QUINAULT INDIAN RESERVATION
TRIBAL HAZARD MITIGATION PLAN 2010

TRIBAL HAZARDS MITIGATION PLAN
OCTOBER 25, 2010

This **Quinault Indian Reservation Tribal Hazards Mitigation Plan**
Is completed in the fulfillment of guidelines administered by
Federal Emergency Management Administration

By the
Quinault Indian Nation
Coni Wilson
Department of Planning,
Division of Community Services
Community & Economic Development
807 Fifth Ave.
Taholah, WA 98587

Planning services and document authorship provided by

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Pullman WA 99163
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This planning effort has been completed with the consultation by a Planning Committee comprised of representatives of administrative Divisions from the Quinault Indian Nation, representatives from adjacent government agencies such as the US Forest Service, Washington Department of Transportation & Department of Natural Resources, Grays Harbor County, fire protection districts, and planning consultants from Kamiak Ridge, LLC.

EPIGRAPH

"WHAT WE DO TO THE LAND, WE DO TO OURSELVES."

Joe DeLaCruz, President, Quinault Indian Nation (Storm 1990)

"THE … RED MAN IN HIS GREAT CONTEST WITH NATURE HAS LEARNED NOT TO COMBAT NATURE, BUT TO OBSERVE HER MOODS AND TO PREPARE A SIMPLE MEANS OF ESCAPE."

Frederic Remington, 1889

"THERES NO JUSTICE, JUST US."

Taholah Graffiti 2010

The quotation, photographed in Taholah and presented above, attracted attention not just by its immediate message contained in the word 'justice': "fair treatment and due rewards in accordance with honor, standards, and law". The play of the words in this quotation seems to be obvious: 'justice' in the sense of 'just is' as in a juxtaposition to 'just us'. In this case it adds a semantic accent to 'just us', implying 'us' being an ultimate authority in deciding our own fate.

Chapter 0. Table of Contents

0.1. List of Tables

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And the winners are...

Interview by Pies Underwood

Hazard Mitigation Plan Art Contest winners (l-r) are Lena Campbell (4th place), Lacy Allen (2nd place), Briana Alvarez (3rd place), Dillon Potter (5th place) and Julio Silva (1st place). Their artwork will be featured in the QIN All Hazards Mitigation Plan to be adopted by the Quinault Nation later this year. (Photo by Pies)

The QIR Hazards Mitigation Plan Planning Committee, which consists of representatives from QIN tribal departments, tribal organizations, federal and state agencies, and a select number of citizens at-large, was formed to develop a Hazards Mitigation Plan. The work has been on-going for approximately eight months.

In order to promote public awareness, the Nation sponsored an art contest. An invitation was extended to schools located on the Quinault Indian Reservation and also offered to other students who are linked to the Quinault Indian Reservation. The Lake Quinault School staff and teachers encouraged their students from the middle school and high school to participate in the art contest. These students took all the awards.

First place went to Julio Silva, who is in 7th grade at Lake Quinault Middle School. Lacy Allen, the daughter of Jim and Beth Allen, took second place; she is in 8th grade. Lacy is familiar with flooding and power outages and describes them as scary. Sixth grade student Briana Alvarez won third place. Lena Campbell, a 10th grade student at the high school, took fourth place. Her parents are James Campbell and Kathy Lewis. Living next to a river, Lena is well aware of the danger from flooding, and has experienced storm damage as well. "A branch fell off a tree and hit the side of our house," she said. Finally, 5th place was secured by Dillon Potter, a 10th grade student and the son of Ted and Jody Potter. Remembering the December 2007 storm where the lights went out for weeks, Dillon believes the best way to be prepared is to have bottled water and canned food.

Coni Wilson, Manager of Community Development who works in the Planning Department of the Quinault Indian Nation, comments, "By looking at the students' art work, you would have thought they sat in our meetings. They were taught well by their science teacher and art teacher as to what they were supposed to draw and they all did a fine job!"

Thank you, Lake Quinault Schools, for your help and participation in such a critical and necessary plan that includes everyone in and surrounding the communities of the Quinault Indian Reservation.

Julio Silva's 1st place design will appear on the cover of the Hazards Mitigation Plan.

Artwork which took 2nd, 3rd, 4th and 5th place will appear as chapter headings in the Hazards Mitigation Plan. Here are the winning entries: Lacy Allen's 2nd place design (above left), Briana Alvarez's 3rd place drawing (above right), Lena Campbell's 4th place entry (below left) and Dillon Potter's 5th place poster (below right).

Figure I. Youth Art Contest: 2nd Place, Lacy Allen.

Chapter 1. Organization, Adoptions, Promulgations, and Acceptance

1.1. Organization of this Document

The Quinault Indian Reservation Tribal Hazards Mitigation Plan is organized into several chapters, each addressing a specific component of the natural hazards risk assessment, exposure to risk, resources available for mitigation work, the response to natural disasters, and potential mitigation measures.

The first chapter of this document addresses the review by Washington Military Department Emergency Management Division and acceptance by FEMA Region X, and the adoption by the Quinault Indian Nation Business Council. This chapter also contains signatures from the Planning Committee members who were not necessarily in a position to formally adopt the completed plan, but signed to show their concurrence with the document that was developed by the Planning Committee and to urge adoption of the completed plan.

Chapter 2 addresses the planning environment to include FEMA's guidance for the expectations of the Tribal Hazards Mitigation Plan, and the development of the planning team's mission, vision, and goals. This chapter provides detailed linkages to how this effort integrates with existing plans, programs, and policies of the Quinault Indian Nation, in addition to the state and federal agencies operating in the area. The planning process is documented and includes details about public involvement conducted throughout the planning process.

Chapter 3 of this plan is a wide-overview of the Quinault Indian Reservation to describe the demographics, villages, histories, population density and development, resource economics, land cover, land ownership and management, climatic conditions, stream flows, water quality, and the valuation of property improvements on the Quinault Indian Reservation. This chapter is designed to present an historic and current picture of the people, places, and property – all independent from natural hazards and the risks of those hazards.

In chapter 4 the overall risk profile for the Quinault Indian Reservation is evaluated in terms of historical occurrence and current exposure to risks. Each natural hazard defined in Chapter 2 is evaluated and considered on a Reservation-wide basis with the financial potential for losses from each hazard.

Chapter 5 looks closely at each populated place in the Quinault Indian Reservation and determines the level of risk exposure to each hazard. This chapter also includes presentations of potential mitigation measures appropriate for each populated place (village or community).

Chapter 6 includes a discussion of the Resources, Capabilities, and Needs of the Quinault Indian Nation, and associated agencies and organizations, in terms of what is available to serve the citizens of the Reservation and what is needed in terms of the risk exposure identified in this planning document.

Chapter 7 includes a lengthy discussion of how this plan will be implemented, funded, and administered during the next 5 years specifically and beyond that in more general terms. Detailed mitigation measures are proposed in four specific categories of 1) policy related activities, 2) activities to reduce loss potential, 3) resource and capabilities enhancements, and 4) activities to change the characteristics of risk. All combined, this plan details 102 unique mitigation measures to be implemented over the next 5 years on Quinault Indian Reservation. Chapter 7 concludes with a formal program of plan maintenance and continued public involvement.

Finally, Chapter 8 provides the reader with additional information including acronyms and abbreviations used in this report, a glossary of technical terms and their definitions, and a Literature Cited section.

This Quinault Indian Reservation Tribal Hazards Mitigation Plan has been developed through the efforts of various organizations, agencies, and government representatives in an effort to better prepare Quinault Indian Reservation residents against natural disasters.

1.2. FEMA Region X Letter of Approval

U.S. Department of Homeland Security
Region X
130 228th Street, SW
Bothell, WA 98021-9796

FEMA

OCT 2 9 2010

Fawn R. Sharp, President
Quinault Business Committee
Quinault Indian Nation
807 Fifth Ave.
Taholah, Washington 98587

Dear President Sharp:

The U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) has approved the ***Quinault Indian Reservation Hazard Mitigation Plan*** as a Tribal Mitigation Plan, in accordance with 44 CFR Part 201. The Quinault Indian Nation is now eligible to apply directly to FEMA as a grantee for Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) non-emergency programs through October 25, 2015. To continue eligibility, the plan must be reviewed, revised as appropriate and re-submitted for approval within five years from the date of this letter.

As a result of the Disaster Mitigation Act of 2000, States and Tribes are required to develop and maintain hazard mitigation plans compliant with FEMA standards as a condition for receiving non-emergency Stafford Act assistance. Applicable Stafford Act assistance includes Public Assistance (Categories C-G), Fire Management Assistance, Hazard Mitigation Grant Program, and Pre-Disaster Mitigation grants.

FEMA's approval of your plan as a Tribal Mitigation Plan provides the Quinault Indian Nation's eligibility to apply for various Stafford Act programs. All requests for assistance, however, will be evaluated individually according to the specific eligibility and other requirements of the particular programs. For example, a mitigation action identified in the approved plan may or may not meet the eligibility requirements for HMGP funding. If you have any questions regarding specific program requirements and eligibility, please contact Braden Allen, Hazard Mitigation Assistance (HMA) Specialist for HMA programs, (425) 487-4749.

We look forward to continuing a productive relationship between FEMA Region 10 and the Quinault Indian Nation. Please contact our Regional Tribal Liaison, Andy Hendrickson, at (425) 487-4784, or our Regional Mitigation Planning Manager, Kristen Meyers, at (425) 487-4543, with any plan specific questions or for further assistance.

Sincerely,

Kenneth D. Murphy
Regional Administrator

cc: Connie Wilson, Quinault Indian Nation

Enclosure

www.fema.gov

1.3. Authorship and Conveyance

Development of the Quinault Indian Reservation Tribal Hazards Mitigation Plan was completed, in association with the Planning Committee members, by Kamiak Ridge, LLC. Project Management duties and Lead Authorship of this plan have been supplied by William E. Schlosser, Ph.D., a Regional Planner and Environmental Scientist.

The undersigned do hereby attest and affirm that the Quinault Indian Reservation Tribal Hazards Mitigation Plan was completed using information available at the time of its writing. Furthermore, analysis techniques were implemented as appropriate to provide a clear and reasonable assessment of hazard risk exposure within the Quinault Indian Reservation. Recommendations made herein have been based on this information and on feedback from the Planning Committee members and others, and are proposed with the reasonable expectation that once implemented through a holistic hazard mitigation approach, the results will serve to protect people, structures, infrastructure, the regional economy, and the way of life on the Quinault Indian Reservation.

By: William E. Schlosser, Ph.D.
Kamiak Ridge, LLC
Environmental Scientist & Regional Planner
Lead Author and Project Mananger

June 1, 2010
Date

By: Birgit R. Schlosser, B.A.
Kamiak Ridge, LLC
Co-Owner & Planning Specialist

June 1, 2010
Date

1.4. Quinault Indian Nation

QUINAULT BUSINESS COMMITTEE

RESOLUTION NO. 10-129-89

WHEREAS, the Quinault Business Committee is the recognized governing body of the Quinault Indian Nation under the authority of the Quinault Indian Nation's Constitution adopted by the Quinault General Council on March 22nd, 1975; and

WHEREAS, under its Constitution, Article I, Section 2-GENERAL WELFARE; It shall be the goal of the Quinault Nation to provide for the general safety and welfare of all persons acting by the right of membership in the Quinault Nation or acting or residing within the jurisdiction of the Quinault Nation; and

WHEREAS, the Quinault Business Committee has determined the need to identify all natural hazards and their potential impact to the Quinault Indian Nation's people, land and businesses, as well as the social and economic impact; and

WHEREAS, the All Hazard Mitigation Plan has been developed and vetted by a planning team comprised from Tribal membership, staff, other surrounding entities and communities, holding four (4) Community meetings at Queets, Amanda Park and two in Taholah and has elected to submit to the Business Committee for their approval; and

WHEREAS, the All Hazard Mitigation Planning Team has reviewed, commented and recommended the amendments to QIN Contractor Kamiak Ridge LLC whom prepared and submitted to Washington State Emergency Management Division, Federal Emergency Management Agency for their review and approval; and

WHEREAS, Washington State Emergency Management Division and Federal Emergency Management Agency has reviewed and approved for technical and required content of the Tribal Hazard Mitigation Plan (THMP).

THEREFORE, BE IT FURTHER RESOLVED, that the Quinault Business Committee, **approves and adopts the Tribal Hazard Mitigation Plan (THMP).**

BE IT FURTHER RESOLVED, that the staff of the Quinault Indian Nation shall follow up with grant applications for the development of an Emergency Preparedness Plan, an Emergency Response Plan and an Emergency Recovery Plan.

Fawn R. Sharp, President
Quinault Indian Nation

CERTIFICATION

As Secretary of the Quinault Business Committee, I hereby certify that the foregoing resolution was duly enacted by the Quinault Business Committee on the 27th day of September, 2010 by a vote of 6 for, 0 against, and 1 abstaining.

Latosha L. Underwood, Secretary
Quinault Business Committee

Resolution No. 10-129-89
Approved by QBC: 09/27/2010

1.5. Acknowledgments and Thanks

Scientific analyses, expertise of the people, the contents of previous written works, and photographic evidence have been pulled together for the development of this Quinault Indian Reservation Tribal Hazards Mitigation Plan. The Quinault Indian Nation Hazards Mitigation Planning Committee has been instrumental in providing ideas, data, collaborative discussions, and information needed to make this hazard risk assessment and set of mitigation recommendations a reality. The commitment of the Planning Committee has been significant.

Several people on the Planning Committee receive specific mention in this prologue due to their contributions. **It should not be considered that those not mentioned here were somehow less important to the effort.** This prologue is written from the perspective of the Project's Lead Author, "Dr. Bill" Schlosser and I wish to offer special thanks to;

Coni Wilson, Community & Economic Development, Community Development Manager, and First Councilman of the Quinault Indian Nation Tribal Council. Coni has been the contract liaison for the administration of this planning effort and has taken a high level of participation in the development of each phase of the project's execution from recruiting Planning Committee members to scheduling meeting venues, from collecting historical information to sharing stories of "the 1964 tsunami as it washed trees and debris over the road" forcing her and her husband to navigate over trees in the roadway near the Wreck Creek Bridge. Her personal involvement has definitely been instrumental to the successful implementation of this plan.

Jonathan Ciesla, Land Use Planner, Quinault Indian Nation Planning Department. Jonathan has been a constant and timely provider of data, information, and ideas concerning the implementation of the recommendations included in this document. I was especially impressed with his comments early in the planning effort, "I figure that if I give you what you are asking for the first time, that you will not waste time asking for it over and over again." Thank you for that, Jonathan!

Dave Bingaman, Director, Quinault Division of Natural Resources. Dave has been a constant attendee to the planning committee meetings and has provided the Department's support of this effort by encouraging and facilitating his staff to participate in these efforts. During Planning Committee meetings, Dave has developed some of the most insightful and well integrated potential mitigation measures we have seen.

Larry J. Workman, Manager of the QIN Centralized Communications Department, Division of Administration, and photographer. Larry has a long history with the Quinault Indian Nation. He has been described to me as "a Gem of a Person", which I find an accurate description of Larry's persona. In addition to a history with natural resources management with the Nation, Larry currently serves as the Manager of the Nation's Centralized Communications Program. For everyone who has not visited his photographic site at http://www.panoramio.com/user/765658 I recommend a visit. Larry has shared hundreds of photographs from around the world, and from the Quinault Indian Reservation, through this site. He has also provided many of them for our uses in this document. When a photograph is cited here as (Workman 2009-2010) it is in reference to the photographs Larry has provided to us during 2009 and 2010; it is not necessarily the year the photographs were taken. Larry has also assisted efforts in hazard risk assessments through the recommendations of written works concerning the area.

Larry, thank you for bringing the compelling beauty of the Pacific Northwest alive through your photographs and into this document.

The astute reader will also note that Larry J. Workman is the author of three of the citations made here, and the lead author of the most cited document in this effort [Workman 1997].

1.6. Committee Participation and Accord

The undersigned representatives of the Divisions of the Quinault Indian Nation have participated in the development of this Quinault Indian Reservation Tribal Hazards Mitigation Plan. The adoption of this Quinault Indian Reservation Tribal Hazards Mitigation Plan is encouraged.

Beck, John, Quinault Division of Natural Resources, Land	5·13·10 Date
Bingaman, Dave, Director, Quinault Division of Natural Resources	5/13/10 Date
Bly, Richard, QIN Division of Health and Wellness, Environmental Health Specialist	5/28/10 Date
Ciesla, Jonathan, Quinault Division of Community Services, Community Development - Land Use Planner	5/13/10 Date
Curley, Shoshana, Quinault Division of Community Services,	May 13, 2010 Date
Hall, Lisa, QIN EMS/Fire	5/20/2010 Date

The undersigned representatives of the Divisions of the Quinault Indian Nation have participated in the development of this Quinault Indian Reservation Tribal Hazards Mitigation Plan. The adoption of this Quinault Indian Reservation Tribal Hazards Mitigation Plan is encouraged.

Anthony Hartrich (signature) — May 13, 2010

Hartrich, Tony,
Quinault Division of Natural Resources,
GIS

Date

Tyler S. Jurasin (signature) — 5-20-2010

Jurasin, Tyler,
Quinault Division of Natural Resources
Department of Fisheries

Date

Sue Kalama (signature) — May 13, 2010

Kalama, Sue,
QIN Division of Community Services,
Queets Recreation Coordinator

Date

Mark Mobbs (signature) — 5-20-10

Mobbs, Mark,
Quinault Division of Natural Resources,
Department of Environmental Protection

Date

Lisa Riener (signature) — May 13, 2010

Riener, Lisa,
Quinault Division of Natural Resources,
Air Quality Program Manager

Date

M Stamon (signature) — 5/13/2010

Stamon, Mike,
Quinault Division of Natural Resources,
Forestry

Date

The undersigned representatives of the Divisions of the Quinault Indian Nation have participated in the development of this Quinault Indian Reservation Tribal Hazards Mitigation Plan. The adoption of this Quinault Indian Reservation Tribal Hazards Mitigation Plan is encouraged.

Sutton, Brian,
Quinault Division of Natural Resources,
Fire Management Officer

13 May 2010
Date

Wells, Richard,
Director,
Quinault Division of Community Services

5-13-2010
Date

Wilson, Coni,
Quinault Division of Community Services,
Community Development Manager

Date

Workman, Larry,
Division of Administration,
Manager, Quinault Centralized Communications Department

5-17-2010
Date

Young, Robert,
Roger Saux Health Center,
Health & Wellness Director

5/13/10
Date

1.7. Participating Agency Representation and Cooperation

The Quinault Indian Reservation Tribal Hazards Mitigation Plan was developed in cooperation and collaboration with these additional listed agencies and organizations. These entities listed below will not "formally adopt" this plan, but were involved in its development and where practicable, will strive to cooperate in the implementation its recommendations.

5-13-10

Allestad, Stephanie
Grays Harbor Fire Dist #8,
Head of Emergency Planning for GHFD#8,
North Beach CERT Leader
Pacific Beach, WA

Date

Kyle Noble for Dean Millett

5-13-10

Millett, Dean,
US Forest Service
Forks, WA

Date

Kyle Noble

5-13-10

Noble, Kyle,
US Forest Service,
Olympic National Forest
Olympia, WA

Date

Figure II. Youth Art Contest: 3rd Place, Briana Alvarez.

Chapter 2. Planning Process

The Quinault Indian Reservation Tribal Hazards Mitigation Plan has been developed by the Quinault Indian Nation (QIN) during 2009 and 2010 and focuses on short-term and long-term measures with a detailed 5-year implementation strategy.

The Quinault Indian Reservation Tribal Hazards Mitigation Plan has been completed to be consistent with the Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), as amended by the Disaster Mitigation Act of 2000 (P.L. 106-390); the National Flood Insurance Act of 1968, as amended by the National Flood Insurance Reform Act of 2004 (P.L. 108-264); and 44 Code of Federal Regulations (CFR) Part 201 – Mitigation Planning, inclusive of all amendments through November 30, 2009. The requirements have been summarized in the Federal Emergency Management Agency (FEMA) Crosswalk used to analyze a plan's compliance with these federal regulations (release date March 2010).

Planning leadership was provided by the QIN Planning Department, within the Division of Community Services. The QIN contracted with Kamiak Ridge, LLC, of Pullman, Washington, through a competitive bidding process, to assist the Nation in developing the Tribal Hazards Mitigation Plan. Representatives from each of the Nation's Divisions participated in the plan's development through attendance at planning meetings, by providing important planning documents to the planning team, and by collaborating during information exchange, planning meetings, and with the document's development.

Public involvement activities included planning meetings, press releases, a residential survey, a youth art contest, public meetings and open public review opportunities during the plan's development (each are described in detail in this planning document).

Effective November 1, 2004, a Local Hazard Mitigation Plan approved by FEMA became a requirement for Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation Program (PDM) eligibility. The HMGP and PDM programs provide funding through state emergency management agencies to support local mitigation planning and projects to reduce potential disaster damages.

The Tribal Hazard Mitigation Plan requirements for HMGP and PDM eligibility are based on the Disaster Mitigation Act of 2000, which amended the Stafford Disaster Relief Act, to promote and integrate cost-effective mitigation activities. Local hazard mitigation plans are required to meet minimum requirements of the Stafford Act-Section 322, as outlined in the criteria contained in 44 CFR Part 201. The plan criteria summarized for this effort covers the planning process, risk assessment, mitigation strategy, plan maintenance, and adoption process.

2.1. Development and Approval Process

The Quinault Indian Reservation Tribal Hazards Mitigation Plan was drafted in sections by Kamiak Ridge, LLC, led by the Kamiak Ridge Environmental Planner, William E. Schlosser, Ph.D. All sections of the plan were subjected to an internal review at Kamiak Ridge when first written. After this internal review of sections of the document, it was submitted to the Tribal Hazards Mitigation Planning Committee, then released to a wider distribution through an open public review.

Four public meetings were conducted in February 2010, prior to the assemblage of the draft Tribal Hazards Mitigation Plan. The suggestions and recommendations from the public meetings were incorporated into the draft that was provided to the Tribal Hazards Mitigation Planning Committee members for review. Public review of the document was conducted during April 2010. Public review comment opportunities were made open for all residents of the

Quinault Indian Reservation, representatives from neighboring jurisdictions, and other interested parties. Once received, these comments were incorporated into the final Quinault Indian Reservation Tribal Hazards Mitigation Plan.

This extended process provided an opportunity for neighboring communities, Tribal and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development as well as businesses, academia and other private and non-profit interests to be involved in the planning process. It also facilitated the review and incorporation of existing plans, studies, reports, and technical information throughout the plan's development.

This effort utilizes the best and most appropriate science from all partners and the integration of local and regional knowledge about hazard risks and exposure, while meeting the needs of Reservation residents and visitors, the regional economy, and the significance of this region to the rest of Washington State.

Shortly after the formation of the Quinault Indian Reservation Tribal Hazards Mitigation Planning Committee, in June and July 2009, the Mission, Vision, and Goal statements were adopted to reflect a holistic and comprehensive expression of these efforts.

At these initial planning committee meetings, and during discussions between the planning committee members and others within the QIN, the extent of the analyses and the protection afforded by this Tribal Hazards Mitigation Plan was discussed. The **definition of "public"** for this effort was determined to be all residents and visitors to the Quinault Indian Reservation (QIR) while on the QIR. No distinction was made between Indian and non-Indian, Tribal member and non-Tribal member, or commercial, private, or Trust property. The extent of the analysis was determined to be all areas within the QIR but not including Tribal Trust lands located in other places such as the Quinault Beach Resort & Casino at Ocean Shores, or other properties in other locations. The efforts detailed for this entire Tribal Hazards Mitigation Plan focus on the approximately 209,000 acres of the QIR (Figure III).

2.1.1. Mission Statement

To make QIR residents, communities, and businesses less vulnerable to the negative effects of natural hazards through the effective administration of hazard mitigation grant programs, hazard risk assessments, wise and efficient mitigation measures, and a coordinated mitigation policy approach by Tribal, state, federal, and local planning efforts. Our combined prioritization is the protection of people, structures, infrastructure, economy, and unique ecosystems that contribute to our way of life and the sustainability of the local and regional economy.

2.1.2. Vision Statement

Institutionalize and promote a reservation-wide hazard mitigation ethic through leadership, professionalism, and excellence, leading the way to a safe, sustainable QIR and local villages.

2.1.3. Goals

The QIR Tribal Hazards Mitigation Plan Committee has adopted a series of primary and secondary goals intended to benefit each populated place, and the Reservation's residents and visitors.

2.1.3.1. Primary Goals

- Promote and implement disaster-resistant development policies,
- Build and support local capacity to enable the QIN to prepare for, respond to, and recover from disasters,

- Reduce the possibility of damages and losses due to Floods,
- Reduce the possibility of damages and losses due to Wildfire,
- Reduce the possibility of damages and losses due to Landslides,
- Reduce the possibility of damages and losses due to Earthquakes,
- Reduce the possibility of damages and losses due to Tsunami, and
- Reduce the possibility of damages and losses due to Severe Weather.

2.1.3.2. Parallel Goals:

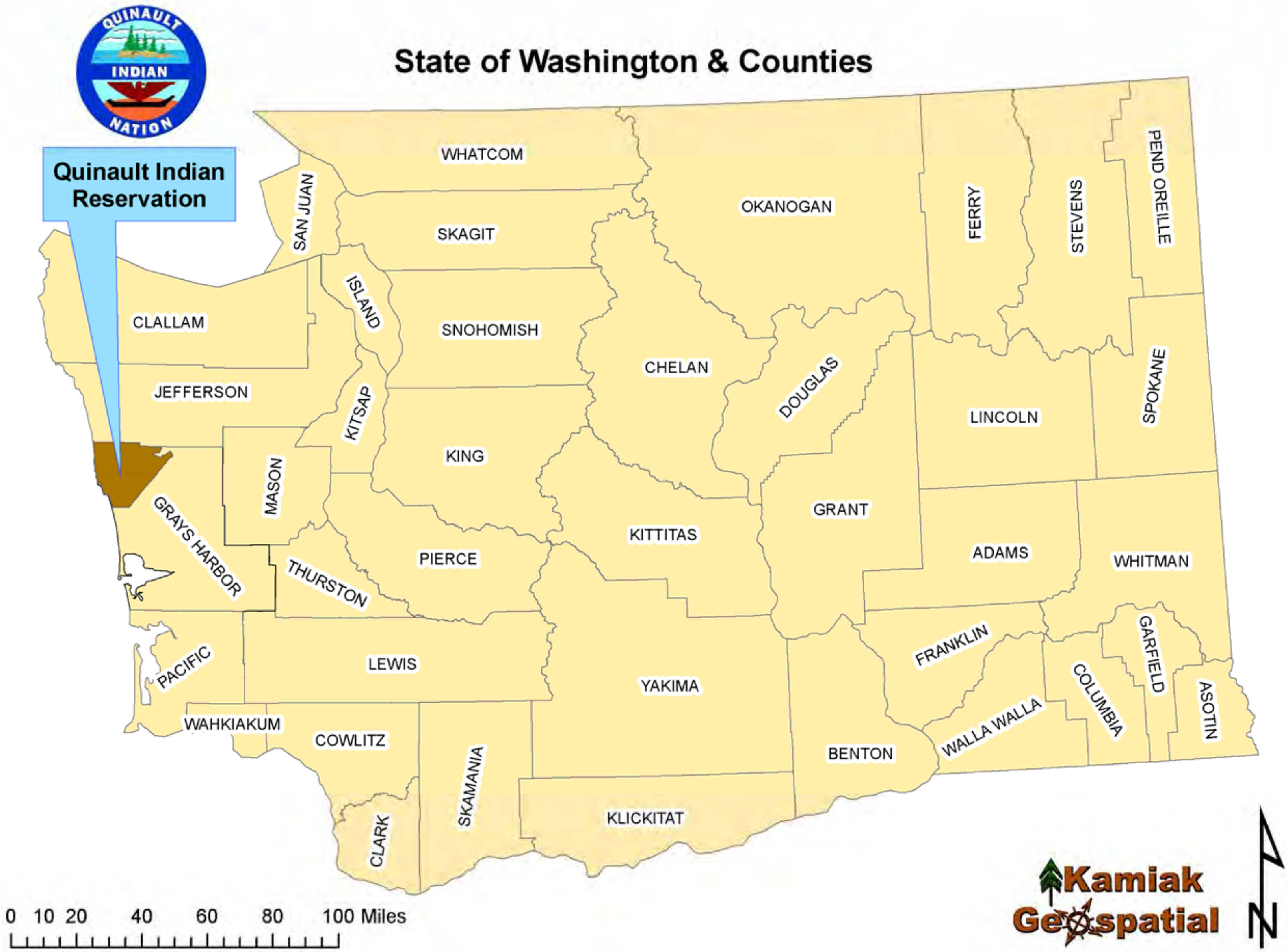
- Reduce the threats to public health and safety posed by natural hazards,
- Prioritize the protection of people, structures, and infrastructure that contribute to our way of life and the sustainability of the local and regional economy,
- Educate people and communities about the unique challenges of hazard mitigation in their daily lives,
- Establish mitigation priorities and develop mitigation strategies,
- Reduce the long-term costs of disaster recovery and disaster mitigation through intelligent and strategic mitigation policies and practices, and
- Identify and facilitate the management for sustainable land use in light of natural hazards and our management of the land resources.

2.1.3.3. Objectives to Meet Goals

This Tribal Hazard Mitigation Plan will implement the following philosophical practices in order to achieve these goals outlined in this plan:

- Improve hazard area identification and emergency warnings to citizens and visitors.
- Increase public awareness of natural hazards and improve appropriate preparation for and response to such hazards.
- Prevent and discourage new developments in areas that are vulnerable to natural hazards or ensure that development occurs in such a way as to mitigate risks to the new development without putting others at increased risk.
- Assess, protect, alter, and/or relocate existing developments in those areas where developments are at current risk to natural hazards, to make them less susceptible to catastrophic loss.
- Ensure that the implementation plan developed to protect existing developments is the most cost-effective alternative, given considerations for:
    - Personal and business investments
    - Natural resources
    - Existing land use plans
    - Economy of QIN
- Utilize the cost / benefit analysis criteria when evaluating implementation plans for mitigation measures (during implementation) to ensure that the benefits of the plan outweigh the costs of implementation – both short-term and long-term.
- Maintain, improve, and where appropriate, formalize, coordination and consistency between actions of the QIN government with the policies and actions of neighboring jurisdictions, including:
    - State of Washington
    - Grays Harbor County
    - Jefferson County
    - Washington State Agencies
    - Federal Governmental Organizations.

Figure III. Quinault Indian Reservation Locator Map within Washington State.



2.2. FEMA Disaster Mitigation Planning

FEMA conducts reviews of all local and Tribal Hazard Mitigation Plans submitted through the appropriate State Hazard Mitigation Officer (SHMO). FEMA reviews the final version of a plan prior to local or Tribal adoption to determine if the plan meets the criteria defined in the CFRs, but FEMA is unable to approve any plan prior to adoption by the local jurisdictions. The Quinault Indian Reservation Tribal Hazards Mitigation Plan has been developed and internally evaluated to adhere to a variety of FEMA developed criteria specifically defined in the Tribal Multi-Hazard Mitigation Plan Review Crosswalk (FEMA Region 10, released March 2010).

2.3. Tribal Mitigation Plan

In September 2009, the Washington State Hazard Identification and Vulnerability Assessment (HIVA) was finalized to assess geographically fixed, biological, geological, meteorological, and man-made hazards that exist in Washington State. Assessment was the first step in the state's emergency management planning process. Once identified, mitigation and preparation for these hazards can commence by using these standards in a categorical and prioritized way. In the event that one of these hazards takes place, the final steps of the planning process, response and recovery, can happen efficiently. The hazards identified in the Washington State HIVA have the potential of becoming emergencies or disasters that can adversely and irreversibly affect the people, economy, environment, and property in the state of Washington.

The Washington State Enhanced Hazard Mitigation Plan was approved by FEMA Region X office on January 28, 2008. This plan developed a blueprint for state recognition of a variety of hazards and appropriate responses to these threats. The intent of this state plan is to reduce disaster assistance costs and preserve disaster assistance eligibility for the state and local governments in Washington. This comprehensive state plan provides a strategy to reduce future disaster losses through sound mitigation projects. However, the State's comprehensive plan does not address the unique challenges faced by Tribal governments in hazard mitigation planning and mitigation implementation.

This notwithstanding, the QIR Tribal Hazards Mitigation Plan planning committee has utilized both the Washington State HIVA and the Washington State Enhanced Hazard Mitigation Plan's analyses and strategies in the development of this Tribal Hazards Mitigation Plan. All of the analyses summarized in this planning effort are consistent with these state efforts and dove-tail together to enhance the potential benefits on the QIR.

In 2007, FEMA released Hazard Mitigation Plan regulations that define Hazard Mitigation Plan requirements specifically designed to account for the unique hazard mitigation planning needs of Tribal governments. A Tribal Hazards Mitigation Plan requires a different and often broader planning process than a State Plan. The Quinault Indian Reservation Tribal Hazards Mitigation Plan has used this approach as a template for assessing potential risks on the QIR, and developing a comprehensive and integrated disaster mitigation approach.

The QIR is located on the Pacific Coast of Washington, primarily in northwestern Grays Harbor County, with a small portion extending north into southwestern Jefferson County (Figure III). The QIR has a land area of approximately 209,000 acres. There are no incorporated cities on the Reservation. The Reservation represents approximately 16% of the total Grays Harbor County land area (Grays Harbor County is approximately 1,238,741 acres of land – excluding ocean water areas). The QIN is a self-governing Treaty Tribe. The QIN was not invited to participate in the development of either the Grays Harbor County or the Jefferson County Hazard Mitigation Plans.

2.4. Guidance and Integration with Tribal Planning Activities

The Quinault Indian Reservation Tribal Hazards Mitigation Plan effort was initiated by the QIN in 2007 with the application for funding assistance from FEMA Region X. Funding from FEMA for the preparation of the Tribal Hazards Mitigation Plan was received in 2008.

