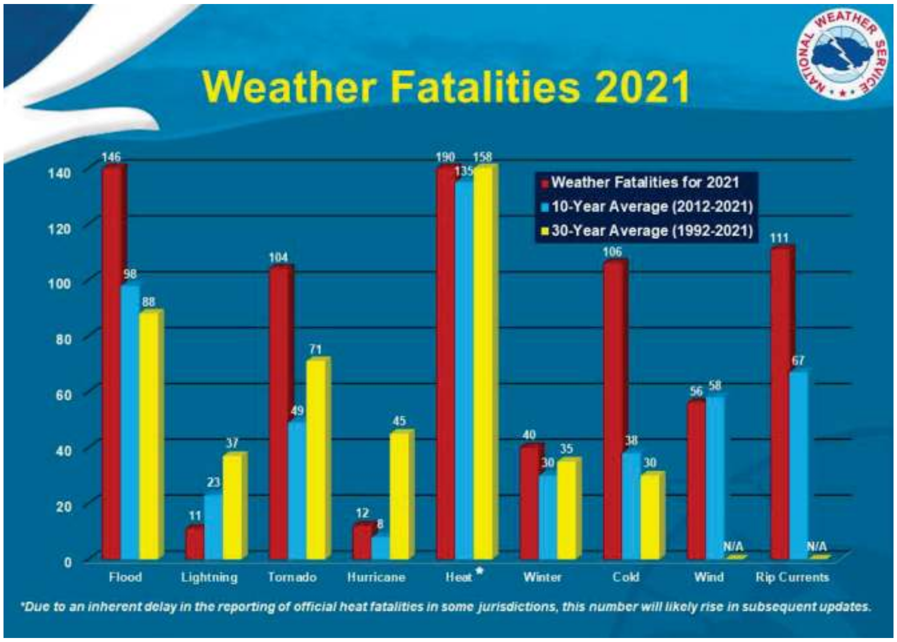


Figure 9-12 Tornado Risk Areas in the United States (2023)

Weather Fatalities

Figure 9-13 identifies the number of weather fatalities nationwide based on 10- and 30-year averages.[21] 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. No deaths or injuries have occurred on the Reservation due to a severe weather event, although an individual visiting a nearby reservation was killed by a log carried on shore by a wind-induced storm surge/wave, which struck the person.



*Due to an inherent delay in the reporting of official heat fatalities in some jurisdictions, this number will likely rise in subsequent updates.

Figure 9-13 Average Number of Weather-Related Fatalities in the U.S.

---

[21] NOAA, 2023. Accessed 11 May 2023. Available online at https://www.weather.gov/hazstat/

9.2 HAZARD PROFILE

9.2.1 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 March, although they have occurred year-round. When reviewing NOAA and FEMA data, the months of December (nine events), November (five events), and January (four events) have the highest severe weather occurrences (see Chapter 3, Tables 3-2).

The area has been impacted by significant strong winds and heavy rains at least annually. Tornado warnings have been issued, but no direct impact has been experienced. Based on FEMA ranking, severe storm is the number one typed hazard to impact the QN. Due to the size (and elevation) of the reservation, some areas are more significantly impacted than others.

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 throughout 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. Wind damage has also been significant with respect to the trees on the QN, particularly in the forested areas, where large groups of trees have been impacted by windstorms. Trees impacting transmission lines is one of the primary causes for power outages, particularly when associated with storm or wind related events.

Severe storms and weather also affect transportation. Access is sometimes unpredictable as roads are vulnerable to damage from severe storms, flooding, and landslide/erosion, which is regularly experienced along the coastline area.

Severe storms and storm surges, particularly when coupled with King Tides, 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 Quillayute River flooding areas of the Reservation, causing damage along major roadways, impacting ingress and egress to the Reservation, or impacting residential structures. While the Reservation itself does not experience large quantities of snow in the lower elevations, the Olympic Mountains, which feeds into the watershed in the area, 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 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.

9.2.2 Previous Occurrences

Types of severe weather occurring on the QN can vary but impact the tribe at least once annually. The most common types of severe storms experienced can include heavy precipitation, straight line winds, thunderstorms, and damaging downburst winds. Less frequent severe weather phenomena include ocean squalls, heavy snowstorms, and ice storms.

Since 1957, 13 severe weather events (including FEMA's severe winter, severe wind, and severe storm-typing) have been declared in Clallam County. Table 9-1 describes several of the more significant severe weather events impacting the area. 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. Chapter 3, Section 3.5, Table 3-1 identifies all disaster events occurring since 1957.

As indicated, downed trees and windstorms continue to be the leading cause of power outages throughout the planning area, as well as road closures. All areas of the QN are regularly impacted both as a result of the winds themselves, or as a result of power outages and road closures in other areas of the county causing impact.

Forest Management practices on the QN have provided some relief with respect to the tree trimming/removal in areas of the power lines, but events do nonetheless occur with a high frequency, occurring several times annually. When such events occur, they typically last for less than one day. Approximately eight facilities on the Reservation are equipped with generators, but not all. The QN does have some portable generators on trailers, which can be relocated as needed, but additional or permanent generators are needed. Residential structures are not equipped with generators when built.

The most recent tornado event to have occurred in the area occurred on March 19, 2021, when tornado warnings were issued for much of the Olympic Peninsula, including LaPush and Forks. The event included large hail and significant thunderstorms; however, no funnel cloud developed. Figure 9-14 identifies some additional tornadoes occurring within the state between the period 1950-2022.

Winds in general are a regular occurrence on the QN, and have impacted every home, business, power line, and shoreline, within all areas of the Reservation. In addition to the structures and infrastructure of the QN that have been impacted by high winds, the losses to standing timber volume have been substantial. Across the QIR, forest management activities have covered timberlands adjacent to the major access routes where power lines are located. The result has been a power delivery infrastructure that is currently at reduced risk. These are positive activities that should be conducted when the management of the forestlands can help to protect the investment in the power supply system and not adversely affect homes and businesses on the Quileute Reservation.

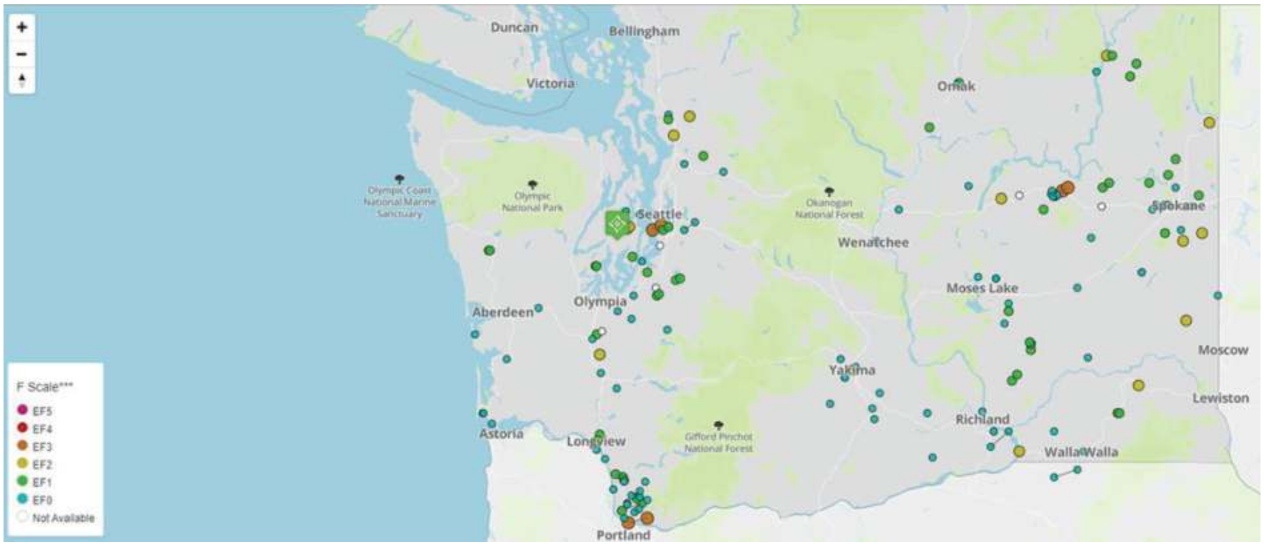


Figure 9-14 Tornado History in Washington 1950-2022

TABLE 9-1.
SAMPLING OF SEVERE WEATHER EVENTS IMPACTING PLANNING AREA SINCE 1960

Date	Type	Deaths or Injuries	Property Damage
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.*			
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.*			
January 2006 Disaster 1641	Severe winter storm, flood, landslide, mudslide, tidal surge	Unknown	Unknown
Description: *Heavy rains, including tidal surge.*			
December 2006 Disaster 1682	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.*			
December 2007 Disaster 1734	Severe winter storm, snow, heavy rains, landslides, winds, tidal surge	Unknown	Unknown

TABLE 9-1.
SAMPLING OF SEVERE WEATHER EVENTS IMPACTING PLANNING AREA SINCE 1960

Date	Type	Deaths or Injuries	Property Damage
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.
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.)*			
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.

TABLE 9-1.
SAMPLING OF SEVERE WEATHER EVENTS IMPACTING PLANNING AREA SINCE 1960

Date	Type	Deaths or Injuries	Property Damage
Description: *Severe winter storm, including record and near record snowfall and heavy rains and winds. 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.)*			

9.2.3 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. A limited number 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. Wind zones for the area are based on 120 and 130 mph wind guests for building codes. 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 can cause flooding on the rivers on the Reservation. Such events occur (almost) annually, and while more of a nuisance than a declared event, it does impact ingress and egress in areas of the reservation.

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

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 is 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 9-7 (above) illustrates the new wind chill temperature index.[22] The Index includes a frostbite indicator, showing points where temperature, wind speed and exposure time will produce frostbite to humans. The chart shows three shaded areas of frostbite danger. Each shaded area shows how long a person can be exposed before frostbite develops (NWS, 2009).

The extent of extreme temperatures is generally measured through the heat index (shown above). Created by the NWS, the Heat Index accurately measures apparent temperature of the air as it increases with the relative humidity. The Heat Index can be used to determine what effects the temperature and humidity can have on the population (NCDC, 2000).

9.2.4 Frequency

The severe weather events are often related to high winds and associated with 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 QN 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 5 years, with a probability of occurrence of 20 percent per year that such a significant event will occur.

The National Weather Service reports that Washington state averages 2.5 tornadoes per year, which ranks in the bottom ten states. Washington State Department of Ecology has estimated frequency intervals for wind speed as follows:

---

[22] NWS, 2008

WIND SPEEDS EXCEED	FREQUENCY
55 MPH	Annually
76 MPH	~ 5 years
83 MPH	~10 years
92 MPH	~25 years
100 MPH	~50 years
108 MPH	~100 years

9.3 VULNERABILITY ASSESSMENT

9.3.1 Overview

Severe weather incidents can and regularly do occur throughout the entire planning area. Similar events impact areas within the planning region differently, even though they are part of the same system. While in some instances some type of advanced warning is possible, as a result of climatic differences, topographic and relative distance to the coastline, the same system can be much more severe in certain areas 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.

9.3.2 Impact on Life, Health, and Safety

The entire planning area is susceptible to severe weather events. Populations living at higher elevations with large stands of trees or above-ground power lines may be more susceptible to wind damage and black- out conditions, while populations in low-lying areas are at risk for possible flooding and landslides associated with the flooding as a result of heavy rains or king tides. 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 events, when combined with the high population of elderly residents significantly impacts response capabilities and the risk factor associated with such weather incidents. Within the densely wooded areas, increased fire danger during extreme heat conditions increases the likelihood of fire, which increases 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, based on Census data, approximately 59 residents are over 65, with approximately 44 children 5 years of age or under. There are 111 residents under the age of 18 years. [23] 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:[24]

    - 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 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 QN does have its own water system, which must be pumped and a wastewater system which also utilize pumps. During power outages, many residents may lack drinking water or sewer services. When combined with flooding, which commonly occurs during a severe weather event, the likelihood of such ramifications increases.

9.3.3 Impact on Property

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

The QN, 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

---

[23] Census Report. Accessed 2 Feb. 2023. Available at: Quileute Reservation - Profile data - Census Reporter

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

significant. The Tribe is looking at establishing a more robust logging industry, and has been working towards that goal.

The frequency and degree of damage will depend on specific locations and severity of the weather pattern impacting the region. It is improbable to determine the exact number of structures susceptible to a weather event, and therefore emergency managers and public officials should establish a maximum threshold, or worst-case scenario, of susceptible structures..

9.3.4 Impact on Critical Facilities and Infrastructure

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 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. It is uncommon for the Tribe to go more than a month without some power outage event not related to storms or traffic-related incidents resulting from severe weather. 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; areas of the Reservation do operate on wells and septic systems. The Tribe maintains a water system, which distributes water to much of the planning area. Several of the fishery buildings also have water distribution systems. The existing water and septic systems on the Reservation could be impacted by severe weather events through inundation from ground water seepage, as well as through power outages impacting lift stations or pumphouses. 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 all critical facilities.

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. Clallam County as a whole experiences major road closures very frequently, which would impact the QN. 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.

9.3.5 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. For the QN, the fishing industry is significant, and delays in shipments could be costly. In addition, the QN relies heavily on the tourism industry with its hotels and restaurants, which would also be impacted by obstruction of major routes.

Severe windstorms, downed trees, and ice can create serious impacts on power and above-ground communication lines, as well as negatively impacting 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. As indicated, the QN and tribal members 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.

9.3.6 Impact on Environment

The environment is highly exposed to severe weather events. Natural habitats such as streams and trees are exposed to the elements during a severe storm and risk major damage and destruction. Prolonged rains can saturate soils and lead to slope failure. Flooding events caused by severe weather or snowmelt can produce river channel migration or damage riparian habitat, also impacting spawning grounds and fish populations for many years such as occurred during the 2015 crash. The Tribe does maintain an active fish hatchery, which could also be potentially impacted by various severe weather events, including the depletion of river flows such as on the Sol Duc River, for which the QN and WDFW conducted sandbagging in an attempt to elevate the river so fish could return to spawning grounds (see Figure 9-15).[25] 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.

Figure 9-15 Sandbagging the Sol Duc River (2015)

---

[25] Northern Arizona University. Photo by Debbie Preston. Available online at: [Tribes: Northwest - Tribes & Climate Change (nau.edu)]

9.3.7 Impact from Climate Change

Climate change presents a challenge for risk management associated with severe weather. The frequency of severe weather events has increased steadily over the last century. The number of weather-related disasters during the 1990s was four times that of the 1950s and cost 14 times as much in economic losses. Historical data shows that the probability for severe weather events increases in a warmer climate.

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.

9.4 FUTURE DEVELOPMENT TRENDS

All future development will be affected by severe storms. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. The 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. Sound forest management practices has helped reduce the impact of power outages on the QN to some degree, but such practices are not in place throughout Clallam County. As such, the Tribe is impacted from other areas of the planning region.

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 QN 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 QN 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 wind and flooding is a component of the severe weather event. Newly completed structures and infrastructure (e.g., water system) are outside of the flood zone and built to meet both current seismic and wind standards.

9.5 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 QN 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.
- 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.
- Based on the 2016 study completed by the Olympic Peninsula Tribes (Quileute, Hoh and Quinault), climate change will increase the frequency and magnitude of winter flooding or storm surges, thus exacerbating severe winter events.

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 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 13 events occurring since 1957. FEMA has identified Severe Storm/Weather as the number one hazard impacting the area within.

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 causing economic losses to both the QN and its tribal members. 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. 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 some portable generators, and fixed 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.

Based on the potential impact, the Planning Team determined the CPRI score to be 3.4, with overall vulnerability determined to be a high level.

CHAPTER 10.
TSUNAMI

A tsunami is a series of high-energy waves radiating outward from a disturbance. Earthquakes may produce displacements of the sea floor that can set the overlying column of water in motion, initiating a tsunami.