This effort utilizes the best and most appropriate science from all partners, and the integration of local and regional knowledge about natural hazards, while meeting the needs of residents, Tribal members of the Quinault and Queets Tribes and the descendants of the Quileute, Hoh, Chehalis, Chinook and Cowlitz Coastal Tribes that share this Reservation, the regional economy, and the significance of this region to the rest of Washington State and the Pacific Northwest. The QIN strives to develop practices and policies consistent with the theme of self-reliance while developing relationships and coordinated approaches to hazard mitigation that build on the themes of cooperation and collaboration with neighboring jurisdictions from Counties (Grays Harbor and Jefferson), the State of Washington, FEMA Region X, and the organizations and agencies operating in the region (private, state, federal, and other Tribes).

2.5. Planning Committee Membership

Leadership for the QIN's hazard mitigation planning effort was provided by the QIN Community Development Manager, Coni Wilson. Project Management by the contractor, Kamiak Ridge, LLC, was provided by Dr. William E. Schlosser, an Environmental Scientist and Regional Planner. Together, these two individuals and their staff provided leadership for the Planning Committee and cooperated in all phases of the plan's development.

Committee communication and information dissemination was facilitated by the Project Manager through the provision of available information for inclusion in the QIN's website that included information about the Committee meetings, copies of FEMA guidance for developing plans, and other relevant documents for Planning Committee use, as well as the schedule of meetings and outreach efforts.

A File Transfer Protocol (FTP) internet site was established for use by the Planning Committee (hosted by Kamiak Ridge). The FTP site allowed Planning Committee members and the Project Manager to share documents, photographs, and other electronic files for use in the planning process. In addition, the large map set files, which were created and stored in Adobe Acrobat PDF (Portable Document Format) files, were made available for download by all Planning Committee members. These document sets included detailed mapping for all five populated areas of the Reservation: Taholah, Queets, Amanda Park, Qui-nai-elt, and Taholah Ocean Tracts. One map set was also created for the entire Reservation. Each map set was formatted to display on 24"x20" sheets within Adobe Acrobat Reader. Each set included between 5 and 11 individual maps of one specific area (a total of over 40 maps). In addition, complete QIR map sets were generated at a size of 36"x36" showing the same themes as the populated places maps and made available to the Planning Committee members.

This format of providing mapping analysis products (in PDF format and at high resolution) was selected for the ability to display detailed attributes otherwise not recognizable when reduced to a normal page size of 8½"x11". Server logs for the FTP site indicated that over 635 file downloads from this site were conducted between July 2009 and May 2010. Copies of these maps were used by the Nation's departments, participating agencies, organizations and local citizenry while developing an understanding of risk exposure and potential mitigation measures.

Committee members were provided draft sections of the analysis as they were developed. This issuance of sections, monthly, allowed planning committee members the ability to comment and provide feedback as the analysis progressed. Thus, the entire Planning Committee shared the same perspective of risk exposure, vulnerability to losses, and potential mitigation measures.

At the launch of the planning process, potential Planning Committee members were invited by the Planning Committee leadership, including representatives from each Tribal Division, agency representatives (regional, state, and federal), fire protection organizations, school districts, and public service organizations. In addition, openings on the committee were created for citizens-at-large to serve without an affiliation as otherwise identified.

Formal letters of invitation to serve on the Planning Committee were sent on behalf of the Quinault Indian Nation President, Fawn Sharp. The invitation was met by over 30 dedicated individuals. These respondents became the core of the Planning Committee. All QIN Divisions were invited to attend and participate on this Planning Committee. Invitation letters were also sent to administrative representatives of organizations and agencies off the Reservation:

- Grays Harbor County Emergency & Risk Management
- Jefferson County Disaster Services Dept
- Washington Military Department, Emergency Management Division
- State of WA Dept of Transportation
- State of WA Department of Natural Resources
- USDA: Forest Service
- USDI: Bureau of Indian Affairs (BIA)
- US Coast Guard
- National Weather Service (from NOAA)
- Fire Protection District #4 – Lake Quinault
- Fire Protection District #7 – Moclips
- Fire Protection District #8 – Pacific Beach
- QIN Fire Department
- Quinault Fire District #6 – Amanda Park
- Quinault Pride: Fish House (commercial)
- Queets-Clearwater School District
- Lake Quinault School District in Amanda Park
- Taholah School District #77

Only a few of the neighboring jurisdictions, such as the Grays Harbor County Office of Emergency Management, US Forest Service, Washington Department of Natural Resources, Grays Harbor County Fire Protection District #8, and the Washington Department of Transportation responded with active participation in this effort. However, the participation indicated by planning committee attendance in Table 1 should not be considered the sole means of participation by the planning committee members as many of those indicated, and others, participated not just with planning committee attendance alone, but also through correspondence, discussions, the sharing of materials and collaboration with planning committee members.

2.6. Planning Committee Meetings

Planning meetings were held monthly from July 2009 through May 2010, on the second Thursday of each month (except December 2009). Meeting attendance is summarized in Table 1 and graphically shown in Figure IV. A summary of planning committee meeting discussion points is included in the following discussions of this section.

July 8, 2009: An introductory meeting to orient Tribal Departments to the hazard mitigation planning approach was conducted. This initial meeting included a slide presentation communicating the purpose and components of a FEMA Tribal Hazards Mitigation Plan. FEMA definitions were provided, plan requirements were detailed and the Phase I Hazard Profile (Table 20) was introduced. The Risk Assessment approach, vulnerability appraisal and mitigation strategies were outlined for attendees. Additional Potential Planning Committee members were identified and the importance of public involvement was emphasized.

August 13, 2009: The Planning Committee meeting was attended by representatives from Tribal Divisions and Departments as well as representatives from other organizations and agencies, and followed a progressive schedule of accomplishments based on themed meetings. This "meeting theme" technique began with the discussion and identification of the goals, objectives, and vision of the planning process. This meeting also included Phase I Hazard Profile (Table 20) discussions, which identified the combined potential for a hazard to occur and the potential of disaster events to impact people, structures, infrastructure, the economy, and traditional way of life of the QIR. At this meeting, the Planning Committee identified and endorsed the plan of work to accomplish a hazard resistant community philosophy. Existing QIN policies, plans and programs were identified for inclusion in the plan. Additional potential Planning Committee members were also identified and invited to participate. Tribal Division Surveys and Resources, Capabilities, and Needs Surveys began to be returned for summary into the plan. Outreach efforts and public involvement plans were initiated.

September 10, 2009: Planning meeting discussions took place about the risk exposures across the QIR. Extended discussions were augmented with large-size formatted map sets including aerial photography, "potential floodplains" (FEMA has not mapped Flood Insurance Rate Maps (FIRM) on the Reservation, and as a result, Kamiak Ridge developed a "potential floodplain" assessment to be able to locate and quantify flood risks on the QIR), tsunami hazards, landslide prone landscapes, wildfire risk quantification, seismic shaking hazards and fault lines, high wind and severe weather-prone landscapes, as well as other descriptive mapping products. These map sets were provided to Planning Committee members and others as requested. Ongoing discussions continued regarding QIN policies, plans and programs, outstanding surveys, the Youth Art Contest, press releases and other public outreach efforts. The second half of the September meeting included a presentation by the FEMA Region X team regarding the Quinault Nation's participation in the National Flood Insurance Program (NFIP).

October 8, 2009: Planning Committee efforts included a review of the FEMA visit in September, and discussions regarding the NFIP entry and of Pre-Disaster Mitigation Grant Opportunities. The committee reviewed flood mapping and tsunami risk mapping presented by Kamiak Ridge in September. Hazard Risk Assessments for Landslides, Seismic Shaking Hazards, and Wildfire were viewed and discussed. Discussions regarding plans, programs and policies, and the Youth Art Contest continued. The internet-based Residential Survey was authorized and responsibilities for scheduling the Public Meetings were delegated.

November 12, 2009: Planning Committee efforts included a review of additional risk profiles for wildfire and landslides. The initial draft of the QIN Legal and Regulatory Resources Available for Hazard Mitigation Efforts was presented to the Planning Committee for review and comment. The Committee provided comment and feedback to an on-line solution for a Residential Survey to collect survey responses without the need to use personal addresses to send out the survey to QIR residents. Discussion continued regarding public meeting venues, dates and times. The November meeting also marked the deadline for the Youth Art Contest submissions.

December 2009: Planning Committee meeting was not held in recognition of the holidays at the decision of the planning committee.

January 14, 2010: Planning Committee actions included a review of the public meeting dates and locations scheduled in February, and discussions concerning remaining risk analyses for wildland fire and landslides using some newly generated data that includes satellite imagery spanning 30 years of history to identify past wildfires and landslides for developing the risk analyses on the QIR. The committee reviewed and discussed the population density analysis on the Reservation and growth and development trends and how that relates to future hazard mitigation efforts.

A draft of selected sections of the plan was distributed to the Planning Committee members in attendance and provided on the Planning Committee FTP site.

February 11, 2010: Planning Committee actions included a discussion about the public meetings held earlier in the week and the remaining public meeting scheduled for later that same day, and another public meeting tailored for the employees of the QIN in Taholah, the following day (February 12). The focus of this meeting was to discuss the potential mitigation measures developed throughout the planning process. Several specific recommendations were made at the meeting through written summaries and location specific drawings on the maps at the meeting.

March 11, 2010: The draft of the QIR Tribal Hazard Mitigation Plan was delivered to the Planning Committee for internal review. This launched the committee review of the document before its release for public review starting in April. The public review period was discussed and the month of April was selected for that purpose. During that time, the planning committee members can continue to provide edits and augmentation to the plan. With the public review (and extended planning committee review) completed by the end of April, the intent is for this plan to be ready to submit to the state in May on its way to FEMA for approval. Discussions about potential mitigation measures and responsibilities were numerous and led to the modification of the plan.

April 2010: During the month of April, a planning meeting was not conducted as the Tribal Hazard Mitigation Plan was released for public review during this time. However, the level of Planning Committee review increased substantially as additional ideas were shared, potential mitigation measures were identified, and new details were included in the plan. All of the review augmentations were conducted through telephone calls, e-mail discussions, and electronic file sharing.

May 2010: This month welcomed the last Planning Committee meeting to discuss all of the changes to the document since first submitted for a Planning Committee review, through that review, the public review period, and additional changes to the document. Discussions included implementation responsibilities and the process of updating this plan. In March 2010, FEMA released a revised Tribal Multi-Hazard Mitigation Plan Crosswalk that has been used to further update the QIR plan to articulate those requirements and those changes were further identified to the planning committee. Additional activities included a certificate of appreciation signed by QIN President Fawn Sharp, presented to all of the active planning committee members to thank everyone for their active participation in this important activity for the Quinault Indian Nation.

Table 1. Planning Committee Membership and Attendance.

Name	2009					2010			
	July 8	Aug 13	Sep 10	Oct 8	Nov 12	Jan 14	Feb 11	Mar 11	May 13
Core Planning Team Representatives									
Allestad, Stephanie: Grays Harbor Fire Dist #8, Head of Emergency Planning for GHFD#8, North Beach CERT Leader. Pacific Beach, WA		√		√			√	√	√
Beck, John, Quinault Division of Natural Resources, Land.	√	√	√	√	√	√	√		√
Bingaman, Dave, Director, Quinault Division of Natural Resources.	√	√	√	√	√	√	√		√
Bly, Richard, QIN Division of Health and Wellness, Environmental Health Specialist.		√				√		√	
Ciesla, Jonathan, Quinault Division of Community Services, Community Development - Land Use Planner.	√	√	√	√	√	√	√	√	√
Curley, Shoshana, Quinault Division of Community Services, Community Development – Secretary.		√		√	√	√	√	√	√
Hartrich, Tony, Quinault Division of Natural Resources, GIS.	√	√		√	√	√	√		√
Kalama, Sue, QIN Division of Community Services, Queets Recreation Coordinator		√	√	√	√				√
Noble, Kyle, US Forest Service, Olympic National Forest. Olympia, WA			√	√		√		√	√
Riener, Lisa, Quinault Division of Natural Resources, Air Quality Program Manager.			√	√		√		√	√
Sanders, William, WA DNR. Forks, WA		√	√						
Schlosser, Birgit, Kamiak Ridge LLC. Pullman, WA	√	√	√	√	√	√	√	√	√
Schlosser, William, Kamiak Ridge LLC. Pullman, WA	√	√	√	√	√	√	√	√	√
Stamon, Mike, Quinault Division of Natural Resources, Forestry.	√	√	√				√	√	√
Sutton, Brian, Quinault Division of Natural Resources, Fire Management Officer.		√	√	√	√		√	√	√
Trudeau, Rick, Taholah Agency BIA, Forest Technician.		√	√	√	√	√	√	√	
Veach, Susan, Kamiak Ridge LLC. Port Orchard, WA	√	√	√	√	√	√	√		
Wallace, Charles, Deputy Director of Emergency Management, Grays Harbor County. Hoquiam, WA						√	√		
Wells, Richard, Director, Quinault Division of Community Services.	√		√	√	√	√	√	√	
Wilson, Coni, Quinault Division of Community Services, Community Development Manager.	√	√	√	√	√	√	√		√
Workman, Larry, Division of Administration, Manager, Quinault Centralized Communications Department.		√	√		√	√	√		
Young, Robert, Roger Saux Health Center, Health & Wellness Director.	√	√	√						√
Other Planning Team Attendees									
Capoeman, Melissa, Deputy Director, Division of Health & Wellness.				√	√				
Donnelly, Shawn, QIN Public Safety Manager.		√	√	√	No longer employed by the Nation				
Eastman, Fred, Quinault Construction.	√								
Ferrier, Jana, QIN EMS/Fire.		√							
Hall, Lisa, QIN EMS/Fire.			√						
Henry, Randy, Kamiak Ridge LLC. Chiloquin, OR	√								
Hobucket, Eugena, QIN Finance Division, Self Governance Coordinator.	√	√							
James, Gene, QIN Tribal Operations.	√		√	No longer administering Tribal Operations.					
Jurasin, Tyler, Quinault Division of Natural Resources – Dept. of Fisheries.		√	√						√
Keegan, Chris, WSDOT. Olympia, WA		√							
Marz, Patty, Taholah School District #77.		√							
Millett, Dean, US Forest Service. Forks, WA		√							√

Table 1. Planning Committee Membership and Attendance.

Name	July 8	Aug 13	Sep 10	Oct 8	Nov 12	Jan 14	Feb 11	Mar 11	May 13
	2009					2010			
Mobbs, Mark, Quinault Division of Natural Resources, Dept. of Environmental Protection.		Participated greatly through e-mail and telephone correspondence.							
Moody, Randy, WSDOT. Aberdeen, WA			√						
Sellers, James, QIN Councilman. Queets, WA		√							
Twigg, Ted, WSDOT. Aberdeen, WA			√						
Underwood, Clarinda, QIN Nugguam.			√						

Representatives from FEMA Region X joined the September 10, 2009, planning meeting in Taholah and presented details regarding the NFIP and FEMA relationships with Tribes (Figure IV). Individuals from FEMA who attended and presented included:

- Allen, Braden, CFM, HMA Specialist
- Biasco, Tamra, Earthquake Program Manager
- Meyers, Kristen, Mitigation Planning Manager
- Wood-McGuiness, Karen-Flood Plain Specialist
- Woodward, Jeff – Insurance Specialist

Figure IV. Selection of Planning Committee Meeting Photographs.

August 13, 2009, Planning Committee meeting discussed the Mission, Vision, and Goals of the planning effort.

September 10, 2009, Planning Committee members review SHELDUS hazard event summary.

September 10, 2009, Planning Committee members consider hazard risk assessments of the region, especially tsunami and flooding.

September 10, 2009, presentation by representatives from FEMA Region X is made following the regularly scheduled Tribal Hazards Mitigation Plan meeting.

Figure IV. Selection of Planning Committee Meeting Photographs.

October 8, 2009, discussions about the role of wildland fire on the QIR concentrates on current risks.

October 8, 2009, Planning Committee members discuss policies and programs of the QIN and hazard mitigation implementation measures.

November 12, 2009, Youth Art Contest submissions from across the QIR is displayed for the Planning Committee to review.

February 11, 2010, Planning Committee members gather around risk assessment and infrastructure maps to develop additional mitigation measures for inclusion in the plan.

Figure IV. Selection of Planning Committee Meeting Photographs.

Last Planning Committee Meeting on May 13, 2010, in Taholah.

2.7. Public Involvement

Public involvement in this planning process was made a priority from the inception of the effort. Initial press releases beginning in mid-2009 introduced the Nation's launch of the planning effort made possible by the FEMA funding award. Subsequent progress of the planning process was achieved mainly through the publication of press releases in the Nugguam, the Quinault Tribal Newsletter, which is the only widely distributed media source specific to the QIR and delivered to all Tribal members regardless of where they live (on and off reservation). The press releases published in 2009 focused on defining hazard profiles for tsunami, flood, and earthquakes. By 2010, the press releases included assessments of wildfires and landslides, public meeting notices, access to the public mail survey, and the announcement of the public review process.

Additional public outreach efforts included a Youth Art Contest designed to develop awareness in the schools, and within families, of natural hazard risks. The posting of Hazard Risk Assessments (maps provided to Planning Committee members) at the offices of the Tribal Departments participating on the committee extended the public outreach effort. An online Residential Survey was announced in the Nugguam and at a Mid-Year Annual Membership meeting held in November 2009. Four Public Meetings were delivered in February, and a Public Review period of the draft Tribal Hazards Mitigation Plan was conducted in April 2010.

2.7.1. Press Releases

Press releases were written and submitted to the Tribal Newsletter, the Nugguam, to share information concerning the status of the planning effort and details about the Residential Survey, public meetings, and the release of the draft plan for public review and comment. These articles were published throughout the planning process from July 2009 through April 2010. The Nugguam also printed full page articles featuring the results of the risk analyses for tsunami, flood and landslides written by Dr. Schlosser of Kamiak Ridge.

Following is a brief description of the announcements and requests for public involvement made throughout the planning process:

- **August 2009 –** The August press release announced the hazard mitigation planning efforts that were launched by the QIN in July 2009, and invited citizens at-large to contact Coni Wilson of the Planning Department to participate beginning with the August 13th, 2009, Planning Committee meeting.
- **October 2009 –** The October press release announced the Quinault Indian Reservation Tribal Hazards Mitigation Plan 2009-2010 **Youth Art Contest** designed to develop awareness in the schools and within families of natural hazard risks. It also included an article entitled **"QIR Risk assessments for Floods: A first Approximation"** written by Dr. Schlosser of Kamiak Ridge which included maps of the predicted flood impact areas and gave readers the opportunity to review and comment on the initial flood risk assessment for the Reservation.
- **November 2009 –** The November press release described the Planning Committee's efforts through October, announced the Planning Committee meeting on November 12th, 2009, and reminded students to submit entries for the Youth Art Contest by November 10, 2009. It also included an article entitled **"Quinault Indian Reservation Risk Assessments for Tsunami: A First Approximation"** written by Dr. Schlosser of Kamiak Ridge which gave readers the opportunity to review and comment on the initial tsunami risk assessment for the QIR.
- **December 2009 –** The December issue featured the artwork of the First Place winner of the Youth Art Contest. The December press release gave an update on the Planning Committee's activities and asked for input from QIN residents by filling out a residential survey about the exposure to natural hazards. Instructions were included in order to complete the online survey by way of a link from the QIN website, as well as how to obtain a printed copy of the survey. Printed surveys were also distributed by the Nation's Community Services Office at the QIN Mid-Year Annual Membership meeting held in November, as well as at the Public Meetings held in February 2010. Respondents were offered one of eight free color aerial imagery prints of their choice as an incentive to participate.
- **February 2010** – The February Nugguam featured three separate articles about the Tribal Hazards Mitigation Plan. The first article featured a group photograph of the Youth Art Contest Winners and their winning artwork (reproduced on page 1 of this document). The article, written by Nugguam staff writer, Pies Underwood, described the implementation of the Youth Art Contest and interviewed Coni Wilson, Manager of Community Development who works in the Planning Department of the Quinault Indian Nation, who commented, *"By looking at the students' art work, you would have thought they sat in our meetings. They were taught well by their science teacher and art teacher as to what they were supposed to draw and they all did a fine job!"*
- The second article about the Tribal Hazards Mitigation Plan in the February 2010 issue, informed readers about the public meetings to be held in Taholah, Queets and Amanda Park. The announcement was also distributed to The Daily World which serves Grays Harbor and Pacific Counties, The North Coast News which serves Ocean Shores, The Forks Forum serving Sequim and the Olympic Peninsula, and in Indian Country the National Independent Native Journal.

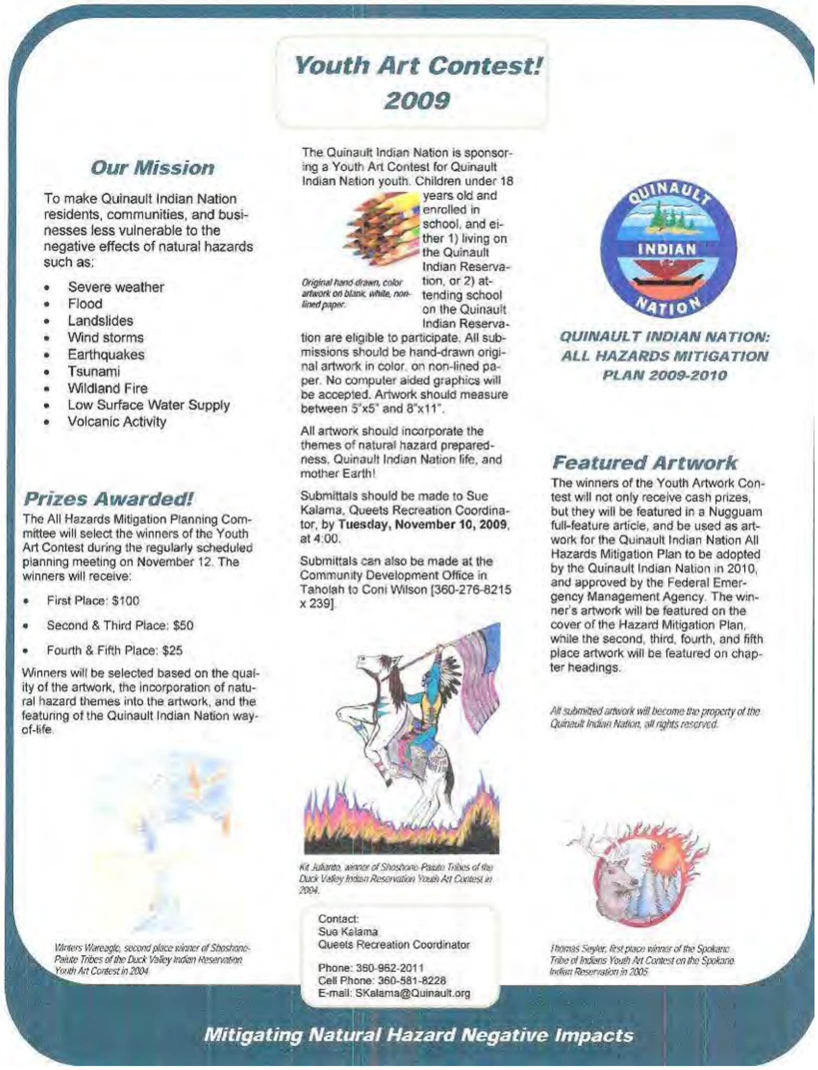
Posters announcing the public meetings were placed at local businesses on the QIR, organizations and Tribal bulletin boards. The February issue also included a replication of the Residential Survey (the third article in the Nugguam that month), asking residents of the QIR to complete the short survey and receive a free map print of their choice of places on the Reservation.

- **March 2010 –** The March issue of the Nugguam included a summary of the Public Meetings attendance held in February and announced the intention to distribute the Public Review Draft of the Tribal Hazards Mitigation Plan on April 1, 2010.
- **April 2010** – The Nugguam article announced the release of the draft QIR Tribal Hazards Mitigation Plan available for comment from April 1 until May 1, 2010, and then described the submission process of the Final Plan to Washington State, then to FEMA Region X, and then back to the QIN for adoption.

2.7.2. Youth Art Contest

The QIR Tribal Hazards Mitigation Plan Committee launched a Youth Art Contest to develop awareness in the schools, and within families, about natural hazard risks on the QIR. Young people were engaged in important discussions regarding the effects of natural hazards and how to mitigate the negative effects within their communities. Posters and tri-fold handouts were used as invitations to participate in the contest and were distributed to the three schools on the Reservation as well as to local youth centers (Figure V). The Nugguam also included invitations for youth on the QIR to participate in both the October and November 2009 issues. The artwork was collected through November and the winners were awarded cash prizes. Winners also received recognition in the December 2009 and the February 2010 issues of the Nugguam. The winning artwork has been included in this plan on the cover and as chapter dividers.

Figure V. QIN Youth Art Contest! 2009, invitation to participate poster.



2.7.3. Residential Survey

A Residential Survey was developed for use in this planning process. The Residential Survey was intended to collect information from a wide selection of residents living on the QIR concerning past experiences with natural hazards, the characteristics of risk and past losses for those homes, and overall preparedness for natural hazards.

The December 2009 press release printed in the Nugguam gave an update on the Planning Committee's activities and asked for input from QIR residents by filling out a Residential Survey. Instructions were included about how to complete the Residential Survey online by way of a link from the QIN website, as well as how to obtain a printed copy of the Residential Survey from the Quinault Community Development Manager. Printed Residential Survey copies were also distributed by the Community Services office at the Mid-Year Annual Membership Meeting in November 2009, at the Public Meetings held in February 2010, and in the Nugguam in February 2010, as a full-page reproduction of the survey and map-print request form. Respondents were offered one of eight free color aerial imagery wall-map prints of their choice as an incentive to participate in the survey. An introductory commentary was included on the QIN website link to the Residential Survey:

> We ask all residents of the Quinault Indian Reservation to take some time to read and respond to a short inquiry. The Quinault Indian Nation's Departments, and a host of federal, state, and county disaster relief organizations are working together to prepare a FEMA compatible Quinault Indian Reservation Tribal Hazards Mitigation Plan.
>
> We are asking all residents of the Quinault Indian Reservation to participate in this effort. As an individual who lives here, you know this area is at risk to casualty loss due to natural hazards. We have all witnessed the storms, flooding, high winds, and landslides that have ravaged this region over the years. We have all witnessed the tsunami risks around the Pacific Ocean that have taken a toll on coastline communities.
>
> Today, we are doing more than watching for hazards; we are taking a proactive role in reducing casualty loss in our area. We are inviting you to take a proactive role as well.
>
> We would like you to complete the online Residential Survey about your home's defensibility in the case of a natural hazard event. Your responses will be kept completely confidential and released only in aggregated form. This questionnaire will allow us to identify key factors that may place your home and the homes of your neighbors at the greatest risk. We will use this information to develop mitigation activities that may lead to saving your home and the community you live in. Information also helps to secure funding for disaster mitigation funding on the Quinault Indian Reservation.
>
> We would like to thank you for your assistance on this project with a small token of appreciation. We are completing some advanced mapping of the Quinault Indian Reservation for this project. When you complete your survey, we will color print a 2009 Aerial Photograph Image of your selected area on 24" x 24" paper and send it to you at no charge. This offer is available to the first 200 residents who complete the survey. It is our way of thanking you for your input to this very important project. The Map Request form is provided at the end of the Residential Survey. We appreciate the input from everyone who participates!
>
> If you prefer to take the survey on the printed page, or if you have any questions, you can contact:
>
> > Coni Wilson
> > Quinault Indian Nation
> > Community Development Manager
> > PO Box 189
> > Taholah, WA 98587
> > (360) 276-8215 X 239
> > CWILSON@quinault.org

A total 53 residents of the QIR responded to the Residential Survey. All responses provided the planning effort with valuable information, which is summarized here.

Respondents to the survey reported where their home is located. Approximately 14% were from Amanda Park, 23% from Queets, 52% from Taholah, 5% from Taholah Ocean Tracts, and the remaining 6% were from other locations on the QIR. Approximately 72% of respondents were home owners and the other 28% rented their home. The average respondent indicated that they have lived in their current home 15 ½ years, ranging from 1 year to 25 years.

Approximately 90% of respondents indicated that they have a “land-line” telephone service in their home. About 77% of the respondent homes have an internet connection, and 68% indicated they have emergency 9-1-1 telephone service. About half of the respondents indicated that if their land-line telephone service became non-functional that they would have alternative communications. All of the respondents that indicated they have an alternative communication source, indicated that their alternative devices include a cellular telephone and that there is service working at their home. Other alternative communication devices included satellite phone, CB, or Ham radio. Cellular telephone service is variable on the QIR. Within the Village of Taholah service is limited to only certain carriers and then only from the “upper village” locations. In the “lower village” of Taholah, cellular phone reception is rare. All of the other villages can receive cellular telephone service depending on the carrier. For instance, one carrier may provide reception in Qui-nai-elt and Taholah Ocean Tracts while a different carrier provides service in Queets or Amanda Park.

Approximately 56% of the respondents indicated that their home is located in a structural fire protection coverage area.

The survey respondents indicated the type of roofing materials covering their home. Approximately 51% indicated a composite roofing material (asphalt shingles) while 20% indicated wooden shingles cover their roof. The remaining 23% of respondents indicated a metal roofing material (aluminum, tin, or other metal).

About 72% of survey respondents indicated that their driveway is 100 feet long or less. Approximately 16% indicated a driveway of 100 to 250 feet long, and only 5% reported a driveway of between 500 and 1,000 feet long. Roughly 35% reported the narrowest point of their driveway width to be 5 to 10 feet, 32% specified 10 to 15 feet, 19% designated 15 to 20 feet driveway width, while the remaining respondents showed a driveway of 20 feet or wider to access their home from the main road to their parking area for their home. Over half (54%) of the respondents designated that they have a paved driveway with the remaining people reporting gravel (26%), dirt (12%) and roadside parking (lives in a village with paved streets and parks at the curb).

Almost half of respondents (47%) indicated their driveway is relatively flat with an equal number reporting a slight grade providing all season access. The remaining respondents (about 5%) reported a mix of moderate to steep grades to access their homes. Most respondents (56%) pointed out that they would not have an alternative access to their home in the event the primary access route was cut off due to a natural hazard such as wildfire, flood, tsunami, or landslide.

Survey recipients were asked to identify if their home address numbers are clearly visible from the nearest public road. Over 58% of respondents signified a positive response to this question.

During natural hazards, power supplies are often compromised. Survey responses indicated that about 58% of residents have alternative power supplies at their home.

Emergency services training within the household is an indicator of a family’s exposure to safety issues and awareness in emergency situations. This training can include one or more family members participating in volunteer activities (such as volunteer fire fighting), or from employment based training, and from other venues. Respondents indicated training in the following areas within the last 10 years: 16% wildland fire, 5% city or rural fire fighting, 3% paramedic or Emergency Medical Technician (EMT), 56% basic first aid, and 13% in search and rescue. Overall, about 65% of respondents reported at least one of these training activities for at least one member of the household. Past training in these same categories by members of the household was slightly higher than the current training received with 16% in wildland fire, 11%

city or rural fire fighting, 22% paramedic or EMT, 20% basic first aid, and 13% in search and rescue. Overall, respondents reported never receiving training in each category as 68% wildland fire, 84% city or rural fire fighting, 75% paramedic or EMT, 23% basic first aid, and 74% in search and rescue.

Respondents to the survey were asked to evaluate four categories of wildfire risk in the areas immediately surrounding their homes (Table 2, Carree *et al.* 1998). The right column reports the average response rates by category.

Table 2. Wildfire Fuel Hazard Rating Worksheet.

		Rating	Results
Fuel Hazard	Small, light fuels (grasses, forbs, weeds, shrubs)	1	52%
	Medium size fuels (brush, large shrubs, small trees)	2	26%
	Heavy, large fuels (woodlands, timber, heavy brush)	3	21%
Slope Hazard	Mild slopes (0-5%)	1	76%
	Moderate slope (6-20%)	2	14%
	Steep Slopes (21-40%)	3	7%
	Extreme slopes (41% and greater)	4	2%
Structure Hazard	Noncombustible roof and noncombustible siding materials	1	21%
	Noncombustible roof and combustible siding material	3	26%
	Combustible roof and noncombustible siding material	7	17%
	Combustible roof and combustible siding materials	10	36%
Additional Factors	Rough topography that contains several steep canyons or ridges	+2	Average -1.5 pts
	Areas having history of higher than average fire occurrence	+3	
	Areas exposed to severe fire weather and strong winds	+4	
	Areas with existing fuel modifications or usable fire breaks	-3	
	Areas with local facilities (water systems, rural fire districts, dozers)	-3	

Values below are the average response scores for each question in the survey and their use in the risk assessment matrix.

Fuel hazard 1.7 x Slope Hazard 1.1	=	1.9
Structural hazard	+	5.8
Additional factors	(+ or -)	-1.5
Average Hazard Points	**=**	**6.2**

Relative risk rating

- Extreme Risk = 26 + points
- High Risk = 16–25 points
- Moderate Risk = 7–15 points
- Low Risk = 6 or less points

Survey recipients were asked about their personal experiences concerning natural hazards within the past 10 years (2000-2009). Responses indicated that high wind storm damages have been experienced by 80% of respondents to the survey resulting in an average of $4,000 in out-of-pocket expenses when a loss was experienced (approximately 7.5% of respondents reported financial loss from wind storm damages). In a similar assessment, about 60% of the respondents to the survey indicated damages from flooding of about $3,400 in out-of-pocket expenses when a loss was experienced (approximately 5.7% of respondents reported financial loss from flooding damages). Earthquake damages were reported by 60% of respondents resulting in a financial loss averaging $4,000 when a financial loss was experienced (approximately 3.7% of respondents reported financial loss from earthquake damages).

An equal proportion of respondents (40% in each category) reported damages from other hazards including storm water damages, tidal surges, tsunami, wildfire, landslides, and volcanic activity. These respondents did not indicate out-of-pocket financial losses to these hazards.

While the comparison of these data are extremely valuable in recognizing the recent historical impact of these natural hazards, it is critical to understand that these losses are not representative of commercial business losses, municipality, or Tribal government losses from these hazards. Neither are these decadal summaries of losses reflective of the expenditures in Tribal, county, state, or federal dollars to mitigate these natural disasters before they happen.

Survey recipients were asked to provide a general summary of their home's exposure to natural hazards and the road access to their home, by indicating risk exposure to various hazards. These data confirm the intuitive recognition of the widespread exposure risk of all QIR residents to high winds, flooding, and earthquakes (Table 3).

When taken in respect to the location of the respondent's home with the hazards considered, some differential insights are illuminated (Table 3). About 80% of respondents from Amanda Park reported home exposure to flooding, 20% from Queets reported home exposure to flooding, and 57% from Taholah reported home exposure to flooding. Similarly, storm water drainage was reported overall as a home risk exposure for 36% of homes, but when taken on a village specific basis, the results point to 80% of the Amanda Park homes, 30% of the Queets homes, and 35% of Taholah homes. Tidal surges were reported overall by 29% of respondents, but in by 70% of the Queets homes and 57% of the Taholah homes. Tsunami risks were reported by 45% of all respondents, but by 50% of the Queets homes, and 44% of the Taholah homes. Wildfire risks were reported by 38% of all respondents, but by 80% of Amanda Park homes, 20% of Queets homes, and 35% of Taholah homes. Landslides were reported as a risk to 40% of homes in Amanda Park, 40% in Queets, and 17% in Taholah. Earthquake risks were reported by 74% of all respondents, but in Amanda Park 100% of respondents reported risk to earthquake, 50% of the homes in Queets, and 74% of the homes from Taholah. Finally, high winds were reported as a risk by 74% of all respondents and in Amanda Park the ratio was 80% of respondents, in Queets it was 60%, and in Taholah it is 74%.

Table 3. Respondent self-assessment of home site risk exposure.

Hazard	Exposure of HOME to risks	Exposure of ACCESS to risks	History of Loss to Home by risks	History of Loss of ACCESS by risks
Earthquake	74%	62%	5%	7%
High Winds	74%	57%	36%	36%
Flood	50%	60%	14%	14%
Tsunami	45%	41%	0%	0%
Wildfire	38%	36%	0%	0%
Storm Water Accumulation	36%	48%	26%	19%
Landslide	31%	43%	5%	17%
Tidal Surge	29%	41%	5%	2%
Volcanic Activity	12%	19%	2%	0%

Survey respondents were also asked how hazard mitigation projects should be funded in the areas surrounding homes, communities, and infrastructure such as power lines and major roads. As shown in Table 4, approximately 50% of respondents indicate a preference for cost-share funding of home defensibility projects to reduce the exposure of individual homes to natural hazards. Conversely, about 73% of respondents indicated a public funding preference for community defensibility projects, with 22% opting for a cost-share approach. Public funding options were preferred by 67% of respondents for hazard mitigation infrastructure projects (Table 4).

Table 4. Public opinions of hazard mitigation funding preferences.

	Public Funding	Cost-Share (Public & Private)	Privately Funded (Owner or Company)
Home Defensibility Projects →	32%	50%	18%
Community Defensibility Projects →	73%	22%	5%
Infrastructure Projects Roads, Bridges, Power Lines, Etc. →	67%	30%	3%

All survey recipients were offered an incentive to participate in the project in the form of a custom made color aerial photography wall map (24"x22") for completing and returning the survey and map request form. Most of the respondents included their map request form, while others did not, although they did return a completed survey. While all of the survey recipients will remain anonymous, the entire Tribal Hazards Mitigation Plan Committee extends its appreciation to those who participated in the survey.

2.7.4. Public Meetings

Four public meetings were scheduled during the week of February 8-12, 2010. The meeting schedule started with a lunch meeting in Taholah at the Community Center on Monday, February 8, 2010, but was rescheduled to Friday, February 12, because of a funeral for a Tribal Member that took place that day. The noon-time Public Meeting was specially scheduled for employees of the QIN and supported by the QIN Business Council who encouraged all employees to attend. The Vice-President of QIN Business Council attended the meeting and requested that all employees stay for the extended discussions of the meeting. He notified Department Heads of the employees that they would return late to work while they participated in this important series of discussions.

The first evening meeting took place in Queets, Tuesday, February 9th at the Head Start Building. Even though the local high school basketball team won a decisive victory on the previous day, people still showed up for the meeting (Figure VI). Many questions were asked by those in attendance. A local school aged boy who came to the meeting asked one of the best questions, "How come everybody's talking about tsunami and we do drills for tsunami, but there is no tsunami? What's up with that?"

The next Public Meeting took place Wednesday, February 10th in Amanda Park at the School Library. Shelves filled with books served as an appropriate background for the discussions. A warm friendly atmosphere of the audience was enjoyed by everyone present. The President of the Quinault Indian Nation was in attendance alongside families and young people to participate in the meeting and discussions (Figure VI).

The third evening Public Meeting was conducted Thursday, February 11th, at the Taholah School Cafeteria. The weather during and after the meeting was an appropriate setting for a hazard mitigation meeting as a rain downpour combined with a strong wind rolled off the ocean and into Taholah to shake the buildings and put an emphasis on the severe weather discussions.

The discussions at each meeting centered around the most important topics for the Reservation: tsunami, floods, forest fires, landslides, earthquakes, and windstorms. One of the goals of the discussions was to identify potential mitigation measures to make it easier to deal with a disaster when it happens. Some of the ideas brought up at the meetings by the audience concerned storm water drainage, landslides impacting roads and infrastructure, and disaster preparedness. Most captivating part for the listeners were issues connected with river flow fluctuations influenced by the climate change and directly impacting the rivers of the

Reservation, salmon spawning grounds, and the traditional values of the people of the QIR. People at the meetings studied the maps depicting how a tsunami wave is formed in the ocean and why it can be so deadly to the QIR shoreline communities when it hits.

Figure VI. Participants at the Queets (left) and Amanda Park (right) Public Meeting on February 10, 2010.

2.7.5. Public Review Conducted

After a Planning Committee review of the document was completed in March 2010, and edits were introduced to the Tribal Hazards Mitigation Plan, it was offered for public review. In addition to the announcement in the Nugguam (Section 2.7.1), posters announcing the Public Review were distributed in key locations around the QIR. Residents were given the opportunity to obtain a printed copy of the plan at various QIN offices in each village and on the Nation's internet web site.

All comments to the plan were directed to the QIN Planning Department for incorporation into the revised Quinault Indian Reservation Tribal Hazard Mitigation Plan. In addition to the public review comments, the planning committee members and the QIN Consultants continued to augment the plan to prepare it for completion.

2.8. QIN Readiness Survey

In order to formally assess and provide an opportunity for all QIN Divisions to participate in providing unique information for the readiness assessment of this project, a QIN Readiness Survey was developed and distributed to all QIN Division Heads. This survey provides an insight to existing preparedness, resources available for mitigation, active response, and post-disaster responses at the Division level.

The cover letter for the Division Survey was distributed on July 8, 2009, and included the following letter requesting participation:

> Kamiak Ridge, LLC, is working with the Quinault Indian Nation to develop a **Tribal Hazards Mitigation Plan** (THMP) for the Quinault Indian Reservation. All Tribal Divisions are important by providing necessary services to Tribal members and residents of the Quinault Indian Reservation during times of natural hazards on the Reservation. You know that many areas of the Reservation are at risk to casualty loss and disruption of services due to a variety of hazards including wildfires, floods, earthquakes, landslides, wind storms, tsunamis, and winter storms. Tribal members and all Divisions have all witnessed the impacts that these naturally occurring events have had on the Reservation over the years.

As part of the Reservation-wide THMP, your department is invited to participate in a number of ways. One way to involve yourself is to complete the attached survey about your Division's experience with natural hazard events on the Reservation and your department's ability to function and provide services in the case of a disaster.

We will use this information to develop mitigation activities that will allow the services that Tribal members expect to continue functioning during hazard events.

Your response and participation is very important to this THMP effort. Please take a few minutes to complete the enclosed Survey and return it to Coni Wilson, Community Development Manager.

Thank you for your assistance. If you have any questions about this project or this survey, please contact me at the Kamiak Ridge, LLC, office in Pullman, WA, at 509-592-7650, Susan Veach at our Port Orchard Office 360-509-5445, or Coni Wilson at 360-276-8215 Extension 239.

2.8.1. Division Survey Results

Surveys were completed and returned by a total of eleven (11) Divisions (Table 5).

Table 5. Respondent Information from the Division Surveys.

Department	Address	Name & Position	Services Provided
QDNR - QIN Forestry	PO Box 189 1214 Aalis, Building C Taholah, WA 98587	James Campbell Tribal Forest Manager	Manage and protect all applicable QIN forest lands and associated resources for the benefit of the QIN and their heirs.
QDNR - QIN Forestry	PO Box 189 1212 Aalis, Building B Taholah, WA 98587	Mike Stamon Special Projects Forester - Technical Support & Services Section Leader	Management of the QIR Forest Lands on Trust Property. Conduct reforestation and silvicultural practices on ALL trust lands, and manage timber sale activities on 100% of QIN lands. We also manage all gravel roads on trust lands, and the fire program on QIR.
QDNR - GIS Program	PO Box 189 1214 Aalis, Building C Taholah, WA 98587	Tony Hartrich GIS Program Manager	Mapping and spatial analysis support services to departmental staff, BIA Taholah Agency personnel, Planning Dept. personnel, Police Department personnel, Tribal legal and policy advisors, the Quinault Business Committee, and outside contractors.
QDNR - Fire Mgmt	PO Box 189 1214 Aalis, Building C Taholah, WA 98587	Brian Sutton Fire Management Officer	Wildfire suppression, fuels management, wildland fire prevention, education, pre-suppression.
QDNR - Quinault Dept of Fisheries	PO Box 189 1214 Aalis, Building C Taholah, WA 98587	Tyler Jurasin Operations Section Manager	The Quinault Dept of Fisheries (QDFi) consists of three sections: Science, Technical Support and Operations. These three sections work together to carry out the primary responsibility of the QDFi, which is to manage the fisheries of the QIN in a manner that protects the self-regulatory status of the QIN. The QDFi monitors and evaluates the fisheries of the QIN, collects necessary biological and fisheries data, drafts seasonal fishing regulations, operates enhancement facilities and provides both technical and fisheries policy support to the QIN.

Table 5. Respondent Information from the Division Surveys.

Department	Address	Name & Position	Services Provided
Dept of Environmental Protection	PO Box 189 Taholah, WA 98587	Mark Mobbs Manager	The Department of Environmental Protection's major overarching responsibility is to protect fish habitat within the Usual and Accustomed Hunting and Fishing Area (U&A) of the Quinault Indian Nation. The Department contains four Sections; Forest Practices, Water Quality, and Wildlife, and Air Quality. The Forest Practices section covers a variety of tasks largely related to forest management. This includes enforcement of Title 61 within the Reservation boundary, which covers activities related to natural resources within the Reservation, largely working with water and forests. The tasks include issuance and oversight of forest practice permits (FPA) mostly for timber harvest and other forest management activities. It also issues and oversees Hydraulic Project permits (HPA) for activities within 200 feet of surface water. In addition to its on-Reservation responsibilities, the section monitors forest management activities off Reservation within the U&A primarily to protect fish habitat. This section also addresses cultural resource issues, primarily off-Reservation. Cultural resource review extends to projects outside of forest management to include many other activities that could damage cultural resources. The Wildlife Section oversees wildlife issues, primarily big game management and endangered species act (ESA) compliance issues. The section interacts with other agencies on wildlife issues (e.g. hunting seasons) within the U&A. The Water Quality section monitors water quality primarily within the Reservation, but also includes some sampling off-Reservation within the U&A. It addresses water quality issues as they relate to both fish and human health, and also addresses compliance with the clean water act. The Air Quality Section monitors air quality within the Reservation and addresses compliance with the clean air act.
Roger Saux Health Center	PO Box 219 1505 Kla-ook-WA Drive Taholah, WA 98587	Robert P. Young, Pharm. D., J.D. Director, Health & Wellness Division/Clinic Director	1) Healthcare - Medical & Dental 2) Behavioral Health 3) Family Services 4) EMS 5) Chemical Dependency
QIN Police Department (360) 276-4424	137 Cuitan Taholah, WA 98587	Shawn Donnelly Public Safety Manager	We provide police service, fire service, animal control, radio dispatching, and a full service corrections/jail facility on a 24/7 basis.
Bureau of Indian Affairs Taholah Agency	1214 Aalis, Building C Taholah, WA 98357	Greg Masten Superintendent	Trust Services in Forestry and Realty for the people and Tribes of the Quinault Nation.

Table 5. Respondent Information from the Division Surveys.

Department	Address	Name & Position	Services Provided
QIN Finance Department	1214 Aalis, Building C Taholah, WA 98357	Cindy Stutesman Accounting Specialist	Financial
Division of Community Services	114 Quinault Street, P.O. Box 189 Taholah, WA 98587	Richard Wells, Director	The Division of Community Services provides a variety of basic and essential governmental services for the Reservation communities and the remainder of Quinault Reservation, including: Police, Fire, Animal Control, Community Water, Community Sewer, Solid Waste Management, Land Use Planning, Economic Development Planning, Building & Zoning Code Enforcement, Public Facilities Management, Recreation, Public Roads Maintenance & Construction, Low-Income Food Distribution (Commodities), Low Income Heating and Energy Program (LIHEAP), and Construction Project Management. The goals of the Division include: ensuring the public health and safety, and improving the quality of life for Reservation residents. 1) Directs Community Services Departments a. Community Development b. Utilities Maintenance c. Facilities Management i. Building Maintenance ii. Custodial Services d. Parks & Recreation e. Public Safety f. BIA/IRR Roads System Maintenance g. Commodities & LIHEAP programs. 2) Construction Project development

The results of the completed surveys demonstrate the differing levels of preparedness across the critical divisions of the QIN. These results were used to help direct mitigation measures and to assist Tribal Divisions with hazard preparedness.

Survey respondents represented 373 full-time employees and 110 seasonal employees. The Roger Saux Health Center represented the most full-time employees with 76. The Quinault Department of Fisheries has the greatest fluctuation in the number of staff with 29 full-time employees and 70 seasonal employees. The average QIN Department employed 34 people, full-time, and 10 people part-time.

Training associated with a general level of preparedness for natural disasters was assessed by the respondents to the survey (Table 6). Ten of the reporting departments (91%) indicated that 25% or less of their employees possess either City or Rural Firefighter training, while the QDNR Fire Management Department reported a higher percentage of trained staff (>75%) in wildland fire fighting, and the Division of Community Services reported that between 50% and 65% of staff possess training in city or rural firefighting. Training in Emergency Medical Technician (EMT) training was indicated for less than 25% of employees in all Divisions (Table 6).

Table 6. General Level of Emergency Response Training by Division Staff.

Type of Training	25% or less of employees	26% to 50% of employees	51% to 75% of employees	More than 76% of employees
Wildland Firefighting	98%	0%	0%	2%
City or Rural Firefighting	81%	0%	19%	0%
EMT	100%	0%	0%	0%
Basic First Aid	65%	2%	27%	0%
National Incident Management System (NIMS)	98%	0%	0%	2%
Hazardous Materials (HazMat)	98%	2%	0%	0%

Survey respondents indicated their office headquarters' exposure to risk from a list of natural hazards (Table 7). The results of this assessment indicate that virtually all office headquarters face exposure to a disruption as a result of one or multiple natural hazards. The QIN has a main Tribal Center in Taholah that houses six of the eleven department headquarters represented in the survey. The Roger Saux Health Center, Division of Community Services, and the QIN Police Department are located in Taholah in separate locations. The QDFi Hatchery facility's main office is also located in Taholah.

Earthquake risk exposure was reported by the highest number of responding Divisions (100%), followed by winter storm (91%), wind storm/tornado (82%), and tsunami (64%). Both wildfire and floods were indicated by 27% of the respondents as a risk factor for the office facility. Landslides were only indicated by 9% of responding departments, but it should be noted that landslides have the potential to impact the QIR infrastructure significantly as the main access route to Taholah along SR109 is prone to landslides.

Table 7. Respondent Assessment of Office Headquarter Exposure to Natural Hazards.

Type of Hazard	No	Yes
Wildfire	73%	27%
Flood	73%	27%
Earthquake	0%	100%
Landslide	91%	9%
Wind Storm/Tornado	18%	82%
Winter Storm	9%	91%
Tsunami	36%	64%

Respondents reported a number of additional potential hazards which could impact their normal operations. These included:

- Power outage/surge
- HazMat spills
- Oil/chemical spills
- Access route closure
- Liquefaction resulting from earthquake

Approximately 64% of responding Department Managers reported that they have the ability to function if the power grid fails. In the event of an extended power outage 36% of respondents indicated that they have backup generators available, and 45% reportedly have phones or radios that could be operational at their place of work. The QDNR Building has two telephone lines that allow fax/phones to operate on battery backup. The QDFi Hatchery facilities have backup generators and power failure alarm systems, however, the offices do not have a backup power source. The Roger Saux Health Center reports that their backup generator has questionable reliability and capacity (should be replaced and upgraded).

Approximately 27% of respondents indicated that an alternate access route to their office is available in the case of a disaster cutting off the primary access. About 64% of the respondents indicated that they have an alternate location from which they can operate in case of an emergency. Plans are in place to implement an alternate operations center for 18% of the responding departments. Two departments indicated that some of their operations cannot be operated remotely; the QDFi hatchery operations affecting fish health, and QIN Police Department operations affecting prisoner safety and containment.

Responding Department Managers were asked to provide historic information on the impact of hazards that have affected their ability to operate during the past 10 years (Table 8).

Table 8. Historical Impact of Hazards that have Affected Departmental Ability to Operate.

Did Hazard Affect your Department?	If YES, Complete these questions…		Did this hazard cause damage to or affect:			
↓Hazard↓	Yes	→	General Office Operations	Reduced ability to provide services	Equipment Operations	Briefly describe impact on your department. (i.e., employee ability to get to work, etc.)
Wildfire	0%	→	0%	0%	0%	
Flood	45%	→	0%	54%	18%	Employees unable to get to work. Limited access to lowland areas. Minor flooding in lower Taholah village. In Queets, sewer lagoons are threatened every year by Queets River.
Earthquake	27%	→	0%	0%	0%	No significant impact.
Landslide	55%	→	0%	36%	0%	Employees unable to get to work. Blocked access to Taholah. A landslide on the 7000 Road threatened the Taholah water supply.
Wind Storm/ Tornado	82%	→	27%	82%	36%	Employees unable to get to work. Power outage. Limited access to office, no backup to run payroll so had to hand write checks.
Tsunami	0%	→	0%	0%	0%	

Table 8. Historical Impact of Hazards that have Affected Departmental Ability to Operate.

Did Hazard Affect your Department? ↓Hazard↓	If YES, Complete these questions… Yes	→	Did this hazard cause damage to or affect: General Office Operations	Reduced ability to provide services	Equipment Operations	Briefly describe impact on your department. (i.e., employee ability to get to work, etc.)
Winter Storm	82%	→	27%	82%	52%	Employees unable to get to work. Power outage. Limited access to office, no backup power to run payroll, so had to hand write checks. Dec 2007 winter storm caused power outage for over a week.

Respondents indicated that 64% of the departments have alternative communications available in the case of a disaster. Many employees (64%) have two-way radios in their assigned vehicles which may or may not be accessible during emergencies. Approximately 27% of the departments report that employees have personal cell phones, the main office does not normally have cell phone coverage (no repeater in the area of Taholah). CB/Ham Radios are available to 18% of the offices reporting. No respondents reported access to operational satellite phones.

Respondents were asked to rank the perceived relative threat posed by a variety of natural hazards (Table 9). Based on this assessment, winter storms ranked as the highest threat in the list of potential impacts (71 points where total agreement on the highest risk hazard would score 77 points). Wind storm / tornado was ranked second overall (49 points), followed by floods (46 points), earthquakes (41 points), landslides (39 points), tsunami (38 points) and then wildfire (24 points) (Table 9).

Table 9. Relative Ranking of Various Hazards.

Type of Hazard	Rank	Composite Score
Winter Storm	1	71
Wind Storm/ Tornado	2	49
Flood	3	46
Earthquake	4	41
Landslide	5	39
Tsunami	6	38
Wildfire	7	24

Relative risk scores reported for each hazard (Table 9) were determined by assigning a point score of 7 to the highest ranked hazard, 6 to the next lowest, and so forth to the lowest ranked risk, which received a 1. All respondent's scores were added together for each hazard and the risk with the highest score received the ranking as the largest comparative risk exposure.

Two Divisions indicated the existence on an Emergency Operations Plan (EOP) for their operations and both were last updated in 2008. The remaining respondents indicated no EOP although many reported to be working on these documents.

Finally, respondents were asked to identify a list of resources available to their department to respond to disasters on the QIR, and to indicate what resources they feel are needed in order for their operations to continue during natural hazard events. Their responses are combined and summarized below. This summary represents all data combined into one summary.

Resources Available:

- Personnel (volunteers), vehicles with 2-way radios, chain saws and other hand tools.
- 15-20 vehicles and two fire engines (forestland type). One 6500 KV Honda generator at Seed Orchard. Radio system with repeater (battery BU 24-36 hrs) covering 99% of QIR. Most of these vehicles have radio and up to 15 battery operated handheld radios.
- Global Positioning Systems (GPS) equipment, GIS layers and hardcopy Reservation maps.
- Engines, manpower, chainsaws, pumps, helicopter operator.
- The QIN Administration Building complex could potentially be used for temporary shelter during some types of natural disasters.
- Five four-wheel drive vehicles (50% are 4x4) and will be converting fleet to 100% 4x4 over the next few years. They are currently in the process of upgrading mobile radio communications capabilities in the next several months. Building a portable (suitcase) radio / repeater system that can be used with any vehicle that will be compatible with all QIN radios for search and rescue needs. Seven fully ready chain saws. Five handheld GPS units for search and rescue.
- Nineteen full time employees, and five 4x4 pick-up trucks.
- Public Safety Department- Police Officers, EMS, Ambulance, Fire Trucks, radios, communications.
- Utilities Department- stand by water & sewer plant operators, generators (some), small backhoe, lift truck.
- Building Maintenance- pickup trucks, generators, plywood.
- Road Maintenance- Equipment Operators, dump trucks, low boy tractor/trailer, backhoe, excavator.
- Commodities- warehoused food supplies.

Resources Needed:

- Increased cell phone coverage for communication.
- Alternate access routes to the work site.
- Backup generators for power.
- More staff trained in the Incident Command System (ICS).
- Generator to support Radio System (Repeater).
- Police and fire have a radio components supporting system. Police, fire, and forestry all share a frequency. Need to separate frequency sharing while enabling cross-frequency communication.
- The gas pump is on a generator in case of a power outages in Taholah, Amanda Park, and Queets.
- Need generator for seedling storage for tree cooler to run 2 cooling condensers (cooler often houses thousands of dollars worth of tree seedlings for reforestation).

- Need generator for lights and computers at QDNR office, seedling storage and Tsa'alal field station.
- Weather tower & repeater on "Bear Mountain" may need battery backup.
- Electricity to run computers, internet access to gain information and to communicate. Can support SharePoint Asset Inventory and other geospatial asset inventorying.
- Command, communication, operations plan.
- The operation of the QDFi requires communications such as radios, telephone and fax. The use of computers is essential to the day-to-day work conducted in the QDFi offices. QDFi staff must be able to travel and access numerous geographic areas both on and off the QIR to conduct the required field work. Hatchery staff must be able to access hatchery facilities and receive necessary supplies (e.g. fish feed, diesel fuel) and equipment maintenance and repair in a timely manner.
- Larger, more reliable energy source, current generator (refurbished 2006 model) is unreliable.
- If road is blocked, staff cannot get into work and patients cannot get to treatment. For treatment of Pandemic Flu - lack of oxygen and respirators may be a problem.
- We need to increase our fire/rescue capabilities – both equipment and training.
- Eight hand held multi-channel radios.
- An increased capacity backup generator.
- Police- police protection,
- Fire- volunteer fire fighters,
- Jail- inmate housing, feeding, handling.
- Incident Command Center.
- Utilities-
    - 4 community water supply systems,
    - 3 community Sewer systems,
    - Garbage disposal.
- Road Maintenance- road clearing, tree removal.

2.9. QIN Legal and Regulatory Resources Related to Hazard Mitigation Efforts

A complete summary of legal and regulatory resources developed and adopted by the QIN is summarized in Table 10. A further discussion of these items is presented in subsequent sections of this sub-chapter. These plans, laws, and programs provide a framework for implementing the mitigation items termed as "policy" recommendations. Many of the potential mitigation measures referenced in Table 63 will be implemented through the existing framework of plans, laws, and programs already established within the QIN. Through the utilization of existing QIN plans, laws, and programs, the implementation of the THMP will be met with higher success, and both financial and administrative achievement.

Table 10. Quinault Indian Nation Legal and Regulatory Resources Available for Hazard Mitigation Efforts.

Regulatory Tool	Name	Description	Hazards Addressed	Date of Adoption
Category: Plans	The 20 Year Comprehensive Land Use Plan for the Quinault Indian Reservation February 1997	Articulates goals and establishes policies to guide the stewardship of the land and resources of the Quinault Indian Reservation.	All	November 03, 1997 Resolution No. 97-11-01 March 09, 1998 Resolution No. 98-538-75
Category: Plans	QIN 2008-2009 Comprehensive Land Use Plan: Capital Improvement Plan 2008 (Update to the Comprehensive Land Use Plan)	This element of the Quinault Comprehensive Land Use Plan deals specifically with the issue of capital improvement on the Quinault Indian Reservation.	Emergency Preparedness, Water Quality, Evacuation	February 05, 2008 Resolution No. 08-202-86
Category: Plans	QIN 2008-2009 Comprehensive Land Use Plan: Natural Resource Management Element 2009 (Update to the Comprehensive Land Use Plan)	Presents a Natural Resource Inventory for Reservation covering Vegetation, Surface Water, Sub-Surface Water, Other Waters, Animals, and Minerals.	Vegetation disease and pests, illegal harvest, fire and wind.	March 9, 2009 Resolution No. 08-146-87
Category: Plans	QIN 2008-2009 Comprehensive Land Use Plan: Transportation Plan Element 2008 (Update to the Comprehensive Land Use Plan)	This element focuses on improving the access of inter-related Reservation communities and properties for the efficient and safe movement of people between land uses.	Tsunami and earthquake escape routes. Flooding and bridge integrity.	April 28, 2008 Resolution No. 08-54-87 Full Element - - - April 14, 2008 Resolution No. 08-211-86 (Appendix B Priority List 2008-2012)
Category: Plans	QIN 2008-2009 Comprehensive Land Use Plan: Housing Element 2009 (Update to the Comprehensive Land Use Plan)	The purpose of this Comprehensive Land Use Plan element is to assess and project the need for additional housing on Reservation. The Nation’s housing policies and development regulations (zoning, building codes, etc.) establish how the development and construction of housing will take place in the community.	All are referenced although none are mitigated through this plan.	October 12, 2009
Category: Plans	QIN 2008-2009 Comprehensive Land Use Plan: Economic Development Plan Element 2009 (Update to the Comprehensive Land Use Plan)	This strategy is a five (5) year plan that represents the Nation’s current long-term strategy for developing its economy. It serves as a roadmap for the future economic prosperity of the Quinault Indian Nation (QIN) while reflecting the values and beliefs of the Quinault people. This plan focuses ideas of prosperity toward a common vision.	References of Economic Growth Areas and need for inclusion of objectives with hazard planning.	July 27, 2009

Table 10. Quinault Indian Nation Legal and Regulatory Resources Available for Hazard Mitigation Efforts.

Regulatory Tool	Name	Description	Hazards Addressed	Date of Adoption
Category: Plans	Quinault Indian Nation 2008 Strategic Plan	This plan supports elected leaders, Tribal Government, and Quinault community members in coming together to create a healthy community by focusing on six domains or core areas of action and opportunity that contribute to Quinault quality of life and wellbeing.		March 2009
Category: Plans	Comprehensive Economic Development Strategy 2008	This plan evaluates the economic climate, economic clusters, economic growth areas, infrastructure, and environmental, social and cultural considerations of the Quinault Indian Nation.	None	August 25, 2008 Resolution No. 08-74-87
Category: Plans	QIN Transit Capacity Study 2008	This plan identifies the steps to be taken within the following six years to meet the future transit needs of the Quinault Indian Nation.		March 9, 2009 Resolution No. 08-113-87
Category: Plans	Forest Management Plan 2003-2013	The Forest Management Plan (FMP) provides direction and technical specification guidebook for all forest management Activities.	Wildfire	October 2003
Category: Plans	QIN Transportation Plan 2006-2026	This plan addresses roadways, transit service, pedestrian and bicycle service, water service and air service.	Evacuation Routes identified	June 25, 2007 Resolution No. 07-98-86
Category: Plans	QIN Coastal Zone Management Plan February 1979	This plan identifies seven coastal management zones and establishes zone management policies		February 20, 1979 Resolution No. 79-106
Category: Plans	QIN Shorelines Management Master Plan February 1994	This Shorelines Management Master Program is a hybrid that incorporates natural resource management elements from varying Agencies, Departments and Sections within the Nation, the Federal Coastal Zone Management Act and the Washington State Shoreline Management Act. As written this is a regulatory document and not so much a planning document.		February 03, 1994 Not formally adopted
Category: Plans	Disaster Plan for QIN Public Safety	This Public Safety Plan includes emergency evacuation and response contact and procedural information.	Tsunami, Earthquake, Flooding, Wild Land Fire, Forest Fire	1998-1999 Not formally adopted
Category: Plans	Annex to the Continuity of Operations Plan for the Indian Affairs Taholah Agency	The Bureau of Indian Affairs Taholah Agency is part of the Continuity of Operations Plan (COOP) and this Annex was prepared in accordance with the direction in Presidential Decision Directive 67 and subsequent implementing guidance in Federal Preparedness Circular 65.	Wildfires, Severe Weather	April 2008

Table 10. Quinault Indian Nation Legal and Regulatory Resources Available for Hazard Mitigation Efforts.

Regulatory Tool	Name	Description	Hazards Addressed	Date of Adoption
Category: Law	Building Code Update to IBC 2006	Formalized adoptions of International Building Code 2006; International Plumbing Code 2006; International Mechanical Code 2006; International Fire Code 2006; National Electrical Code 2005; International Residential Code 2006.		June 10, 2008 Resolution No. 08-95-87
Category: Law	QIN Title 48 Zoning 2008	Title 48 addresses the land use plan, jurisdiction, the establishment of Districts, application of regulations, site development standards, variances, rezoning, planned unit development and subdivision regulations. Title 48 also establishes a Planning Commission for the Quinault Indian Nation.	All	November 24, 2008 Resolution #08-109-87
Category: Law	QIN Title 50 Building & Manufactured Homes	Title 50 establishes minimum standards regulating and controlling the design, construction quality of material, use and occupancy, location and maintenance of all buildings structures and certain equipment.	All	Original: January 11, 1993, Resolution #93-03-70 Update: April 12, 1999, Resolution #99-74-77 Update: November 24, 2008, Resolution #08-109-87
Category: Law	QIN Title 51 Fishing-Hunting-Gathering	The purpose of this Title is to protect the fish wildlife and other natural resources under the jurisdiction of the Quinault Indian Nation and the beauty of the Quinault Indian Reservation by providing guidelines for regulating the use and enjoyment of these resources and by providing both criminal and civil sanctions for violations of this Title and the regulations promulgated under this Title.		November 24, 2008 Resolution #08-109-87
Category: Law	QIN Title 52 Beach Lands	This title is for the preservation, protection and use of beach lands of the Quinault Indian Reservation. To prevent any obstruction, barrier, encroachment, abuse, or interference with the established use of such beach lands and to provide for enforcement.		November 24, 2008 Resolution #08-109-87
Category: Law	QIN Title 61 Natural Resource Management	Title 61 addresses Protection enhancement and perpetuation of the timber growing capacity of Reservation lands, timing of forest harvest activities within major drainages, Protection of cleanliness of the air and the productivity and purity of its waters, regeneration and operation standards.	Wildfire, flooding	November 24, 2008 Resolution #08-109-87
Category: Programs	Community Emergency Response Team (CERT Participant Manual)	This manual provides basic training in disaster survival and rescue skills.	All (Response)	June 2003

Table 10. Quinault Indian Nation Legal and Regulatory Resources Available for Hazard Mitigation Efforts.

Regulatory Tool	Name	Description	Hazards Addressed	Date of Adoption
Category: Programs	QIN Police Department Evacuation Procedures for Corrections	Procedures are detailed for jail evacuation. Departmental disaster preparedness plans are listed as to the type of support and infrastructure each department can provide in the event of a disaster.		
Category: Programs	QIN Wildfire Mitigation Plan	In Process	Wildfire	Pending
Category: Programs	QEPA – Agreement for Partial Delegation – Air Quality	This is an Air Quality agreement between the Quinault Indian Nation and the U.S. Environmental Protection Agency (EPA), Region 10.	None	October 4, 2007 Not formally adopted
Category: Programs	Watershed Analyses	Quinault River Watershed Analysis by USDA Forest Service dated March 31, 1999 Salmon River Watershed Analysis Raft River Watershed Analysis These documents cover the natural processes that define and affect fish habitat.	None	Not formally adopted

2.9.1. The 20-Year Comprehensive Land Use Plan for the Quinault Indian Reservation, February 1997

The Quinault Comprehensive Land Use Plan articulates goals and establishes policies to guide the stewardship of the land and resources of the QIR. The Plan serves as a framework for formulation of an implementation strategy and development of guidelines for zoning, subdivision, and other land use controls for the 20 year period between February 1997 and February 2017. The plan is a growth management tool that seeks to integrate land use policies to guide all future land use development regulations, as well as future capital improvements. It provides a history of land ownership on the Reservation and the resulting impacts on growth management. Public transportation projects, capital improvement issues, zoning, land use, economic development, housing, history, and overall goals are identified in separate sections. This allows each element to be implemented and to be updated independently without losing the cohesive vision of the entire plan.