Tsunamis are classified as local or distant. Distant tsunamis may travel for hours before striking a coastline, giving a community a chance to implement evacuation plans. Local tsunamis have minimal warning times, leaving few options except to run to high ground. They may be accompanied by damage resulting from the triggering earthquake due to ground shaking, surface faulting, liquefaction or landslides. As a result of the high probability of a Cascadia Subduction Zone-type earthquake, occupants of many parts of Washington's coastlines have minimal time to reach high ground, in some areas only 20-30 minutes.

DEFINITIONS

Tsunami—A series of traveling ocean waves of extremely long wavelength usually caused by displacement of the ocean floor and typically generated by seismic or volcanic activity or by underwater landslides.

Tidal bore – A tidal phenomenon in which the leading edge of the incoming tide forms a wave (or waves) of water that travel up a river or narrow bay against the direction of the river or bay's current.

Tsunami Advisory - The purpose of a Tsunami Advisory is to keep people away from rivers, beaches, and harbors for their own personal safety. Tsunami waves during a Tsunami Advisory can also appear as "sneaker waves."

Sneaker wave – A term used to describe disproportionately large coastal waves that can sometimes appear in a wave train without warning.

10.1 GENERAL BACKGROUND

10.1.1 Physical Characteristics of Tsunamis

All waves, including tsunamis, are defined by the following characteristics (see Figure 10-1; Earth Science, 2012):

- **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.

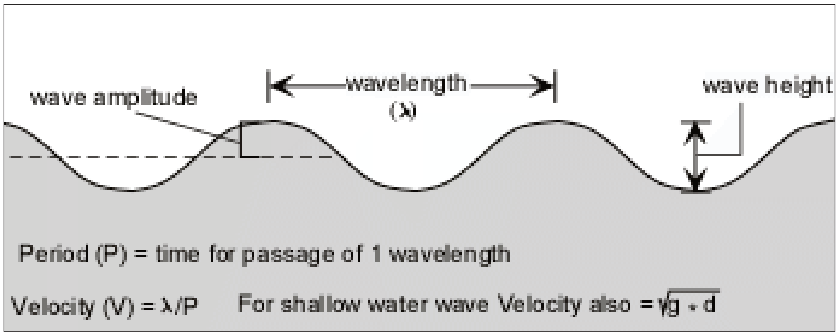


Figure 10-1 Physical Characteristics of Waves

The rate at which a wave loses its energy is inversely related to its wavelength. Since a tsunami has a very large wavelength, it loses little energy as it propagates. Thus, in very deep water, a tsunami will travel at high speeds with little loss of energy. For example, when the ocean is 20,000 feet deep, a tsunami will travel about 600 mph, and thus can travel across the Pacific Ocean in less than one day.

As a tsunami leaves the deep water of the open sea and arrives at shallow waters near the coast, it undergoes a transformation (see Figure 10-2; Earth Science, 2012). Since the velocity of the tsunami is also related to the water depth, as the depth of the water decreases, the velocity of the tsunami decreases. The change of total energy of the tsunami, however, remains constant. Furthermore, the period of the wave remains the same, so more water is forced between the wave crests, causing the height of the wave to increase.

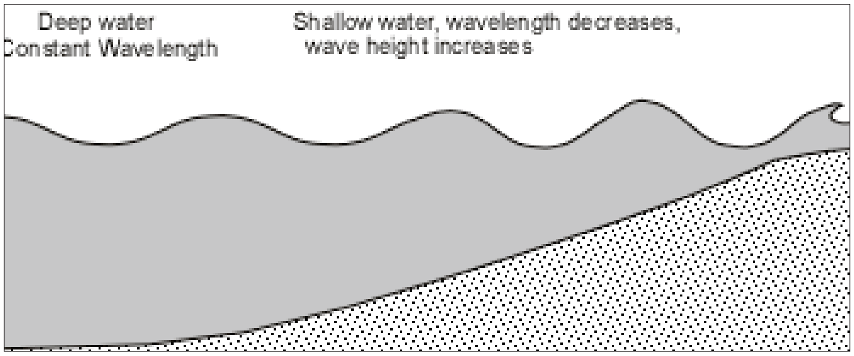


Figure 10-2 Change in Wave Behavior with Reduced Water Depth

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

The configuration of the coastline, the shape of the ocean floor, and the characteristics of advancing waves play roles in the destructiveness of tsunamis. Offshore canyons can focus tsunami wave energy and islands can filter the energy. The orientation of the coastline determines whether the waves strike head-on or are refracted from other parts of the coastline. A wave may be small at one point on a coast and much larger at other points. Bays, sounds, inlets, rivers, streams, offshore canyons, islands, and flood control channels may cause various effects that alter the level of damage. It has been estimated, for example, that a tsunami wave entering a flood control channel could reach a mile or more inland, especially if it enters at high tide.

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

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

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

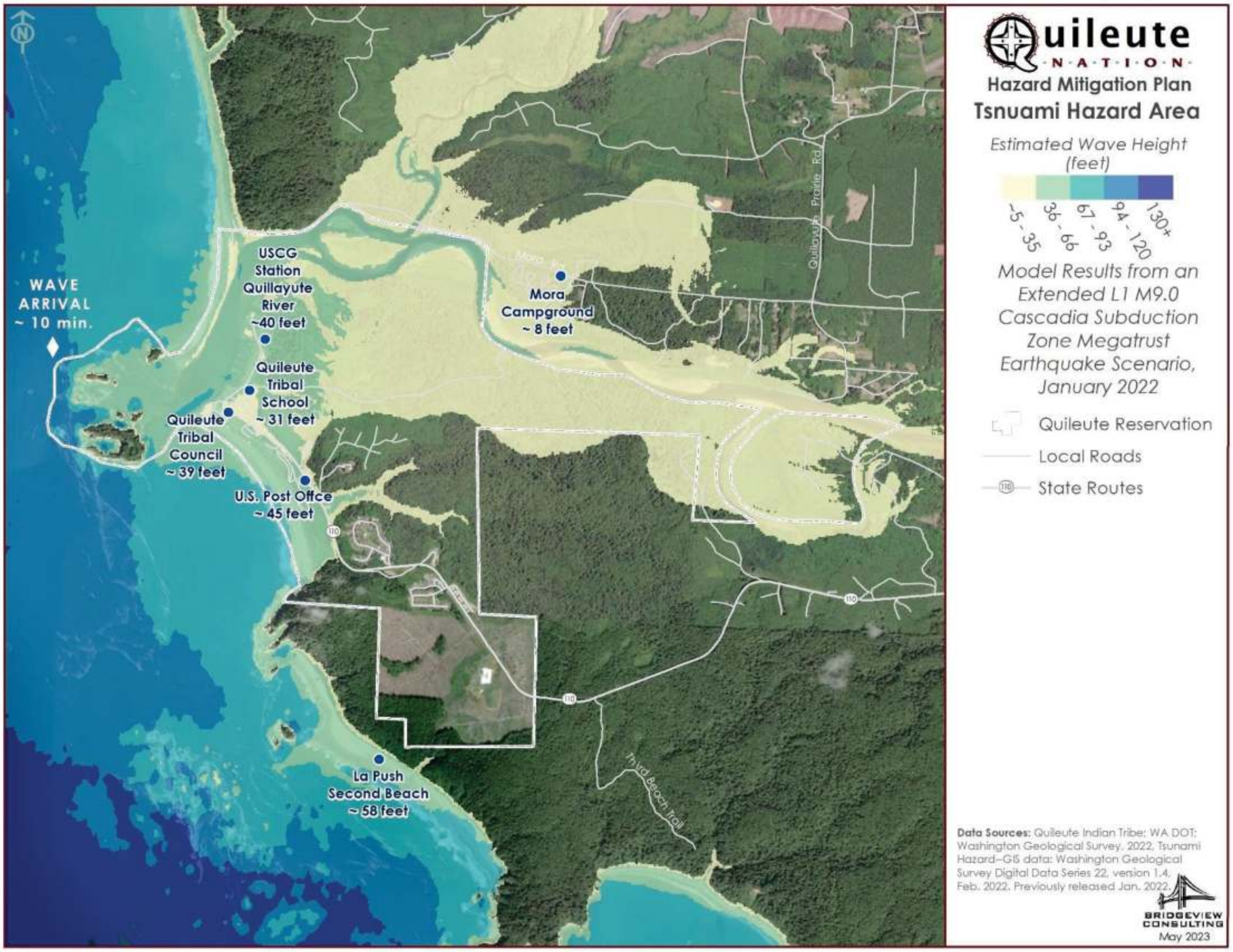
10.2 HAZARD PROFILE

10.2.1 Extent and Location

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

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

The Washington Department of Natural Resources (WDNR) has mapped the tsunami risk zone along Washington's coastline, identifying the various depths based on a M9.0 Cascadia Subduction Zone Earthquake. Due to the size of the map(s), details are difficult to read. 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 and wave arrival time on the QN Reservation is illustrated in Figure 10-3. Figure 10-54 illustrates the estimated wave amplitude and hours after the earthquake waves are expected to continue based on the simulated scenario of a M9.0 Cascadia event as conducted by WDNR. Figure 10-5 illustrates the tsunami hazard zone on the QN Reservation based on the WDNR and FEMA scenarios.



Data Sources: Quileute Indian Tribe; WA DOT; Washington Geological Survey, 2022, Tsunami Hazard–GIS data: Washington Geological Survey Digital Data Series 22, version 1.4, Feb. 2022. Previously released Jan. 2022.

Figure 10-3 Tsunami Inundation Depth (based on WDNR data, 2022)

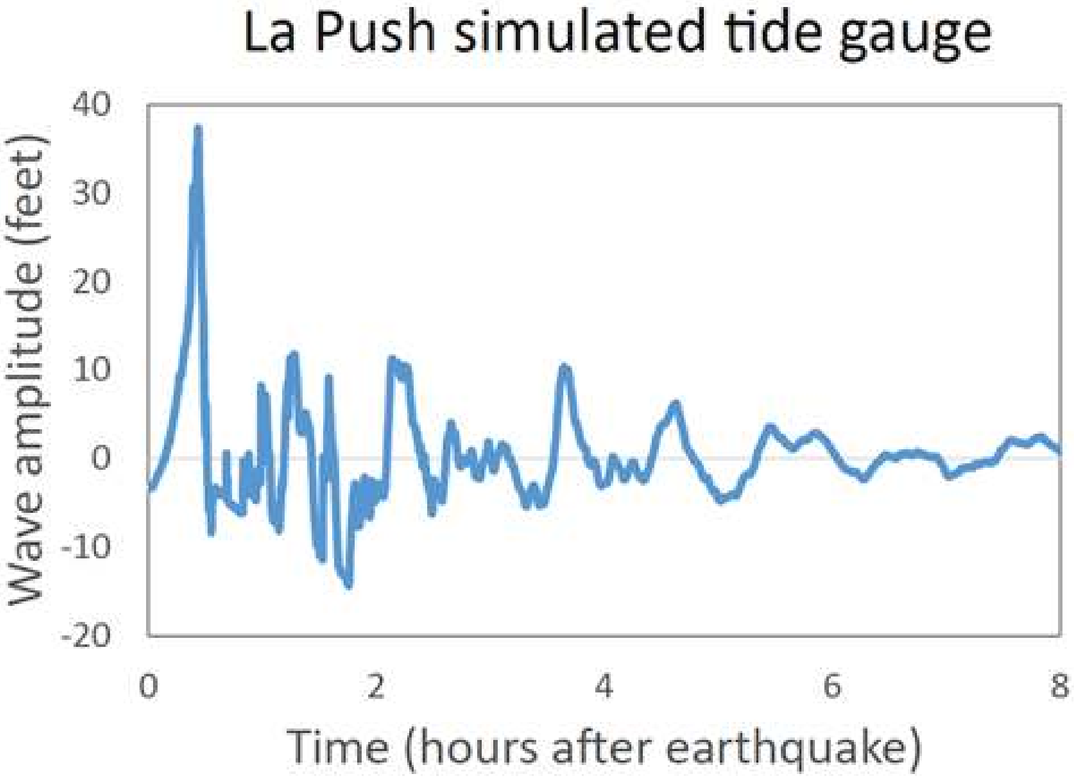


Figure 10-4 Tsunami Tide Gauge Based on Simulated Cascadia M9.0 Event

Inundation map at http://www.dnr.wa.gov/Publications/ger_gm49_tsunami_hazard_southern_coast.zip

Figure 10-5 Tsunami Hazard Zone on Quileute Reservation

10.2.2 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 Tahola; 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.[26]
- 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 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.[27],[28]

10.2.3 Severity

Tsunamis are a threat to life and property to anyone living near the ocean. According to the National Centers for Environmental Information (NCEI), tsunamis took the lives of more than 290,000 million

---

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

[27] NOAA National Centers for Environmental Information. Available online at: National Centers for Environmental Information (NCEI) (noaa.gov);

[28] NOAA National Centers for Environmental Information. Tsunami Runup. Accessed 15 May 2023. Available online at: NCEI Hazard Tsunami Search (noaa.gov)

people in the past 100 years.[29] During the time period covering 1950 to 2007, 478 tsunamis were recorded globally. Fifty-one of those events caused fatalities totaling over 308,000 coastal residents. The overwhelming majority of these events occurred in the Pacific basin. Recent tsunamis have struck Nicaragua, Indonesia, Thailand, and Japan, killing several hundred thousand people. Property damage due to these waves was nearly $1 billion. Historically, tsunamis originating in the northern Pacific and along the west coast of South America have caused more damage on the west coast of the United States than tsunamis originating in Japan and the Southwest Pacific.

The Cascadia subduction zone will produce the state's largest tsunami. The Cascadia Subduction Zone is similar to the Alaska-Aleutian trench that generated the Magnitude-9.2 1964 Alaska earthquake and the Sunda trench in Indonesia that produced the Magnitude-9.3 December 2004 Sumatra earthquake. Native American accounts of past Cascadia earthquakes suggest tsunami wave heights on the order of 60 feet, comparable to water levels in Aceh Province Indonesia during the December 2004 tsunami there. The Cascadia subduction zone last ruptured on January 26, 1700, creating a tsunami that left markers in the geologic record from Humboldt County, California, to Vancouver Island in Canada and is noted in written records in Japan. Water heights in Japan produced by the 1700 Cascadia earthquake were over 15 feet, comparable to tsunami heights on the African coast after the Sumatra earthquake. At least seven ruptures of the Cascadia subduction zone have been observed in the geologic record.

A Cascadia Subduction Zone earthquake is also 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.

10.2.4 Frequency

In the last 100 years, over 100 fatal tsunamis struck coastlines around the globe.[30] Generally four or five tsunamis occur every year in the Pacific Basin. Pacific-wide tsunamis are rare, occurring every 10 to 12 years on average. Most of these tsunamis are generated by earthquakes that cause displacement of the seafloor, but a tsunami can also be generated by volcanic eruptions, landslides, underwater explosions, and meteorite impacts (Nelson, undated). The frequency of tsunamis is related to the frequency of the event that causes them, which would include seismic, volcanic, or landslide events.

10.3 VULNERABILITY ASSESSMENT

10.3.1 Overview

Results from several studies conducted over the course of the last several years vary to some degree to impact; however, most reports are consistent in several factors. Due to the close proximity to the

---

[29] NOAA National Centers for Environmental Information. Word Tsunami Awareness Day. Accessed 8 Nov 2022. Available online at https://www.ncei.noaa.gov/news/november-5-world-tsunami-awareness-day

[30] NOAA National Centers for Environmental Information. Accessed 8 Nov 2022. Available online at NCEI Hazard Tsunami Search (noaa.gov)

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 Washington State Department of Natural Resources, PMEL, and NOAA have illustrated inundation in the area of the QN Reservation, as well as surrounding areas, all of 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).

Recent studies by Washington State Department of Natural Resources illustrate previous impact as a result of Tsunami waves. Within Grays Harbor County, which is approximately 100 miles south of the QN Reservation, there are “ghost forests” which “represent locations where trees were killed when the land suddenly dropped during a major earthquake (see Figure 10-6). Tree ring dating, or dendrochronology, places the death of these trees in the winter of 1699–1700, the same time that the last Cascadia subduction zone earthquake occurred” (WA DNR, 2022).[31] Evidence supports additional land subsidence by several feet during the 1700 Cascadia subduction zone earthquake.