2.9.1.1. QIN 2008-2009 Comprehensive Land Use Plan: Capital Improvement Plan 2008

This element of the Quinault Comprehensive Land Use Plan deals specifically with the issue of capital improvement on the QIR. This element is intended for concise and accurate assessment of the Quinault Indian Nation's needs as identified in 23 Proposed Capital Improvement Projects for 2008-2012. This element addresses many issues regarding the ability to respond to the hazards on the Reservation; however, it does not propose mitigation measures for each Capital Improvement Project that is projected. This 2009 update to the 1997 Comprehensive Plan element does not establish policy or objectives.

2.9.1.2. QIN 2008-2009 Comprehensive Land Use Plan: Natural Resource Management Element 2009

This Element presents a Natural Resource Inventory for the Nation covering Vegetation, Surface Water, Sub-Surface Water, Other Waters, Animals, and Minerals on the Reservation. The QIN currently houses all of its natural resource management duties within the QDNR. This Division of the Nation is divided into specific departments: Fisheries, Forestry, Land Acquisition, Environmental Protection, Resource Protection, and Fisheries Enforcement. Each of these departments carries out short-term and long-term strategies for the Nation's natural resource management. There are four major threats to vegetation health on the Reservation that are identified and addressed in this Element: 1) Disease and Pests; 2) Illegal Harvest; 3) Wildland fire; and 4) Wind. This 2009 update to the 1997 Comprehensive Plan element does not establish policy or objectives.

2.9.1.3. QIN 2008-2009 Comprehensive Land Use Plan: Transportation Plan Element 2008

This element focuses on improving the access between the Reservation's communities and properties for the efficient and safe movement of people. The major traffic corridors serving the reservation are US101, SR109 and BIA26. A description of each is provided in this element. All information pertaining to road class derives from the BIA Indian Reservation Roads (IRR) Inventory definitions. In addition to the major routes, there is a network of local reservation roads operating as Class 3 and 4 facilities. These roads provide internal access and circulation within the villages and connections to the regional transportation network. Bridge replacement is a continuing problem on the reservation. Two Raft River logging bridges were lost over a decade ago and never replaced. A railroad car bridge across Whale Creek on Cape Elizabeth Road was lost in the mid 1990s and has not been replaced. The Chow Chow Bridge, a wood truss suspension bridge crossing the Quinault River, washed out in the mid-1980s and has not been replaced. The loss of these and other bridges has diminished travel, access, timber hauling, and natural resource management options on the QIR. Emergency evacuation is also identified as an existing issue in the cases of tsunami and earthquake hazards. This Element presents existing transportation information from the QIN Transportation Plan 2006-2026. This 2009 update to the 1997 Comprehensive Plan element does not establish policy or objectives.

2.9.1.4. QIN 2008-2009 Comprehensive Land Use Plan: Housing Element 2009

The purpose of this Comprehensive Land Use Plan element is to assess and project the need for additional housing on Reservation. The Nation's housing policies and development regulations (zoning, building codes, etc.) establish how the development and construction of housing will take place in the community; however, unlike the other elements discussed in this comprehensive plan, the Nation does not directly provide housing.

This element sets the conditions under which housing will operate and discusses measures to be taken to meet the community's housing needs. This element is organized in the following manner:

- Existing and projected conditions of population, age, housing units and occupancy, and
- income and housing values
- Review of community input and project discovery
- Review and assessment of 1997 element's goals and objectives
- Future Housing

The Quinault Indian Nation defines Housing as "directly relating to the specific residential structure/unit or structures/units that are fully enclosed and provide a temporary or permanent residence for individual or individuals".

This Plan allows for policy and administration to make appropriate, informed decisions regarding the allocation of Nation resources. Any priority established by the Nation can be complimented by this plan as the Nation and its people work toward a clear direction of improvements that are essential to achieving a healthy and enriching future.

Identified in separate sections are: Capital Improvement projects, zoning, land use, economic development, natural resource management, history, and overall goals. This allows each element to be implemented independently without losing the cohesive vision of the entire plan.

This plan has made specific reference to the components of this THMP's efforts to identify specific risks to natural hazards and to address a comprehensive schedule of mitigation measures. Specifically, the Housing Element addresses "Housing Threats" as

> "Hazardous disasters present real threats to current housing on the Reservation in the form of Tsunami, flood, fire, earthquake, or landslides. The Nation is currently preparing an All Hazards Mitigation Plan to address Reservation-wide concerns related to mitigating these natural disasters related to housing, government buildings, and private interests. The Nation is also considering the possibility of participating in the National Flood Insurance Program."

The QIN has developed and administered plans and programs through the administration of codes carried out by appropriate departments within the QIN. The Housing Element also recognizes these administrative codes as instrumental to the successful administration of the Nation's safety.

> "Codes were updated in June 2008 to the most current and applicable codes regarding building, plumbing, mechanical, fire, electrical, and residential development. The identified ***Objective 4- Ensure that all Reservation housing is safe and will be available for continuous use by future generations should remain a priority of the Nation to keep laws pertaining to the safety of developed structures.***"

These guiding goals and objectives of the Housing Element are simultaneous with those of the THMP (this document). This 2009 update to the 1997 Comprehensive Plan element does not establish policy or objectives.

2.9.1.5. QIN 2008-2009 Comprehensive Land Use Plan: Economic Development Plan Element 2009

This Plan allows for policy and administration to make appropriate, informed decisions regarding the allocation of Nation resources. Any priority established by the Nation can be complimented by this plan as the Nation and its people work toward a clear direction of improvements that are essential to achieving a healthy and enriching future.

Identified in separate section are: Capital Improvement projects, zoning, land use, transportation, housing, history, and overall goals. The Quinault Indian Nation defines economic development as: "a program, group of policies, or activity that seeks to improve the economic well-being and quality of life for the Reservation, by creating and/or retaining jobs, increasing Reservation resident's access to developing individual and community wealth, and facilitating the overall economic growth of the Quinault Indian Nation."

The Nation implemented a new model to guide economic development planning in the 2008 CEDS: Economic Growth Area (EGA). The text of this plan states that EGA's are not land use growth boundaries, are not meant to be strictly interpreted as such, and they may evolve over time.

An EGA was defined as a 6 mile radius established from a central point within each of the primary economic centers on and off the QIR. Four EGA's were established and are as follows:

1. Taholah Economic Growth Area
2. Queets Economic Growth Area
3. Amanda Park/Lake Quinault Economic Growth Area
4. Ocean Shores Economic Growth Area

A discussion of items one through three is contained within this document. Since number 4. Ocean Shores Economic Growth Area is located off-Reservation, it is not discussed in the context of this Plan; however, it has been addressed in the 2008 Comprehensive Economic Development Strategy. This 2009 update to the 1997 Comprehensive Plan element does not establish policy or objectives.

2.9.2. Quinault Indian Nation 2008 Strategic Plan

The organizing framework of the Strategic Plan supports elected leaders, Tribal Government, and Quinault community members in coming together to create a healthy community by focusing on six domains or core areas of action and opportunity that contribute to the Quinault Nation's quality of life and wellbeing. These include the Domains of Community, Wellness, Learning, Prosperity, Land, and Quinault Government. Input from the communities focuses on the future they would like to see and opportunities for community engagement.

The Domain of Land encompasses the abundance, quality, management and utilization of the Tribe's abundant natural resources including fish and shellfish, the ocean and beaches, Lake Quinault, timber, fire and pest control, resource protection, roads, water, air, game, harvesting, and land use including ecotourism, cultural activities, guiding, carbon credits, carbon footprint, aggregate rock, and probate. It also addresses land acquisition, fee lands, comprehensive planning, development and zoning. Tribal programs and groups involved with the Land Domain include the River Committees, Ocean [Committee], Off-Reservation Tribal members, Hunters, Resource Protection, QDNR including Environmental Protection, GIS, Forestry, Fisheries, and the BIA, Quinault Housing Authority (QHA), Senior Program, and Planning.

2.9.3. Comprehensive Economic Development Strategy (CEDS) 2008

Within the strategic planning process, the economic development portion of the strategic plan is the "Prosperity Domain." The prosperity domain team identified the following as preferred future conditions to achieve prosperity: 1) Positive Business Climate, and 2) Multi-faceted financing options available to make a vibrant economy with private and Tribally-owned businesses. The QIN CEDS represent the Nation's current long-term strategy for developing its economy. It serves as a roadmap for the future economic prosperity of the QIN while reflecting the values and beliefs of the Quinault people. The CEDS weaves the social, cultural, political, environmental and economic values and beliefs within and throughout this CEDS through the evaluation of QIN economic climate, economic clusters, economic growth areas, infrastructure, and environmental, social and cultural considerations. The CEDS is scheduled to be updated a minimum of every 5 years. This 2009 update to the 1997 Comprehensive Plan element does not establish policy or objectives.

2.9.4. QIN Transit Capacity Study 2008

The 2008 Transit Capacity Study prepared a Transit Implementation Plan which identifies the steps to be taken within the following six years to meet the future transit needs of the QIN. Also discussed are the implementation steps and financial requirements for the development and installation of the preferred transit service plan. This plan identifies demographic and geographic statistics for the QIN, including the level of transit dependence of the population.

2.9.5. Forest Management Plan 2003-2013

The FMP provides direction and is a technical specification guidebook for all forest management activities on the QIR. It is a 10-year plan that commenced in October 2003 and will remain in effect through July 2013. It addresses natural resource management policy and direction for implementation. While the plan is predominately economic forest products focused, other areas addressed include: Fire Management, Trespass, Water Quality, Fish Habitat, Wildlife Habitat, Cultural Resources, and Mineral Management.

2.9.6. QIN Transportation Plan 2006-2026

This 2006 Transportation Plan incorporates previous work and addresses current findings. Its purpose is to move the Quinault transportation agenda forward. The goal is to enable the safe and efficient movement of people, goods and services to and from Quinault properties. Like the Reservation itself, Quinault transportation is rural. This plan discusses scheduled system improvements by the Nation and those planned by others. Grays Harbor County has designated Tsunami Evacuation Routes near the QIR and the Nation's Ocean Shores properties. These are SR109, SR115, US101, Moclips Highway and Ocean Beach Road. In June 2006, the County published the Grays Harbor County – Tsunami Warning Plan, which advises on emergency preparedness protocols and procedures. The Quinault Police Department is listed as a notification agency.

This plan addresses roadways, transit service, pedestrian and bicycle service, water service and air service. The Nation's commerce and development depends on the safe and efficient function of State Route 109 and other critical roadways. Service deficiencies are identified in this Plan along with options for correcting them. In light of the increased warnings of earthquakes, hurricane and tsunami activity, the plan recommends that an Emergency Preparedness Taskforce comprised of Tribal, state, county and federal officials to develop an emergency preparedness plan and escape routes for the QIR to be established by 2007. Funding strategies were identified for proposed projects.

2.9.7. QIN Coastal Zone Management Plan, February 1979

The individual components of this plan are displayed in seven data categories considered essential for effective coastal zone management and land use decisions: Costal Geology, Coastal Drift, Soil Suitability for Development, Natural Hazard, Critical Biological and Scenic Area, Land Cover and Use, Land Ownership and Coastal Access. The Natural Hazards section addresses: Slope stability, coastal flooding, estuaries, and Quinault coastal zone management policies.

2.9.8. QIN Shorelines Management Master Plan, February 1994

The Shorelines Management Master Program defines the QIN waters as an Aquatic Environment. No structures should be allowed over water nor is the disturbance of the seabed habitat permitted. All lands within one kilometer (.62 miles) of water are within the shoreline jurisdiction. This planning environment requires a review of items such as: ground stability, soil suitability for septic, potable water sources, accessibility, utilities' availability and other possible impacts. A proposed building setback requirement from water is one hundred meters (328 feet). This plan combines policy and procedure into one document with the intent of creating a manageable system that provides equal protection of all lands within the historic Reservation boundaries.

The coastal zone is viewed as an interrelated natural unit irrespective of ownership, jurisdictional claims, or individual goals or policies. The coastal zone will be managed in all its aspects to provide for the maximum overall benefit to the QIN. The QIN Shorelines Management Plan covers all shorelines of the Quinault Reservation, including: ocean shorelines, river shorelines, and lake shorelines.

2.9.9. Disaster Plan for QIN Public Safety

This Public Safety Plan includes emergency evacuation and response contact and procedural information. This document explains the Warning Siren tone identification protocols for the following emergencies: 1) Notification Siren, 2) Tsunami Siren, 3) Distant Tsunami Arrival Evacuation, and 4) Immediate Tsunami Arrival. Evacuation Safe Zones are identified for Taholah and Queets. Step-by-step protocols are also listed with contact information, safety procedures, and site-specific actions to take in the event of Tsunami, Earthquakes, Flooding, Bomb Threats, School Violence, Hazardous Materials, Hostage / Barricaded Subjects, Civil Disorder, Major Crime Scenes, Weapons of Mass Destruction, Communications Outage, and Wildland or Forest Fire.

2.9.10. Annex to the Continuity of Operations Plan for the Indian Affairs Taholah Agency, April, 2008

The Indian Affairs Taholah Agency is part of the COOP and this Annex was prepared in accordance with the direction in Presidential Decision Directive 67 and subsequent implementing guidance in Federal Preparedness Circular 65. This Annex contains information that is site-specific and lists actions taken by individual Indian Affairs offices to fulfill their COOP responsibilities in order to conduct its Essential Activities and Functions (EAFs) under all operational conditions, even emergencies that suddenly limit the availability of facilities, personnel, or other resources. This plan covers emergencies that may include, among others, structural fires, failure of critical information systems, effects from severe weather conditions, terrorism, and civil disruption. The COOP provisions are applicable to both the federal government and Tribal employees within the Taholah office. This plan also identifies mitigation measures for the above mentioned emergencies.

2.9.11. International Building Code Update to IBC 2006

The Community Services Sub-Committee voted unanimously at their June 4, 2008, meeting to recommend that the Quinault Business Committee adopt the following codes: International Building Code 2006; International Plumbing Code 2006; International Mechanical Code 2006; International Fire Code 2006; National Electrical Code 2005; International Residential Code 2006. The recommendation was approved by Tribal Council in June of 2008 and incorporated into Title 50. The Quinault Nation follows the same building codes as the adjacent jurisdictions.

2.9.12. QIN Title 48 Zoning 2008

The purpose of Title 48 is to exercise the right of the Quinault Indian Nation and its members to make and enforce laws, and be ruled by them, and to exercise the right of self-government as affirmed by the Treaty of Olympia, 12 Stat. 971. The goal of this Title is to maintain the QIR and the QIN as a social, cultural, political, and economic unit for the continuing benefit and prosperity of the members of the QIN. This Title is interpreted to implement this goal so long as all persons subject to this Title are guaranteed due process of law and the equal protection of the laws of the QIN and the United States of America.

The following Zones are addressed in this plan: Residential, Commercial, Industrial, Forestry, Forestry and Industrial Buffer, Wilderness, and Special Temporary Retail June 17th through July 10th. The Official Zoning Maps, which are located in the Tribal Planning Office, represent the decisions of the final authority as to the current zoning status of the land and water uses, buildings and other structures on the Reservation. Permit requirements are articulated in the plan as well as the land use plan, jurisdiction, the establishment of Districts, application of regulations, site development standards, variances, re-zoning, planned unit development and subdivision regulations. Title 48 also establishes a Planning Commission for the QIN.

2.9.13. QIN Title 50 Building & Manufactured Homes

The purpose of Title 50 is to safeguard life, health, property and public welfare. Under Title 50 of the Quinault Tribal Code the Quinault Indian Nation has provided minimum standards regulating and controlling the design, construction quality of material, use and occupancy, location and maintenance of all buildings structures and certain equipment. The Uniform Building Code (UBC) and companion codes have been updated by the International Conference of Building Officials (ICBO).

2.9.14. QIN Title 51 Fishing/Hunting/Gathering

Title 51 defines the regulatory environment in relation to the QIR's external borders. From time immemorial, the QIN has conserved and protected the invaluable wildlife and natural resources of its traditional and usual and accustomed hunting, gathering, and fishing areas from waste and excessive exploitation.

The QIN has regulated ceremonial subsistence, commercial and recreational hunting, gathering, and fishing on the QIR, and within usual and accustomed fishing and hunting areas both prior to, and subsequent to the formation of the United States of America, the Washington Territory, and Washington State. It is the policy of the QIN to continue to regulate all on-Reservation and off-Reservation hunting gathering and fishing without interference or intervention by the State of Washington.

The QIN has the inherent authority and obligation to maintain the natural beauty of the lands and water of the QIR, and to protect the wildlife and natural resources under its jurisdiction for the use and enjoyment of present and future generations.

The purpose of this Title is to protect the fish wildlife and other natural resources under the jurisdiction of the QIN and the beauty of the QIR by providing guidelines for regulating the use and enjoyment of these resources and by providing both criminal and civil sanctions for violations of this Title and the regulations promulgated under this Title.

Title 51 gives the Business Committee the discretion to establish or disband a QIN Fish and Game Commission.

2.9.15. Title 61 Natural Resource Management

The policies and goals of Title 61 include, but are not limited to: protection, enhancement and perpetuation of the timber growing capacity of QIR lands and the requirements for minimum reforestation that will reasonably utilize the timber growing capacity of these forest lands and ensure uninterrupted, perpetual timber harvest opportunities. This title recognizes the need to stabilize and balance the ecosystems of the QIR by reasonable long-range controls on the timing of forest harvest activities within major drainages. Protection of cleanliness of the air of the QIR and the productivity and purity of its waters are also considered in this Title. Promotion of efficiency by permitting maximum operating freedom is consistent with the other policies and goals of this Title. Consideration of land use planning goals is given to Tribal zoning regulations. Recognition and achievement of the objectives are set out in the Code of Federal Regulations at 25 CFR 163, especially as they pertain to Indian self-determination, sustained yield, and conservation.

2.9.16. Title 52 Beach Lands

This Title regulates the continued use of the beach lands and adopts reasonable regulations on their use so as to prevent any obstruction, barrier, encroachment, abuse, or interference with the established use of such beach lands and to provide enforcement. Beach lands are defined as the lands along the Pacific Ocean seaward from the line of natural vegetation to the low water mark. Construction is prohibited within the beach lands without written permit from the Business Committee. Destruction of the beach lands subjects violators to fines, criminal or civil prosecution.

Title 52 authorizes the Business Committee to commission a study of the beach lands to determine the feasibility of designating and developing certain areas of the beach lands for limited additional uses such as areas where camping, overnight camping or the operation and parking of motor vehicles may be permitted. Pursuant to such study, the Business Committee is authorized to prepare plans for development of the beach lands to classify the beach lands for such uses and to designate areas where such activities may be permitted. When the Business Committee determines that the regulatory provisions provided in this Title can be reasonably enforced, it is authorized to open, or close, all or any portion of the beach lands subject to the restrictions set forth.

2.9.17. QEPA Agreement for Partial Delegation

This agreement between the Quinault Tribe and the EPA Region 10, sets forth the legal and procedural basis for partial delegation of administrative authority for implementation of certain sections of the Federal Implementation Plan (FIP) for the Quinault Reservation (40 CFR Part 49 Subpart M, Sections 10401 through 10430).

The Quinault Tribe has delegated authority to initially respond to air quality complaints on the Reservation. This initial response will generally include a site visit to gather information which will be transmitted to EPA in writing. EPA will staff the Federal Air Rules for Reservations (FARR) Hotline (located in EPA's Seattle office) to log complaints and immediately report complaints on the QIR to the Quinault Tribe, Air Quality Office.

2.9.18. Watershed Plans

Watershed analyses have been completed for the Quinault, Salmon, and Raft Rivers. The analyses cover the natural processes that define and affect fish habitat. None of the watershed plans contains a regulatory component.

2.9.19. Community Emergency Response Team SM-317 (Participant Manual)

The CERT concept was developed and implemented by the City of Los Angeles Fire Department (LAFD) in 1985. They recognized that citizens would very likely be on their own during the early stages of a catastrophic disaster. Accordingly, LAFD decided that some basic training in disaster survival and rescue skills would improve the ability of citizens to survive until responders or other assistance could arrive. In 1994 the Emergency Management Institute (EMI) in cooperation with the LAFD expanded the CERT materials to make them applicable to all hazards. Two teams from the QIN participated in this training and use the Participant Manual as a resource on the Reservation.

2.9.20. QIN Police Department Evacuation Procedures for Corrections

Procedures are detailed for jail evacuation. Departmental Disaster Preparedness plans are listed as to the type of support and infrastructure each department can provide in the event of a disaster.

Figure VII. Youth Art Contest Winner: 4th Place, Lena Campbell.

Chapter 3. Quinault Indian Reservation Background and Characteristics

The earliest account of the people of the Quinault is retold by Patterson (1968) and Meyers (1994) and offered here to illuminate "the creation".

> The creation of the Quinault people and the occupation of their land date back to the birth of the ocean, land, and sky. Quinault legend describes the creation of the world in three distinct phases. In the beginning, Wha-neh, wha-neh, the great giver of life, created the forces of nature – clouds, mountains, ocean, rivers, and sky – as people. The second phase is the time when animals and birds possessed the same characteristics as people and they coexisted as equals. Finally, during the third phase, Misp' the Transformer, traveled throughout the land and changed the animals, birds, land features, and people into their present form and way of life (Patterson 1968). Before the arrival of humans, only supernatural creatures, the magical animals, inhabited the world. The Great Spirit called the magical animals together in a great counsel and disclosed that he wanted to place humans on the earth. He described them and said he would name them "Quinault", which means "the People" (Meyers 1994).

By about 3,000 years ago, as the human population of the Northwest coastlines increased, early inhabitants shifted their focus to lowland rivers and lakes. Fishing, gathering shellfish, hunting sea mammals and land mammals formed the foundation of a rich and complex culture for which the Pacific Northwest is known. The forests also provided essentials like food, fibers, medicine and shelter. Crafted from western redcedar trunks were longhouses to protect families from the relentless rain, canoes to hunt seals and whales, baskets, clothing, tools, and bentwood boxes for cooking and storage. Archaeological sites, like ones on the Hoko River and at Lake Ozette, contained thousands of wood, shell and bone artifacts that helped modern Tribes piece together more of their rich heritage. The skilled workmanship of the artifacts reveal the intimate connection between the artisans, the land and the sea (NPS 2009).

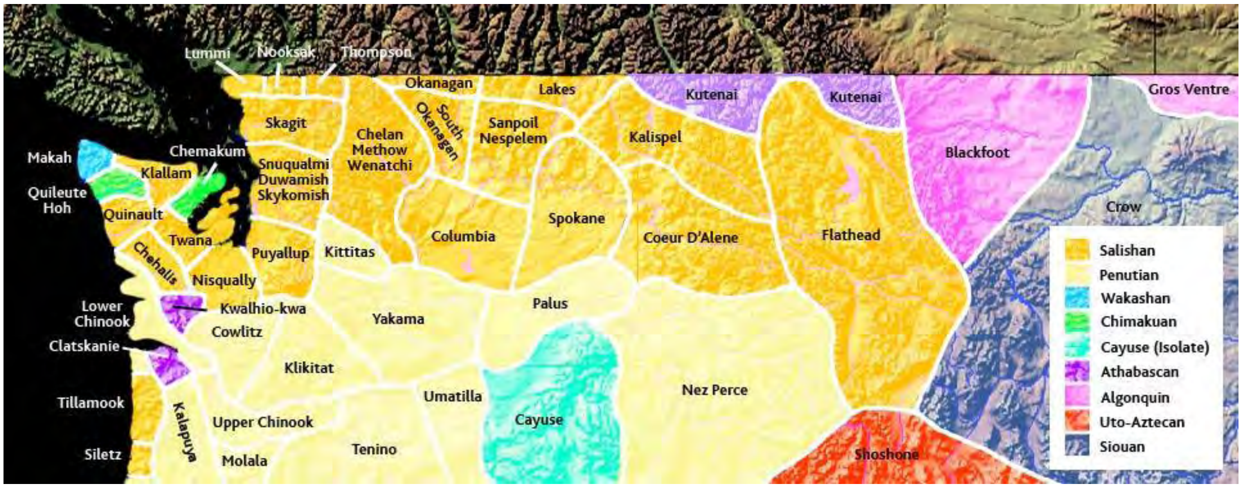
Olson (1936) and Storm *et al.* (1990) agreeably described the daily life of the Quinaults as revolving around the abundant food found in the area. They described how the regional trail networks were an important economic means for trading and exchange with Tribes across the Olympic Mountains and into the area that today is called Puget Sound.

After the arrival of Europeans in the 18th century, the lives of the area's indigenous people were forever changed. Exotic diseases wiped out entire villages. Long-standing social traditions were disrupted by new technologies and restrictions. Euro-American settlers competed for the abundant resources of the Olympic Peninsula. Salmon were fished from the streams, elk populations decimated, and huge swaths of trees were harvested from the forests. The land and the land's control changed forever (NPS 2009).

The Quinault Indian Nation, today, is an amalgam of several Tribes: principally Quinault and Queets, but also the descendants of five other coastal Tribes: the Chehalis, Chinook, Cowlitz, Hoh and Quileute. The Quinault tongue is a branch of the Salishan language family (Figure VIII), which also was spoken by the Queets and Copalis locally, but was spoken by Tribes as far east as the east side of the Rocky Mountains (USH 2010).

Native languages can be described as having groups and subgroups. The Salishan family group includes as many as 23 languages. This was one of the three largest family groups before European arrival in what became the Washington Territory. Figure VIII shows where Salishan-speakers lived along the upper Columbia River, and in lands across the northern part of the area into what is today Canada, and how Coast Salish was spoken on Puget Sound. Speakers of the Penutian language group spread from the coast far into the entirely different climate and culture area of the Columbia River plateau. A few additional languages were scattered among these dominant forms (WSHS 2010).

Figure VIII. Dominant Language Groups spoke by Indians, pre-European colonization (WSHS 2010).



The word Quinault evolved from "Qui-nai-elt", the name of the Tribe's largest settlement once situated at present-day Taholah, at the mouth of the Quinault River. The original Quinault flourished with access to good fishing (especially salmon and steelhead), hunting, berry picking and wood gathering. They fashioned immense cedar canoes. Lewis and Clark, on their famed trek to the Pacific Ocean at the beginning of the 19th century, noted that the craft were "...upward of 50 feet long, and will carry 8,000 to 10,000 pounds' weight, of from 20 to 30 persons...." (USH 2010).

The Quinault people remained isolated from European contact until Spanish vessels anchored off the coast near Point Grenville and the Tribesmen visited the Spanish frigate *Santiago,* and the schooner *Sonora,* in their canoes on July 14, 1775. Early in the "morning a canoe with nine Indians approached the frigate [*Santiago*], making gestures of friendship, and inviting [the crew] to go to their settlement … They gave [the sailors] some fish and exchanged some otter skins" *Quoted from James and Chubby (2002).*

Spanish, British, Portuguese, French, Russian, Bostonian, and Swedish explorers arrived at the Pacific Coast in the last quarter of the 18th century and into the 19th century seeking to increase territorial claims, acquiring furs for trade and expanding their geographical knowledge.

Workman (1997-2010) reported:

> "There are reports of wrecked Japanese Junks along the Northwest coast [1820, 1831 and 1827]. Japanese boats may have drifted across the ocean for centuries before the arrival of Europeans and provided the coastal people with many non-native items."

The initial encounters between Europeans and the Quinault Indians in the several decades at the end of the 18th century and beginning of the 19th century resulted in violence and deaths for all parties. Exposure to a totally different culture changed the lives of local Indians in two ways. First, they started trading for such commodities as guns, metal and beads, and second, new unknown diseases started to spread through Tribes along the coast. One of the most devastating diseases to sweep the Tribes in the Northwest was smallpox, which was referred to as "the double-edged scourge of white men and devil" (Workman 1997-2010). However, Indians continued to lead their traditional lifestyle until the European settled land claims and turned their attention to the land and resources held by native peoples.

The Lewis & Clark Expedition (1804-06) followed by the opening of the Oregon Trail (1841), opened this region to new European settlers from the east who sought property to settle in and start farming. In the 1820s, white trappers, traders and settlers began to homestead the Quinault and other Olympic Peninsula Tribal homelands. Industry followed homesteading as whites began to tap into the area's natural resources. Fishing and lumber communities mushroomed and dotted the region. Although the Quinault were initially friendly and helped their new European neighbors, increasing numbers of pioneers arrived with their radically different ways, which created friction (USH 2010, Stumpff 2007).

After the US Congress established the Washington Territory on March 2, 1853, Territorial Governor and Indian Agent, Isaac I. Stevens began acquiring title to lands held by native peoples to make it “available to white settlers” (Neumann *et al.* 1997). To accommodate land-hungry European settlers, Territorial Governor Isaac Stevens drew up a treaty for the Indians to sign, which said Indian Tribes would relinquish almost all the coastal area. At the first meeting with the coastal Tribes that occurred at the Chehalis River from February 20 to March 2, 1855, Stevens said that they would all be moved to a reservation intended to be the Quinault Reservation of a smaller size than it is today. Stevens and his advisors had decreed this forest covered land was “unsuitable for white farmers, therefore highly suitable for a common reserve”. However, most Tribes did not want to retreat to the land of the Quinaults as they traditionally shared enmity with the Quinault Tribe’s large and rich reputation. Indian leaders balked at these terms and the 1855 treaty was never signed by either side (Storm *et al*. 1990).

One year later, a new treaty was drawn up that the Quinault Indians did sign on January 25, 1856. That treaty established a 10,000-acre reservation around the village of current day Taholah. In exchange, the Quileute, Queets, Hoh, and Quinault gave up all the lands north of Gray's Harbor all the way to the homeland of the Makah Tribe. The Quinaults, Queets, Quileutes and Hohs agreed to cede their aboriginal lands in exchange for a reserved homeland (Figure IX), and for the right to fish in their accustomed locations (Neumann *et al.* 1997).

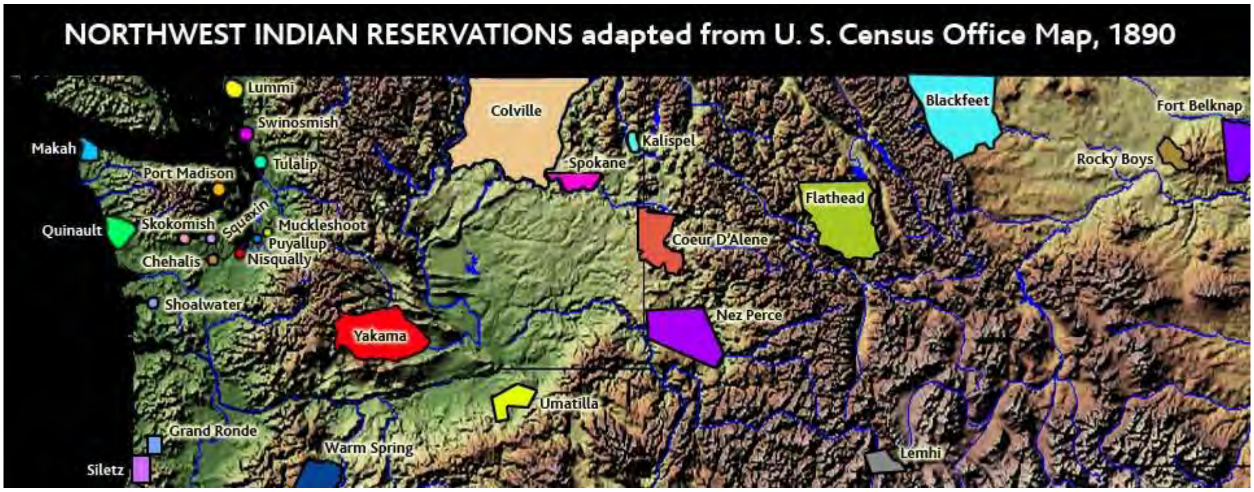
An Office of Indian Affairs (OIA), Indian Agent Report in 1860 documented (Workman 1997-2010):

> Indian Agent recommends “land between Point Granville (Grenville) and Qui-nai-elt river” be set aside as their reservation. He encourages Indians to begin trade with their salmon saying that the “salmon that run up the Qui-nai-elt river, in great numbers, are considered the fattest and best flavored of any taken on the coast” (his use of Granville instead of Grenville was applied to the village at the mouth of the Quinault River which would be renamed Taholah (Workman 1997-2010).

The treaty commission's intent was to concentrate numerous coastal Tribes onto this reservation (Figure IX). To accommodate that many additional Indians, the reservation was expanded to nearly 189,621 acres (first expansion of the Quinault Reservation) by an order of President Ulysses S. Grant on November 4, 1873 (USH 2010). In 1988 the “North Boundary” area of about 12,000 acres was added – Public Law 100-638 (see Section 3.2.1.1, page 70).

As a result of the General Allotment Act of February 8, 1887, whose spirit was to encourage an agrarian life among Indians, allotments of land to individual Indians on the Quinault Reservation were made, beginning in 1905. The allotment program proved to be a source of contention among Tribal members, particularly around the issue of who was qualified to receive parcels. By 1912, practically all of the few suitable agricultural and grazing lands had been allotted. The last of 2,340 allotments were issued by 1933.

Figure IX. Northwest Indian Reservations, circa 1890 (WSHS 2010).



3.1. Demographics

According to the 2000 US Census, the population on the QIR was 1,370 people, of which 80% were Native Americans. The overall population density for the Reservation was approximately 4.3 people per square mile. According to the QIN Enrollment Office as indicated in the QIN 2008 5-year Comprehensive Economic Development Strategy (CEDS 2008), the number of Quinault Tribal enrolled members was 2,812 (not all live on the QIR).

According to the 2000 US Census, the QIR experienced an increase of approximately 12.6% from 1990. In comparison, Grays Harbor County, had a population increase of 4.7%. This demonstrates that the QIR population grew faster than the County's population off the Reservation from 1990 to 2000. In comparison, the state of Washington had a population increase of approximately 21.1% during that same time period.

The population and demographic statistics (Table 11) are extracted from the QIN 2008 CEDS unless otherwise noted.

Table 11. Population and Demographics, Census (2000).

Attribute	Number
Quinault Indian Enrollment (CEDS 2006)	2,328
• Living on the QIR	983
• Living off the QIR	1,345
Total Native American Population on QIR	1,051
• Taholah Village	818
• Queets Village	162
• Other Areas	71
Total Population by Age (living on QIR) (Qui-nai-elt Village population not included)	1,370
• Less than 19 years	554
• 20 to 64 years	742
• 65+ years	74
Total Population by Area (living on QIR)	1,370
• Taholah Village	906
• Queets Village	203
• Amanda Park	260
• Other Areas	1

The coastal villages of Taholah and Queets are home to 81% of the total population on the QIR. Across the QIR 54% of the total population range between the ages of 20 and 64, and according to the Census (2000), 46% are female and 54% are male. The Native American population represents 77% of the total population living on the QIR. More than half of the QIN Enrollment live off of the QIR.

The High School Dropout Rate on QIR decreased significantly from 1990 to 2005 (CEDS 2008). While QIR unemployment rates have declined over the years, they remain over double the state of Washington and almost double Grays Harbor County unemployment rates (Table 12).

Table 12. Descriptive Population Descriptors (Census 2000).

Attribute		Percent of Total
Total Income Levels by Native Family		
• Less than $5,000 per year		15%
• $5,000 to $9,999		14%
• $10,000 to $14,999		19%
• $15,000 to $24,999		20%
• $25,000 to $34,999		10%
• $35,000+		22%
High School Dropout Rate on QIR		
• 1990		50.0%
• 1995		42.1%
• 2005		13.1%
Occupations for enrolled residents of QIR:		
Description:	Count:	Percent:
Professional/Technical/Managerial	185	36.93%
Clerical/Sales	29	5.79%
Service	79	15.76%
Agriculture/Fishery/Forestry	112	22.36%
Processing	3	0.6%
Machine Trade	18	3.59%
Benchwork	4	0.8%
Structural Work	65	12.97%
Other	6	1.2%
Total	501	100%
Places of Work for Enrolled Residents of QIR (2006 CEDS):		
Description:		Count:
Quinault Indian Nation FTE's		173
Quinault Indian Nation PTE's		73
Quinault Pride Seafood FTE's		12
Quinault Pride Seafood PTE's (seasonal/varies)		50
Quinault Land & Timber Enterprises		19
Quinault Housing Authority		6
Taholah Mercantile		8
Self-Employed		54
Taholah School District		12
Lake Quinault School District		2
Clearwater School District		1
Other		21
Retired		70
Total		478

Table 12. Descriptive Population Descriptors (Census 2000).

Attribute	Percent of Total
Unemployment Rates & Comparisons for 2007 (Workforce Explorer Data)	
• State of Washington	5.9%
• Grays Harbor County	4.8%
• Quinault Indian Reservation	9.5%

The Census (2000) data indicate that during the period that Washington State had an 8.7% vacant housing rate, while the QIR had a 1.8% vacant housing rate (Table 13). The Quinault Housing Authority maintains a housing waiting list of families, and maintains that if more housing were developed on the QIR, that there would be increases both in off-Reservation Tribal members who would apply for a new home, and on-Reservation Tribal members that currently share a home that houses two or more families, would apply for additional housing (CEDS 5-Year Plan – 2008-2012).

The QIN News, Nugguam (March 2010), reported that the QHA announced in September 2008, that they successfully submitted a grant application and were awarded a Low Income Housing Tax Credit (LIHTC) contract. The contract led to the construction of 35 new homes. QHA advertised and selected a general contractor and construction started at Qui-nai-elt Village in September 2009. The first families began moving into new homes in March 2010, and the completion of all the houses is scheduled by October 2010. The Board of Commissioners is currently working on new policies for the LIHTC homes. QHA has also received a grant to construct 18 additional units at Qui-nai-elt Village during the next two years. (Figure X).

Figure X. Qui-nai-elt Village Expansion Project (Nugguam March 2010, Photo by Workman 2010).

Table 13. Housing Data (Census 2000).

HOUSING OCCUPANCY – Taholah and Amanda Park Census (2000).	
Total housing units	507
Occupied housing units	419
Vacant housing units	88
For seasonal, recreational, or occasional use	60
Homeowner vacancy rate	1.8%
Rental vacancy rate (percent)	4.75
HOUSING TENURE – Taholah and Amanda Park Census (2000).	
Occupied housing units	419
Owner-occupied housing units	296
Renter-occupied housing units	123

Table 13. Housing Data (Census 2000).

Average household size of owner-occupied unit	2.91
Average household size of renter-occupied unit	3.24

3.1.1. Cultural History on the Quinault Indian Reservation

Point Grenville separates a coastal line between the northern coastline of Washington State, with jagged and rocky shorelines, from its southern part, which is straight, flat and mostly sandy. Quinaults have shared fully in both worlds, "in the realms of the sea mammal hunters of the northern coast and the land mammal hunters and clam and oyster diggers of the southern coast" (Storm *et al.* 1990). Almost all coastal Tribes of Washington lived along the rivers, which is easily explained by dependence of lifestyles on plentiful salmon runs. The brilliant and vigorous cultures of the Northwest coast have always revolved around fish, and technologies and social organization designed for this purpose by thousands of people over thousands of years (Storm *et al.* 1990).

Quinaults historically lived where canoes could be navigated; common locations were found along the lower stream courses and coastal rivers. Indian longhouses were built solidly and with comfort for their numerous inhabitants. The houses of a Quinault village were situated along the bank in a line. And the long axis of the house was parallel to the river; each house faced west, toward the afternoon sun and the mouth of the river. There was an advantage to several families sharing a house: it was easier to keep it warm and dry; and the fire was not allowed to burn out. Each household served as an effective economic or task unit for fishing, manning canoes, or root gathering efforts (Storm *et al.* 1990).

The ancient religion of the Quinaults was connected to the powers of nature, it was useful, meaningful, and true as any other religion, and it was the Quinault people's religion. It was not supernatural, as these beliefs belonged to Nature. It also belonged to the edge of the world, where land ended and water began. Quinaults' religion served generations of ancestors of today's Quinault people over the thousands of years. It found reflection in their numerous rituals and ceremonies practiced to this day. Quinaults tended to have guardian spirits to protect them and improve their fortunes in this life. They often found their spirits in water or next to water. The mystery of the surrounding nature is believed to account for heightened spirituality of this Indian Tribe. For a Quinault, Nature that surrounded him day after day of his life, it lay both within and without him, and he was an inalienable part of it (Storm *et al. 1990*).

Like other coastal Tribes, the Quinault people developed their transportation system using dugout canoes crafted from a single old-growth western redcedar tree. It is hard for us today to visualize the significance the canoe has always had for Indians, especially in their earlier days.

> "The Quinault spent in his canoe every day. If not on the sea, then along the river in a long slender canoe, made out to shoot like an arrow through riffles and gravel bars. Without a canoe, the Quinault must struggle through the mossy rain forests, climb over logs, or trek down long beaches. At death his body was placed inside a canoe. In dreams and intercourse with spirits he might fly through the air in one, or travel across the ocean to the mythical western islands. In the folklore and in life, conceptions occurred in canoes, and babies were born in them" (Storm *et al.* 1990).

Depending on the waterway and the function, there were several types of canoes. A double bow dugout canoe was used on rivers because of its ability to maneuver the currents and slide over logjams. Ocean transportation and whale hunting required a much larger canoe that could cut through ocean waves and carry larger loads. Quinault canoes could carry over 500 pounds (an ocean canoe could carry 8 to 12 people in it), and were an important item of trade between the Puget Sound and Columbia River Basin Tribes (James & Chubby 2002).

The land abounded in food and the Quinault people were one of the most successful hunting and gathering societies. They traveled the mountains, prairies and seashores in search of berries, fish, game, and medicinal plants. A trail system throughout the Olympic Peninsula facilitated these pursuits and promoted frequent social interaction with other Tribes (James & Chubby 2002).

A Seattle Expedition of news reporters discovered in 1889 how the Quinault excelled at canoe travel (Wood 1989). In May 1889, after crossing the Olympic Mountains on foot, the expedition reached the Quinault River and tried to float downstream in a handcrafted raft. The raft floated into a fallen tree and capsized. The men felt very lucky to survive and to retrieve their field notes and maps. Soon after this incident, a Quinault canoe was returning downriver from the fork of the south and main stem. The Quinault band picked up the expedition members and brought them all the way to Taholah. Charles Barnes (as cited in Wood 1989) wrote of the Quinault's abilities:

> "In the hands of the Indians, who have been brought up from boyhood on the river, and had frequently traveled as far as the forks, the voyage was made in perfect safety. Their knowledge of the current is wonderful. They know every submerged sandbar, rock, and snag on the river, and just the right stroke of the paddle at the right time sends the canoe past dangers which to us were invisible until we were by them. "

The western redcedar provided wood for longhouses, canoes for transportation, baskets for storage, and bark for clothing. The Quinault people harvested fish, whales, and seals from the sea. Historically, the Quinault people traded with other Tribes. The famed Quinault Blueback (sockeye salmon) was a highly valuable commodity and could be traded for a profit.

The turbulent times of encounters with first Europeans, brought unknown diseases decreasing the population of the Quinaults to about ten percent of what it had been a century earlier. Some of the Indian Tribes of the region became totally extinct during the 19th century. People have lived on the Olympic Peninsula for over nine thousand years, however, evidence of the early occupation has been fragmented (Storm *et al.* 1990).

Today, most information about the Tribes of the Olympic Peninsula has been is based on traditional oral history, or through reports of government employees. The lack of information is explained by a number of reasons. First, in the last few decades of the 19th century, visitors to the Reservation were few. And secondly, the Indian peoples' small numbers made it difficult to become part of a "new" way of life (European way of life). The Indian people were absorbed in simple survival (Storm *et al.* 1990).

3.1.2. Current Quinault Cultural Affairs Policy

The Quinault Nation Cultural Affairs Office has articulated the Quinault Nation's Policy concerning ancestral areas and their belongings that remain. That document is an attempt to put in writing a longstanding verbal policy of the QIN concerning ancestors' living places and their belongs that still remain (Chubby 2003).

Concisely stated, it directs:

1) It is based in the spiritual views of our elders as passed down.
2) Our Ancestors base it on their concerns for ownership of those belongings.
3) It is based in our respect for our Ancestors, their resting places and the sacredness of such places, our respect for the ownership of their personnel belongings.

4) When the belongings or remains of our ancestors are threatened by natural or made elements we will make effort to secure their remains or the belongings and remove them to a safe place.

5) Time dims the memories of our past and it may be necessary for future generations of Quinaults to rediscover their heritage from the belongings of our elders. It is for this reason and the others stated above that we are diligently protecting them and all that belongs to them. They can still teach us!

Our policy is simple and it has been honored for seven generations since the treaty with the Whiteman.

(Revised May 2003, QIN)

Vine Deloria, Jr., was born of the Standing Rock Sioux (South Dakota). Vine Deloria, Jr.'s notion of seven generations, as explained to him by a Dakota elder, signifies that at all times and in every place each of us is a unique expression of the seventh generation of our families and, more broadly our people (Wildcat 2009).

> "In our lives each of us constitutes the seventh generation in the sense that our actions ought to represent what we learned from the three previous generations: parents, grandparents, great-grandparents, and simultaneously we must be mindful of how our present actions will influence the lives of the three future generations: our children, grandchildren, and great-grandchildren.
>
> "Each of us, in our respective places in the space-time of the universe we inhabit, constitute the seventh generation at the center of the three generations that came before us and the three generations that will come after us. As the seventh generation, we are the existential center of life processes that embody nonlinear relationships and complex processes… (citation of Vine Deloria, Jr. in Wildcat 2009)

Cultural heritage for the QIN is the legacy of physical artifacts and intangible attributes of the Quinault people that are inherited from past generations, maintained in the present and bestowed for the benefit of future generations. Often though, what is considered cultural heritage by one generation may be rejected by the next generation, only to be revived by a succeeding generation. It is not the intention of the QIN to create a database of culturally sensitive, or culturally significant places on the QIR. It is not the objective of the QIN to educate all hazard mitigation personnel of the cultural resources of the QIN and their known locations. It is the intent that personnel living and working on the QIN sustain the objectives defined within this Tribal Hazards Mitigation Plan to be sensitive to culturally significant locations when encountered, while placing emphasis on the protection of people, structures, infrastructure, the economy, and traditional way of life (in order of precedence). When there is opportunity to preserve culturally identified locations while also protecting those current goals (for instance – life), it will be carried out to the extent it can be realistically accomplished.

Physical or "tangible cultural heritage" includes buildings and historic places, monuments, artifacts, and like features, that are considered worthy of preservation for the future (Lowenthal 1985). The QIN has determined that a hierarchy of potential assets is not within the scope of current generations to decide. The QIN desires to maintain what is possible for the current and future generations to discover and use in the definition of life. This tangible cultural heritage includes objects significant to the religion, life, archaeology, architecture, science or technology. This heritage can also include cultural landscapes (natural features that may have cultural attributes). Recently, heritage practitioners from around the globe have moved away from classifying heritage as "natural", as man has intervened in the shaping of nature in the past millions of years, it is meaningless to create artificial definitions (Lowenthal 1985).

3.1.3. Schools

Traditionally, extended families sharing life in a single household provided many teachers for their children. As children grew up, they learned about all aspects of Quinault life and participated in the life of the parents and community. They learned practical skills, including weaving, tool construction, carving, hunting, fishing, root and plant gathering, and other aptitudes. Tribal elders were the main instructors of language, oral history, legends, plant use and social development. This kind of education provided them with necessary survival skills and intellectual challenges; it also encouraged community support and cooperation among all members of the family through study of natural environment and legends (James & Chubby 2002).

The OIA established a boarding school for children on the QIR in Taholah in 1867, and the first teacher for that school was hired in 1868. For many years the school was not well received by the community as parents and elders feared that children would lose contact with their traditional culture, language and religion while under supervision of the non-Indian teacher. Despite funding problems and opposition from the Quinault community, the attendance grew with every year and increased from low of 12 students in 1869, to 35 students in 1893 (Superintendent report, 1893 as reported in Workman (1997-2010)).

With the opening of a day school at Queets in 1886, 47 of the Reservation's 66 school-age children were attending school (OIA Indian Agent's annual report for 1886). However, according to the Agent's annual report in 1893 (as reported in Workman (1997)):

> "The public school in Quinault opened for a six months term with Lisa Ida Locke as teacher. The school cannot run in winter on account of the children not being able to go through the winter storms."

The OIA believed that "civilizing" the Indians by separating them from their traditional ways of life and surrounding would only be succeeded through instruction in the English language and exposure to western religion. The Taholah and Queets-Clearwater schools provided education for the elementary grades, and the middle and high school students traveled to Moclips and Lake Quinault school districts. A local boarding school operated into the mid-1950s and was replaced in 1956 by Taholah Public School District 77, kindergarten through sixth grade. In 1972 the Taholah Education Center expanded the Reservation school system to include middle school, and a high school was added in 1991.

3.2. Development of the Economy

After the Treaty between the Quinault Indians and the US Government was signed in 1856, it was ratified by Congress on 8 March 1859, and proclaimed US Public law on April 11, 1859 (WSHS 2010). The War Department established its Agency in Taholah. Beginning in the 1870s the Quinault Tribe remained under close supervision of U.S. government agents who "would set a tone of paternalism and disapproval of the old culture, religion and language" (Storm *et al*. 1990). The agents were human and based their judgments on their own moral and social beliefs. Besides, in total isolation, their duties as government agents "was the only touchstone that helped them cling to reality" of everyday life. They expected Indians to assimilate into the American way of life blindly and rapidly. The misunderstanding of Indians in the late 19th and early 20th centuries exacerbated the agents' unsuccessful attempts to instill American spirit into the Indian's life. It was not a small part behind the decision to provide individual allotments to the Indians of the Quinault Reservation (Storm *et al.* 1990).

Under the OIA's reservation policy, the main goals of the agents were the establishment of schools, churches and development of the land for agricultural purposes. The last goal proved virtually impossible to accomplish on the QIR as the local terrain, soil and climatic conditions were inadequate for establishment of agricultural farming.

Quinault Indian Agency annual report made by G.A. Henry, September 1872 (as reported in Workman 1997) (Table 17):

> "Crops deemed a failure due to extreme drought and early frost. I am convinced, after repeated trials, that the soil of this reservation is of such inferior quality that farming cannot be successfully carried on, and that the Indians must depend chiefly upon the salmon and other fish which they have in great abundance most of the year."

The Quinault Indians clung to traditions, with fishing primary amongst one of them. Eventually, agricultural endeavors proved hopeless on the QIR, as government efforts to foster land cultivation ethics did not meet with encouraging results.

OIA Agent annual reports noted that the Quinault continued to be very successful with fishing and trapping fur animals. In 1872, the OIA Indian Agent described efforts to develop an agricultural model on the QIR as misapplication of funds that would be better used for creating a large fishery, given the supply of the "finest salmon on the Pacific coast". Twenty years later, Quinault Indians sold their salmon in markets around Puget Sound and as far away as Chicago.

OIA Indian Agent report, 1883, provided the following synopsis (as cited in Workman (1997-2010)) (Table 17):

> "The trader, John W. Hume, is greeting suitable buildings for canning the salmon and this will give employment to all adult Indians during the fishing seasons. The Indians are highly elated at the prospect of having more constant employment and better pay than ever before."

In August 1877, OIA Indian Agent G.A. Henry in his annual report says that "many of the Indians' living quarters compare favorably with the ordinary class of pioneer farmers (Workman 1997-2010). On August 26, 1889, OIA Indian Agent, Edwin Ellis, in his report on the Quinault (as cited in Workman 1997-2010) (Table 17).

> "They get most of their living by hunting and fishing. They get their money by picking hops (September) and fishing for the canneries."

The QIR remoteness and transportation difficulties and unpredictable weather patterns prevented any industrial development on the Reservation before the 20th century. Despite repeated requests by OIA Indian Agents for building a sawmill on the Quinault Reservation, none was built according to available documentation before 1908. Sawmills were considered very important as a potential source of employment for residents and a source of construction materials for local houses, fences and Agency facilities. Shipping was expensive and hardly reliable since Taholah did not have a safe sea-vessel harbor and log rafts often broke up and were washed on the beach (Neumann *et al.* 1997).

OIA Indian Agent report, Summer 1872 (as reported in Workman (1997-2010)):

> "Six houses built at the Quinault agency by the Indians. It is about a hundred miles to the nearest sawmill, but fortunately, a vessel load of lumber was wrecked on the coast of the Reservation a few days ago and blown ashore, and has furnished all the lumber needed".

The turn of the 20th century proved to be a transitional and important time in the life of the Quinault Tribe. They were slowly adjusting to a new way of life, working hard to seek an acceptable assimilation between the two cultures. They were struggling to preserve their national identity, making first attempts at defending their treaty rights and building their fisheries.

By 1915, Quinault Indians were facing an unknown future on their land. All around them white settlers were increasing in number, new towns growing, and soon, loggers would enter the Reservation (Storm *et al.* 1990).

3.2.1. Land Allotments

"What we do to the land, we do to ourselves"

Joseph B. DeLaCruz President, Quinault Indian Nation (1990)

Allotments of the land on the QIR began in 1905 under the General Allotment Act of 1887. The Allotment Act caused previously undivided land to be divided into individual ownership allotments among Quinaults and other Tribes with the "surplus" land sold off to the general public. Land ownership was still an alien concept to Indian people at the turn of the 20^{th} Century, and the trust period was established to protect them from unprincipled speculation by whites. Individual Tribal members could sell their land after a period of twenty five years, which created a complicated web of mixed land ownership. Allotments resulted in a fractionated land ownership pattern of trust, fee patent and Tribal land that hampered natural resource management and jurisdiction then, and still does to this day.

The Dawes Severalty Act (February 8, 1887) advanced the federal government's policy to assimilate Indians into the Anglo-society by turning them into independent property holders. By dividing reservation lands into privately-owned parcels, legislators hoped to complete the assimilation process by forcing the deterioration of the communal life-style of the Native societies and imposing Western-oriented values of strengthening the nuclear family and values of economic dependency strictly within this small household unit (Gibson 1988). Opponents of the Dawes Act were of the opinion that its implementation would alienate most Indians from their lands as white speculators rushed to buy Indian property (Neumann *et al.* 1997). The Dawes Severalty Act was amended in 1891 and again in 1906 by the Burke Act. The act remained in effect until 1934.

The amount of land granted to most Indian allottees was not sufficient for economic viability, and division of land between heirs upon the allottees' deaths resulted in land fractionalization. Most allotment land, which could not be sold during a statutory period of 25 years, was eventually sold to non-Native buyers at bargain prices. Additionally, land deemed to be "surplus" beyond what was "needed" for allotment was opened to white settlers, though the profits from the sales of these lands were often invested in programs meant to aid the American Indians. Nationally, Indians lost over the 47 years of the Act's life, about 90 million acres of treaty land, or about two-thirds of the 1887 land base. About 90,000 Indians were made landless in the process (Case & Voluck 2002).

Land allotment ended on the Quinault Indian Reservation in 1933, when all the lands had been allotted. It ended for all Indian Reservations in 1934 with the passage of Indian Reorganization Act. The QIN owned less than 2.2% of the total land area of the QIR in 1970.

By 1978, nearly one-third of the QIR was held by fee owners, most of whom were timber companies. As a result, the QIR ownership pattern resulting from allotment practices has created land management practices which stagger the imagination and greatly diminish the potential for economic development. Just as allotments divided ownership of the land, so too they divided the Quinaults and forced them to develop new relationships with each other and the land (Storm *et al.* 1990)

3.2.1.1. Land Consolidation

Almost all land on the QIR was allotted between 1907 and 1933. Additionally, Tribally owned lands were scattered across the Reservation intermingled with lands held by allottees and private corporations (non-Indian), and the US Federal Government. This patchwork collection of lands prohibited the creation of forest management policies and plans for the entire QIR. Additionally, the small scattered acreage controlled by the Tribe provided little in the way of timber revenues, which the Tribe saw as a means to make themselves more self-sufficient. A consolidated and larger land base would permit the Tribe to secure more revenues and pursue unified management of all lands on the Reservation, regardless of ownership.

The Tribe established as one of its goals, the restoration of the land base to ensure proper management and to allow the Tribe to become self-sufficient. The biggest impediment to expanding and consolidating the land base was a lack of capital to buy-back the lands previously sold. When the QIN did acquire small parcels, usually from allottees, they were forced to sell any timber on the parcel immediately to cover the purchase price. The QIN needed either an infusion of money from the Federal Government or a mechanism for securing land transfers of such size that timber revenues from those parcels would cover the purchase price with the money remaining to be used for future land purchases (Neumann *et al.* 1997).

In 1978, the QIN secured a Federally backed loan for $1.0 million to purchase QIR land. The program moved along slowly, and by 1987 the QIN ownership of the QIR had risen to 4.7%. On September 1, 1987, President Joseph B. DeLaCruz provided testimony to the US Congress that the QIN held title to only 7,890 acres of the QIR's total acreage of 189,621 (DeLaCruz 1987). In the same year, the QIN started negotiations with the Federal Land Bank of Spokane that held some Reservation land (former Mayr Brothers [logging] land holdings). This is the same parcel of land that US Air Force General Richard Secord tried to buy with Iranian funds (Iran-Contra Affair). This parcel of 9,985 acres became known as the "Irangate Forest". When this was exposed, the QIN was able to deal with the Federal Land Bank of Spokane. Thus, the Iran-Contra scandal was an important event in helping QIN expand its land re-acquisition on the Reservation (Workman 2010-03, Storm *et al.* 1990).

The QIN eventually succeeded in reaching an agreement with the Federal Land Bank of Spokane. To facilitate the land acquisition, Quinault Land and Timber Enterprise (QLTE) was established. The primary purpose of QLTE was to develop and operate business ventures relating to the forestry resources of the QIR.

The year 1988 proved to be a good year for the QIN for increasing its land base within the QIR. Not only did it nearly double its land holding with the Federal Land Bank of Spokane purchase, but the long-standing North Boundary Dispute was resolved (Storm *et al.* 1990).

In 1861, the Superintendent of Indian Affairs established for the Quinault Reservation a rectangular tract of land approximately 10,000 acres at the mouth of the Quinault River. In 1883, President U.S. Grant issued an Executive Order to enlarge the Reservation to 300 square miles, with one of the points located at the northwest corner of Lake Quinault (Storm *et al.* 1990).

Boundary surveying for the 1883 adjusted QIR boundary was initiated in 1892. Some reports claim that the surveyors had insufficient knowledge of the lake's orientation at the time and that lack of professional expertise led to the inaccuracy of choosing its southwesterly point as the surveying starting-point instead of the intended northwesterly point, which resulted in the exclusion of about 15,000 acres from the Reservation (Storm *et al.* 1990). Others aptly point out that the people making the boundary line were professional surveyors and they must have used equipment sufficient to accurately determine the lake's orientation (such as a hand-compass). There were some white settlers along the north shore at that time and some think that to avoid problems with them they ran the survey from the southwest corner of the lake. Others say they wanted to avoid running the line through rugged country had they used the correct starting point. The surveyors may have simply used the west end as the priority over north. Unless the surveyor's notes can be found this question will remain open to speculation (Workman 2010-03).

The QIN filed a claim for this excluded land and in a 1945 decision the Court of Claims concluded the QIR had been erroneously surveyed in 1892 and the 15,000 acres were improperly excluded. However, the issue was not satisfactorily resolved for the QIN after the court case. The QIN decided not to appeal the decision at the time, but not to give up on the land claim (Storm *et al.* 1990).

In September 1987, before Senator Daniel J. Evans, Vice-Chairman of the Senate Select Committee on Indian Affairs, Quinault President Joseph B. DeLaCruz submitted testimony on the boundary dispute and the increasing fractionalized ownership of the Reservation. Nearly a century after the erroneous survey, President R. Reagan on November 8, 1988, signed into law the North Boundary Restoration Legislation. As a result of the bill, nearly 12,000 acres of USFS land on the north side of the QIR were returned to the QIN (Storm *et al.* 1990).

3.2.2. Indian Employment

In 1968, the BIA allocated about $460,000 for a ten-year reforestation program on the QIR. The contract was awarded to the Tribal enterprise. Besides promoting growth of timber on commercial lands, the project provided employment to Tribal members and their training in forestry. In the early 1970s the concept of managing QIR forests as a single unit started to materialize itself (Neumann *et al.* 1997).

In January of 1971, according to the auditors from the Office of Survey and Review of the US Department of the Interior, Tribal members held only a small percentage of jobs in forest industries on the QIR. Approximately 90 Indians were employed in wood processing or logging operations. Only 37 Quinaults were employed on the Taholah and Crane Creek Units; 22 worked in processing plants operated by the two purchase contractors. Five independent, Indian-owned logging operations on the Reservation provided employment for 13 Tribal members and the remaining 18 worked at producing shakes. It was also noted in the Superintendent's (Western Washington Agency) comments on the findings that substantial portion of their livelihood came from fishing and other non-timber activities (Neumann *et al.* 1997).

In 1973, The Quinault Business Tribal Committee proposed to start a Tribal enterprise to conduct salvage logging and to build a cedar shake mill to utilize the existing amount of cedar slash. It was estimated at the time that the operation would provide over 30 jobs to Tribal members. During 1975, 21 workers found employment at the mill and two additional shake saws were installed, bringing the facility's total to five saws. By the end of the 1970s, over 20 salvage logging operations worked on the QIR, fuelling the mill's output. Between 1974 and 1979, salvage operators recovered over 26,000 cords of cedar (Neumann *et al.* 1997).

3.2.3. Fisheries

The QIR boasts five primary river systems: The Quinault, Queets, Moclips, Raft, and Salmon Rivers in addition to usual and accustomed fishing rights on the Humptulips and Chehalis rivers. The river systems contained Coho, Chinook, Chum, and Blueback (Sockeye) salmon, Steelhead, bull trout, and other species.

Fisheries enhancement activities of the QRDA were initially concentrated in two areas: 1) addressing environmental impacts of logging on QIR fisheries and water resources, and 2) development of fish enhancement projects for the QIR. For decades in the 20th century, logging practices of clearcuts drastically reduced the viability of the streams to support fish populations. Slash accumulated into huge log jams as heavy rainfall build dams behind the slash accumulations, improper road construction and maintenance was seen, and the use of heavy equipment in and near streambeds produced vast silt loads which choked the life from the streams (Storm *et al.* 1990).

A four-year study conducted by the QIN and the University of Washington in the 1970s proved that the cumulative effects of environmental changes in the soil and streams on the QIR were disastrous to the fish runs. The staff provided the oversight for extensive slash removal projects for logging companies and the BIA. At the same time the Quinault Resource Development Project (QRDP) established a fish enhancement program. In the early 1970s egg incubation facilities were constructed and a floating pen rearing facility was built on Lake Quinault with the goal of artificially propagating fish in ways that would preserve wild characteristics of the fish runs. The Lake Quinault pen facility has been extremely successful in enhancing five species of fish in coastal streams: chinook, chum, coho, sockeye, and steelhead (Storm *et al.* 1990).

The QRDP started developing fishery management plans which proved to be very critical to the future management of the QIN Fisheries Program. Within a few years of operations, the QIN fishery management system was held up as being among the best in the Pacific Northwest. New projects were added both on- and off-Reservation to assist the status of fish populations and to investigate critical factors of wild fish production, which allowed forecasting of salmon run sizes and to better develop fishery and enhancement plans (Storm *et al.* 1990).

The QIN Fishery Enhancement Program continues to grow to this day. The construction of new rearing pens on Lake Quinault has led to a production capability to foster over four million fish annually. A lot of effort was put into adapting the enhancement program to the needs of the fisheries while minimizing the effects on the wild runs. After years of litigation and confrontation between Washington State and the QIN, there was a need on both sides to put an end to controversies and find a better way of doing business which affected the interest of both sides. Since a “Port Ludlow” meeting in 1984, Tribal and State leaders agreed they could work together to build a better future for Indian and non-Indian fisheries (Storm *et al.* 1990).

Currently, the QIN has two major salmon enhancement facilities on the QIR: the Lake Quinault Hatchery, capable of handling every phase of fish propagation and a satellite rearing pond on Salmon River (tributary to the Queets River). There was a satellite facility near the mouth of Raft River but it is no longer in operation. In addition, the QIN helps operate the BIA’s National Fish Hatchery at Cook Creek (tributary to Quinault River), the Washington Department of Fisheries Rearing Station on Shale Creek (tributary within Queets drainage); and the Whishkah River Hatchery (within the Chehalis drainage). The Quinault Nation annually releases approximately 5-10 million juvenile salmon and steelhead into coastal streams (Storm *et al.* 1990).

3.2.4. Government and Local Resources

In 1856, the Treaty of Olympia was signed by the Quinault, Quileute, and the bands of the Hoh and Queets Tribes. They ceded nearly a third of the Olympic Peninsula to the United States in exchange for "*tract or tracts of land sufficient for their wants*". In exchange for the ceded territories, the U.S. Government promised to provide reservation homelands, education, medical care and to reserve the right of the Tribes to continue to hunt, harvest fish and shellfish, and collect roots, berries and other natural resources that were essential to coastal Salish people’s ways of life in their usual and accustomed areas (WSHS 2010).

On August 24, 1922, the Quinault people, for the first time, documented the shape and character of modern Quinault government in the Bylaws of the “Tribal Council of the Indians of the Quinault Indian Reservation". Under these Bylaws, the QIN established an elected government ruled by a Tribal Council made up of voting members of the Nation, and a Business Committee made up of a President, Vice-President, Secretary, Treasurer and seven councilmen. Certain legislative powers were placed in the Tribal Council and certain legislative and executive powers were placed in the Business Committee. Changes in the economic, social and political aspirations of the Quinault people led to the amendment of the Bylaws of 1922 and with the formal ratification of the Constitution of the Quinault Indian Nation on March 22, 1975 (Storm *et al.* 1990).

The QIN is a federally recognized Tribe and Sovereign Nation with the inherent right to govern itself and deal with other Tribes and Nations on a government-to-government basis. Under the Self-Governance Act of 1988 the Quinault Indian Nation is designated a "Self-Governance" Tribe. In 1990, the Nation and six other Tribes implemented self-rule over BIA programs, and later, Indian Health Service programs (Storm *et al.* 1990).

3.2.4.1. Quinault General Council

The Quinault General Council is made up of all enrolled QIN Tribal members. Members of the General Council age 18 years or more who are present at the appointed time and place of elections are permitted to vote in General Council meetings. The purpose of General Council meetings is to elect or recall members of the Quinault Business Committee and to declare the will of the General Council on issues placed before the General Council as detailed in the agenda and by persons raising issues at any meeting.

3.2.4.2. Quinault Business Committee

The Quinault Business Committee was recognized as the governing body of the QIN under the authority of the Quinault Indian Nation's Constitution adopted March 22, 1975, by the Quinault General Council. The eleven Quinault Business Committee members are elected to three-year, staggered terms of office. Officers of the Nation include the President, Vice President, Secretary and Treasurer and seven Councilmen.

According to the Quinault Indian Nation Constitution, "It shall be the duty of the Quinault Business Committee to govern all people, resources, lands, and waters under the jurisdiction of or reserved to the Quinault Nation in accordance with this Constitution, the Quinault Tribal Code of Laws, the Quinault Treaty, the laws of the United States expressly limiting the powers of the Quinault Nation, and the instruction of the General Council."