Figure 10-6 Dead Cedar Snags Along Copalis River in Grays Harbor County

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 and marinas often are swamped and sunk or are left battered and stranded high on the shore. Breakwaters and piers collapse, sometimes because of scouring actions that sweep away their foundation material and

---

[31] Washington State DNR (2022). Tsunamis in Washington. Accessed 15 May 2023. Available online at: Tsunamis | WA - DNR

sometimes because of the sheer impact of the waves. Railroad yards and oil tanks situated near the waterfront are particularly vulnerable. Oil/fuel 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 10-7 illustrates typical time for a tsunami to travel across the Pacific Ocean, based on the 1964 Alaska and 1960 Chile earthquakes and resulting tsunamis.

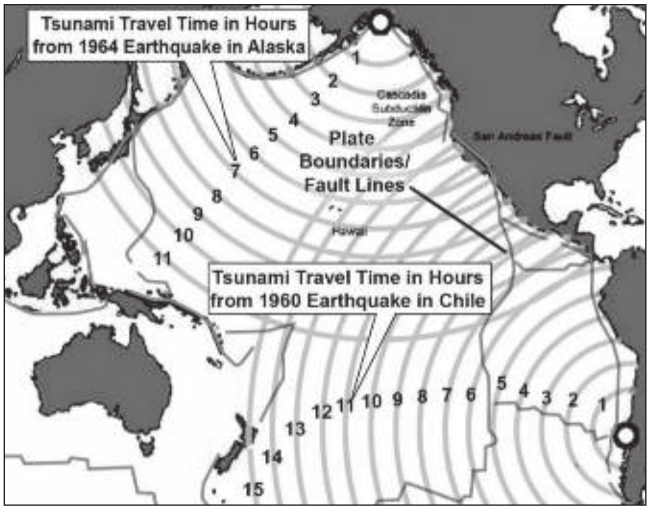


Figure 10-7 Tsunami Travel Times in the Pacific Ocean

According to Washington State's Hazard Mitigation Plan (2013) at least thirteen of Washington State's Pacific Ocean coastal communities and tribal reservations lack natural high ground that is of sufficient elevation to escape a 30+ foot tsunami triggered by a Cascadia Subduction Zone earthquake. The lack of natural high ground coupled with preceding earthquake damage, close proximity to the fault (~50-100 miles), and limited time for evacuation (15-30 minutes) preclude the use of traditional horizontal or vehicular evacuation strategies. These limiting factors make the 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 throughout our Nation's states, commonwealths, and territories are also constrained by similar geographic factors.

To address this challenge, the concept of vertical evacuation was established. Vertical evacuations allow individuals to move upwards to safety into buildings, towers, or berms, and is particularly important on peninsulas where traditional evacuation measures are not viable options for life safety. 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 successfully constructed our nation's first vertical evacuation at the Ocosta School – Project Safe Haven. Shoalwater Bay Tribe, in 2022, completed a vertical evacuation project on the Reservation. The Hoh Tribe, in its new development in the Hoh Highlands Area identified a walking trail from sea level at the shores of the Pacific Ocean through the existing Reservation up to the new Hoh Highlands as an option for tsunami evacuation in its vicinity. The QN has also established a project to identify a safe harbor with the *Move to Higher Grounds* initiative and is actively seeking funding to assist in this effort.

Arrival Time and Inundation

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 Washington State Department of Natural Resource (2022) data indicate an estimated arrival time of only 10 minutes for the Reservation.[32] 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 4-8 meters subsidence (see Figure 10-8).

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. In the event of a tsunami, all tributaries and creeks connected to the coast would be intermittently flooded. The modeled study area may not encompass the entirety of all drainage basins, and the extent of flooding from the next tsunami could continue along these river channels and creeks.

---

[32] Tsunami Hazard Maps of the Olympic Peninsula. (2022). Accessed multiple times. Available online at https://washingtonstategeology.wordpress.com/2022/01/10/new-tsunami-hazard-maps-of-the-olympic-peninsula/

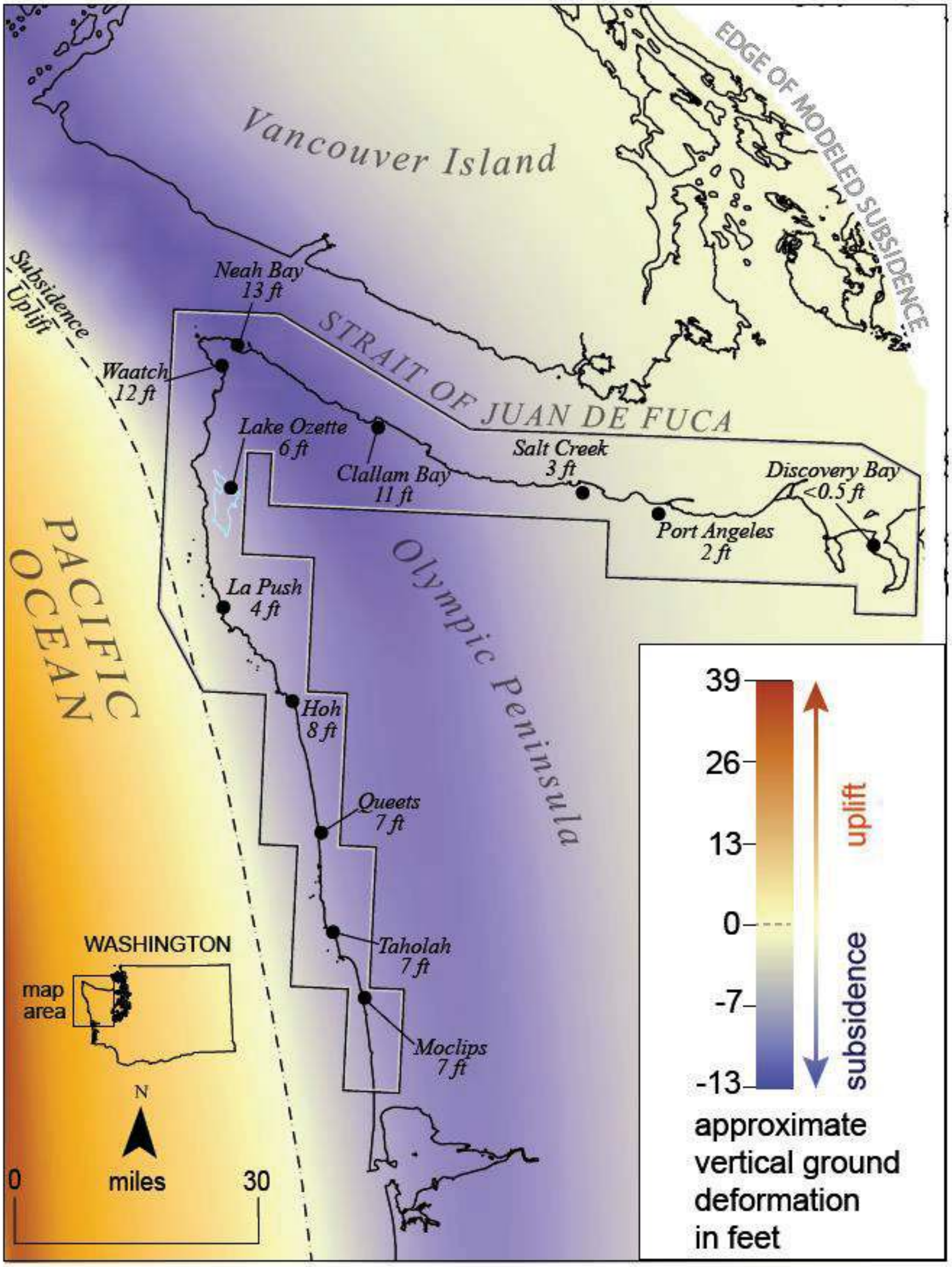


Figure 10-8 Potential Subsidence (WA DNR, 2022)

Based on the 2022 study, locations along the Pacific Ocean within the study area should expect the first offshore wave arrival within 10 minutes following the beginning of the earthquake shaking. Communities that could expect inundation of 40-60 ft or more include Waatch, La Push (QNR), the Hoh Indian Reservation, Queets, Taholah on the Quinault Indian Reservation, Moclips, Pacific Beach, Iron Springs, Copalis Beach, and Ocean City, among others.[33] The M9 Earthquake scenario also causes significant flooding up rivers and along the tributaries and floodplains. The extent of flooding from continuing tsunami waives could continue along river channels and creeks, exceeding their boundaries.

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 waives. The National Weather Service operates two regional information distribution centers. One is located in Ewa Beach, Hawaii, and the other is in Palmer, Alaska. The Ewa Beach center also serves as an administrative hub for the system. When a Pacific basin earthquake of magnitude 6.5 or greater occurs, the following sequence of actions begins:

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

---

[33] ibid

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.

Deep-Ocean Assessment and Reporting of Tsunamis

NOAA's Deep-ocean Assessment and Reporting of Tsunamis system (see Figure 10-9) collects data that is relayed to the Pacific Tsunami Warning Center. These units generate computer models that predict tsunami arrival, usually within minutes of the arrival time. This information is relayed in real time. This system is not considered to be as effective for communities close to the tsunami because the first wave would arrive before the data were processed and analyzed. In this case, strong ground shaking would provide the first warning of a potential tsunami.

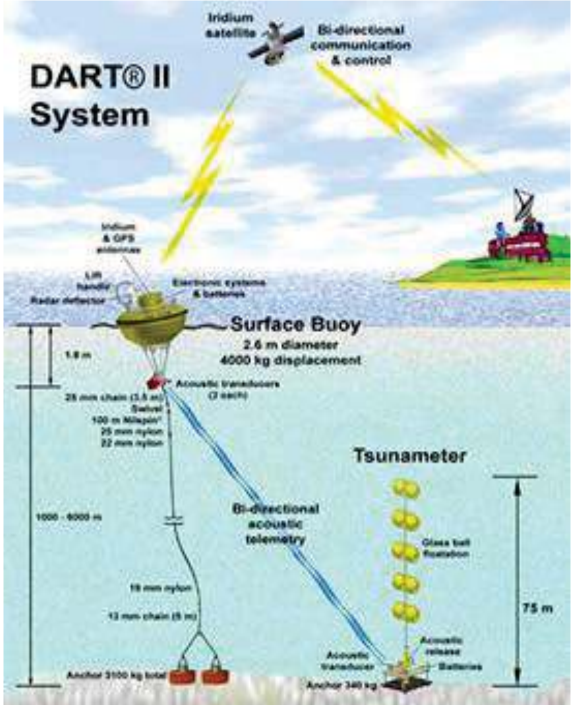


Figure 10-9 Deep-Ocean Assessment and Reporting of Tsunamis System (DART)

10.3.2 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 (10 minutes), so more of the population would be vulnerable as much of the Reservation is in a low-lying coastal area on the mouth of the Quillayute 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 Quileute Nation, as well as any guests and visitors or individuals utilizing any services provided by the Nation are exposed to Tsunami Inundation either through direct impact of the waves, or through limited evacuation. While some areas are more susceptible due to its low-lying proximity to the Pacific Ocean, particularly if subsidence occurs as anticipated, the entire Reservation and all guests will be impacted. It should also be noted that while the entire population of the Reservation (~525 individuals) 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.

Once the *Move to Higher Grounds* initiative is completed, the number of people directly impacted will be reduced as residential structures are moved outside of the inundation zone to the new residential area, as well shelters and governmental services buildings. This will enhance the Nation's ability to continue providing shelter locations and services to those impacted.

The area as a whole also has a very high population of tourists, which stay at the QN hotel and RV campground, as well as vacation rentals in the area, and which utilize the many trails in the area. There are also state and federal campgrounds in the area. The area in general has a high daily count of guests for entertainment purposes, particularly during summertime holidays. Tribal Members also have individual business which operate fishing excursions for tourists. Those population numbers should also be 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 QN (if it maintains the ability to offer such assistance).

10.3.3 Impact on Property

All structures along beaches, low-lying coastal areas, tidal flats, marina, and river deltas would be vulnerable to a tsunami. For the QN, this impact may include the ~25 residential structures in the Lower Village (2015 HMP), as well as several governmental and critical facilities. Three areas of cultural significance (La Push, Lonesome Creek, and Thunder Field) would also be within the tsunami zone (2015 HMP). While it is not owned by the Tribe, it would also include the Mora Campground area, as the tsunami wave would travel through the Reservation up the Quillayute River.

The structures that would be most vulnerable are those located in the front line of tsunami waves, particularly those that are structurally unsound (e.g., older structures, or structures previously impacted by the ensuing earthquake).

In addition, the impact of the waves and the scouring associated with debris that may be carried in the water to more distant locations could cause further damage to structures in the tsunami's path. That would also be the case for run-up waves traveling along the rivers and creek areas.

The Tribe has a few structures which store chemicals, those most common being household-type chemicals, chemicals stored at the hotel and store for maintenance purposes, and chemicals utilized at the hatchery. Both the marina and the Coast Guard facilities also maintain chemicals, including fairly large quantities of fuels. Beyond the gas/diesel at those facilities, there is limited additional gas/diesel on site beyond those mostly for maintenance equipment, but the storage containers may be damaged as a result of the earthquake. There are also individually owned (propane and other) tanks at various residential locations throughout the Reservation, along with limited amounts of chlorine for water purification.

10.3.4 Impact on Critical Facilities and Infrastructure

Figure 10-10 identifies the types of critical facilities owned by the Tribe at risk based on the Tsunami Inundation Zones. This analysis is based on the studies completed by WA DNR for various scenarios as identified.

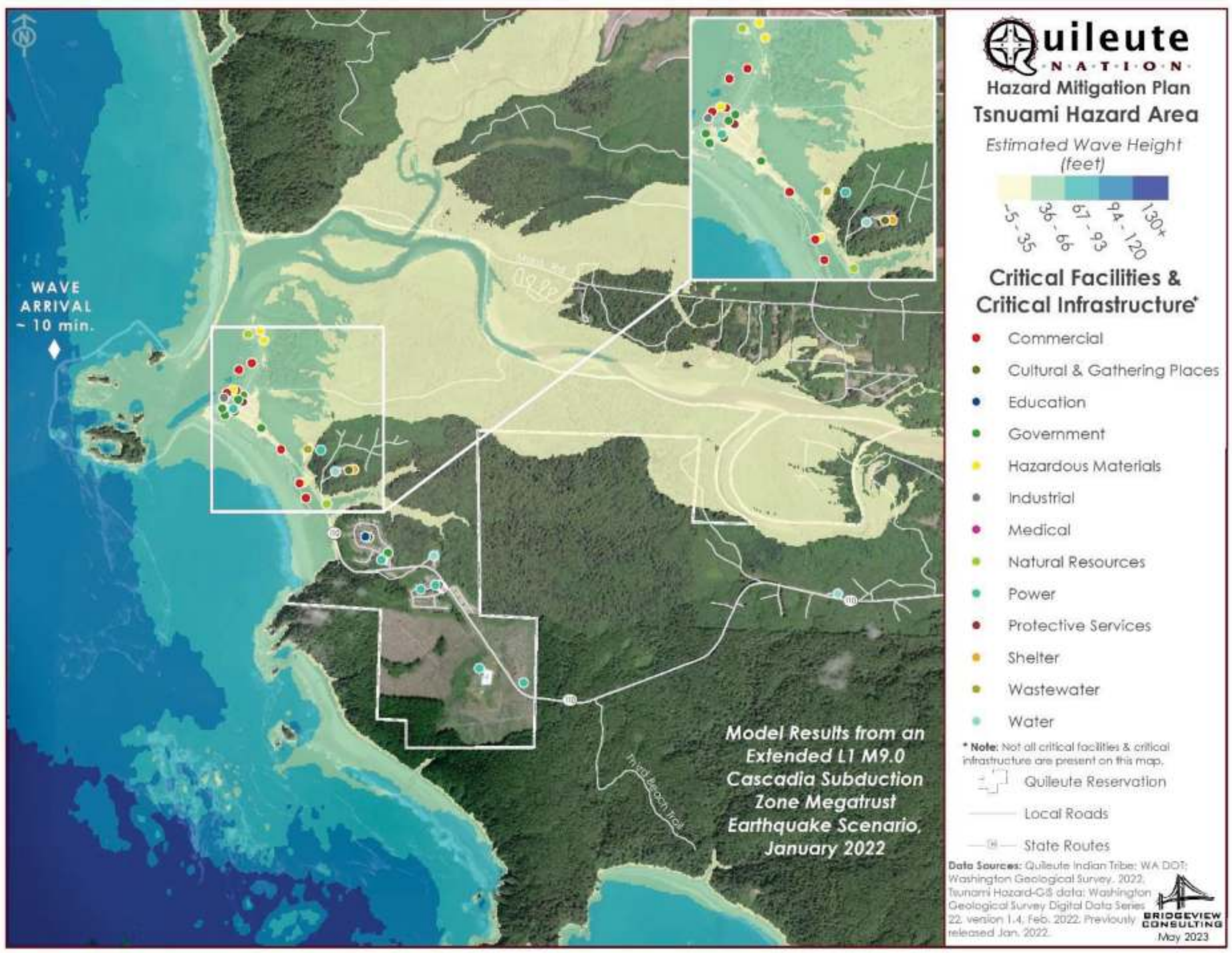


Figure 10-10 Critical Facilities within the Tsunami Hazard Area

Roads and Bridges

Roads are the primary resource for evacuation to higher ground before and during a tsunami event. In addition to the major arterials on and off the Reservation, the QN does have forestry roadways, but the condition of those roads is uncertain until the event occurs, as felled trees or flooding could block those roadways and make them useless for evacuation purposes. 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 Reservation, Clallam and Jefferson Counties.