3.2.5. The Quinault Resource Economics

The QIN Economic Development Plan "the 5-Year Plan" (2008-2012) identifies three economic clusters in the three areas of Forestry, Fisheries, Tourism & Hospitality. This five year plan set the framework for future capital needs, labor projections, resource allocation; natural and human, and managed revenue streams. Mitigating the impact of potential hazards is paramount for the Quinault way of life. Homes, industries, and the way of life, are all dependent on natural resources. As a result the three clusters are presented here for continuity between the economic development plans for the QIR and the Quinault Indian Reservation Tribal Hazards Mitigation Plan.

3.2.5.1. The Quinault Resource Development Project

The Quinault people harvested trees to meet their own needs for centuries, with little impact to the forests. By the 1880s, logging began to make a profound change and emerged to become the economic backbone of the region. By the turn of the 20th Century, forest products evolved into the dominant industry throughout most of the Pacific Northwest (Neumann *et al.* 1997).

Logging on QIR has been complicated by land ownership issues, unpredictable weather patterns, lack of roads and fluctuating log market demands. The beginning of the 20th century marked the start of dramatic political and economic changes locally and in the world. Vast timberland of the rainy Northwest generated by nature for millennia, became a Klondike for European settlers who started exploring the west coast. Timber at the time presented "an inexhaustible natural resource" to extend endlessly into the future. Access to timber, however, was limited by dense forest growth, difficult access due to lack of roads, primitive technology and vagaries of the local climate. Logging pressures by timber companies attracted by extremely valuable old growth timber in the QIR kept increasing. In 1917, World War I efforts spurred the BIA to commence timber clear-cutting on the Quinault Reservation, which left behind heavy logging slash debris accumulations.

> In written works by Stumpff (2007), the QIN early years are described as, "the Office of Indian Affairs (OIA), and later the BIA, acted like a landlord over the Tribe, allocating large timber sales to non-Indian timber companies. The Dawes Act fragmented the Quinault Reservation into many small individually owned allotments: the Tribe retained little for the general purpose. Years of mismanagement of Reservation forest lands by the BIA left devastated lands and waters. Legislation and actions by leaders like Joe DeLaCruz pushed the envelope to reform the U.S.–Tribal Trust relationship, eventually returning land use decision-making to the Quinault Indian Nation. The Tribe took over planning, timber sales, and decision-making for forestry as they came to work in partnership with the BIA and neighboring agencies. The challenge was great, large areas of the land base's timber was cut-over. New decisions about forest management were made to acquire allotted lands and to transfer them into the Tribal ownership so they could be restored."

In 1934, an important piece of legislation was passed by Congress called the Wheeler-Howard Act or Indian Reorganization Act. It ended the allotment system and for the first time the BIA was told to consult with Quinault Tribal officials about timber contracts. The latter would not happen until well past 1980 (Storm *et al 1990*).

From the early 1950s to the mid 1970s, whole watersheds were logged off, streams were jammed with logging debris, and landowners received poor prices for their logs. In 1971, the Quinaults protested these practices by blocking the roads into the logging units and were called upon to take the lead in initiating the resource development programs with the BIA to provide the technical aid for this resource management effort (Neumann *et al.* 1997). In 1976 and 1977, the US Congress established a 10-year program to promote reforestation and improve the health and vigor of Reservation Forests.

The Quinault Tribe has pursued management of its forest resources since early 1900s. As management of the Reservation resources became more complex in the 1960s, the Quinaults saw the need to assume more control of the natural resources. They decided to put an end to the devastation of the land and fisheries under the BIA management. With the help of the University of Washington, a request for technical assistance was prepared and submitted to the Economic Development Administration (EDA). The request outlined the plan to reacquire reservation lands and develop forestry and fisheries resources. Reservation's lands EDA funded the proposal and in 1970, the Quinault Resource Development Project (QRDP) was created (Storm *et al 1990*).

In January, 1976 QRDP was renamed the Quinault Division of Natural Resources and Economic Development (QDNR & ED). Currently, it includes three major Departments: Forestry, Fisheries and Environmental Protection. The overall goal of the QIN is to manage resources to ensure sustainability of the resources for generations to come while maximizing revenues and creating jobs. Beginning in the 1980s, improved forest cutting practices, prescribed burns of woody debris, and reforestation through tree-planting programs began to slowly show results. As technology improved, so did management practices (Neumann *et al.* 1997).

By the end of 1970s, the role played by the QIN in determining the future of forest resources had grown considerably. The QIN now directly controls forest management and development issues such as reforestation and salvage logging. More important was the established precedent of independent management policies for QIR forests. Through zoning ordinances, forestry practice regulations, and forest management plans, the QIN now exercises direct control over the future of its forests (Neumann *et al.* 1997).

The QIN has transitioned to a value-added model of resource management. Tribal governments have the authority to operate Tribally-owned businesses, which in turn generate revenues for governmental services, provide jobs, and revenue to develop the natural resource. 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 access to. Today, the QIN maintains a natural resources industry and a tourism and hospitality industry. The QIN emphasis on tourism and hospitality is, in part, due to declining timber markets and limited resources to support fisheries (Neumann *et al.* 1997).

The Economic Development Strategy of the QIN includes the support for Tribal enterprises with multiple goals (revenue, land consolidation, and job creation), and provides individual entrepreneurs with employment opportunities, and revenues from the sale of timber. Additionally, the QIN employs a large QDNR staff that is a major supplier of jobs on the QIR. QDNR ensures the conservation, enhancement, preservation, and productivity of all resources within the QIR exterior boundaries and traditionally used resources off-Reservation.

The **QDNR** is responsible for managing the natural resources of the QIN. QDNR consists of a large and highly educated staff, including foresters, biologists, technicians, and information technology specialists.

> The **Forestry Division** protects and manages Quinault forestlands, which have suffered from decades of poor Harvesting practices. The Forestry Division supervises activities involved with regeneration and restoration of forests, while managing them for sustainable timber harvest and specialized minor forest products.
>
> The **Environmental Division** maintains the integrity and health of the QIR lands for the continued prosperity of its members. The Environmental Division works with private, state and federal agencies and timber companies to protect natural wildlife and salmon habitats, and to ensure compliance with environmental laws.
>
> The main goal of the **Fisheries Division** is to perpetuate the Tribe's fishing heritage, to provide harvest management, hatchery production, and technical services. Harvest management is a significant component of the fisheries program. The Fisheries Division provides current biological information and technical guidance to manage and regulate fisheries activities. In addition, it has developed an enhancement program which is responsible for QIR aquatic ecosystem restoration.

3.2.5.2. Quinault Land and Timber Enterprises

The Quinault Land and Timber Enterprises (QLTE) is a QIN enterprise and was established in 1988 to consolidate and strengthen the Nation's timberland acquisition efforts. Revenues from timber harvests are used to replant trees and purchase more land to convert it to Tribal ownership. Historically this enterprise has been very successful at generating cash and consolidating land to QIN ownership. The recent decline in the timber market has negatively impacted this enterprise and the timber industry will prove to be challenging in the years to come. Opportunities for expanding Tribal involvement in the forest products industry increased as the QIN forestry program encouraged more intensive harvesting of minor forest products starting in the 1990s.

3.2.5.3. Loggers, Fallers and Truckers

Tribal and non-Tribal loggers, fallers and truckers benefit from QIR timber harvest by bidding on timber sales and logging timber units. Truckers move the logs to the Port of Grays Harbor for export, or to domestic markets.

3.2.5.4. Shingle, Shake, and other Value-Added Businesses

Local shake mills and other value-added businesses (including a local fence-post company) produce value-added cedar and wood products from QIN timber harvests.

3.2.5.5. Cedar Salvaging

The QLTE administered cedar salvage contracts on QIR owned lands in the 1980s, but by 1991 the program had become a financial burden with the newly acquired responsibilities for administering timber sale contracts from Rayonier Timber Operating Company and the North Boundary Area. In 1992, QDNR established the Special Salvage Project to administer the contracts and guard against trespass in salvage areas. This facilitated coordination between the trespass responsibilities and the cedar salvage operations, which were a significant source of trespass problems (Neumann *et al.* 1997).

QIN adopted a salvage policy for western redcedar in February 1995. The purpose of the policy was to promote effective and efficient administration by establishing the guidelines and consolidating operational responsibility within the QDNR. The policy affected salvage operations on all lands 100% owned by the QIN or under contract to QLTE. The policy's main objectives focused on providing employment opportunities to Tribal members and maintaining the long-term stability of salvage operations, which would be accomplished through consistent policy administration and efficient processing and sale of western redcedar salvage. The new policy recognized that timber sale administration on the QIR had changed and requires new policies and approaches to protect forest resources while improving employment opportunities for Tribal members in forestry-related work (Neumann *et al.* 1997).

When QLTE harvests western redcedar trees, Tribal member entrepreneurs hire crews to salvage remaining western redcedar salvage from the harvested land, which are then turned into cedar shakes and shingles. Salvagers with permits to salvage are often former Quinault Tribal fishermen who can no longer make a livable wage from fishing.

3.2.5.6. Minor Forest Products (MFP)

Higher prices for forest resources contributed to increased demand for permits to collect specialized minor forest products (MFP). In 1996, Dave Bingaman, QIN Forest Manager, judged that the illegal taking of MFPs to be the most difficult problem faced by QDNR because of the problems of coordinating protection efforts and the lack of sufficient funding for the program. Trespass of western redcedar comprised a large portion of trespass activity, but the illegal taking of MFPs, such as bear grass, salal brush, mushrooms and yew bark, increased dramatically during the 1990s as the price of those commodities rose. The illegal taking of those products constituted not only a potential loss of income to Tribal members, but also a loss and possible destruction of resources that hold cultural significance to Tribal members. This problem has presented one of the biggest challenges for the QIN forestry program.

Tribal member entrepreneurs harvest renewable MFPs like ferns, western redcedar boughs, salal sprays, and other MFPs and sell them to buyers from Taholah to Olympia. There are about 5-6 operators with 15-man harvest crews. At least two of the Tribal members are also buyers.

3.2.5.7. Land Owner Timber Sales

Land within the QIR is owned by individual Tribal members, the QIN, and non-Indian individuals and companies. When their timber is ready to harvest, land owners receive revenues from the sale of their timber. Also, some Tribal members have received revenues through land leases for economic development and other purposes.

3.2.5.8. Fishery Enterprises

QIN fisheries is comprised of seafood buying stations, a QIN seafood processing plant (Quinault Pride), individual Tribal fishermen, and Tribal fishing guides. The QDNR manages the river systems and the Quinault Fish and Game Commission regulates the rivers to ensure they meet salmon escapement goals. Declining runs have hurt this industry, mainly due to deteriorating upper Quinault River aquatic ecosystems as a result of development off the Reservation. The ocean fishery, on the other hand, has improved.

Quinault Pride Seafood (known also as the “Fish House”) is a QIN Tribal enterprise and was established in 1973 as the result of an EDA grant. The intention of creating a seafood company was to give the Quinault fishermen an outlet to sell their catch at fair market prices. During Quinault Pride’s history there have been ups and downs in profitability depending on the size of the fish runs and other factors.

There are approximately 27 Quinault Tribal member **ocean boat** owners and operators. Each boat owner participates in ocean fisheries and hires a crew to assist with the catches. Ocean fishermen can fish up to an allocated quantity of catches. The allocation is negotiated between the Tribes and the State. From there, the Tribes must negotiate among each other to determine individual Tribal allocations of Dungeness crab, rock fish, bottom fish, halibut, and other species.

There are up to 50 **fishing guides** who take clients from all over the world on day-long, and longer, fishing trips. The fishing guides are regulated by the Quinault Fish and Game Commission. The Commission sets the number and species of fish allowed per person per day. The number of guides has steadily increased over the years as commercial fishermen seek other means of providing for their families.

State and the QIN biologists determine the allowable fish catch per harvest area per year and the QIN Fish and Game Commission establishes regulations for harvesting catches until their allocated amount is harvested. The QIN allows both commercial and subsistence (or home use) fish harvests. Many Tribal members benefit through revenues, home consumption, and harvesting for ceremonial gatherings.

3.2.5.9. Other Value-Added Businesses

Several Tribal members are experts at smoking and curing salmon and they have built their small private businesses by smoking, vacuum packing and selling their smoked salmon.

Today’s economic climate, although still primarily natural resource-based, is shifting toward a tourism and hospitality-based climate. With declining fish runs, a reduction in old-growth timber and increasing environmental constraints like the endangered species act, the QIN is developing their tourism and hospitality industry.

In 2000, QIN opened the doors of their first hotel and casino, the **Quinault Beach Resort & Casino** (QBRC), on trust property located off-Reservation in Ocean Shores. The QBRC is a $56 million destination resort and casino that employs roughly 350 employees and features 159 guestrooms, Emily's upscale restaurant, a sidewalk bistro, the "Ocean Lounge" bar, Wasabi sushi bar, 16,000 square foot casino with 450 slot machines, tables, keno and pull tabs, full-service day spa, gift shop and conference center.

The **QIN Marina and Properties** was purchased in 1996 and is comprised of approximately 40 acres of land, and a marina infrastructure, with an asset value of $6 million. The marina includes a dock for moorage, an RV Park and camping ground, a presently unopened store, and the Nation owns all but 3 units of the Silver King Condominiums. The QIN purchased the Ocean Shores Marina and surrounding properties to 1) create a functioning marina for the benefit of both Indian and Non-Indian fishers; and 2) develop the surrounding properties to attract more visitors to the area, generate revenues, and create jobs.

The Quinault Indian Nation's off-reservation businesses have clearly benefited the city of Ocean Shores, surrounding communities, and the state of Washington. Of the 350 jobs at the resort and casino, about 50% are held by non-Tribal members. Many of the goods and services that are purchased for the operation and maintenance of the QBRC come from businesses in Ocean Shores, Hoquiam, Aberdeen, Olympia, and the state of Washington. The resort and casino must buy electricity, telephone services, fuel, furniture and fixtures, food, and a myriad of other goods and services, and many of the purchases are within Washington State.

3.2.5.10. Miscellaneous and Small Retail

A mention of the remaining businesses is necessary for a full understanding of QIN businesses. QIN owns three convenience stores/gas stations and a community cable company. One Tribal member operates a metal fabrication shop. Many artists and carvers sell their artwork to the general public.

3.3. Population Density and Growth

Desired Population Growth areas have been established by the QIN for Taholah, Queets, Amanda Park, Taholah Ocean Tracts, and Qui-nai-elt.

3.3.1. Taholah

The QIN center of operations rests in Taholah. There are two general areas referred to in Taholah, the "lower village" where ancestral habitation was first established, and the "upper village" where new developments have been concentrated at a higher elevation and to the southeast of the lower village. The lower village is located along the banks of the Quinault River at its entry to the Pacific Ocean, and is exposed to natural disasters including storm water drainage, storm inundation from the Pacific Ocean, tsunami risks, flooding risks, and liquefaction (all of which are addressed in this Tribal Hazards Mitigation Plan). The upper village is mostly protected from these natural disasters, although high winds and earthquakes will impact all residents of the QIR. There are currently 259 structures in the lower village and 68 in the upper village (Table 15). The upper village is one of the Infrastructure Growth Boundaries identified by the QIN Planning Department and is where future developments in this area are targeted for construction.

Taholah is the location of Quinault Tribal Headquarters. The major activity centers in Taholah include the Tribal Administration Offices, Roger Saux Health Clinic, Senior Center, Quinault Pride Fish House, School, Cultural Museum, Quinault Land & Timber Enterprise, QDNR, Executive Offices, Taholah Mercantile (food and gas), and the Community Center.

3.3.2. Queets

The Village of Queets and businesses in close proximity to that village are located to the very northern extent of the QIR along the Queets River. The Queets Village has frequent power outages from wind storms and is often the last village to get lights back on after outages have occurred here and in surrounding areas. There are approximately 82 structures in Queets with another 14 located in the area of Clearwater (near the Queets-Clearwater School) (Table 15). This is one of the Infrastructure Growth Boundaries identified by the QIN Planning Department and is where future developments in this area are targeted for construction. The major activity centers in Queets include a Tribal Office, Gymnasium, Charolette Kalama Health Clinic, Day Care, Head Start, Senior Center, and the Queets Trading Post Store & Gas Station.

3.3.3. Amanda Park

Amanda Park, Lake Quinault community, and the area of Tsa'alal, are situated where the Quinault River flows through Quinault Lake. While Lake Quinault is within the QIR and the QIN owns the lake, properties adjoining the lake shore are outside the QIR and are owned by private landowners, the NPS, the USFS, and the QIN. According to the 2000 Census, approximately 260 persons reside in this area and the majority are non-Indian residents. The QIN recently secured land purchases in this area, including residential, commercial, and forestry-zoned properties. This is an eco-tourism attraction and features lodges, resorts, hiking trails, an interpretive center, grocery store, restaurants, a convenience store/gas station, and a beauty shop. There is a school and a library at Amanda Park and within the QIR. The QIN has offices at the Tsa'alal facility. The QIN has ongoing concerns about the condition of the lake due to failing septic systems seeping into the ground water. There are approximately 82 structures within the QIR located in Amanda Park and another 64 in the area of Tsa'alal (Table 15). Additional structures are located in what can be referred to as the Northern US101 area with 24 structures (Table 15). Amanda Park is one of the Infrastructure Growth Boundaries identified by the QIN Planning Department and is where future developments in this area are targeted for construction.

3.3.4. Taholah Ocean Tracts and Point Grenville

Taholah Ocean Tracts is located near Point Grenville with access provided by SR109 along Canyon Road. The community is currently zoned Forestry and features a community water supply and individual private septic systems. There are currently 25 structures in this community (Table 15). This is one of the Infrastructure Growth Boundaries identified by the QIN Planning Department and is where future developments in this area are targeted for construction.

Previously known as “Sanitago” this development has been renamed in recent years to Taholah Ocean Tracts by the QIN. Both “Point Grenville Estates” and “Taholah Ocean Tracts” were developed before QIN zoning was established, and both subdivisions were initially registered with Grays Harbor County.

Near Taholah Ocean Tracts, there are homes built near the shorelines of Point Grenville (4 structures) and at higher elevations near the access road to Point Grenville (10 structures) (Table 15). In this area, only Taholah Ocean Tracts is targeted for near-future residential developments.

3.3.5. Qui-nai-elt

The newest development on the QIR is at the Qui-nai-elt Village (Figure X). This development area has been engineered with public water and sewer systems and an infrastructure of power, telephone, public transportation, and good planning. As of fall 2009, there were 20 structures located here (Table 15), but current developments promise to increase these numbers early in 2010 (Section 3.1).

3.3.6. Populated Places Outside of Villages

Other human habitation has left the footprint of housing structures and commercial developments that have either been built prior to the exercising of QIN self-governance to regulate planning and zoning on the QIR, or through the un-permitted development of these rural lands. The plan for the QIN is to target sustainable developments 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.

3.3.7. Population Density Indices

Current population density trends on the QIN have been determined based on the location of structures within the QIR and extending 5 miles in each direction from the QIR. This analysis approach has been defined by Schlosser (2010) in the development of Wildland-Urban Interface (WUI) population density indices and is used here (Figure XI). These assessments indicate where the relative density of structures is located currently. As a planning tool, these population density indices indicate where high density is currently located in juxtaposition to other high and low density areas.

In Figure XI, the <u>white</u> areas indicate areas of <u>wildlands</u>; where no structures currently exist. The <u>light-yellow</u> colored areas can be referred to as <u>rural lands</u> where there are few structures located or those areas adjacent higher population densities. The <u>bright-brown</u> colors represent the <u>highest population densities</u> (the highest number of structures per acre) on the QIR. These areas are influenced by the number of structures within a small area on the Reservation and those areas adjacent to the Reservation (such as Moclips to the southwest of the QIR extending the extent of the high population densities into the area of the Qui-nai-elt Village). The <u>light-tan</u> colors surround the bright-brown and show <u>interface areas</u> of transition between the high population densities and rural population densities.

A time-series study of these analyses over time in other locations, has revealed that populations will tend to grow into two different areas unless regulated through planning and zoning efforts to direct the expansion of growth. The first area of growth pressures is the occupation of those areas that are currently in the interface zone between two disjunctive areas of high population density. This is the case as seen (Figure XI) between Taholah and Moclips along SR109. The second area of development pressures are generally in those areas that are currently in the situation of rural lands (light-yellow on Figure XI).

The QIN Planning Department is implementing growth management strategies to encourage development within defined Infrastructure Growth Boundaries: Taholah, Queets, Amanda Park, Taholah Ocean Tracts, and Qui-nai-elt. This strategy will serve the QIN well in the management of planned communities with the infrastructure support needed to ensure sustainable development and natural hazards pre-construction mitigation needs.

3.3.8. Structure Assessment & Values

The summary of structure values (Figure XI) has been brought together from differing sources. The first source included the initial building footprints design (in GIS) for the entire QIR assembled by the QIN Planning Department and including each property's current use, owner, and current value for many structures, but not all. To fill in the missing data, additional values were collected from the assessments made by the Grays Harbor County Assessor and the Jefferson County Assessor of the Fee Lands within the QIR. These two County Assessor Offices do not make assessments of QIR properties held in Trust by the federal government.

Quinault Trust lands include much of the Village of Taholah where a significant number of structures, both residential and government services, are located. Many of these government structures were included in the initial list of facilities developed by the QIN Planning Department, but mostly, residential structures were not valued prior to this effort. An estimated average for the Lower Village and another for the Upper Village were used as proxies for these structures. Another area with a large component of Quinault Trust Lands included structures in the Queets Village. By collecting the value of structures that were assessed by the Jefferson County Assessor's Office, a proxy was developed to apply for the average value of structures in this village. Similar approaches were used for missing values across the rest of the QIR until all structures were represented by a current value estimate (Table 15).

An area of the QIR that is experiencing current growth through developments (housing) is the Qui-nai-elt Village (Figure X) where several dozen new structures are actively being built. Values for these homes were provided by the QIN Housing Authority. Their values are included in the estimates for the Qui-nai-elt Village although not all of the homes are currently occupied. However, they are expected to be populated by the time this Tribal Hazards Mitigation Plan is adopted and thus, this estimate will be concurrent with the most up to date information available.

The results of this analysis determined that there are approximately 746 structures located on the QIR with a total value of approximately $113 million. Apparent uses are summarized (Table 15) with the structural value located in each community for each use identified. These values are illustrative of the resources potentially at risk to loss from natural disasters on the QIR. It is important to recognize, however, that these values only articulate the financial investment in structures used for residences, businesses, government services, and community infrastructure (water and waste). These values do not articulate the potential loss of life, damages to the ecosystem, or the traditional way of life for the Quinault people or the non-Indians living on the QIR.

3.3.9. Population Growth Projections

Population projections were developed for the QIR as part of the 2008 Technical Assistance Project: New and Expanding Transit Services (Table 14). Population estimates and projections from 1990 to 2030 for the QIR estimate that the QIR population will increase less than 1% each year from 2000 until 2030, at which time the population is expected to be 1,712 people. This growth rate is based on information from the US Census and Washington State Office of Economic Information Center. The greatest population growth is likely to occur in Taholah, Queets, and Amanda Park as well as along SR 109.

Table 14. Population Trends and Projections 1990 – 2030 (TAP 2008).

Year	Population	Percent Growth
1990	1,216	-
2000	1,370	12.66%

Table 14. Population Trends and Projections 1990 – 2030 (TAP 2008).

Year	Population	Percent Growth
2005	1,422	3.78%
2010	1,476	3.78%
2015	1,531	3.78%
2020	1,589	3.78%
2025	1,650	3.78%
2030	1,712	3.78%

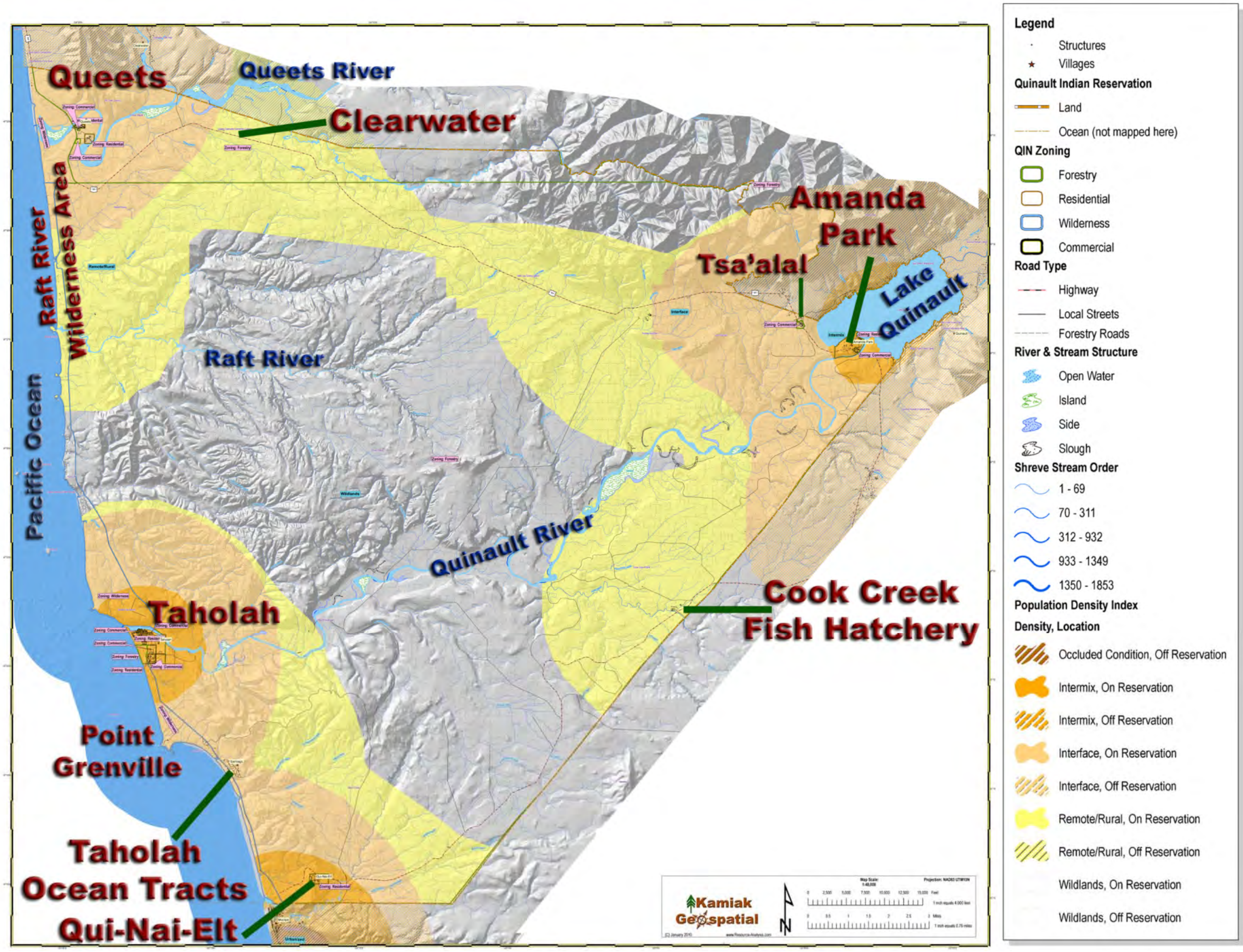
Source: 1990 and 2000 US Census Bureau, Census and Economic Information Center, LSC, 2008.

Table 15. Structural Location, Use, and Count within the QIR.

Community Area	Total Value	Commercial	Community	Emergency	Environment	Government	Health Care	Residential	School	Number of Structures
Amanda Park	$18,045,408	$5,691,283	$132,000	$189,260	$1,587,590	$667,503	$-	$5,140,909	$4,636,863	150
Cook Creek Hatchery	$7,592,491	$-	$-	$-	$6,747,199	$645,292	$-	$200,000	$-	28
Point Grenville	$864,555	$-	$-	$-	$462,800	$65,000	$-	$336,755	$-	13
Queets	$7,809,796	$684,689	$529,807	$64,310	$708,500	$884,295	$327,000	$4,235,145	$376,050	81
Queets / Clearwater	$1,978,706	$-	$-	$-	$874,524	$-	$-	$37,320	$1,066,862	20
Qui-nai-elt Village	$7,508,619	$-	$-	$-	$-	$-	$-	$7,508,619	$-	56
Quinault River	$16,000	$-	$-	$-	$-	$16,000	$-	$-	$-	1
Raft River Wilderness	$390,960	$30,000	$-	$-	$256,680	$-	$-	$104,280	$-	20
Taholah - Lower Village	$36,338,174	$1,467,250	$1,652,660	$332,980	$-	$3,079,629	$761,320	$21,570,000	$7,474,335	262
Taholah - Upper Village	$23,023,899	$553,726	$230,100	$-	$-	$10,582,573	$4,500,000	$7,157,500	$-	69
Taholah Ocean Tracts	$1,530,285	$-	$-	$-	$-	$10,000	$-	$1,520,285	$-	25
US101 Zone	$8,386,947	$7,888,467	$-	$-	$-	$128,000	$-	$370,480	$-	21
Total	$113,485,840	$16,315,415	$2,544,567	$586,550	$10,637,293	$16,078,292	$5,588,320	$48,181,293	$13,554,110	746

* The US101 Zone is that area between Amanda Park and Queets / Clearwater along US101 where developments are located.

Figure XI. Population Density Indices for the QIN Based on Current Structure Locations (2010).



3.4. Transportation Systems

US Highway 101 (US101) is a major transportation system of the United States of America providing access from California to Canada. The highway is of importance to the Reservation as it connects the Villages of Amanda Park and Queets. State Route 109 (SR109) runs along the Pacific Coast from west of Hoquiam to Taholah. SR109 is the major north/south access route linking the communities of Taholah, Moclips, Pacific Beach, Copalis Beach, and Ocean City. It provides connection to SR115 for access to Ocean Shores and US101 for access to Hoquiam and Aberdeen. The Moclips-Olympic Highway (AKA Cook Creek Road) provides the Reservation with a nearby connection of SR109 and US101. These three routes make up the major transportation network of the QIR.

Over 2,000 miles of forestry roads blanket the QIR to provide access to the remote forestlands, river ecosystems, and shorelines of the QIR. These roads are mostly closed to general public access.

3.5. Chronology of Events in the Life of the QIN in the last 150 years

Workman (1997-2010) in “Land of Trees”, compiled an extensive series of news events and written reports concerning the QIN and the greater southwestern Olympic Peninsula. These reports have been reviewed for details that can be used throughout this Quinault Indian Reservation Tribal Hazards Mitigation Plan for a history of plans, policies, regulations, culture, fisheries, forestry, and more (Table 16 - Table 19). Within this document, the reader will see citations for “Workman 1997-2010” in reference to weather, floods, winds, earthquakes, tsunami, and other topics. Larry Workman provided the authors of this plan with an update to the original 1997 collection with updates from the original publication date through March 2010. The authors of this work wish to extend extreme gratitude to Larry Workman for the compilation of that effort that has proved to be very useful in writing this document.

Table 16. Regulatory and Infrastructure Related Events on the QIR (Workman 1997-2010).

Date	Theme	Information
1856 January 25	Regulations	Quinault Treaty signed by Territorial Governor in Olympia.
1860 Report by Indian Agent	Regulations	Recommends “land between point Grenville and Quinault River be set aside as their Reservation. He encourages Indians to begin trade with their salmon that the “salmon that run up the Quinault River, in great numbers, are considered the best flavored of any taken on the coast.”
1863 Indian Agent Report	Regulations	Recommends the Indian Agency be located at the mouth of the Quinault River instead of on Baker’s prairie as it is too wet even in the dry season.
1871 March	Regulations	Indian Appropriation Act; Tribes no longer independent entities, but declared wards of the State. Reservations divided among religious groups. Two years later they will be replaced by Indian Agencies and return to a spoils system of government.
1872 September	Regulations	Commissioner of Indian Affairs recommend the enlargement of the Quinault Reservation to include the mouth of the Queets river and Quinault lake.
1888 April 1	Regulations	Quinault, Nisqually and the Skokomish Indian Agencies consolidated to form the Puyallup Agency. It is in a chaotic state of affairs.
1927 March 31, 1927 August 19, 1931 January 14	Roads	Taholah-Moclips road work progresses well. Moclips-Taholah Road nears completion. Road open to Taholah again. Also, Indians guilty of minor offenses are building levee at Taholah.
1928 January 23	Roads	Thirty Taholah Tribesmen work to clear big slide blocking the recently completed road Moclips-Taholah.
1930 July 25	Roads	Pontoon bridge now crosses Quinault River half mile below Forks.
1930 June 17	Roads	Work starts on Queets river bridge near Clearwater.
1930 November 1	Roads	Queets bridge opens today.

Table 16. Regulatory and Infrastructure Related Events on the QIR (Workman 1997-2010).