Likewise, bridges will also be impacted. While there are state and county owned bridges in the area which have the potential to impact evacuation, of significant concern is the Forks Bridge, which is a major roadway providing access to the Reservation, including its newly acquired economic hub in Forks. Also of concern would be the Bogachiel Bridge, which provides access to the public water supply which travels along Highway 110.

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 not otherwise impacted by the tsunami. The forces of tsunami waves can impact above-ground utilities by knocking down power lines and radio/cellular communication towers. Power generation facilities can be severely impacted by both the impact of the wave action and the inundation of floodwaters. This would also impact facilities that are outside of the actual tsunami inundation area.

10.3.5 Impact on Economy

Structures impacted by a tsunami include governmental structures, economic hubs, the marina, Coast Guard Station, and residences. The loss of those structures 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.

QN 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 both Clallam and Jefferson Counties' 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 (e.g., service industries at which tribal members work). Tribal members not living on the Reservation but working for the Nation would not be able to travel to/from work, with lost income.

In general, coastal communities with port or marina 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. The QN does have marinas and docks which support various industries for both the Nation itself, as well as tribal members. These areas could provide for off-loading of supplies should roadways be impacted. 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 potential remoteness of the Reservation, with the impact to roadways, supply chain disruption will be impact everyone, including businesses. With limited resources available, and access impacted, waterway or air-drop deliveries may be the only option to get supplies to the area, 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 currently not a large part of the QN land use and economy, would be impacted with loss of revenue and destruction of businesses for future growth of timber in the area.

The inundation zone for the planning region as a whole is significant and would have a devastating impact on the area's economy. Loss of tax base, destruction of government facilities, destruction of private businesses, loss of land-base, loss of marine vessels for the fishing industry, among other items, all would be significant impacts to overcome to allow the economy to sustain itself. 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 as a result of impact on major highways, the port system, and the travel time associated with loss of the transportation infrastructure.

10.3.6 Impact on Environment

The vulnerability of agricultural and aquatic habit and associated ecosystems would be highest in low-lying areas close to the coastline. Areas near chemical deposits, 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, particularly in high of the Nation's hatchery and potential impact to spawning areas and young fish.

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.

10.3.7 Impact from Climate Change

The impacts of climate change on the frequency and severity of tsunami events could be significant in regions with a 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 waive height travelling further inland.

10.3.8 Future Development Trends

With tsunami wave heights estimated to reach as high as ~58 feet in some areas (La Push) as a result of a Cascadia Subduction Zone Earthquake, standard floodplain development regulation would not provide adequate risk protection for new development. Although somewhat limited, the planning area also has some areas of bluffs and steep hillsides, which would be impacted as a result of wave activity. Roadways will be impacted, restricting access to and from areas of the Reservation. As a result of the expected impact, the QN has elected to move portions of the Reservation to new areas, which are significantly above sea level, and outside of the tsunami inundation zone. Until that total relocation is completed, the Tribe is restricting development in the hazard areas as much as possible, with any new construction being built to much higher standards than existing structures.

10.4 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 Reservation. Based on scenario modeling by WA DNR, residents can expect waves to reach their boundaries within 10 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 to allow for evacuation from the coastal areas.

- To measure and evaluate the probable impacts of tsunamis, hazard mapping needs to be regularly updated based on probabilistic scenarios likely to occur. The science and technology in this field are emerging. For tsunami hazard mitigation programs to be effective, probabilistic tsunami mapping will need to be a key component, with updates occurring as new data emerges. WDNR (et al) recently completed such a study for much of the Washington Coast in 2022. 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.

10.5 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 catastrophic impact in some areas of the existing reservation, including loss of life, injuries, and structure impact. Wave height is estimated to be ~58 feet in La Push. The entire Reservation will be impacted to some degree, including the seawall, roadways, and bridges in the area, which will significantly impact the possibility for evacuation.

For existing structures, the age of the building stock (and previous impact from other hazard events) have left many structures weakened. Impact to the seawall will also increase inundation. While the area has experienced tsunami impact historically, those incidents have occurred infrequently, with minimal damage on the Reservation. A Cascadia-type earthquake event will undoubtedly generate a significant tsunami within the entire region from Canada to California, with a high probability of occurrence.

Implementation of mitigation strategies (e.g., building code enhancement, evacuation sites outside of the tsunami inundation zone, relocation of portions of the Reservation, etc.) will help protect some lives, but not all due to the potential population on the Reservation at the time of the tsunami related to the economic hubs in place, such as the marina, hotel, RV camping, and restaurant, as well as the surrounding parks, which have a high daily population count.

Guests to the Reservation may not be familiar with the area, and while signage is in place for tsunami evacuation, travel time is limited to 10 minutes before the first waves are anticipated. Individuals from outside the area will not know of the short evacuation period. Relocation to the new area of the Reservation outside the tsunami and flood inundation areas, when completed, are the only certain efforts to help reduce the impact on tribal citizens and guests on the QN Reservation.

Based on the potential impact, the Planning Team determined the CPRI score to be 3.7, with overall vulnerability determined to be high.

CHAPTER 11.
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, an average of 10,866 acres annually; human caused fires burn an average of 4,404 state-protected acres each year. Fires during the early and late shoulders of the fire season usually are associated with human-caused fires; fires during the peak period of July, August and early September often are related to thunderstorms and lightning strikes.

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 elect to work with the Center for Natural Lands Management to help identify areas which would benefit environmentally from such practices, and to seek grant funding to help support the natural lands of the Tribe.

11.1 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.

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.

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 is 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 QN as being considered a community at risk; however, there are portions of Clallam and Jefferson Counties 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 (USFS), 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 11-1 identifies those areas of risk on the QN Reservation as identified by U.S. Forest Service (USFS) – Wildfire Risk to Communities dataset.[34] Based on review of the data by the USFS, risk to structures/homes is at the "low range for most of the populated areas – lower than 87% of tribal areas and counties in the United States" (USFS, USDA, Wildfire Risk, 2023) .

---

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

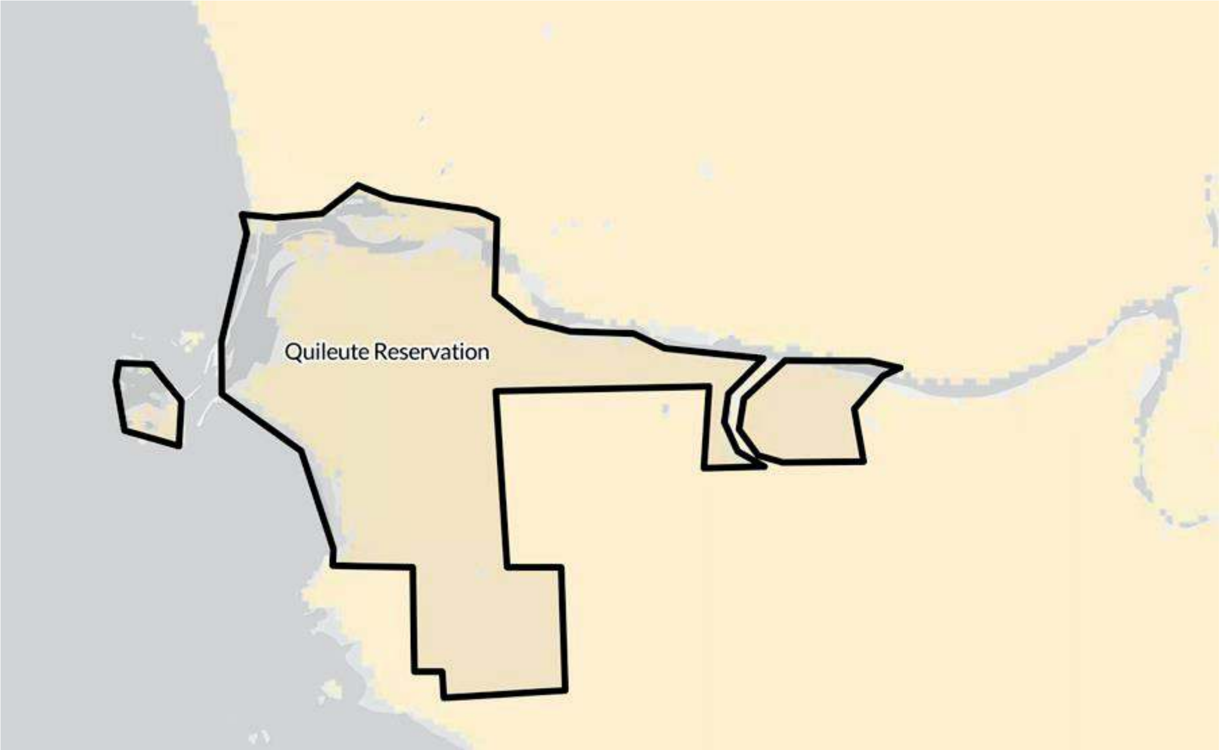


Figure 11-1 Wildfire Risk to Communities (USFS, 2020)

11.1.1 Wildfire Behavior

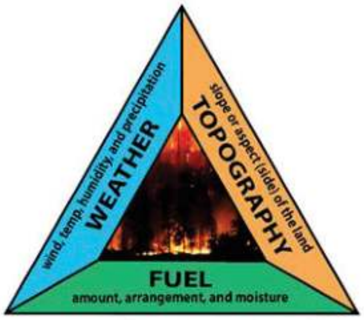


Figure 11-2 Wildfire Behavior Triangle

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.

The following are key factors affecting wildfire behavior:

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

- **Weather**— Relevant weather conditions include temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount and duration, and the stability of the atmosphere. Of particular importance for wildfire activity are wind and thunderstorms:
    - Strong, dry winds produce extreme fire conditions. Such winds generally reach peak velocities during the night and early morning hours. East wind events can persist up to 48 hours, with wind speed reaching 60 miles per hour. Being a coastal community, the QN and Clallam 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 landforms (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.

11.1.2 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 rural in nature, with housing in the area being scattered throughout cluster development, as well as random cabin or vacation rentals distributed through the densely wooded areas. The Reservation does border areas that have a high rate of tourism, including camping, which could increase wildfire danger with respect to campfires. The Tribe does regularly issue burn bans when appropriate, with enforcement powers.

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.

11.1.3 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.

11.1.4 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.

11.2 HAZARD PROFILE

11.2.1 Extent and Location

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

11.2.2 Previous Occurrences

Wildfire causes are highly variable and dependent upon many factors, including the general weather patterns of the region. Within the existing ecosystem of the Reservation, the forestlands are susceptible to forest disturbance patterns such as logging slash accumulation, weather damage which also causes forest debris, and periods of prolonged drought in some areas, with 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, 53 percent of exposure is related to direct sources, such as adjacent flammable vegetation, while 41 percent is from indirect exposure, such as embers and home-to-home ignition (see Figure 11-3).[35]

---

[35] USDA (2023). Wildfire Risk to Communities. Accessed 16 May 2023. Available online at Wildfire Risk to Communities

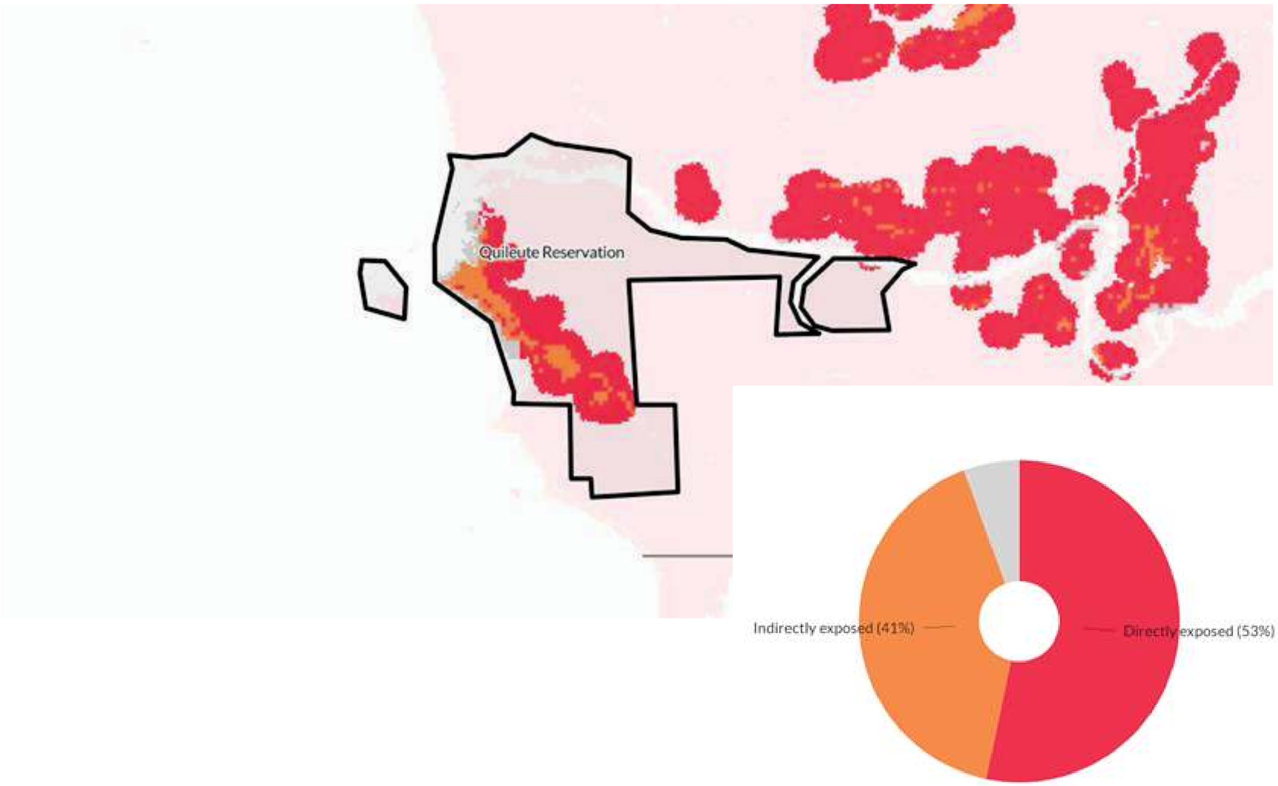


Figure 11-3 Exposure by Type in Populated Areas

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, as well as for cultural practices. These are not considered hazards unless they get out of control.