Date	Theme	Information
1931 April 27	Roads	Work on Taholah road entrance has started. Work on the streets to begin soon.
1931 August 14	Roads	Road to Taholah being graveled.
1931 January 10	Roads	Big slide on highway isolates Taholah.
1931 September 23	Roads	Taholah's new one mile, high land entrance road avoids river flooding.
1932 December 12	Roads	Aloha is hauling piling for emergency work on seawall at Taholah. Indians under Cleve Jackson are hauling cedar down the river as part of the work, too.
1932 June 2	Roads	Indian crew building road to Queets mouth.
1933 October 4	Roads	Tribe to widen Moclips-Taholah road.
1934 February 12	Roads	State engineers on Reservation since Jan 12, surveying a new right-of-way from Moclips to Taholah and a site on the Quinault River for a bridge crossing to extend the Roosevelt highway.
1934 May 29	Roads	Polson Railroad now stretches three miles north of the Quinault river.
1935 March 27	Roads	Quinault Tribe presses for a coastal road from Taholah to Queets.
1936 July 17	Roads	Lewellyn Logging Company bridges upper Quinault River for the first time with a 120' stringer bridge.
1936 June 30	Roads	Taholah-Queets road authorized.
1937 June 7	Roads	Queets-Taholah road advances all the way to Raft River.
1939 September 15	Roads	Moclips-Taholah road being rebuilt.
1940 April 17	Roads	WPA work resumes on Moclips-Taholah road.
1941 March 15	Roads	Queets –Taholah road half finished.
1941 May 17	Regulations	Quinaults petition Congress for the right to sell timber.
1941 October 13	Regulations	Indians lose fight on timber rules on the Reservation.
1942 January 10	Roads	Queets-Taholah road being pushed with 17 Indian CCC workers; six miles remain to be completed.
1945 April 4	Roads	Tribe and PUD working on agreement for a power line from Moclips to Taholah. (Completed in 1947.)
1948 May 1	Roads	Scores cross Quinault River to help construct three mile missing link in Taholah-Queets road.
1949 February 28	Roads	If built, Taholah-Queets road would open wonderland.
1950 November 29	Roads	Aloha opens new span across Quinault River near Mount Creek.
1957 January 21, 1957 October 30	roads	BIA to pave Moclips-Taholah road for $85,000; it then plans to turn the road over to the state. Dedication to transfer Moclips-Taholah road to State Highways.
1957 October 1	Roads	Taholah-Queets "Missing link" Highway endorsed by WA State Good Roads Association.
1957 October 3	Roads	Paving completed on Moclips-Taholah road. New Wreck Creek bridge to be built.
1958 April 25	Regulations	QIR Policy Committee formed in February, votes for state law and order jurisdiction on Reservation.
1959 April 11	Regulations	The President signs Quinault River Treaty.
1960 October 13	Roads	Work progresses well for the new span over the Quinault River at Amanda Park.
1960 September 15	Roads	Rayonier railroad bridge over Quinault River modernized for diesels.
1961 May 9	Roads	New bridge spans Quinault river on US 101.
1961 October 26	Roads	Taholah-Queets road location under survey.
1963 December 19	Regulations	State Supreme Court ruled that State can restrict Indian fishing to protect resource.
1964 December 14	Regulations	Quinault Indian tribe vs. Washington. Judge Wright of Thurston County Superior Court (The Court is in Olympia and many suits against the Stet are heard there) rules that Quinaults have the right to catch, sell and transport fish from the Reservation's waters.
1964 February 14, 26	Regulations	Quinaults, Queets, Makah, Quileute, and Hoh tribes meet in Forks to confer on fisheries rehabilitation and conservation. Quinaults ask Governor to lift State legal jurisdiction from Reservation.
1964 July 31	Regulations	NCAI urges a survey to return jurisdiction to the Tribe, taken away by the state in 1958.
1965 June 26	Roads	Moclips river bridge completed.
1966 September 7	Regulations	Indians object to 18 ½ acre Point Grenville housing development.

Table 16. Regulatory and Infrastructure Related Events on the QIR (Workman 1997-2010).

Date	Theme	Information
1969 August 24	Regulations	Quinaults close reservation beaches to public.
1969 May 8	Regulations	Quinault Nation adopts building code.
1969 October 2	Regulations	US assumes jurisdiction over Quinault Reservation from the state.
1970 March	Regulations	The Quinault Indian Nation establishes the Quinault Resources Development Project (QRDP) to rehabilitate the natural resources on the Reservation.
1971 November 28	Regulations	Mitchell vs. U.S. (The Quinault allottees Association, their President, and the QIN initiated this law suit against the BIA for mismanagement of the regeneration of the QIR's forest. In 1986 the US Claims Court ruled the allottees could sue, but only for the six years immediately prior to the filing of the lawsuit. Final judgment awards funds for regeneration and repairing fisheries damage.)
1974 April 30	Regulations	Joe DeLaCruz and Tribe battle all month long with non-Indian owners about zoning along coast. (This is a battle that remains on simmer. In spite of several federal court decrees, some fee owners refuse to recognize the Tribe as having any jurisdiction over Reservation lands.)
1975 29	Regulations	National Park Service proposes trading North Shore of Lake Quinault for Quinault Reservation ocean shoreline.
1977 March 20	Roads	USCG improve navigation unit at Point Grenville.
1978 September, 1981 March 15	Roads	Rip rap replaces old wooden sea wall facing the river at Taholah.
1979 August	Roads	Quickly built roads plaguing Ocean Shores.
1981 April 7	Roads	Logs to stay under Ocean Shores roads.
1981 January 16, 22	Regulations	State moves to halt Indian fishing on Quinault river. Official refuses to halt Quinault steelhead fishing.
1982 December 16	Roads	County roads and bridges crumbling.
1982 November 7	Roads	Faulty underground line keeps PUD busy in Queets-Clearwater area.
1983 October 17	Regulations	Economic disaster status sought on Grays Harbor in wake of El Nino.
1984 January 13	Regulations	State Park and Recreation Commission propose a 5-acre park at mouth of Copalis river.
1984 July 3	Regulations	President Reagan signs Wilderness Bill. It includes 93,000 acres in five new wildernesses in the Olympic National Forest, including 12,120 acres in the Mt. Colonel Bob Wilderness near Lake Quinault.
1984 October 26, 27	Roads	Quinaults give go-ahead to coast highway. "Missing link" (Quinault section of the coast highway) now hinges on federal funding.
1984 October 6, 8	Roads	Quinaults debate "The Road to Nowhere" and show support by narrow margin. DeLaCruz says Tribe wants respect on road plan.
1985 March 27	Roads	Slow down building over the "Missing Link" highway.
1985 May 8	Roads	Governor signs Quinault Highway bill.
1987 December 14	Roads	Quinault public hearings on Taholah-Queets road.
1988 April 15	Regulations	Quinaults close Federal Land Bank deal for 9,400 acres.
1988 February 4	Regulations	Congressional investigation into BIA shaping up.
1988 January 10	Regulations	55 bald eagles sighted about Lake Quinault in annual count.
1988 September 12, October 8, November 8, December 10	Regulations	Quinaults testify before Senate Indian Affairs Committee about Northern Boundary. Senate passes Quinault Land Bill. President Reagan signs QLB. Quinaults celebrate return of North Boundary by dinner.
1989 April 23	Regulations	Quinault timber venture provides a solid land base for the tribe.
1989 June 4	Roads	Seven mile section of I-90 opens in Seattle. It is the most expensive section of freeway in the world.
1990 December 1	Regulations	Last week, the QIN and ITT Rayonier agreed to buy land on Reservation in four options.
1990 February 13	Regulations	Quinault Indian Nation closes deal to purchase 3,200 acres of Weyerhaeuser land on the Reservation.

Table 16. Regulatory and Infrastructure Related Events on the QIR (Workman 1997-2010).

Date	Theme	Information
1990 July 27	Regulations	Quinaults named as one of six tribes to manage own funds and to take over former BIA programs. (Self-Governance.)
1990 October 1	Regulations	Quinault Indian Nation begins 3-year project of self-governance. (This project would become a permanent program in October 1993. QIN would sign an annual funding agreement with the Indian Health Service on June 27, 1994 and assumed responsibility for that program on October 1, 1994).
1991 August 15	Roads	Part of State 101 from Hogan's corner to Taholah resurfaced with a gravely texture in areas prone to ice.
1991 October 5	Roads	Dam failure floods Chehalis.
1992 June 26	Roads	New Queets bridge on US 101 opens to traffic.
1994 December	Roads	Moclips bridge on state 109 is open after nearly two days closure due to High water. Rock added to seawall at Taholah as ocean waves sweep over the spit at the mouth of the river.
1995 November 4	Roads	North Shore Road at Lake Quinault opens after 5 years of closure (the South Shore Road would wash out four days later).
1997 June 5	Regulations	New agreement gives tribal plans to protect fish and wildlife on Indian lands priority over government enforcement of the Endangered Species Act.

Table 17. Cultural Events on the QIR (Workman 1997-2010).

Date	Information
1857 June 30	Sydney Ford submits a report to Indian Affairs about the Indians of Coastal WA Territory. He first became acquainted with them in spring of 1846. He says the Quinault is presently engaged in a petty warfare with the Indians on the lower Chehalis. He said the population had decreased since 1846 as a result of alcohol provided by whites, smallpox, measles, flu and venereal disease.
1868 Indian Agent Report	Was Kinos, the Head of the Quinault Tribe, refused to let his children be taught at school, used his influence to keep others from school fearing the children would be taken away and put into slavery.
1869 Indian Agent Report	There is "some feeling of jealousy on the Indians' part about the white sea-otter hunters who trespass upon the hunting grounds of the Indian reservation. The chief source of revenue for them is fish and fur"
1870 Indian Agent Report	The road over Point Grenville has been entirely rebuilt. It has been made from the beach to the Agency, which saves half a mile of heavy traveling over lose ground and shifting sands. The salmon this year are plenty and of superior quality.
1872 Report by Indian Agent G.A. Henry	I am convinced after repeated trials, that the soil of the Reservation is of such inferior quality that farming cannot be successfully carried on, and that the Indians must depend chiefly upon the salmon and other fish which they have in great abundance most of the year.
1881 August	Oliver Wood (US Indian Agent) reports that agriculture is greater among the Quinaults than any other tribe belonging to this agency. During the sealing season all the Hoh Indians able to work in a canoe are engaged in sealing and obtain most of their means of living from this source. Their sales of seal skins this year amounted to $1,200. (about $22,400 in dollars of 1997.)
1883 Indian Agent Report	"The trader, John Hume, is greeting suitable buildings for canning the salmon and this will give employment to all adult Indians during the fishing season. The Quinault river has a great abundance of salmon than any stream of this size on the coast, and the Indians are highly elated at the prospect of having more constant employment and better pay than ever before."
1883 June	Woods are full of land hunters now.
1883 November 15	Land is rapidly being taken on the Wishkah.
1884 July 14 Indian Agent Report.	"As a tribe the Quinault are peaceful and easily governed."

Table 17. Cultural Events on the QIR (Workman 1997-2010).

Date	Information
1886 August	"Many of the Indians in the Gray's Harbor labor for the whites. Not a foot of lumber has reached the Quinault Agency for a number of years. Communication is poor due especially to the dangerous high bluff (Point Grenville) that must be crossed. Whites are pressing hard on the reservation boundary to the south. There are seven white and three Indians employed by the agency."
1886 January 29	R.M. Ryatt, Teacher at the Quinault reservation said that three weeks ago a large three-masted schooner drifted on the ledge of rocks extending out from the reservation and stranded. No one was aboard and the crew probably perished. Two weeks ago a smaller vessel also went ashore. The beach from Quinault to Cape Flattery is strewn with lumber and wreckage.
1888 July	Seattle census shows a population of 25,000. An increase of 16,000 in the past three years.
1889 August	Joseph N. Locke is first white to post a claim on land in the valley above Lake Quinault.
1889 August 26	Edwin Ellis in his report on the Quinault. They get most of their living by hunting and fishing. They get their money by picking hops (September) and fishing for the canneries. "Our Indians seem to us very much like the white people. They have not the sterling qualities, however, which will keep them up, and easily slide back to their former condition. Like all lower races, they like their pleasure, and willingly barter substantial benefits for fleeting pleasure." (Most agents were educated in the east and finding themselves in the western wilderness had great difficulty in relating to another people. In all agents' reports since the 1870s we find they set the tone of paternalism and disapproval unto harassment of the old culture, its mores, religion, and language that would persist for scores of years. This ruthless separation from the Quinault past to make the Indians into the white man's image resulted in disorganization, deterioration, and cultural breakdown. This conquest nearly took all the meaning out of their lives and its effects have lasted to this day.)
1890 August	Quinault report says that large numbers of white settlers have taken up claims bordering on three sides of the reservation, and that the Indians have been brought into contact with the white man as never before.
1890 September 19	Settlers have squatted on nearly all unsurveyed land along the coast.
1892 August Quinault Sub-agency report	:Fish and game are becoming scarce and the hunting of sea otter, which has been a profitable business for these Indians, can no longer be considered a leading industry with them, there being many more white men hunting now than in the past. I have surveyed by running inaccurate lines, 45 claims along both sides of the Quinault and Queets Rivers. These claims have been take by Indians, and each man has a small garden and a hay field. They are slow at making improvements fearing that their claim might be on some other claim than their own after the official survey is complete. I urge that at least the boundary lines and the river bottoms be surveyed as soon as possible."
1893 July Report on the Reservation	"The Reservation is now, and must be for some time, quite inaccessible. There is some land on the Queets and Quinault Rivers and bordering the lake, but most of the remainder is comparatively valueless. Consumption (TB) has been destructive and is probably due to the great amount of rainfall and heavy sea fogs which prevail in this agency".
1896 February	If the rate of decrease of Indians is maintained at the level of the past quarter century, there will be no Indians in a 100 years.
1898 May 13	It is reported that the surveying of Lake Quinault area is at last accepted. It is almost three years since the survey was made. Settlers feel quite happy.
1901 March 1	Quinault agent mail carrier says that numerous slides of blue oily clay has obstructed the road north of Granville mountain (Point Grenville) to such an extent that teams cannot pass except at a very low tide. It is further reported, the same strata of oily clay has been discovered at various points cropping out along the Quinault River. It would appear that the Quinault Indian Reservation is nearly the center of the oil belt.
1902 January 11	Quinault Reservation is a long way from opening.
1903 September 11	Most of the Indians (Quinaults) are off hop picking.
1905 January 14	Prior to the snowfall the Indians were hunting sea lions.
1907 October 28	500 allotments made on the Quinault Reservation. "The natives were simply given the agricultural land, the timber being held for the government".
1909 June 24	Special agent Downs praises Quinault District and says Quinaults rich.

Table 17. Cultural Events on the QIR (Workman 1997-2010).

Date	Information
1929 September 3	Scientists inspect fossil bed at the Bluebanks on the Quinault River.
1930 June 20	W.B. Sams Indian Agent, thinks the Quinaults are very progressive Indian Tribe and will govern themselves in 25 years.
1931 April 4	Potential Quinault River electric power resources are big.
1933 August 14	Taholah busy installing pipes. $20,000 water system recently completed.
1933 February 13	Work begins on the Taholah water system.
1933 January 14	N.O. Nicholson, the Indian Agent, says the depression is hitting the Quinault's tribesmen hard.
1933 June 8	The big tower water tank for Taholah arrived yesterday.
1934 January 9	Civil Works Administration (CWA) funds used to build seawall at Taholah, construction of which is under way. Emergency Conservation Works (ECW) funds to be used to plant 1,000 acres on Reservation.
1934 May 8	ECW Reservation program continues with construction of truck roads, trails to lookout, and log jam clearing on the Quinault River.
1935 April 27	Soil Conservation Service established.
1936 December 31	Taholah Agency says past year the most beneficial and active in decade.
1936 November 3	New survey underway for gravity flow water system in Taholah.
1938 March 11	Hydroelectric generator brought to Quinault. Many houses on lake already wired for electricity.
1938 November 9	New Quinault power station on Ziegler Creek. It's only one of two hydro-power stations built with assistance of Rural Electrification Administration (REA)
1968 May 30	Electricity comes to Queets village.
1975 January 19	12 new HUD houses in Taholah.
1977 April 25	Meetings begin in Taholah on a new elementary school.
1978 March 26	Quinaults say logging a threat to wildlife.
1980 June 18	First set of graves moved from mouth of Quinault River to a new cemetery.
1980 September 11	Water problems in Taholah.
1983 March 9	Taholah accepts school settlement over construction problems at school.
1984 February 7	Taholah voters want High School.
1984 January 14, 27	Queets villagers upset; no water since December 21st. Queets has water again.
1985 August 16	Alcohol most costly to health of Indians.
1985 January, 16	Queets has been without water for a week as a result of a burned out pipe.
1985 September 29	Photo of pelicans at Taholah in "The Daily World".
1987 May 23	USFS has open house in newly rebuilt Quinault Ranger Station.
1988 December	Quinaults sign a letter of intent for Weyerhaeuser land purchase.
1988 January 13	Taholah High School assured.
1988 November 6	Ground breaking for Taholah Community Center.
1991 July 3	The Taholah boxing program featured in "The Daily World".
1991 June 23	The QIN book "Land of the Quinault" wins NFPW national award for best historical book.
1991 May 2, November 2	Ground breaking for the new Amanda Park Library. New Amanda Park Library dedicated.
1991 September 3, October 12	Classes begin at the new Taholah High School. Taholah High School dedication.
1993 August 18	Former top-secret sub spotting system (The Pacific Beach Facility is one of the relay stations) finds deep-sea volcano 270 miles from Astoria. It erupted June 22.
1993 July 27	Quinault information center opens at Amanda Park.
1994 January 29, 1994 April 4	Quinaults steam cedar canoe log in ancient tradition and ceremony at Taholah. Quinaults launch ocean canoe with ceremony and potlatch.
1994 July 14	Ground breaking for the new QIN Administrative complex.

Table 17. Cultural Events on the QIR (Workman 1997-2010).

Date	Information
1994 September 3	Quinaults flourish with less federal bureaucracy.
1994 September 7	Three large new steel pipes now mark the southern boundary of the Quinault Reservation on the beach at Moclips.
1995 August	Ron Mullins, candidate for mayor of Elma, accused of illegally dumping untreated septic sludge on the QIR.
1995 December 14	Crowd of 250 split on Quinault Casino plan at State Gaming Commission information meeting at Ocean Shores.
1995 March	Quinaults vote to study casino gambling at their annual General Council Meeting.
1995 September 29	Federal program gives more Quinaults homes of their own.
1996 August 7	Quinaults buying the marina at Ocean Shores.
1996 June 1	State Gambling Commission approves the Quinault nation’s plans to build a casino at the Sampson John’s allotment near Ocean Shores.
1996 October 17	Lake Quinault Community Forum attempts to unify communities near the lake.
1997 December 5	The Taholah Chitwhins win the state B-8 football championship in 47-42 victory over Colton at the Tacoma Dome. The following day, the Elma Eagles come from a 22-point deficit at half time to win the 2A championship 37-34 over Pullman.
1997 June 5	Canoes roar at Taholah days.
1997 November 26	Grand Opening of the Charlotte Kalama Health Center in Queets.
1998 April 17	Grand opening of QIN’s Queets Store.
1998 December 14	County claims authority on Quinault Indian Reservation fee lands.
1998 February 9	QIN Strategic Plan approved by Business Committee.
1998 January 14	Good omens at ceremonial ground breaking for the Quinault Casino and destination resort.
1998 September 18	The Taholah gym dedicated to former QIN president James Jackson.
1999 December 10	The National Weather Service list the Columbus Day storm of ’62, first in Washington’s top ten weather (natural phenomena) disasters of the century.
1999 May 13	The Quinault Indian Nation celebrates the Grand Opening of its 30,000 sq. foot Natural Resources Building (QDNR).
2000 February 25	Pearl-Capoeman-Baller re-elected president of the QIN for a third term.
2000 June 10	Grand opening of the Quinault Beach Resort begins.
2001 March 28	The first item under the U.S. Repatriation Act, a Speaker’s Staff, is returned from the Ilwaco Heritage Center to the Quinaults.
2001 May 14	QIN closes Quinault River and Lake Quinault to commercial and sport fishing to protect salmon resources.
2001 November 1	After nearly three decades of work, the final section of the Cook Creek-Moclips Highway paved.
2001 November 12	Tribes from all over the country, attending weeklong Self-governance conference at the Quinault Beach Resort.
2002 August 10	23-ocean canoes in ceremonial arrival at Taholah viewed by thousands.
2002 August 4	*The Daily World* features Paddle to Quinault 2002 and a series of articles over the next week: the carving of the new Queets Canoe, Canoes to arrive at Taholah for Tribal Journeys 2002, Quinault women weaving, Taholah set for historic gathering.
2002 May 25	Lake Quinault opens to fishing for the first time in a decade.
2002 October 7	“Sovereignty Run” from Quinault ends up on steps of the U.S. Supreme Court (See September 11).
2002 September 11	“Sovereignty Run” begins at the mouth of the Quinault River - to end at the US Supreme Court in October.
2002 September 22	Taholah School makes impressive gains on WASL scores.

Table 17. Cultural Events on the QIR (Workman 1997-2010).

Date	Information
2003 December 14	Randy Capoeman featured in *The Daily World's* Sunday Profile.
2003 December 26	Fourth annual Showcasing Grays Harbor tour makes a stop in Taholah.
2003 February	After more than ten years of work, the new $2.4 million Taholah water system completed.
2003 February 13	*The Daily World* features the Clinic at Taholah and proposal for a new facility.
2004 April 1	Trial guided bear hunt begins on the Quinault Reservation as an aid in reducing damage to trees.
2004 August 13	Groundbreaking ceremony for the new health clinic in Taholah.
2004 August 4	Sea Otter population between Hoh River and the Strait of Juan de Fuca has risen from 17 in 1977 to 700.
2004 February 20	Francis "JB" McCory, one of the most respected members of QIN, dies at 84.
2004 February 8	*The Daily World* features article on the North Boundary timber land complaint and federal moneys set aside for QIN.
2004 July 12	*The Daily World* features the Quinault Nation's Housing Program at Qui-nai-elt Village.
2004 July 27	Canoe Journey 2004. Canoes gather at Port Angeles for pull to Chemainus in British Columbia.
2004 May 13	Clam digging by Quinault members featured in *The Daily World*.
2004 November 7	"Good ol" log days' gone at the Port of Grays Harbor. No logs have been exported in three years from Port facilities.
2004 October 25	The Makah Tribe and natives from the Russian province of Chukotka gather at Neah Bay for a cultural exchange.
2004 September 20	Quinaults sign North Boundary deal for $32.2 million to protect 4,207 acres of marbled murrelet habitat.
2005 April 2	QIN General Council kicks off the 150th anniversary of the Quinault River Treaty.
2005 July 1	Dedication of Memorial Park in Taholah.
2005 June 30	Treaty Run from Olympia kicks off the Quinault Nation's five day 150th Treaty Anniversary commemoration.
2005 October 3	Quileute close access to Olympic National Park beach in a boundary dispute with the park.
2006 April 12	Pearl Capoeman-Baller honored by 550 people at Quinault Beach Resort for her 32 years of dedication to the QIN.
2006 March 25	Fawn Sharp elected as president of the QIN.
2006 October 2	Tsunami-safe school planned for Taholah; would rebuild school on hill near new clinic.
2006 September 18	New clinic opens in Taholah.
2006 September 18	Quinault Beach Resort hosts tourism tribes from across the U.S.
2006 September 25	Quinault Beach Resort hosts the National Tribal Environmental Science Conference.
2007 April 17	Governor Gregoire signs Quinault Timber Harvest Excise Tax Bill.
2007 March 26	Ocean Shores council meeting cut short following a screaming match, after the council was accused of making racist remarks regarding the Quinault Indian Nation.
2008 December 12	Fawn Sharp, QIN President attending Kyoto climate change conference in Poznan, Poland
2008 July 10	Eight Olympic Peninsula Tribes and the National Park sign historic Memorandum of Understanding.
2009 July 24	U.S. Court of Appeals rules that the Dept. of Interior must account for century-old land royalties owed to American Indians.
2009 July 26	Franklin DeLaCruz featured in *The Daily World* Profile about the cedar canoe he built to honor Joe DeLaCruz.
2009 July 6	Pastor Stan and Michele Lien featured in *The Daily World* for the work they are doing with the Taholah Food Bank.
2009 November 5	Obama pledges new relationship with Native Americans.

Table 18. Events on the QIR Associated with Fish (Workman 1997-2010).

Date	Information
1888 October 19	Fish were never more plentiful than at the present time in the rivers and harbor. They are good size, fat and excellent quality.
1889 October 29	Farmers are saying that for the first time on record there are no salmon in the Wynoochee. The Satsop is, however, alive with them.
1894 July 17	The Quinault Agency reports that salmon of their rivers has found a market this past season for the first time in Chicago. The floods and strikes stopped the transportation, or more would have been sold.
1895 November 1	Streams are low and salmon have not commenced running much yet.
1897 July 9	Quinault Indians are not making a very good catch of salmon.
1898 May 13	The Quinault Indians are not catching many salmon at the lake this spring.
1904 April 29	The Blueback run has at last commenced. It has been latest in coming in for many years.
1904 June 17	Blueback run proving to be the poorest in years.
1904 May 13	The Indians are catching about 300 Bluebacks a day.
1907 March 19	Steelhead has a poor season.
1908 July 8	75,000 Quinault salmon caught this year; worth $35,000 to the tribesmen.
1909 June 30	30 Quinault families take in 120,000 salmon in 90 days for new record.
1909 October 13	Salmon catch sets high record.
1910 June 4	Quinault salmon run increases greatly in last three days, 5,000 fish per day.
1910 October 24	Salmon run breaks all records on the Harbor.
1911 November 8	Heavy salmon runs in Quinault and Queets Rivers.
1914 May 28	Best Quinault salmon run in years.
1915 January 7, February 26	Quinault reports best Steelhead run in years.
1916 September 30	Chinook run early and heavy.
1920 August 23	Quinaults opposed to a big shingle mill at Lake Quinault. Claim sawdust from the mill deadly to young fish.
1920 June 30	Small catch of Quinault salmon this season.
1921 April 29, June 2	Salmon count on Quinault River dwindles to 10,000 yearly and US government hopes to bring it back. Run of Quinault Blueback gaining larger by third than last year.
1921 July 29	Fishing on Quinault River poor; only 22,000 Bluebacks caught at season's close on the 1st. Average weight is 3,5 lb.
1922 June 5	Big Quinault salmon haul nets more dollars than 1915 run.
1923 June 15	Season ends.; Quinault catch at 150,000 fish. In 1922 it was 266,000; 65 Indians fishing river this year.
1924 January	Large Steelhead run reported.
1924 June 15	Bluebacks catch half as large as last year. Only 75,000 caught.
1925 March 31, April 10, 27	Quinaults gather at river at midnight for early opening of Blueback season. Salmon run on the Quinault is heavy, both on Quinault and Queets Rivers.
1926 October 20	Big Silver Salmon catch begins following heavy rains.
1927 May 4, June 20	Great amounts of "moss" clogging Blueback nets brings fishing to halt. Blueback run near end; peaked two weeks ago with 2,000 fish caught a day.
1927 October 8	Queets salmon catch is currently larger than that on the Quinault.
1928 January 21	Large Steelhead runs on Quinault and Queets Rivers.
1928 April 15	Quinault Blueback season opens.
1928 December 28	Fishing now poor with cold and snow on the upper Quinault.
1928 November 26	The Quinaults are making large catches of Silver and Chum Salmon on lower Quinault River.
1929 April 22	Early Blueback run good.
1929 September 23	Fishing lean for Quinault tribesmen.
1930 April 26	Quinault Salmon (Blueback) runs begin to pick up despite high water.
1930 June 30	Quinaults net more than 310.000 fish this season.
1930 May 2	Quinaults make big salmon catches; 75-100 fish per day per fisherman.
1930 May 27	Record Quinault salmon underway. Fishermen get 55 cents per fish.
1931 December 5	Salmon run big, prices poor.
1931 June 26	Blueback catch poor this year.

Table 18. Events on the QIR Associated with Fish (Workman 1997-2010).

Date	Information
1931 November 6	Record salmon rush continues. Largest in history of the oldest Indians.
1931 September 29	Rains increase run of salmon at Taholah.
1932 July 8	Tribe closes down fish season. Fair season (far below normal) and poor prices.
1932 June 22	Run of Blueback slackens.
1932 May 17	Salmon catch is big at Quinault.
1932 November 8	Tribesmen are catching 2,500 to 3,000 salmon a day.
1932 October 18	Brown's cannery at the mouth of Queets River is running now full time.
1933 February 23	Quinault Hatchery greets millions of infant salmon.
1933 May 13	Blueback catch still below normal.
1934 April 10	Blueback arrive in large numbers with recent rain.
1934 June 30	Blueback season fair; starts briskly and ends slowly.
1935 April 1	Blueback season opens 15 days earlier.
1935 February 20	Federal Government to improve Lake Quinault Hatchery.
1935 July 10	Blueback season closes today. Nearly 4,000 fish caught daily in mid-June.
1935 October 9, 19	Queets fishermen make largest haul in memory of Blacks (Kings) and Silvers this week. 92-pound Black (King) caught at Taholah.
1936 May 2	Tribe may build own fish plant.
1937 April 1	Quinault salmon season opens.
1937 June 5	2,000-5,000 Blueback caught each day.
1937 November 13	Driftwood cuts Taholah fish catches.
1938 March 11	Early Blueback run produces good hauls at Taholah.
1941 April 1	Blueback season opens.
1941 July	Enormous Blueback harvest nets 509,140 this season. (Largest single season catch ever recorded.)
1941 June 28	Quinault boils as Blueback fight their way to the lake to spawn.
1947 May 22	Blueback best in five years.
1948 April 16	Blueback salmon run points to good season.
1949 May 21	Blueback run strong.
1950 July	Blueback harvest tops 91,000.
1953 January 31	Indian fishermen at Taholah want state to stop interfering with their traditional fishery.
1953 July	Blueback harvest proves poor, 15,600.
1956 July	112,600 Blueback this year's harvest.
1959 August	25,300 Blueback harvested this year.
1961 March 27, 31	Quinaults close Lake Quinault to whites. Ban hunting too. Also ban Indians from fishing on Lake. Part of conservation move.
1962 July	Blueback harvest dips to less than 19,000; worst since 1953.
1965 July	21,6000 Blueback this year.
1965 September 24	Rivers flow at low levels.
1967 July	37,600 Blueback caught this year.
1970 July	Less than 6,000 Blueback caught this year; all time low.
1975 July	73,600 Blueback netted this season, best since 1956.
1975 September 18	Quinault postpone opening of Chehalis fisheries because of lack of fish.
1976 October 3	Quinaults close Grays Harbor fisheries due to small Chinook and Coho returns.
1977 September 30	Quinault Hatchery gets grant for back-up water supply system.
1978 July	21,000 Blueback caught this year.
1979 June 13	Quinaults close Lake Quinault to conserve low Sockeye Salmon run.
1982 June 5	Quinaults dedicate new hatchery.
1983 August 24	Quinault Tribal Hatchery ranks second highest in release among 16 treaty tribes in Washington.
1983 July	Blueback season nets only 679 fish; poorest season ever.
1983 October 1	Steel headers and Quinaults seeking common ground to improve fishery.
1983 September 29	Salmon catches down all along the West Coast.
1984 November 20	Joint project between Indians and the state to boost stock of salmon.

Table 18. Events on the QIR Associated with Fish (Workman 1997-2010).

Date	Information
1984 October 1	Rivers seem to be jumping with salmon.
1985 February 17	Quinaults second in fish production of tribal hatcheries in state.
1985 July 22	Quinaults surprised by excellent salmon run.
1985 November 13	Tribes given rights to hatchery fish.
1987 July	Blueback season nets 24,000.
1987 June 7	Quinaults top in list in hatchery production.
1990 July	Less than 9,000 Blueback caught this year.
1991 March 9	Cooperative effort breeds life into Steelhead survival.
1993 July	The 32,000 Blueback caught this year is best since 1975, but nowhere near the half million caught in 1941.
1995 July	A mere 207 Blueback netted this season; all time low. (22,000 fish made it to escapement.)
1997 July	Just over 2,500 Blueback caught this season.
1997 September	The Quinault River is full of salmon and the Indians are happy.
1999 March 16	Feds list nine Northwest salmon stocks as threatened or endangered.
2003 July 6	*The Daily World* features story about the best Blueback run in years.
2004 February 6	Washington Fish and Wildlife Commission votes for catch-and-release of all wild Steelhead from April 1, 2004 until March 31, 2006.
2004 March 14	Steelhead decision (see February 6, 2004) sparking a cultural war on the Olympic Peninsula.
2006 August 12	Recent fish kills along coast caused by oxygen poor water in recent upwellings.
2006 August 29	*The Daily World* runs feature on the effects of the “dead zone” which caused fish kill at Point Grenville in July.
2006 July 27	Large number of dead bottom fish wash ashore at Point Grenville.
2009 March 4	Scientists think weather changes left salmon starving in the Pacific in 2005.

Table 19. Events on the QIR Associated with Forestry (Workman 1997-2010).

Date	Information
1882 October	*Orient* loads first lumber cargo from Grays Harbor (North Western Lumber Company) to San Francisco.
1883 May	Logs are plenty in Hoquiam and the mill is running full time.
1884 July 13	73,000 feet of lumber cut made at Hoquiam is largest ever made in one day.
1885 April 22	A.M. Skeen started a log camp on the Wishkah river and says there is excellent timber on the river.
1885 July 30	Logging camps are all shut down. Logs have fallen to 50 cents per thousand.
1885 November 20	All the mills are running again.
1889 January 31	Timber claim fever is not abating.
1889 March 15	Logging quiet as lumber market poor. Still immense number of logs cut last year.
1892 August 26	Lumber markets are dull.
1892 July 22	Cedar logs are in demand.
1914 April 27	Quinault timber offers problems as allotments made on timber land.
1914 May 22	Many forest fires in Western Washington.
1918 January 22	Spruce logging puts a big burden on roads, notably those from the Quinault region.
1921 March 18	The January 29th Olympic storm worst on record. Timber damage is almost too vast to be estimated.
1922 August	‘Aloha’ starts logging on the Quinault Indian Reservation.
1927 August 3,	Proposal that timber strips be left on both banks of lower Quinault river to protect scenic beauty.
1928 July 6	Henry Steer says land ownership on the Quinault Reservation is a big problem to forest management.
1930 August 27	Moth pest hits Olympic forest.
1930 February 18	Quinault Indian Service spurs reforestation.
1930 June 12	Indian Service building fire road from Point Grenville to lookout.
1930 May 5	45,000 trees planted at Quinault Experimental Forest this spring at a cost about $10.50 per acre.
1930 November 7	A new type of beetle discovered in the Queets valley has interest of a zoologist.
1931 April 7	Spruce is being stripped out of Queets County.

Table 19. Events on the QIR Associated with Forestry (Workman 1997-2010).