According to FEMA data, the Tribe has not been included in any disaster declarations for fires. None of Washington State's most significant wildland fires have occurred on the Reservation, although smaller fires have occurred in the region, particularly in the area of the Olympic National Park. The Reservation does occasionally experience fires along the beaches, when campfires are unattended, or on occasion, get out of control. However, no fires burning one acre or more have occurred since completion of the last plan, nor in the last decade. With climate change, it is anticipated that the wildfire risk may increase.

Lightning Fires

Lightning-caused fires have accounted for approximately half of the ignitions and two thirds of the burned acreage throughout the Olympic National Park since it was established in 1938. The Olympic National Park abuts the QN. 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. However, isolated lightning storms have occurred over all areas of the park, including the coastal strip. The greatest numbers of ground strikes recorded in proximity to the QN 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, which as of this update, was closed as a result of a loss of the day lodge due to a fire occurring on May 7, 2023.

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.”

11.2.3 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.

Potential losses from wildfire include human life, structures and other improvements, and natural resources. Beyond the direct loss of life from the fire, 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 the Reservation has a low probability of fires impacting its lands (U.S. Forest Service 2022). Further, the populated areas of the QN Reservation have, on average, an 87 percent lower level of risk than other tribal areas (and counties) in the state.[36]

---

[36] U.S. Forest Service. (2023). Accessed 17 Nov 2023. Wildfire Risk to Communities.

Due to many years of fire suppression, logging, and other human activities, the forests and rangelands have changed. Much of the lands on and surrounding the Reservation are historic logging areas, with small growth timber now in its place. Areas that historically once experienced frequent, low-severity wildfires when ignited, 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.

11.2.4 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. No fires of significance have been reported on the Reservation in the last decade.

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.

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, with most fires occurring at campfire sights, with minimal (below one acre) impact. The majority of lands owned by the Quileute Nation fall within Fire Regime V, with a 200+ year frequency (see Figure 11-4).

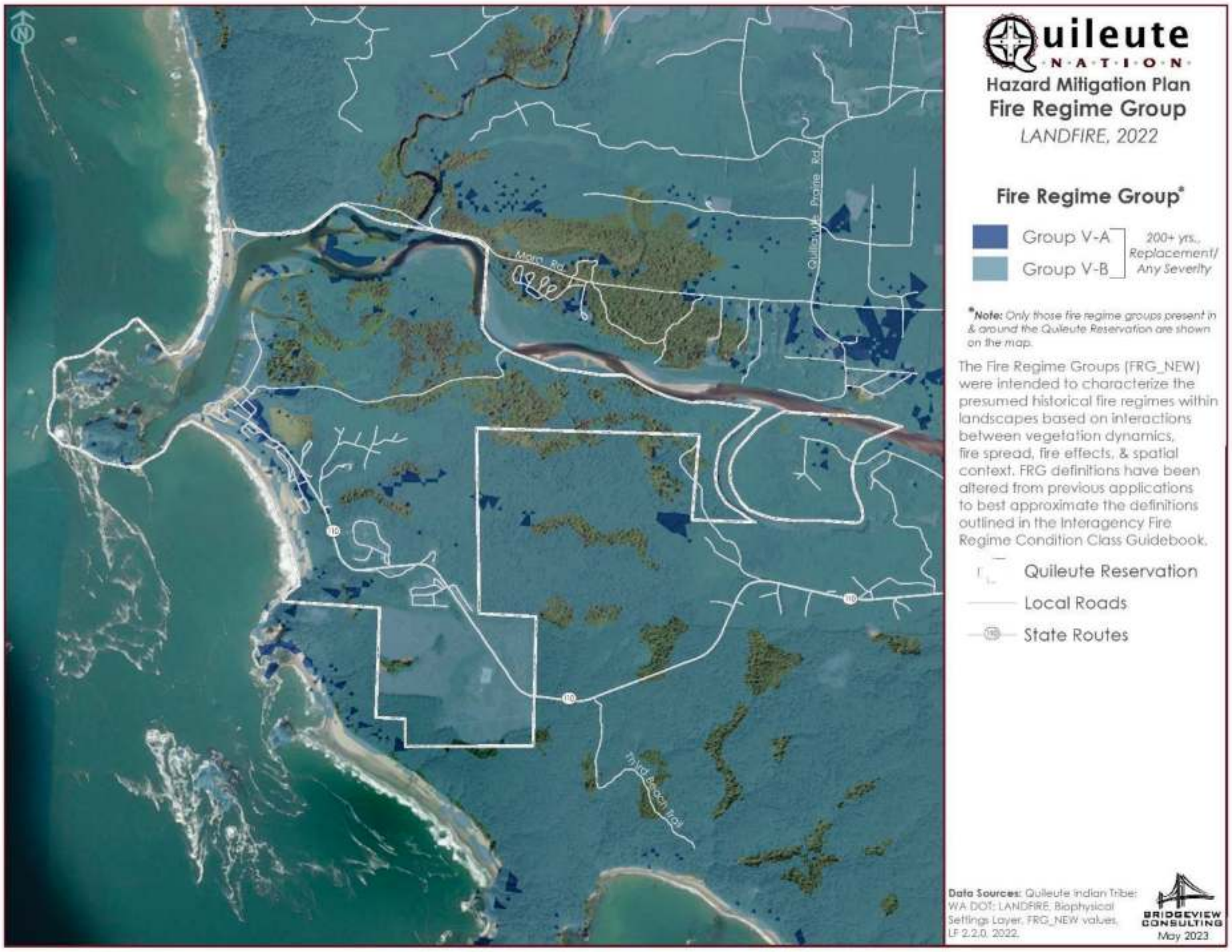


Figure 11-4 Quileute Nation Fire Regime Group

The 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 the Reservation are identified in Figure 11-5.

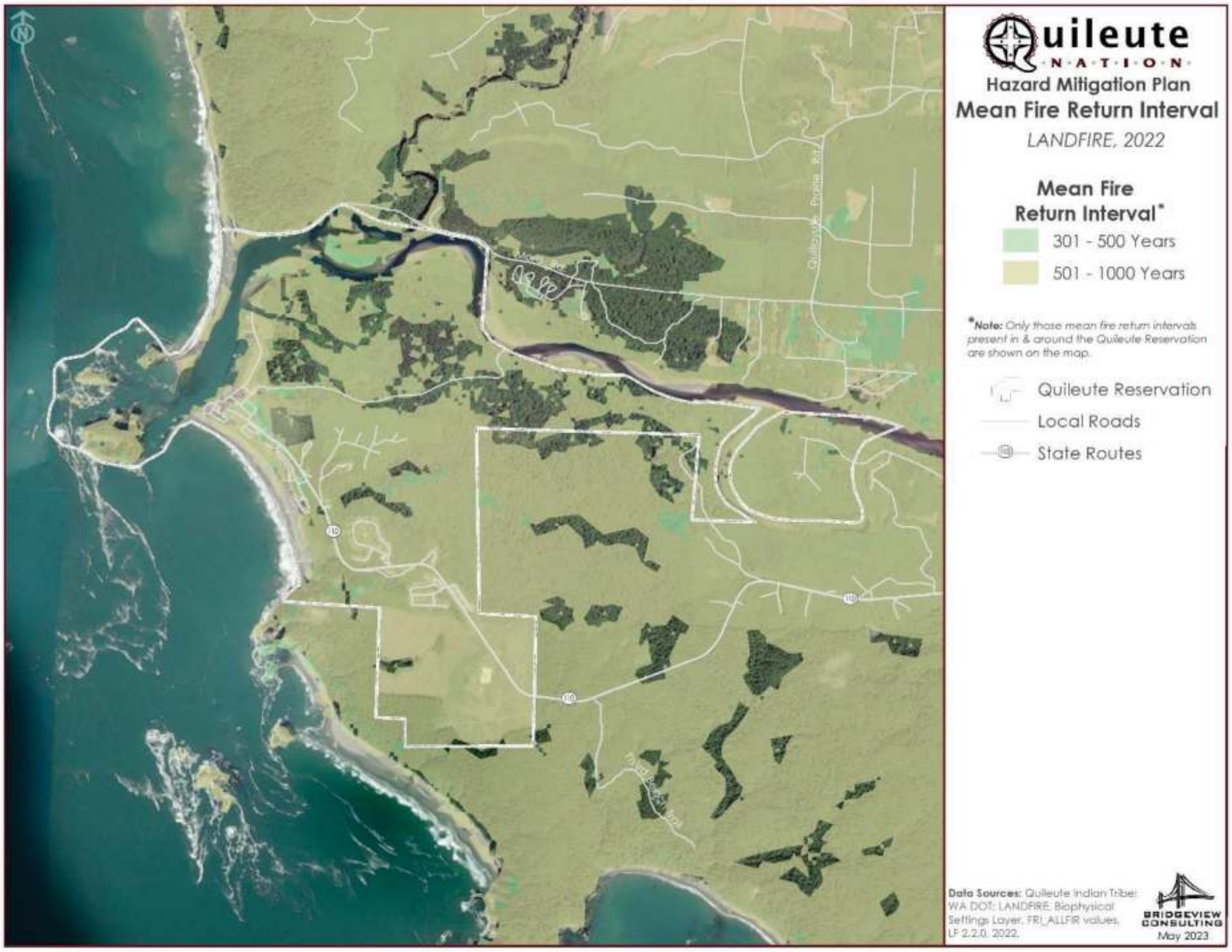


Figure 11-5 Mean Fire Return Interval

11.3 VULNERABILITY ASSESSMENT

11.3.1 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 have its own fire service, but does rely on mutual aid from surrounding communities should the need exist.

11.3.2 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 in excess of 500+/- tribal and non-tribal members living on the reservation daily, as well as tribal staff that work on the Reservation, and non-tribal students and instructors at the school.

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 major thoroughfares traveling 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 Census data, approximately 44 residents are under 5 years of age, with 59 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.

11.3.3 Impact on Property

Property damage from wildfires can be severe and can significantly alter entire communities. Currently there are residential structures scattered throughout the Reservation, both tribal and non-tribal owned. There are also many cabins and vacation rentals that are not used on a regular basis. The majority of the structures are wood and aged. Roofing is standard, combustible materials. Section 3.6.3 further discusses the age and type of building stock, which would be vulnerable to wildfire. Proximity to the Mora Campground and the Olympic National Park, which hosts campsites with fire pits, must also be taken into consideration. Firefighting services in the outlying areas may be taxed if a significant wildfire occurs increases the exposure 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 ecosystem, the forestlands are susceptible to forest disturbance patterns such as logging slash accumulation, weather-damaged forest debris, and periods of prolonged drought and high temperatures in some areas. 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.

The probability of occurrence of a fire based on historic events appears to be low, with no fires of significance (1 acre or more) having occurred in the last decade. 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 on the current Reservation, but that will hopefully change in the new development, where the tribe anticipates incorporating fire resistant materials for construction purposes, and additional wildfire mitigation efforts (e.g., low-burning vegetation, covered eves, sprinkler systems, defensible space, etc.).

11.3.4 Impact on Critical Facilities and Infrastructure

All structures on the Reservation fall into Fire Regime 5, with only five having a Mean Fire Return Interval of 404 years, the remainder well over 600 years. Most critical (and other) facilities on the Reservation are of wood frame construction and 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 their age and building type. Most roads and railroads would be without damage except in the worst scenarios. Fueling stations could be significantly impacted, with the Lonesome Creek Fueling System falling within the 400-year return interval period.

As indicated, the Nation does currently maintain fuel on the Reservation; however, if impacted, that would mean that vehicles would have to travel a significant distance to obtain fuel for vehicles, heating/cooling, etc. During a wildfire event, hazardous material storage containers could also 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.

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 could be impacted. Within the new area, it is anticipated that the power will be underground, thereby reducing impact on the actual Reservation. 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. The Tribe does maintain a number of docks which support various industries (both QN and private).

11.3.5 Impact on Economy

The economy of the Tribe is largely dependent on governmental operations/functions, entertainment/tourism (restaurant, hotel, campgrounds, marina, fishing excursions) and other businesses conducted by tribal members. A large-scale wildfire could destroy structures, equipment, and the existing forest stand, albeit younger in nature. The economy could suffer both from lost revenue and tax base (at the county level for tribal members working off the Reservation), 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. Secondary impacts include erosion on burned slopes leading to runoff and contributing to flooding, landslides, and impacts to fish-bearing streams.

11.3.6 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 fish annually.

- 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.

11.3.7 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. 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.

11.3.8 Future Development Trends

In an effort to reduce the impacts of wildfires on the Reservation, the QN plan on development in the new area to be in a cluster format, which enhances the Nation’s ability to reduce and fight wildfires by use of landscaping that will reduce the spread of fire on the reservation. With that development, availability of water will also increase, specifically for firefighting purposes. This will also enhance the ability to fight fires with respect to existing structures, while also enhancing the ability to fight fires on the new structures.

The Nation 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 Nation 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 well as strong forest management practices.

A growing body of research suggests that "the only effective home protection treatment is treatment in, on, and around the house (see Figure 11-6); 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."

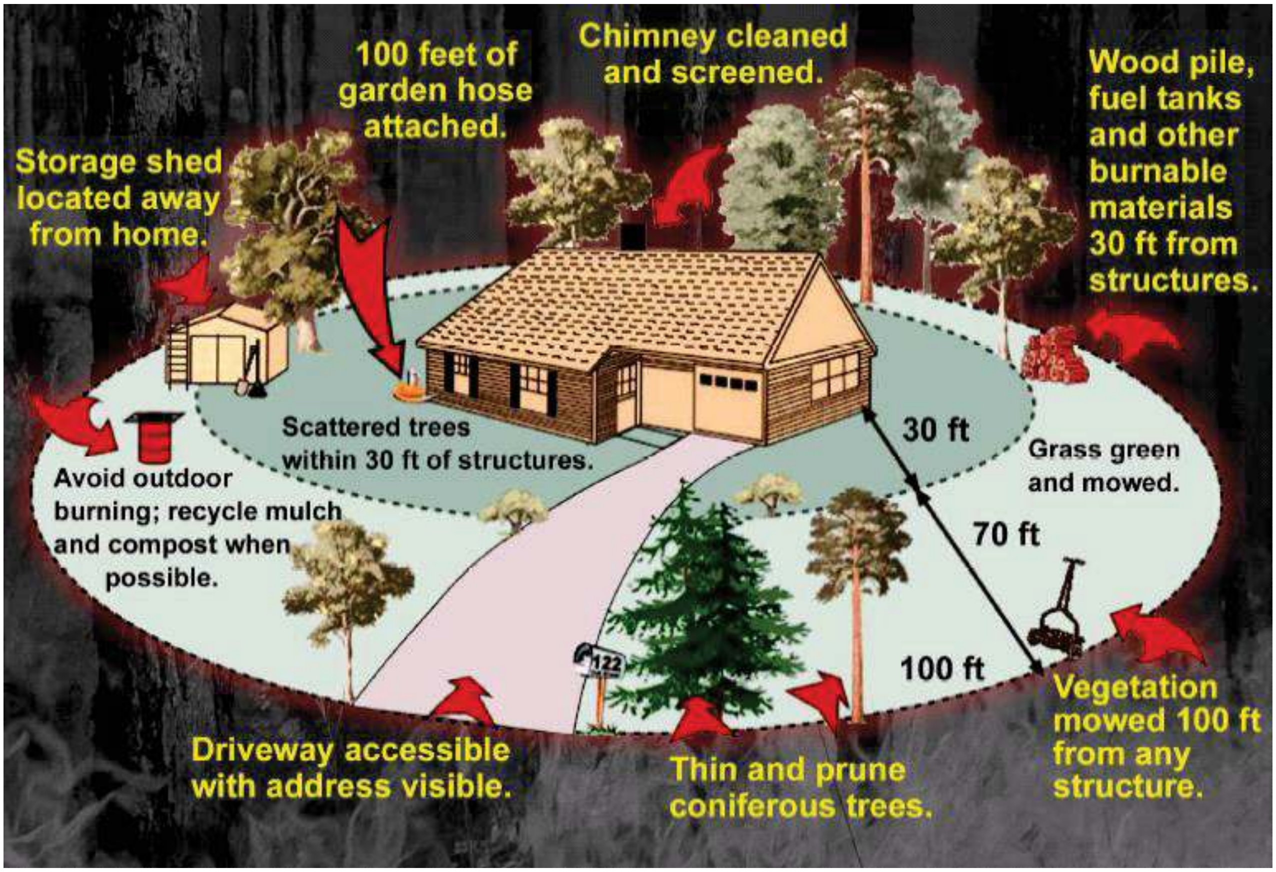


Figure 11-6 Measures to Protect Homes from Wildfire

11.3.9 Issues

The major issues for wildfire in the planning area are the following:

- Public education and outreach to people living in or near the fire hazard zones should include information about and assistance with mitigation activities such as defensible space, and advance identification of evacuation routes and safe zones.
- Wildfires could cause landslides as a secondary natural hazard.
- Climate change 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.

11.4 IMPACT AND RESULTS

Due to its close proximity to densely wooded areas, fire danger is of medium concern to the QN, although historical fire damage has been low. With the increase in popularity of tourists to the QN and the Olympic National Park, 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 limited with respect to geographic extent. While the reservation itself has never experienced a significant 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 low-medium. There is the potential for isolation should a significant wildfire occur in certain areas, as well as the potential impact from smoke and the elderly / young populations of citizens living on the Reservation. This determination is also due to the forested lands and limited timber industry on which the Nation relies, with forest management practices having been very successful for the QN.

As the tribe continues to build and develop into its new areas, it will continue to 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.

Construction into the wildfire hazard areas undoubtedly will continue to expand, thereby increasing the risk of fires. This is particularly true since there are non-tribal properties located within the Reservation boundary, for which the QN have limited ability to maintain or control. For new construction by the QN, implementation of mitigation strategies which help reduce wildfire risk, such as landscaping regulations, type of construction material, 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 1.75, with overall vulnerability determined to be a low level.

CHAPTER 12.
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 12-1 Calculated Priority Risk Index

TABLE 12-1
CALCULATED PRIORITY RANKING SCORES

Hazard	Probability	Magnitude and/or Severity	Geographic Extent and Location	Warnin g Time	Duration	Calculated Priority Risk Index Score
Climate Change	4	2	3	1	4	3.00
Earthquake	4	4	4	4	1	3.85
Flood	4	2	3	1	3	2.95
Landslide	2	2	1	4	2	2.00
Severe Weather	4	3	4	1	3	3.40
Tsunami	4	4	3	4	2	3.70
Wildfire	2	1	1	4	2	1.75

The Calculated Priority Risk Index scoring method has a range from 0 to 4. “0” being the least hazardous and “4” being the most hazardous situation.

TABLE 12-2
HAZARD RANKING

Hazard Ranked in Order of Concern	Hazard	CPRI Score	Level of Concern and Significance
1	Earthquake	3.85	High
2	Tsunami	3.70	High
3	Severe Weather	3.4	High
4	Climate Change	3.0	High
5	Flood	2.95	High
6	Landslide	2.0	Medium
7	Wildfire	1.75	Low

CHAPTER 13.
MITIGATION STRATEGY

The development of a mitigation strategy allows the community to create a vision for preventing future disasters. This is accomplished by establishing a common set of mitigation goals and objectives, a common method to prioritize actions, and evaluation of the success of such actions.

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 Quileute Nation Reservation.

13.1 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 2015 Hazard Mitigation Plan. During the February 2023 Kick Off Meeting, the Planning Team determined that the two sets of goals (primary and parallel) were not necessary and elected to combine the two sets of goals. It also reviewed and updated the objectives. The 2023 Goals and Objectives are as follows:

1. Reduce natural hazard-related injury and loss of life.
2. Reduce property damage.
3. Promote a sustainable economy.
4. Maintain, enhance, and restore the natural environment’s capacity to absorb and reduce the impacts of natural hazard events.
5. Increase public awareness and ability to respond to disasters.
6. Preserve the cultural resources of the Quileute Nation.

TABLE 13-1
PROPOSED 2023 OBJECTIVES

Objective Number	Objective Statement	Goals for which it can be applied
O-1	Acquire, retrofit, or relocate structures in high hazard areas where safety to life, preservation of vital ecosystems, or provision of services cannot be assured, thereby reducing the adverse impacts of disasters.	1, 2, 3, 4, 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 and reduce adverse impacts.	1, 2, 3, 4, 5, 6
O-3	Utilize the best available data and science to continually improve the understanding of the location and potential impacts of natural hazards.	1, 2, 3, 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 the 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, 3, 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.	1, 5
O-8	Establish a partnership among all levels Tribal departments, surrounding tribes, governments, adjoining communities, and the business community to improve and implement methods to protect property.	1, 2, 4, 5, 6
O-9	Seek mitigation projects that provide the highest degree of natural-hazard protection at the least cost.	1, 2, 3, 4, 6

13.2 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 2023 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.

During development of these strategies, the initial starting point was the 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 13-2 and referenced as having been previously identified. The status of the previous action items are discussed in detail in Section 13.5 (Table 13-4).

In addition to the referenced *Catalog*, many of the hazard mitigation initiatives recommended in this plan were selected from among examples presented from other studies, planning, or strategic documents – integrating various planning efforts already in existence to the extent possible.

TABLE 13-2.
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 M = Modified for 2023 Update	Initiative Type: Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources
1—Develop necessary emergency management and post-disaster action plans addressing hazards of concern. This may include a Hazard Mitigation Plan, 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. (Previous 1A)									
Y	New and existing	All Hazards	3, 4, 5, 6	Police/ Emergency Management	Low	FEMA BRIC, HMGP funds, EMPG funds, BIA funds,	Short-term	Y M	All
2—Adopt the *QN Mitigation Plan* as an element of any comprehensive land use plan that the Tribe will create to ensure linkage between the documents to explore the need for high hazard zoning and high-risk land use ordinance. This includes acquisition of new land or development of owned lands. (Previous 1.B)									
Y	New and existing	All Hazards	1, 2, 3, 4, 5, 6	Planning/Land Use Office	Low	General Fund	Short-term	Y M	Emergency Services, Property Protection, Prevention, Recovery, Structural Projects
3—Map the QN 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. Identify and implement mitigation opportunities of Repetitive Loss and Severe Repetitive Loss properties owned by the Tribe and Tribal members; implement acquisition, relocation, elevation, and flood-proofing measures to protect identified properties, i.e. construct berms to divert water flow; install debris fences or traps; construct onsite detention ponds; improve onsite drainage. (4.D, 4.I)									
N	New and existing	Flood, Landslide	1, 2, 3, 4, 5	GIS	Medium	FEMA Risk Map program, LIDAR data	Short-term	Y	Emergency Services, Prevention, Structural Projects

<table>
<tr><th colspan="10">TABLE 13-2.
HAZARD MITIGATION ACTION PLAN MATRIX</th></tr>
<tr><th>Action Identified in Any Other Plan (Y or N)#</th><th>Applies to New or Existing assets</th><th>Hazards Mitigated</th><th>Objectives Met</th><th>Lead Agency (listed first) and others potentially involved</th><th>Estimated Cost</th><th>Sources of Funding</th><th>Timeline</th><th>Included in Previous HMP Yes/No M = Modified for 2023 Update</th><th>Initiative Type: Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources</th></tr>
<tr><td colspan="10">4—As appropriate, develop regulatory authority to address land use development, including, potentially, an ordinance for the National Flood Insurance program (NFIP). Obtain flood insurance policies for Tribal properties located in the floodplain. (4.E)</td></tr>
<tr><td>N</td><td>New and Existing</td><td>Flood</td><td>All</td><td>Planning/ Land Use Office, Tribal Government</td><td>Low</td><td>General Fund</td><td>Short-term, ongoing</td><td>Y
M</td><td>Protection, Prevention, Structural Project</td></tr>
<tr><td colspan="10">5-Update Comprehensive Waste Management Plan and assure wastewater system for new development has Maintenance and Operations Plan and adequate staffing to prevent damages. (1.H)</td></tr>
<tr><td>N</td><td>New and Existing</td><td>Flood, Severe Weather</td><td>1, 2, 3, 4, 5, 6,</td><td>Facilities</td><td>Medium</td><td>Wastewater Utility</td><td>Long-term</td><td>Y</td><td>Property Protection, Prevention</td></tr>
<tr><td colspan="10">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.</td></tr>
<tr><td>N</td><td>New</td><td>Wildfire</td><td>1, 2, 3, 4, 5, 6, 7, 9,</td><td>Planning/ Land Use</td><td>Low</td><td>General Fund</td><td>Short-term</td><td>N</td><td>Emergency Services, Property Protection, Prevention, Projects, Public Info., Natural Resources</td></tr>
</table>

TABLE 13-2.
HAZARD MITIGATION ACTION PLAN MATRIX

<table>
<tr><th>Action Identified in Any Other Plan (Y or N)#</th><th>Applies to New or Existing assets</th><th>Hazards Mitigated</th><th>Objectives Met</th><th>Lead Agency (listed first) and others potentially involved</th><th>Estimated Cost</th><th>Sources of Funding</th><th>Timeline</th><th>Included in Previous HMP Yes/No M = Modified for 2023 Update</th><th>Initiative Type: Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources</th></tr>
<tr><td colspan="10">7— Work with the National Tsunami Hazard Mitigation Program and surrounding community to determine possible vertical evacuation sites for Tsunami hazard for evacuation purposes. If identified, seek granting fund for project.</td></tr>
<tr><td>N</td><td>New</td><td>Tsunami</td><td>All</td><td>Emergency Management, Public Works Department, Natural Resources Department, Washington Emergency Management Division</td><td>High</td><td>E&T Program</td><td>Long-term</td><td>N</td><td>Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources</td></tr>
<tr><td colspan="10">8—Consider building codes that would harden new and existing structures from the potential impacts of earthquakes and seismic shaking. (3.A)</td></tr>
<tr><td>N</td><td>New and existing</td><td>Earthquake</td><td>1, 2, 3, 4, 5, 6, 9</td><td>Planning/ Land Use and Tribal Council</td><td>Low</td><td>General Fund</td><td>Short-term</td><td>Y
M</td><td>Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Natural Resources</td></tr>
<tr><td colspan="10">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. This includes replacing undersized culverts at various locations. (4.P)</td></tr>
</table>

TABLE 13-2.
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 M = Modified for 2023 Update	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,	Public Works	Low	Land Use Permitting Fees, Grant Funds, General Funds, BIA	Short-term, ongoing	N	Property Protection, Prevention, Recovery, Structural Projects, Natural Resources
10—Promote and increase inspections on Highway 101 and SR 110 along the Reservation to reduce risk from landslides and washouts (e.g., Bogachiel Bridge abutment). Work with Washington Department of Transportation and Clallam County to identify areas along Highway 101 and SR 110 which require modification. Seek ways to improve slope stability, vegetation management, 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 for Tsunami Evacuation, to include areas included in the 2023 maps released by DNR for Tsunami Evacuation Walking Routes. (3.C, 4.A, 4.B)									
N	New and Existing	Landslide	3, 4, 5, 6, 8, 9	Public Works, WDOT, Clallam County	High	General fund, WA DOT, BIA	Long-term	Y M	Emergency Services, Property Protection, Recovery, Structural Projects
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	N	Emergency Services, Prevention, Public Info.

<table>
<tr><th colspan="10">TABLE 13-2.
HAZARD MITIGATION ACTION PLAN MATRIX</th></tr>
<tr><th>Action Identified in Any Other Plan (Y or N)#</th><th>Applies to New or Existing assets</th><th>Hazards Mitigated</th><th>Objectives Met</th><th>Lead Agency (listed first) and others potentially involved</th><th>Estimated Cost</th><th>Sources of Funding</th><th>Timeline</th><th>Included in Previous HMP Yes/No M = Modified for 2023 Update</th><th>Initiative Type: Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources</th></tr>
<tr><td colspan="10">12—Continue to conduct vulnerability assessments of water and wastewater (and other) utilities for exposure to all identified hazards of concern. This effort may include engineers and various subject matter experts as needed.</td></tr>
<tr><td>N</td><td>Existing</td><td>All Hazards</td><td>1, 3, 4, 6, 7</td><td>Public Works</td><td>Medium</td><td>FEMA Hazard Mitigation Grant funding; Technical Assistance Grants</td><td>Short-term</td><td>N</td><td>Emergency Services, Property Protection, Structural Projects</td></tr>
<tr><td colspan="10">13—Review utility designs and standards for safety and competence under natural and human caused disasters, utilizing information from this Hazard Mitigation Plan. Bury utilities that are at risk of failure during a windstorm or winter storm event, start at the school - wires that pose an extreme and immediate danger. As appropriate, seek out funding to assist in implementation of this effort; as appropriate, also see out grants to install generators in those structures which are at higher risk. (4.N)</td></tr>
<tr><td>N</td><td>New</td><td>All hazards</td><td>1, 2, 3, 4, 8, 9</td><td>Public Works</td><td>High</td><td>General Fund, Land Use Permit Fees, Grants, BIA</td><td>Short-Term, ongoing</td><td>Y
M</td><td>Emergency Services, Property Protection, Prevention, Recovery</td></tr>
<tr><td colspan="10">14—Develop a Reservation-wide comprehensive education program to educate the Tribal members and staff about the hazards of concern on the Reservation and about hazard mitigation opportunities, including such things as: tie downs and brackets for furniture, bookcases, etc.; vegetation management and chipping program for wildfire and wind impacts; voluntary building safety inspection for electrical issues or load capacities for roofs or wind and tie down opportunities. As appropriate, seek out and apply for grants to help facilitate these efforts. (3.B, 4.K, 4.L, 4.M, 4.O, 5.B, 5.C, 5.D)</td></tr>
<tr><td>N</td><td>New and existing</td><td>All</td><td>1, 2, 3, 5, 9</td><td>Police/ Emergency Management Department; Facilities</td><td>Low</td><td>General Fund, Grant funds when available</td><td>Short-term, ongoing</td><td>Y
M</td><td>Emergency Services, Prevention, Recovery, Public Info.</td></tr>
<tr><td colspan="10">15— Move Human Resources, Senior Services, and Commodities upland as part of the Move to Higher Grounds initiative. This includes the USDA Commodity Program (1.G, 2.H))</td></tr>
</table>

TABLE 13-2.
HAZARD MITIGATION ACTION PLAN MATRIX

<table>
<tr><th>Action Identified in Any Other Plan (Y or N)#</th><th>Applies to New or Existing assets</th><th>Hazards Mitigated</th><th>Objectives Met</th><th>Lead Agency (listed first) and others potentially involved</th><th>Estimated Cost</th><th>Sources of Funding</th><th>Timeline</th><th>Included in Previous HMP Yes/No M = Modified for 2023 Update</th><th>Initiative Type: Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources</th></tr>
<tr><td>N</td><td>New and existing</td><td>Flood</td><td>1, 3, 4, 5, 6, 7, 9</td><td>Public Works</td><td>High</td><td>National Weather Service Grants, USGS grants, Corps of Engineers</td><td>Long-term (depends on funding)</td><td>Y</td><td>Emergency Services, Property Protection, Prevention, Natural Resources</td></tr>
<tr><td colspan="10">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.</td></tr>
<tr><td>N</td><td>New and existing</td><td>All</td><td>1, 2, 3, 4, 5, 6, 8, 9</td><td>Executive Director/ Public Works Department</td><td>Low</td><td>General Fund, FEMA grant programs</td><td>Short-term, development, long term maint-enance</td><td>N</td><td>Emergency Services, Public Info., Recovery</td></tr>
<tr><td colspan="10">17—Relocate public facilities that have been repeatedly flooded to areas outside of the floodplain area through acquisition projects funded by PDM and HMGP.</td></tr>
<tr><td>N</td><td>Existing</td><td>Flood</td><td>1, 2, 3, 4, 5, 6, 8, 9</td><td>Executive Director/ Tribal Government</td><td>High</td><td>General Fund, BRIC & HMGP Grants, HUD, BIA</td><td>Long-Term</td><td>Y</td><td>Emergency Services, Property Protection, Prevention, Recovery, Structural Projects</td></tr>
<tr><td colspan="10">18—Relocate private residences that have been repeatedly flooded to areas outside of the floodplain through acquisition projects funded by BRIC and HMGP.</td></tr>
</table>

TABLE 13-2.
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 M = Modified for 2023 Update	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
19—Seek alternative energy sources and telecommunications systems in all Tribally owned assets. (2B)									
N	New	All	1, 2, 3, 4, 5, 6, 7, 9,	Public Works Department and Natural Resources Department	High	General Fund, Land Use Permit Fees, BRIC & HMGP, BIA and HUD Grants	Long-Term	Y	Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources
20 Provide for secure records management and conversion. (1.F)									
N	New and Existing	All	All	Executive Director, Tribal Council	Medium	USDA Fire Grants	Long-term	Y	Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources

<table>
<tr><th colspan="10">TABLE 13-2.
HAZARD MITIGATION ACTION PLAN MATRIX</th></tr>
<tr><th>Action Identified in Any Other Plan (Y or N)#</th><th>Applies to New or Existing assets</th><th>Hazards Mitigated</th><th>Objectives Met</th><th>Lead Agency (listed first) and others potentially involved</th><th>Estimated Cost</th><th>Sources of Funding</th><th>Timeline</th><th>Included in Previous HMP Yes/No M = Modified for 2023 Update</th><th>Initiative Type: Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources</th></tr>
<tr><td colspan="10">21 Expand existing Public Safety facilities and shelters to include supplies, alternative power sources (e.g., solar power), etc., to enable the structure to be utilized during power outages or other times of hazard impact. This includes development of new or expansion of existing structures to be utilized as shelter or resilience centers for not only tribal but also other citizens living or traveling through the area that become isolated. (2.C)</td></tr>
<tr><td>N</td><td>New</td><td>All</td><td>All</td><td>Executive Director, Tribal Council</td><td>High</td><td>US Dept. of Commerce, USDA, BIA</td><td>Long-term</td><td>Y
M</td><td>Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources</td></tr>
<tr><td colspan="10">22 Seek out grant funding and relocate Health Clinic to new development and away from top of bluff. (1.E)</td></tr>
<tr><td>N</td><td>New</td><td>All</td><td>All</td><td>Executive Director, Tribal Council</td><td>High</td><td>BRIC, US Dept. of Commerce, BIA, IHS</td><td>Long-term</td><td>Y</td><td>Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources</td></tr>
<tr><td colspan="10">23. Improve warning system and communications system. Link and coordinate phone system and fire alarm system to ensure you can hear chimes. At present, the system is ineffective. (2.F)</td></tr>
<tr><td>N</td><td>New and Existing</td><td>All</td><td>All</td><td>Public Safety, EM</td><td>Medium</td><td>THLS, BRIC, Tsunami & Earthquake Program,
E911</td><td>Short-Term</td><td>Y</td><td>Prevention, Public Awareness, Emergency Services</td></tr>
</table>

<table>
<tr><th colspan="10">TABLE 13-2.
HAZARD MITIGATION ACTION PLAN MATRIX</th></tr>
<tr><th>Action Identified in Any Other Plan (Y or N)#</th><th>Applies to New or Existing assets</th><th>Hazards Mitigated</th><th>Objectives Met</th><th>Lead Agency (listed first) and others potentially involved</th><th>Estimated Cost</th><th>Sources of Funding</th><th>Timeline</th><th>Included in Previous HMP Yes/No M = Modified for 2023 Update</th><th>Initiative Type: Emergency Services, Property Protection, Prevention, Recovery, Structural Projects, Public Info., Natural Resources</th></tr>
<tr><td colspan="10">24. Install engineered log structures along the banks of the Quillayute River upstream of Thunder Field to mitigate flood damage and stabilize the riverbank (Phase 4 of project during 2024 lifecycle). Work with the ACOE and perhaps WSDOT Environmental Office (4.C).</td></tr>
<tr><td>Y</td><td>New and Existing</td><td>Flood, Severe Storm</td><td>All</td><td>Natural Resources</td><td>High</td><td>BRIC, HMGP,
Historic Oxbow restoration through Flood Plains By Design.</td><td>Medium</td><td>Y</td><td>Property Protection, Prevention, Recovery, Structural, Natural Resources</td></tr>
<tr><td colspan="10">25. Stabilize landslide-prone areas through engineered stabilization measures, i.e. interceptor drains, in situ soil piles, drained earth buttresses, and sub-drains. (4.G) This project has 3 areas of concern:-
– Raven Crest II geo tech engineering report recommendations (no action yet taken).
– Mudslide below Coast Guard apartments that was cleaned up, but no stabilization measures yet taken.
– Pedestrian walking path below observation deck that requires Geotech Analysis due to erosion exacerbated by fiber optic cable installation.</td></tr>
<tr><td>Y</td><td>New and Existing</td><td>Flood, Severe Storm, Landslide /Erosion</td><td>All</td><td>Natural Resources</td><td>High</td><td>BRIC, HMGP, USCG</td><td>Medium</td><td>Y M</td><td>Property Protection, Prevention</td></tr>
<tr><td colspan="10">26. Work with various service providers to determine ability to provide medical services for remote locations of the Reservation or during times when travel is not possible through web-based appointments or traveling medical professionals. This may require establishing a room with internet services and computer access for Tribal Members that do not have computers or internet services capable of supporting secure access, or a treatment room where traveling health care providers could facilitate/administer medical treatment. (2.I)</td></tr>
<tr><td>N</td><td>New</td><td>All</td><td>All</td><td>Health Services</td><td>Medium</td><td>HIS Medical Insurance</td><td>Short</td><td>Y M</td><td>Emergency Services</td></tr>
<tr><td colspan="10">27. Increase intergovernmental and public-private sector coordination with various supporting entities/agencies.</td></tr>
<tr><td>N</td><td>New</td><td>All</td><td>All</td><td>Tribal Council, Public Safety</td><td>Low</td><td>Tribal General Fund</td><td>Short</td><td>Y M</td><td>Emergency Services</td></tr>
</table>

13.3 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.

13.4 ACTION PLAN PRIORITIZATION

Table 13-3 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 13-3.
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
1	5	High	Low	Yes	Yes	Yes	High
2	6	High	Low	Yes	Yes	Yes	High
3	5	High	Medium	Yes	Yes	Yes	High
4	9	Medium	Low	Yes	No	Yes	High
5	6	Medium	Medium	Yes	No	Yes	High
6	8	Medium	Low	Yes	No	Yes	High
7	9	High	High	Yes	Yes	No	High
8	7	High	Low	Yes	No	Yes	High
9	8	High	High	Yes	Yes	No	High
10	6	High	High	Yes	Yes	No	High
11	5	High	Low	Yes	No	Yes	High
12	5	High	Medium	Yes	Yes	No	High
13	6	High	High	Yes	Yes	No	High
14	5	High	Low	Yes	Yes	Yes	High
15	7	High	High	Yes	Yes	No	High
16	8	Medium	Low	Yes	No	Yes	Medium
17	8	High	High	Yes	Yes	No	High
18	8	High	High	Yes	Yes	No	High
19	8	High	High	Yes	Yes	No	High
20	9	High	High	Medium	Yes	Yes	Medium
21	9	High	High	Yes	Yes	No	High
22	9	High	High	Yes	Yes	No	High
23	9	High	Medium	Yes	Yes	No	Medium
24	9	High	High	Yes	Yes	No	High
25	9	High	High	Yes	No	No	High
26	9	High	Medium	Yes	Yes	Partial	High
27	8	High	Low	Yes	No	Yes	High

13.5 2023 ACTION PLAN STATUS OF 2015 INITIATIVES

In addition to establishing new action items for the 2023 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 13-4 identifies the results of this review.

TABLE 13-4.
2023 STATUS OF 2015 HAZARD MITIGATION ACTION PLAN

Previous Action Number	Action Description	Mitigation Type	Hazard (s) Addressed	Existing or New Development	Completed (C) Removed (R) Carried Over (CO) Merged (M)	Status Update
1.A	Integrate the vulnerability analysis and implementation strategy within the Tribal Mitigation Plan into the Quileute Tribe Comprehensive Plan	Prevention	All	New & Existing	C	As the Nation continues land use development, it has and will continue to utilize information from the HMP to assist in guiding where development should occur based on its land use authority.
1.B	Explore the need for hazard zoning and high-risk hazard land-use ordinances	Prevention	All	New & Existing	M	This is part of the Nation's land use authority and is addressed in its land use regulations.
1.C	Update land acquisition criteria within Tribal planning and real estate development documents to include a hazard analysis component	Prevention	All	New & Existing	M	This is part of the Nation's land use authority and is addressed in its land use regulations.
1.D	Conduct engineered risk/safety analysis on new construction	Prevention	All	New	C, R	The Tribe, as a course of normal practice, adheres to established building codes and inspection requirements. As such, this strategy is removed as it is conducted in a normal course of operation.
1.E	Relocate Health Clinic to new development and away from top of bluff	Prevention	All	New	CO	Part of move to higher ground planning. Phase 2 planning is just beginning.
1.F	Provide for secure records management and conservation	Prevention	All	New	CO	Some digitization of historic documents utilizing grant funds move some records off sit to 1010 building

TABLE 13-4. 2023 STATUS OF 2015 HAZARD MITIGATION ACTION PLAN						
Previous Action Number	**Action Description**	**Mitigation Type**	**Hazard (s) Addressed**	**Existing or New Development**	**Completed (C) Removed (R) Carried Over (CO) Merged (M)**	**Status Update**
1.G	Move Human Resources, Senior Services and Commodities upland	Prevention	All	New	CO	Part of move to higher ground planning. Phase 2 planning is just beginning.
1. H	Update Comprehensive Waste Management Plan; and assure waste water system for new development has Maintenance and Operations Plan and adequate staffing to prevent damages	Prevention	All	New and Existing	CO	Part of move to higher ground planning. Phase 2 planning is just beginning.as we continue to expand in higher ground this will need to be updated
2.A	Create a mitigation outreach program that helps tribal members prepare for human-caused and natural hazards (connect with 2.H); post clear information at resort	Public Education & Awareness	All	New & Existing	C, CO	This is part of the on-going mitigation strategy developed for the 2023 HMP.
2.B	Develop a plan and seek funding for backup electric and telecommunications systems in a Tribally owned asset	Prevention	All	New & Existing	CO	Need for electrical and telecommunications backup as MTHG progresses.
2.C	Build or install emergency shelters in strategic areas (at cemetery, Akalat) stock with provisions	Emergency Services	All	New	Partially completed, CO	Emergency supplies are located at Akalat. Emergency shelter and supplies to be evaluated at the secondary cemetery location.

TABLE 13-4. 2023 STATUS OF 2015 HAZARD MITIGATION ACTION PLAN						
Previous Action Number	**Action Description**	**Mitigation Type**	**Hazard (s) Addressed**	**Existing or New Development**	**Completed (C) Removed (R) Carried Over (CO) Merged (M)**	**Status Update**
2.D	Install and maintain back-up generators in high need areas, i.e. lift station #4 on water system, and Akalat for emergency center.	Prevention Emergency Services, Property Protection	All	New & Existing	C	FEMA grant provided 4 generators which were installed at critical facilities including well pump house, Akalat, head start, waste water treatment center Additional grant provided for installation of generator at commodities/senior center.
2.E	Support Hazard Mitigation, Safety & Emergency Management Training for Tribal Members to build professional capability on Reservation	Public Education and Awareness	All	New and Existing	CO	As the Tribe continues to develop its EM program, this will continue to occur.
2.F	Improve warning system and communications system. Link and coordinate phone system and fire alarm system. Can't hear chimes, ineffective.	Prevention, Public Awareness, Emergency Services	All	New and Existing	C, CO	WA state installed a second warning system. Now two tsunami towers on the reservation. Continued testing and updating of chimes, fire, and phone systems needed.
2.G	Dedicate staff position with responsibility for implementing and maintaining QHMP, check emergency stations, inspect generators, public awareness, promote full participation in evacuation drills.	Prevention, Property Protection, Public Awareness	All	New and Existing	C	Tribal Emergency Management Officer was established in 2015. Provides community outreach and notifications.

TABLE 13-4. 2023 STATUS OF 2015 HAZARD MITIGATION ACTION PLAN						
Previous Action Number	**Action Description**	**Mitigation Type**	**Hazard (s) Addressed**	**Existing or New Development**	**Completed (C) Removed (R) Carried Over (CO) Merged (M)**	**Status Update**
2.H	Move USDA Commodity Program upland, out of flood & tsunami zone.	Emergency Services	All	New and Existing	CO	Part of move to higher ground planning. Phase 2 planning just beginning.
2.I	Work with UW Medical to establish Web-based Telenet Medical Service for remote locations	Emergency Services Public Awareness	All	New and Existing	CO, M	The Tribe continues to work on this effort with travel medical providers. The strategy was updated/modified in the 2024 plan.
2.J.	Increase intergovernmental coordination	All	All	New and Existing	CO	Continuing and ongoing communications with regional law enforcement and emergency management entities both federal state and county.
3.A	Inspect and retrofit Tribal assets that do not meet current Washington state building codes or are otherwise vulnerable to seismic shaking	Property Protection	Ground shaking ground movement	Existing	CO	The Tribe adheres to relevant building codes in place based on Federal standards as required from all federal funding. As the Tribe continues to construct facilities, it will continue to adhere to the current building codes in place.
3.B	Secure furniture, bookcases, bureaus to walls using safety brackets, durable straps, etc. in Tribal facilities and incorporate model into outreach materials.	Prevention	Ground shaking, ground movement	Existing	C, CO	The Tribe does address this type of mitigation activity within its public outreach and will continue to seek grant funding to help facilitate this activity for tribal members.
3.C	Re-evaluate tsunami evacuation route for necessary upgrades	Prevention	Ground Shaking, ground movement, tsunami	New and Existing	C, CO	New maps released by DNR in 2023, but still relevant as expansion or reservation continues.

TABLE 13-4. 2023 STATUS OF 2015 HAZARD MITIGATION ACTION PLAN						
Previous Action Number	**Action Description**	**Mitigation Type**	**Hazard (s) Addressed**	**Existing or New Development**	**Completed (C) Removed (R) Carried Over (CO) Merged (M)**	**Status Update**
4.A	Work with WSDOT to resolve SR 110 at MP8 where the road frequently floods, and the Bogachiel Bridge abutment. Communication started, bridge on STIP for scour and deck repair.	Property Protection, Structural Project	Flood	New	CO	Continued ongoing bridge repairs over the last few years, mainly repair of potholes in surface asphalt, and inspections of the bridge.

TABLE 13-4. 2023 STATUS OF 2015 HAZARD MITIGATION ACTION PLAN						
Previous Action Number	Action Description	Mitigation Type	Hazard (s) Addressed	Existing or New Development	Completed (C) Removed (R) Carried Over (CO) Merged (M)	Status Update
4.B	Reinforce the water main along Highway 110 near Three Rivers and the Bogachiel Bridge. Depending on the method used to secure the road (see above); the water main could be re-routed to follow the road at a higher elevation and out of the floodplain. Include utilities in road redesign.	Property Protection	Flood	Existing	CO	Water main has not been changed. If state DOT makes changes to 110 the rerouting of watermain may be feasible but no reason for reroute if state is not re-doing 110
4.C	Install engineered log structures along the banks of the Quillayute River upstream of Thunder Field to mitigate flood damage and stabilize the riverbank. Work with the ACOE and perhaps WSDOT Environmental Office.	Property Protection	Flood	New	C. CO	Phase 3 of river restoration project has been completed utilizing funds from funding secured for phase 4 historic oxbow restoration through Flood Plains By Design. .
4.D	Identify and implement mitigation opportunities of Repetitive Loss and Severe Repetitive Loss properties owned by Tribal members; implement acquisition, relocation, elevation,	Property Protection	Flood	Existing	C, CO	Since completion of the last plan, the Nation has removed structures which were frequently flooded. With development of the 2023 HMP, the Tribe has established an SRL policy. The Tribe will continue to work with FEMA and NFIP personnel to assist in implementation of mitigation

TABLE 13-4. 2023 STATUS OF 2015 HAZARD MITIGATION ACTION PLAN						
Previous Action Number	**Action Description**	**Mitigation Type**	**Hazard (s) Addressed**	**Existing or New Development**	**Completed (C) Removed (R) Carried Over (CO) Merged (M)**	**Status Update**
	and flood-proofing measures to protect identified properties, i.e. construct berms to divert water flow; install debris fences or traps; construct onsite detention ponds; improve onsite drainage.					projects to reduce impact to frequently flooded structures.
4.E	Continue to participate in the NFIP and obtain flood insurance policies for Tribal properties located in the floodplain	Prevention	Flood	New and Existing	CO	Maintained.
4.F	Construct a bridge across Lonesome Creek to provide ingress and egress to the southern campground. The campsite is subject to flooding from the creek. It can also be a fire hazard from campfires. Enforce new ordinance banning fires.	Emergency Services, Natural Resource Protection	Flood, Wildland Fire	New	R	No longer relevant.
4.G	Stabilize landslide-prone areas through engineered stabilization measures, i.e. interceptor drains, in situ soil piles, drained	Property Protection	Landslide/ Mudslide	Existing	CO	3 areas of concern:- Raven Crest II geo tech engineering report with recommendations but no action yet taken. Mud slide below coast guard apartments that was cleaned up

TABLE 13-4. 2023 STATUS OF 2015 HAZARD MITIGATION ACTION PLAN						
Previous Action Number	**Action Description**	**Mitigation Type**	**Hazard (s) Addressed**	**Existing or New Development**	**Completed (C) Removed (R) Carried Over (CO) Merged (M)**	**Status Update**
	earth buttresses, and sub-drains					but no stabilization measures taken. Pedestrian walking path below observation deck that requires Geotech Analysis due to erosion exacerbated by fiber optic cable installation
4.H	Develop and implement vegetation management plans along the hills adjacent to Highway 110, the tsunami evacuation route, for secure slope stabilization.	Property Protection, Natural Resource Protection	Landslide/ Mudslide	Existing	M	Related to slide and stabilization issues noted above.
4.I	Explore options for acquisition of developed areas for relocation of facilities of Tribal structures where repetitive and ongoing flooding & landslide hazards cannot be mitigated, and when opportunities and funding are available.	Prevention, Property Protection	Landslide/ Mudslide	Existing	CO	The tribe has acquired several properties over the years off-reservation and is working to put them into tribal trust status. This includes the Kitla Business Park located on Hwy 110, the Riverview RV Park, Hermison RD property for clinic services, Smokehouse restaurant property located next to Kitla.
4.J	Work with ACOE to replace or repair sunken breakwater that was damaged in January 2012 storm. Planned over next two years.	Property Protection	Coastal Erosion	New	C	USACE completed repairs in Sept 2023

TABLE 13-4.
2023 STATUS OF 2015 HAZARD MITIGATION ACTION PLAN

Previous Action Number	Action Description	Mitigation Type	Hazard (s) Addressed	Existing or New Development	Completed (C) Removed (R) Carried Over (CO) Merged (M)	Status Update
4.K	Manage vegetation in areas within and adjacent to rights-of-way, and in close proximity, to Tribal assets and utilities to reduce property damage from trees; and to promote wind screens wherever possible.	Property Protection	Windstorm	Existing	CO	Ongoing conducted when and where necessary, danger trees recently removed at Resort
4.L	Develop a free annual tree chipping and tree/brush pick-up service to encourage Tribal members to manage trees and shrubs that are at risk of falling on overhead power lines.	Property Protection	Windstorm	Existing	CO, M	This strategy has been carried over but expanded to include fuels reduction for wildfire mitigation activities.
4.M	Bolt down or otherwise reinforce the roofs of Tribal residences and/or facilities to prevent wind damage	Property Protection	Windstorm	Existing	C, CO	HUD IDBG grant that replaced roofs on 45 houses. Continuous and ongoing as necessary and as funding becomes available.

TABLE 13-4.
2023 STATUS OF 2015 HAZARD MITIGATION ACTION PLAN

Previous Action Number	Action Description	Mitigation Type	Hazard (s) Addressed	Existing or New Development	Completed (C) Removed (R) Carried Over (CO) Merged (M)	Status Update
4.N	Bury utilities that are at risk of failure during a windstorm or winter storm event, start at the school - wires that pose an extreme and immediate danger.	Property Protection	Windstorm, Winter Storm	Existing	CO	Continuing and ongoing as part of MTHG planning. Newly installed fiber optic cables have been added under ground except for few key areas where we were unable to.
4.O	Determine the structural stability of assets, roofs, carports, and garages, to withstand ice and snow loads, and other weatherization requirements for extreme storm conditions.	Property Protection	Winter Storm	Existing	M	See elements in 4.M
4.P	Work with Natural Resource Conservation Service to replace undersized culvert at fish hatchery	Property Protection	Winter Storm/Flooding	Existing	C	Confirm with Hatchery
5.A	Conduct a vegetation management project to create defensible space around Tribal assets, utilities, and culturally sensitive areas. Thin or remove vegetation within a 50-foot radius, or reasonable distance depending on situation.	Property Protection	Wildland Fire	Existing	R	Similar initiatives already exist.

TABLE 13-4. 2023 STATUS OF 2015 HAZARD MITIGATION ACTION PLAN						
Previous Action Number	**Action Description**	**Mitigation Type**	**Hazard (s) Addressed**	**Existing or New Development**	**Completed (C) Removed (R) Carried Over (CO) Merged (M)**	**Status Update**
5.B	Offer vegetation management services to elderly, disabled, or low-income Tribal members who need help to remove flammable materials near their homes.	Property Protection	Wildland Fire	Existing	M	See 4.K and 4. L these are similar and ongoing needs
5.C	Create a voluntary building fire-safety inspection evaluation program for homes or businesses. Professionally inspect for faulty pilot lights, overloaded electrical circuits, open containers containing a combustible substance, and other fire hazards	Prevention	Urban Conflagration	Existing	CO	Not been completed. We haven't had a functional and operation FD but we are now contracted MOU for Fire services through Clallam County Fire District one which as combined La Push and Three Rivers Fire Departments so may be more opportunities to offer these services .
5.D	Create an education program to inform Tribal members about the safe use of wood-burning stoves, and other fire prevention activities.	Prevention	Urban Conflagration	Existing	M	This strategy has been merged with the public outreach strategy developed for the plan maintenance section of the 2023 HMP.

13.6 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:

- Watershed Analysis and/or replacement, including state, federal, local governments, and landowners for:
    - Sol Duc Watershed Analysis
    - North Fork of Calawah Watershed
    - Sitkum/South Fork of Calawah Watershed
    - E-W Fork Dickey Watershed Analysis
    - Bogachiel River Assessment
    - Dickey Watershed Restoration
- Wetland projects, which reduce impact from flooding.
    - Reconstruction of channel diversity, shoring up of banks, fixing blowdowns
- Forest Management Plans.
- Fish Restoration Projects
    - Culvert replacement Powell Springs.
    - Culvert replacement Fossil Creek Bridge.
    - Culvert installation at Prairie Falls (joint project with Rayonier, private landowner, WDFW, and Clallam County).
- Establish and enforce burn-bans on Tribal owned lands, reducing the risk of wildfire.
- 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 2015 HMP, including with FEMA, Clallam and Jefferson Counties, Rayonier, and state agencies, such as the Department of Transportation, among others.

Forest Management Practices

Across the Quileute Tribe, forest management activities have covered timberlands adjacent to the major access routes where power lines are located. The result has been a power delivery infrastructure that is currently at reduced risk. These are positive activities that should be conducted when the management of the forestlands can help to protect the investment in the power supply system and not adversely affect homes and businesses on the Reservation.

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 studies, Environmental Protection Agency (EPA), U.S. Army Corps of Engineers (USACE), the US Coast Guard, Climate Change, and 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).

13.7 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, as well as the grant management personnel. The Planning Team shall share information regarding projects as they are implemented and completed. Projects specific to the HMP mitigation strategies will be reviewed annually by the Planning Team and Emergency Management Director, among others.

The Tribe has 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. Quileute Nation 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, and approval by resolution of the Quileute 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, and approval by resolution of the Quileute Tribal Council.

As previously indicated in Section 1.2, and 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. This includes 2 CFR 200 and 3002. To ensure compliance, the Quileute Nation, 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.

CHAPTER 14.
IMPLEMENTATION AND MAINTENANCE

14.1 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 November 2023. A copy of the resolution is provided in Figure 14-1.

INSERT RESOLUTION

Figure 14-1 Resolution Adopting Hazard Mitigation Plan

14.2 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 QN 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.

14.2.1 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 QN 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 Quileute Nation Tribal Council.

The Emergency Manager or HMP Project Manager (as staffed) will have lead responsibility for overseeing the Plan implementation and maintenance strategy, including future updates. 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 Emergency Manager, 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 QN. As described in the previous section, progress on mitigation actions will be described in an annual report to the QN 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 (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 pursuant to 2 CFR 200 and 3002.

14.2.2 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.

14.2.3 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.

14.2.4 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 QN 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.

14.2.5 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 QN 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.

14.2.6 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 QN, 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 QN has done extensive planning and assessment with respect to climate change, various hazard assessments, forest management planning, and appropriate land use zoning as it relates to the relocation of vulnerable areas of the reservation. Various policies have been regularly updated and 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/NFIP Regulations
- Emergency response plans
- Capital improvement programs
- Tribal codes
- Community design guidelines (such as for the newly constructed water system or additional construction associated with the *Move to Higher Grounds* initiative)
- Restoration plans
- Water-efficient landscape design guidelines
- Stormwater management programs
- Community Wildfire Protection Plans
- Vegetation Studies
- Transportation Plans
- Climate Adaptation Plans and Studies
- Tsunami Inundation Zone Studies or Evacuation Plans (including vertical evacuation planning)

Some action items do not need to be implemented through regulation. Instead, these items can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation. As information becomes available from other planning mechanisms that can enhance this plan, that information will be incorporated via the update process. Several integrative initiatives have also occurred, such as those identified in Section 13.6.

REFERENCES

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

American Geosciences Institute. 2020. How much do landslides cost the U.S. in terms of monetary losses? Available at: https://www.americangeosciences.org/critical-issues/faq/how-much-do-landslides-cost-terms-monetary-losses

Climate Impacts Group. 2022. Climate Impacts Group website. Accessed online at http://cses.washington.edu/cig/res/res.shtml

Federal Emergency Management Agency (FEMA). The Disaster Process & Disaster Aid Programs. Federal Emergency Management Agency Website Accessed multiple times at: https://www.fema.gov/pdf/rrr/dec_proc.pdf

Federal Emergency Management Agency (FEMA). National Flood Insurance Program, Community Rating System; CRS Coordinator's Manual.

Frankle, A., E. Wirth; N. Marafi, J. Vidale, W. Stephenson. Bulletin of the Seismological Society of America. (2018) 108 (5A):2347-2369. Accessed online 18 March 2023, Available at: https://pubs.geoscienceworld.org/ssa/bssa/article-abstract/108/5A/2347/544772/Broadband-Synthetic-Seismograms-for-Magnitude-9?redirectedFrom=fulltext

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

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

Ludwin, Ruth, 2006, Historic earthquake catalog for Cascadia--1793-1929: Pacific Northwest Seismic Network.online at http://www.pnsn.org/NEWS/PRESS_RELEASES/CASCAT2006.html

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

Miller, I.M., Morgan, H., Mauger, G., Newton, T., Weldon, R., Schmidt, D., Welch, M., Grossman, E. 2018. Projected Sea Level Rise for Washington State – A 2018 Assessment. (Updated 07/2019.)

National Weather Service (NWS). Wind Chill Chart. Accessed online on 14 April 2023 at: https://www.weather.gov/safety/cold-faqs

NOAA National Centers for Environmental Information. Accessed various times. Available online at: National Centers for Environmental Information (NCEI) (noaa.gov)

NOAA. National Climatic Data Center website. Accessed various dates, 2023. Storm Events Database - Search Page | National Centers for Environmental Information (noaa.gov)

OTA (Congressional Office of Technology Assessment). 1993. Preparing for an Uncertain Climate, Vol. I. OTA–O–567. U.S. Government Printing Office, Washington, D.C.

Pacific Northwest Seismic Network (PNSN). 2019. Cascadia Historic Earthquake Catalog, 1793-1929 Covering Washington, Oregon, and Southern British Columbia. Accessed online at http://assets.pnsn.org/CASCAT2006/Index_152_216.html

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

Tilling, Robert, I. et.al. 1990. Eruptions of Mount St. Helens: Past, Present, and Future, U.S. Geological Survey Special Interest Publication.

U.S. Army Corps of Engineers, Seattle District. (2021). Technical Assistance Response for the January Coastal Storm Event of 2021.

U.S. Environmental Protection Agency (EPA). 2006. Excessive Heat Events Guidebook. EPA 430-B-06-005. Available online at http://www.epa.gov/heatisld/about/pdf/EHEguide_final.pdf

U.S. Environmental Protection Agency (EPA). 2022. Climate Change Indicators in the United States. U.S. Environmental Protection Agency, Washington, DC, USA. Available online at: Climate Change Indicators in the United States | US EPA

U.S. Environmental Protection Agency (EPA). 2011. Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act, EPA Response to Public Comments. U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency (EPA). 2022. Climate Change Facts: Answers to Common Questions. U.S. EPA Website. Accessed Feb 2023 at: https://www.epa.gov/climate-research

U.S. Geological Survey (USGS). 1989. The Severity of an Earthquake. U.S. Government Printing Office: 1989-288-913. Accessed online at: http://pubs.usgs.gov/gip/earthq4/severity_text.html

U.S. Geological Survey (USGS). 2008. An Atlas of ShakeMaps for Selected Global Earthquakes. U.S. Geological Survey Open-File Report 2008-1236. Prepared by Allen, T.I., Wald, D.J., Hotovec, A.J., Lin, K., Earle, P.S. and Marano, K.D.

U.S. Geological Survey (USGS). 2010. Rapid Assessment of an Earthquake's Impact. U.S. Geological Survey Fact Sheet 2010-3036. September 2010.

U.S. Geological Survey (USGS). 2022. USGS Fault Database, accessed online at https://earthquake.usgs.gov/hazards/qfaults/ or U.S. Quaternary Faults (arcgis.com)

U.S. Geological Survey (USGS). 2022. The Modified Mercalli Intensity Scale. USGS website accessed online https://www.usgs.gov/programs/earthquake-hazards/modified-mercalli-intensity-scale?qt-science_center_objects=0#qt-science_center_objects

U.S. Geological Survey (USGS). 2022. *Landslides 101*. 2020. Accessed 14 March 2023. Available online https://www.usgs.gov/natural-hazards/landslide-hazards/science/landslides-101?qt-science_center_objects=0#qt-science_center_objects

U.S. Global Change Research Program (USGCRP). 2009. Global Climate Change Impacts in the United States. Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.

Vaisala, 2022 Annual Report. Accessed 27 Feb 2023. Available online at: 2021 Annual Lightning Report (vaisala.com)

Washington State Enhanced Hazard Mitigation Plan. (Various editions 2013, 2018). Accessed various times. Available online at: https://mil.wa.gov/enhanced-hazard-mitigation-plan

Western States Seismic Policy Council. 1964 Alaska Tsunami. Available online at: 1964 Alaska Tsunami - Western States Seismic Policy Council (wsspc.org)

This page intentionally left blank.

Quileute Nation

2023 Hazard Mitigation Plan

APPENDIX A.
ACRONYMS AND DEFINITIONS

APPENDIX A.
ACRONYMS AND DEFINITIONS

ACRONYMS

CFR—Code of Federal Regulations

cfs—cubic feet per second

CPRI – Calculated Priority Risk Index

CIP—Capital Improvement Plan

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.

Quileute Nation
2023 Hazard Mitigation Plan Update

APPENDIX B. EXAMPLE PROGRESS REPORT

APPENDIX B.
EXAMPLE PROGRESS REPORT

The Quileute Nation
Hazard Mitigation Plan
Annual Progress Report

Reporting Period: *(Insert reporting period)*

Background: The Quileute Nation 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 _____, 2024, 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 _______, 2029. 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