Date	Information
1931 August 24	Quinault Seedling Nursery
1931 August 3	Timber surveying on the Reservation.
1931 July 13	Jams block the lower Quinault.
1931 July 16	Scientific poison, calcium arsenate, killing the hemlock loopers, is saver for timber.
1931 July 20	Big Baker Prairie fire burning through Aloha's slashings.
1931 July 22	Loggers recall big hemlock looper infestation on the Wishkah in 1891-92.
1932 August 2	Indians removing log jam on the Quinault river.
1932 October 7	Edict outlaws ax at Quinault. 1,400 acres of timber to be protected forever, will be known as the Quinault Natural Area.
1933 January	Thousands of feet of Queets spruce are, now being cut, allowed to rot because of lack of cheap transport. (Only the best logs were taken out.)
1933 July 6	First forest camp at Queets opens, first three on the Reservation. 25 working on road construction. Other camps to be at Taholah and Aloha.
1934 April 3	800,000 trees planted on the Reservation by ECW, mostly tribal members.
1934 September 17	Quinaults removed a large log jam and several small ones on the Quinault River this summer making it navigable.
1936 August 5, 13	Polson signs a new big stand contract on Quinault. Fire threatens Harbor forest.
1937 March 31	Some believe hemlock may be a Cinderella tree; will soon be valuable.
1940 August 3	Northwest trees have a seedless year.
1940 February 13	Quinaults win first point in legal battle against selective logging.
1941 January 29	Twenty years later dense new forest heals 1921 storm scars.
1945 October 13	Quinault Tribal Council sets up Committee to work with Taholah Indian Agency to arrange timber cutting on north side of reservation.
1949 April 7	US approved big Quinault timber sale of three big blocks north of Quinault river on the Reservation.
1949 January 26	Huge Quinault's timber sale planned north of Quinault River. (The 1929 sale of the same area was cancelled after protest.)
1951 October 10	Bears kill more trees than fires say foresters (tree stripping).
1952 June	Indians protest big timber sales.
1971 September 11	Quinaults shut down all logging on the Reservation to protest logging practices and stumpage payments. (Chow Chow.)
1978	Logging begins on the Wishkah, the first valley exploited for its timber resource. (Tributary of Chehalis river)
1979 October 2	First "modern" prescribed burn on Quinault Reservation.
1983 February 6	Quinault blow down.
1985 January 1	Timber collapse heads list of top '84 stories.
1989 January	Spotted owl debate continues and intensifies.
1990 June 22	Spotted owl listed as threatened.
1993 August 31	First seed crop collected from the Quinault Nation Seed Orchard.
1998 June 15	The mild winter leads to a large spruce aphid population along the coast and has resulted in a great deal of brown foliage in spruce trees.
2004 January 21	Land Commissioner Sutherland proposes clear-cut ban on old-growth stands located on state trust lands.
2004 April 26	QIN hosts the 28th Annual Intertribal Timber Council Symposium at the Quinault Beach Resort.
2009 August 24	Beetles, wildfires a double threat in a warming world.

Figure XII. Youth Art Contest Winner, 5th Place, Dillon Potter (top), racing canoe eagle head in Taholah, August 2009 (bottom).

Chapter 4. Natural Hazards Assessment

Chapter 4 presents hazard profiles for the QIR as developed from the Phase I Hazard Profile completed by the Planning Committee in July and August 2009, plus additional items identified during the planning process. Historical hazards experienced in this region are presented, plus State and Presidential Hazard Declarations in the area. The extent and location of each hazard's profile is discussed. The overview of this Chapter includes:

During the first two QIR Tribal Hazards Mitigation Plan Committee meetings, the attendees participated in a scoping exercise to subjectively place all relevant hazards into a matrix used to compare various hazard-importance levels based on the potential for the hazard to occur and its capacity to negatively affect people, structures, infrastructure, the economy, and traditional way of life of the QIR. This exercise helped to spark discussions about relative risks and the types of impacts commonly experienced. Resources for this discussion included the tabular risk analysis data presented in Table 21 and Table 22, augmented with the extensive personal experiences of the combined Planning Committee membership.

For the purposes of the Planning Committee discussion while creating the data found within Table 20, the relative categories of Low, Medium, and High were considered as follows:

- Probability of Occurrence
  - Low – historically, the listed hazard has been observed with a frequency of one or fewer notable events within a ten-year period. This category also includes infrequent hazard events that may occur only once a century.
  - Medium – the occurrence of the listed hazard has been observed more frequently than once in a ten year period, but less frequently than twice every five year period, on average.
  - High – the listed hazard has occurred more than twice every five years, and includes annual event hazards, and even multiple times per year hazards. To be considered for this ranking, the hazard does not necessarily occur every year, but when considered over a five-year period, the hazard is witnessed three or more times per five-year period.
- Potential to Impact People, Structures, Infrastructure, the Economy, and Traditional Way of Life
  - Low – the occurrence of the listed hazard has low potential to negatively impact the listed resources based on the exposure to developments and population centers, coupled with considerations for available resources to respond to these

threats. The risk exposure potentially impacts no lives and less than 25 structures when it is witnessed.

- o Medium – the occurrence of the listed hazard has moderate potential to negatively impact the listed resources based on the exposure to developments and population centers, coupled with considerations for available resources to respond to these threats. The risk exposure potentially impacts fewer than 5 lives or less than 50 structures when it is witnessed.
- o High – the occurrence of the listed hazard has high potential to negatively impact the listed resources based on the exposure to developments and population centers, coupled with considerations for available resources to respond to these threats. The risk exposure potentially impacts more than 5 lives or more than 50 structures with each occurrence.

The findings of the Planning Committee are summarized in Table 20.

Table 20. Phase I Hazard Assessment of QIR.

Probability of Occurrence	High		Wind Storms Mass Wasting	Severe Weather Flood Landslides (esp. infrastructure)
	Medium		Earthquakes & Seismic Shaking Hazards	
	Low	Drought		Wildland Fire Tsunami
		Low	Medium	High
		Potential to Impact People, Structures, Infrastructure, the Economy, and Traditional Way of Life		

These data presented the initial basis for evaluation in the QIR Tribal Hazards Mitigation Plan.

Additional discussions during these meetings and during subsequent considerations between planning committee members included attention given to:

1. Volcanic Activity,
2. Potential for oil spills along the coastline negatively affecting the QIR shoreline,
3. Hazardous Materials spills along US101 and SR109, and in commercial locations,
4. Civil Unrest and Terrorism incidents,
5. Mass Epidemics (human health),
6. Potential for Expansive Soils within the QIR.

The first hazard on this list, Volcanic Activity, was initially described as a natural hazard for the QIR. However, upon further discussion and analyses, it was recognized that all volcanic activity witnessed in the region is centered along the Cascade Mountain range, and that the non-volcanic Olympic Mountains provide a substantial buffer between the QIR and the source of volcanic activities. Earthquakes, seismic shaking hazards, tsunami, and related seismic events are discussed in Chapter 4, but the actual event of volcanic activity is not directly asserted.

The last of these potential hazards (Potential for Expansive Soils within the QIR) is a natural hazard and has been included in this hazard mitigation plan, in this chapter (Section 4.7.1, page 214). The other potential disasters (numbered 1-4, above) are not considered natural disasters and will not be directly addressed in this plan. However, there is a need for the QIN to address these other potential events in the near future and it is recommended that once the infrastructure of this “natural disasters” Tribal Hazards Mitigation Plan is established, that the

QIN initiate the needed planning and adoption of appropriate measures detailed in an appropriate planning document.

In relation to the human caused disasters referenced above (oil spills along the coastline and hazardous materials), there has been both some record of past disaster incidents, and responses from the QIR and surrounding jurisdictions. Most notable, in reference to an oil spill along the coastline, happened on December 23, 1988, when a tug boat, the U.S. Nestucca, collided with its oil-carrying barge and began an oil spill that would wreak ecological catastrophe along the Washington coastline, including the QIR shorelines (Storm 1989). The damage was seen through the loss of thousands of waterfowl lives, and the unquantifiable loss of shell fish, subterranean clams, and mussels. The tug boat causing in this incident was approaching Grays Harbor oil depot pulling a barge loaded with nearly 3 million gallons of oil. While approaching the harbor, the tow-cable broke and while attempting to reattach the cable, the tug and barge collided, cutting open a rift in the barge's oil storage compartment. Although the tow-cable was reattached the oil spill had started (Storm 1989).

The Capitan of the Barge contacted the US Coast Guard and the Washington Department of Ecology (DOE), the DOE gave the recommendation to the tug to head out to sea at a distance of 1 ½ miles from the shoreline to await repairs. Repairs were attempted, but were unsuccessful and the barge returned to Astoria, Oregon, as it continued to spill oil that would wash ashore along a 1,000 mile stretch of the Pacific coastline from British Columbia to California, including the QIR coastline (Storm 1989).

Within hours of incident Tribal, State, County, and Federal agencies began an assessment of the damages and organized a response and cleanup effort. The cleanup and recovery was accomplished with efforts by hundreds of oil clean-up experts, workers, and volunteers (Storm 1989). Although the long-term damages to the shoreline and wildlife have not been quantified as a result of this event, some research involving Washington State University has been conducted and observed that the frequency of Puffin waterfowl had substantially decreased following the oil-spill incident (including other impacts).

Coordination between the QIN's QDNR and the NW Spill Response Community including the US Coast Guard, and Washington DOE has been ongoing. There have been discussions between the QIN's QDNR and associated Federal and State agencies to increase the capacity of first responders and the need for the QIN to develop both an emergency response plan and a disaster mitigation plan concerning ocean oil spills and hazardous material spills along US101 and SR109. These efforts have not been realized to their potential as of yet.

A geologic abnormality exists within the QIR called the "Quinault Mud Volcano". The Garfield Gas Mound (a.k.a. mud volcano) is located north of Taholah and despite attempts to drill for oil here, only methane gas was retrieved. Mud volcanoes have been discovered near Taholah (the Garfield Gas Mound), another closer to the Cape Elizabeth, and more are seen along the shoreline in tidal pools from the sand moving north from Cape Elizabeth to Duck Creek. The lithologic description is thought to be geologically part of the Quinault Formation. Although no commercial oil extraction has been successful in this area, it is unknown how much oil can be extracted from these geologic formations on-shore, or off-shore (Workman 1991).

4.1. History of Past Natural Disasters

4.1.1. Major Presidential Disaster Declarations within and Adjacent to the QIR

When an emergency incident exceeds the capability of the local jurisdiction to adequately respond and requires assistance by the federal government, the State's Governor can request the President to make a major disaster declaration. This responsibility is not extended to the President of an Indian Nation, such as the QIN. The President of the QIN must make a formal request to the State's Governor, who can then extend the declaration to the US President.

The Code of Federal Regulations has defined a major disaster as:

> "Any natural catastrophe (including any hurricane, tornado, storm, high water, wind-driven water, tsunami, earthquake, volcanic eruption, landslide, mudslide, snowstorm, or drought), or, regardless of cause, any fire, flood, or explosion, in any part of the U.S. which in the determination of the President causes damage of sufficient severity and magnitude to warrant major disaster assistance under this Act to supplement the efforts and available resources of States, local governments, and disaster relief organizations in alleviating the damage, loss, hardship, or suffering caused thereby." (GPO 2007).

Table 21. Major Disaster Declarations that Included the Extent of the QIR (FEMA 2010).

Declaration Date		Incident Period	Disaster Types	Federal Disaster #
Year	Date			
2009	2-Mar	December 12, 2008 to January 5, 2009	Severe Winter Storm and Record and Near Record Snow	1825
2009	30-Jan	January 6-16, 2009	Severe Winter Storm, Landslides, Mudslides, and Flooding	1817
2007	8-Dec	December 1 - 17, 2007	Severe Storms, Flooding, Landslides, and Mudslides	1734
2007	14-Feb	December 14-15, 2006	Severe Winter Storm, Landslides, and Mudslides	1682
2006	12-Dec	November 2-11, 2006	Severe Storms, Flooding, Landslides, and Mudslides	1671
2006	17-May	January 27 to February 4, 2006	Severe Storms, Flooding, Tidal Surge, Landslides, and Mudslides	1641
2003	7-Nov	October 15-23, 2003	Severe Storms and Flooding	1499
2001	1-Mar	February 28, 2001 through March 16, 2001	Earthquake	1361
1997	2-Apr	Not verified in FEMA Records	Severe Storms, Flooding, Landslides, and Mudslides	1172
1997	17-Jan	Not verified in FEMA Records	Severe Winter Storms and Flooding	1159
1997	7-Jan	Not verified in FEMA Records	Ice and Snow Storms	1152
1996	9-Feb	Not verified in FEMA Records	Severe Storms and Flooding	1100
1996	3-Jan	Not verified in FEMA Records	Storms, High Winds, and Flooding	1079
1994	2-Aug	Not verified in FEMA Records	El Niño Effects (Salmon Industry)	1037
1993	4-Mar	Not verified in FEMA Records	Severe Storm and High winds	981
1991	13-Nov	Not verified in FEMA Records	Fires	922
1991	8-Mar	Not verified in FEMA Records	High Tides and Severe Storm	896
1990	26-Nov	Not verified in FEMA Records	Flooding and Severe Storm	883
1990	18-Jan	Not verified in FEMA Records	Flooding and Severe Storm	852
1989	14-Apr	Not verified in FEMA Records	Heavy Rains, Flooding, and Mudslides	822
1986	15-Dec	Not verified in FEMA Records	Severe Storms and Flooding	784
1986	26-Jul	Not verified in FEMA Records	Severe Storms and Flooding	769
1986	19-Mar	Not verified in FEMA Records	Heavy Rains, Flooding, and Landslides	762
1986	15-Feb	Not verified in FEMA Records	Severe Storms and Flooding	757
1983	27-Jan	Not verified in FEMA Records	Severe Storms, High Tides, and Flooding	676
1980	21-May	Not verified in FEMA Records	Volcanic Eruption: Mount St. Helens	623
1979	31-Dec	Not verified in FEMA Records	Storms, High Tides, Mudslides, and Flooding	612
1977	10-Dec	Not verified in FEMA Records	Severe Storms, Mudslides, and Flooding	545
1975	13-Dec	Not verified in FEMA Records	Severe Storms and Flooding	492
1974	25-Jan	Not verified in FEMA Records	Severe Storms, Snowmelt, and Flooding	414
1972	10-Jun	Not verified in FEMA Records	Severe Storms and Flooding	334
1972	24-Mar	Not verified in FEMA Records	Heavy Rains and Flooding	328
1972	1-Feb	Not verified in FEMA Records	Severe Storms and Flooding	322
1971	9-Feb	Not verified in FEMA Records	Heavy Rains, Snowmelt, and Flooding	300
1965	11-May	Not verified in FEMA Records	Earthquake	196

Table 21. Major Disaster Declarations that Included the Extent of the QIR (FEMA 2010).

Declaration Date		Incident Period	Disaster Types	Federal Disaster #
Year	Date			
1964	29-Dec	Not verified in FEMA Records	Heavy Rains and Flooding	185
1963	2-Mar	Not verified in FEMA Records	Floods	146
1962	20-Oct	Not verified in FEMA Records	Severe Storms	137
1957	6-Mar	Not verified in FEMA Records	Floods	70
1956	25-Feb	Not verified in FEMA Records	Flood	50

4.1.2. SHELDUS Hazard Event Profile

SHELDUS (University of South Carolina 2009) is a county-level hazard data set for the U.S. for 18 different natural hazard event types such as thunderstorms, hurricanes, floods, wildfires, tsunami, and high winds maintained by the Hazards & Vulnerability Research Institute at the University of South Carolina. For each event the database includes the beginning date, location (county and state), property losses, crop losses, injuries, and fatalities that affected, or were attributed to, each county. SHELDUS Hazard Profile for Grays Harbor County and Jefferson County, Washington, 1960-2008 has been combined into a summary of natural disasters that either resulted in damages on the QIR, or adjacent to the QIR. The damages summarized in Table 22 do not represent damages just on the QIR. This summary is inclusive of the listed disasters in their effect across the region. Some of these events were also reported in Table 21. At this time, there is not a comprehensive disaster summary database created for Indian Reservations in the USA. Summaries (Table 21 and Table 22) are intended to represent the natural disasters that have generally impacted the region of the QIR.

Table 22. SHELDUS Hazard Profile for Quinault Indian Reservation and Adjacent Counties in Washington (University of South Carolina 2009).

Begin Date	End Date	Hazard type	Injuries	Fatalities	Property Damage	Remarks	Property Damage 2008
1/28/1960	1/29/1960	Severe Storm/Thunder Storm - Wind	0	2	$2,941.18	RAIN, WIND	$21,848.02
2/2/1960	2/2/1960	Wind	0	0	$4,545.45	WIND	$33,765.04
2/14/1960	2/14/1960	Severe Storm/Thunder Storm - Wind	0	0	$833.33	Wind and Rain	$6,190.24
2/14/1960	2/14/1960	Severe Storm/Thunder Storm - Wind	0	0	$500.00	WIND	$3,714.16
2/20/1960	2/20/1960	Wind	0	0	$1,000.00	WIND	$7,428.32
3/3/1960	3/3/1960	Wind - Winter Weather	0	0	$454.55	SNOW, FREEZING RAIN, WIND	$3,376.54
3/14/1960	3/14/1960	Wind	0	0	$45.45	Wind	$337.62
4/13/1960	4/14/1960	Wind	0	0	$2,941.18	WIND	$21,848.02
4/13/1960	4/14/1960	Wind	0	0	$2,941.18	WIND	$21,848.02
9/4/1960	9/4/1960	Wind	0	0	$294.12	Wind	$2,184.82
9/12/1960	9/12/1960	Lightning	0	0	$294.12	Electrical	$2,184.82
10/6/1960	10/6/1960	Wind	0	0	$100.00	Wind	$742.83
10/23/1960	10/23/1960	Severe Storm/Thunder Storm - Wind	0	0	$29.41	Rain-wind	$218.47
11/16/1960	11/17/1960	Wind	0	0	$294.12	Wind	$2,184.82
11/20/1960	11/20/1960	Winter Weather	0.06	0	$2,941.18	SNOW	$21,848.02
11/24/1960	11/24/1960	Severe Storm/Thunder Storm	0	0	$4,545.45	HEAVY RAINS	$33,765.04
1/7/1961	1/7/1961	Wind	0	0	$454.55	Wind	$3,376.54
1/12/1961	1/12/1961	Wind	0.11	0	$5,555.56	WIND	$41,268.46
1/13/1961	1/15/1961	Severe Storm/Thunder Storm	0	0	$4,545.45	HEAVY PRECIPITATION	$33,765.04
2/18/1961	2/21/1961	Severe Storm/Thunder Storm	0	0	$-	HEAVY PRECIPITATION	$-
3/19/1961	3/20/1961	Wind	0	0	$454.55	Wind	$3,376.54
9/28/1961	9/28/1961	Wind	0	0	$128.21	WIND AND DUST STORM	$952.38
10/6/1961	10/6/1961	Severe Storm/Thunder Storm	0	0	$7,142.86	THUNDERSTORM	$53,059.43
10/26/1961	10/26/1961	Wind	0	0	$294.12	Wind	$2,184.82
11/10/1961	11/10/1961	Wind	0	0	$454.55	Wind	$3,376.54
11/22/1961	11/22/1961	Wind	0	0	$263.16	Wind	$1,954.84
12/20/1961	12/21/1961	Wind	0	0	$1,282.05	WIND	$9,523.47
4/27/1962	4/27/1962	Wind	0	0.03	$128.21	WIND	$888.93
10/12/1962	10/20/1962	Wind	2	0	$350,000.00	WIND, SEVERE STORM	$2,426,604.79
11/19/1962	11/20/1962	Severe Storm/Thunder Storm - Wind	0.05	0	$13,157.89	Wind and rain	$91,228.52
11/24/1962	11/25/1962	Wind	0	0	$1,315.79	Wind	$9,122.86
8/11/1963	8/13/1963	Severe Storm/Thunder Storm	0.08	0	$1,282.05	THUNDERSTORMS	$8,888.93
10/21/1963	10/24/1963	Wind	0	0	$1,282.05	WIND	$8,888.93
1/16/1964	1/17/1964	Wind	0	0	$294.12	Wind	$2,039.24
1/19/1964	1/19/1964	Wind	0	0	$1,282.05	WIND	$8,888.93

Table 22. SHELDUS Hazard Profile for Quinault Indian Reservation and Adjacent Counties in Washington (University of South Carolina 2009).

Begin Date	End Date	Hazard type	Injuries	Fatalities	Property Damage	Remarks	Property Damage 2008
12/16/1964	12/23/1964	Severe Storm/Thunder Storm - Winter Weather	0	0.03	$128,205.13	Cold wave, heavy snowfall, heavy rain	$888,893.64
1/26/1965	1/31/1965	Flooding - Landslide - Winter Weather	0	0	$12,820.51	Flooding, mud slide, snow slide	$88,889.34
2/27/1965	2/27/1965	Wind	0	0	$128.21	Wind	$888.93
5/15/1965	5/16/1965	Wind	0	0.03	$128.21	Wind	$888.93
7/25/1965	7/27/1965	Severe Storm/Thunder Storm	0	0	$128.21	Thunderstorms	$888.93
10/4/1965	10/5/1965	Wind	0	0	$128.21	Wind	$888.93
11/18/1965	11/19/1965	Wind	0	0	$454.55	Wind	$3,151.56
12/27/1965	12/28/1965	Wind	0	0	$454.55	Wind	$3,151.56
1/19/1967	1/19/1967	Severe Storm/Thunder Storm - Wind	0	0	$4,545.45	RAIN AND WIND	$29,544.69
1/29/1967	1/29/1967	Wind	0	0	$1,282.05	WIND	$8,333.12
2/17/1967	2/17/1967	Wind	0	0	$1,282.05	Wind	$8,333.12
3/9/1967	3/9/1967	Wind	0	0	$128.21	Wind	$833.34
3/15/1967	3/16/1967	Wind	0	0	$128.21	Wind	$833.34
3/23/1967	3/23/1967	Wind	0	0	$128.21	Wind	$833.34
10/1/1967	10/1/1967	Severe Storm/Thunder Storm - Wind - Winter Weather	0	0	$277.78	Wind, rain, snow	$1,805.52
10/2/1967	10/3/1967	Wind	0	0	$128.21	Wind	$833.34
12/1/1967	12/2/1967	Coastal - Flooding - Severe Storm/Thunder Storm - Wind - Winter Weather	0	0	$4,545.00	WINTER STORM, FLOODING, WIND, TIDES	$29,541.76
12/3/1968	12/4/1968	Severe Storm/Thunder Storm - Wind	0	0	$1,282.05	Wind and rain	$7,843.20
12/30/1968	12/31/1968	Winter Weather	0	0	$1,282.05	Snow	$7,843.20
1/3/1969	1/10/1969	Severe Storm/Thunder Storm	0	0	$29,411.76	Rain	$169,931.59
3/22/1969	3/22/1969	Wind	0	0	$1,282.05	Wind	$7,407.27
12/14/1969	12/14/1969	Wind	0	0	$454.55	Wind	$2,626.24
9/10/1970	9/12/1970	Wind	0	0	$128.21	WIND	$701.79
1/14/1971	1/15/1971	Wind - Winter Weather	0	0.03	$1,282.05	WIND AND SNOW	$6,666.58
1/22/1971	1/26/1971	Severe Storm/Thunder Storm - Wind - Winter Weather	0.33	0	$2,777.78	WIND, RAIN AND SNOW	$14,444.28
2/24/1971	2/24/1971	Wind	0	0	$-	Wind	$-
3/26/1971	3/26/1971	Wind	0	0	$12,820.51	WIND	$66,665.85
12/8/1971	12/8/1971	Wind	0	0	$384.62	Wind	$2,000.00
1/11/1972	1/11/1972	Wind	0.15	0.05	$12,820.50	WIND	$66,665.80
1/24/1972	1/25/1972	Winter Weather	0	0	$12,820.51	NEAR BLIZZARD	$66,665.85
1/24/1972	2/4/1972	Winter Weather	0	0	$12,820.51	FREEZE	$66,665.85
2/15/1972	2/16/1972	Wind	0.26	0	$12,820.51	WINDSTORM	$66,665.85

Table 22. SHELDUS Hazard Profile for Quinault Indian Reservation and Adjacent Counties in Washington (University of South Carolina 2009).

Begin Date	End Date	Hazard type	Injuries	Fatalities	Property Damage	Remarks	Property Damage 2008
2/27/1972	2/29/1972	Flooding - Landslide - Severe Storm/Thunder Storm - Wind	0.25	0	$41,666.70	HEAVY RAINS, FLOODS, EARTH SLIDES, WIND	$216,664.24
3/5/1972	3/6/1972	Flooding - Landslide - Wind	0	0	$2,777.78	WIND, FLOOD, SLIDES	$14,444.28
11/25/1972	11/25/1972	Coastal	0	3	$100.00	High Waves	$519.99
12/4/1972	12/15/1972	Winter Weather	0	0	$12,820.51	COLD, FREEZE, SNOW	$66,665.85
12/18/1972	12/22/1972	Coastal - Flooding - Landslide	0	0	$18,518.52	LOCAL FLOODS, AND MUD SLIDES, STORM TIDE	$96,295.15
12/18/1972	12/22/1972	Coastal - Flooding - Landslide	0	0	$18,518.52	LOCAL FLOODS, AND MUD SLIDES, STORM TIDE	$96,295.15
12/25/1972	12/27/1972	Flooding - Landslide	0	0	$250,000.00	LOCAL FLOODS AND MUD SLIDES	$1,299,984.40
12/11/1973	12/11/1973	Coastal - Wind	0.38	0	$62,500.00	WIND & HIGH TIDES	$309,528.53
1/14/1974	1/15/1974	Coastal - Wind - Winter Weather	0	0	$50,000.00	WIND, HIGH TIDE, THAW	$216,665.94
1/3/1975	1/4/1975	Wind	0	0	$454.55	Wind	$1,818.20
1/7/1975	1/8/1975	Wind - Winter Weather	0.05	0	$1,282.05	Wind and Snow	$5,128.20
2/19/1975	2/19/1975	Wind	0	0	$1,282.05	Wind	$5,128.20
12/2/1975	12/7/1975	Flooding - Severe Storm/Thunder Storm	0	0	$38,461,538.46	HEAVY RAINS AND MAJOR FLOODS	$153,846,153.84
12/10/1975	12/10/1975	Wind	0	0	$5,000.00	Winds	$20,000.00
12/26/1975	12/26/1975	Wind	0	0	$-	WINDSTORM	$-
12/8/1976	12/8/1976	Wind	0.38	0	$3,846.15	Wind	$14,814.54
11/1/1977	11/1/1977	Wind	0.13	0	$6,250.00	Wind Storm	$22,413.48
12/1/1977	12/2/1977	Severe Storm/Thunder Storm	0.27	1	$45,454.50	heavy rain	$163,006.99
12/15/1977	12/15/1977	Wind	0	0	$10,000.00	Wind	$35,861.57
11/3/1978	11/3/1978	Severe Storm/Thunder Storm - Wind	0	0	$4,545.45	Wind, Heavy Rain	$14,772.82
2/12/1979	2/13/1979	Wind	0	1	$2,941,180.00	wind storm	$8,739,466.33
12/13/1979	12/19/1979	Severe Storm/Thunder Storm	0.5	0	$416,667.00	heavy rain	$1,238,090.57
8/17/1980	8/17/1980	Lightning - Wind	0	0	$7,142.86	wind, lightning	$18,571.21
11/14/1981	11/15/1981	Wind	0	0	$128,205.00	High Winds	$303,027.80
1/23/1982	1/23/1982	Severe Storm/Thunder Storm	0	0	$13,158.00	Rain	$29,115.77
2/13/1982	2/13/1982	Landslide - Severe Storm/Thunder Storm	0	1	$250,000.00	Rain/mudslides	$553,195.26
10/22/1982	10/22/1982	Wind	0	0	$6,250.00	Wind	$13,829.88
12/15/1982	12/18/1982	Coastal - Flooding - Wind	0	0	$416,667.00	Tidal Flooding/Wind	$921,992.83
12/21/1982	12/21/1982	Wind	0	1	$8,333.33	Wind	$18,439.83
11/24/1983	11/24/1983	Wind	0	0	$45,454.55	Wind	$98,484.53
12/2/1985	12/2/1985	Winter Weather	0	0	$128.21	ice storm	$256.42

Table 22. SHELDUS Hazard Profile for Quinault Indian Reservation and Adjacent Counties in Washington (University of South Carolina 2009).

Begin Date	End Date	Hazard type	Injuries	Fatalities	Property Damage	Remarks	Property Damage 2008
1/16/1986	1/16/1986	Wind	0	0	$45,454.55	Wind	$89,193.03
1/18/1986	1/18/1986	Flooding - Severe Storm/Thunder Storm - Wind	0	0	$294,117.65	Heavy rain, wind, flooding	$577,131.29
11/23/1986	11/23/1986	Flooding	0	0	$416,667.00	Flood	$817,603.31
12/9/1987	12/9/1987	Wind	0	0	$12,820.51	High Wind	$24,242.24
12/9/1987	12/9/1987	Severe Storm/Thunder Storm	0	0	$1,282.05	Heavy Rain	$2,424.22
1/15/1988	1/15/1988	Wind	0	0	$4,545.45	Wind	$8,293.41
2/1/1989	2/1/1989	Winter Weather	0	0.03	$128,205.00	SNOWSTORM	$222,223.19
1/6/1990	1/6/1990	Wind	0	0	$2,777.78	High Wind	$4,585.54
1/9/1990	1/9/1990	Flooding	0	0	$3,846,153.85	Flood	$6,349,198.29
1/28/1990	1/28/1990	Wind	0	0	$14,705.88	High Wind	$24,276.34
2/10/1990	2/10/1990	Flooding	0	0	$45,454.55	Flood	$75,035.99
11/9/1990	11/14/1990	Flooding	0	0	$7,142,857.14	Floods	$11,791,368.24
11/22/1990	11/23/1990	Wind	0	0	$12,820.51	High Winds	$21,163.99
11/23/1990	11/25/1990	Flooding	0	0	$4,166,670.00	Floods	$6,878,303.65
12/18/1990	12/19/1990	Wind - Winter Weather	0	0	$416,667.00	Snowstorm, High Winds	$687,830.36
12/19/1990	12/25/1990	Winter Weather	0	0	$1,282.05	Hard Freeze	$2,116.40
12/28/1990	12/29/1990	Wind - Winter Weather	0	0	$277,778.00	High Winds, Snowstorm	$458,553.58
12/29/1990	12/31/1990	Winter Weather	0	0	$1,282.05	Hard Freeze	$2,116.40
4/4/1991	4/8/1991	Flooding	0	0	$45,454.55	Flood	$71,624.83
8/29/1991	8/29/1991	Wind	0	0	$3,333.33	High Winds	$5,252.48
11/16/1991	11/17/1991	Wind	0	0	$45,454.55	Wind	$71,624.83
11/19/1991	11/19/1991	Wind	0	0	$3,846.15	Wind	$6,060.56
12/12/1991	12/12/1991	Wind	0	0	$4,545.45	Wind	$7,162.48
1/3/1992	1/3/1992	Coastal	0.33	0.67	$1,666.67	Heavy Swell	$2,549.01
12/9/1992	12/9/1992	Flooding	0	0	$10,000.00	Flood	$15,294.03
1/20/1993	1/20/1993	Wind	4.43	0	$7,142,860.00	High Wind	$10,612,200.63
12/8/1993	12/8/1993	Wind	0	0	$4,545.45	High Winds	$6,753.21
12/8/1993	12/8/1993	Wind	0	0	$4,545.45	High Winds	$6,753.21
12/9/1993	12/10/1993	Wind	0	0	$4,545.45	High Winds	$6,753.21
11/8/1995	11/8/1995	Flooding - Severe Storm/Thunder Storm	0	0.09	$-	FLOOD AND HEAVY RAIN	$-
11/28/1995	11/29/1995	Flooding - Severe Storm/Thunder Storm	0	0	$555,555.56	FLOOD AND HEAVY RAIN	$780,779.10
12/29/1996	12/29/1996	Flooding	0	1	$-	FLOODS	$-
3/15/1997	3/19/1997	Severe Storm/Thunder Storm	0	0	$1,200,000.00	HEAVY RAIN	$1,600,000.00
3/20/1997	3/20/1997	Flooding	0	0	$133,333.33	FLOODS	$177,777.77
3/30/1997	3/30/1997	Wind	0.29	0.14	$17,857.14	HIGH WIND	$23,809.52

Table 22. SHELDUS Hazard Profile for Quinault Indian Reservation and Adjacent Counties in Washington (University of South Carolina 2009).

Begin Date	End Date	Hazard type	Injuries	Fatalities	Property Damage	Remarks	Property Damage 2008
6/26/1997	6/26/1997	Severe Storm/Thunder Storm - Wind	0	0	$25,000.00	THUNDERSTORM WIND	$33,333.33
11/23/1998	11/24/1998	Wind	0	0	$4,702,857.14	HIGH WIND	$6,191,065.45
12/27/1998	12/28/1998	Severe Storm/Thunder Storm	0	0	$200,000.00	HEAVY RAIN	$263,289.54
1/28/1999	1/29/1999	Wind	0	0	$41,666.67	HIGH WIND	$54,166.73
2/5/1999	2/5/1999	Wind	0	0	$1,571.43	HIGH WIND	$2,042.86
2/11/1999	2/11/1999	Wind	0	0	$6,818.18	HIGH WIND	$8,863.64
3/2/1999	3/3/1999	Wind	0	0.07	$214,285.71	HIGH WIND	$278,571.70
3/3/1999	3/3/1999	Coastal	0	0	$1,000,000.00	STORM SURGE	$1,300,001.30
8/5/1999	8/5/1999	Lightning	0	0	$15,500.00	LIGHTNING	$20,150.02
10/27/1999	10/27/1999	Wind	0	0.08	$7,692.31	HIGH WIND	$10,000.01
11/3/1999	11/3/1999	Wind	0	0	$29,166.67	HIGH WIND	$37,916.71
11/11/1999	11/12/1999	Flooding	0	0	$6,666.67	FLOODS	$8,666.68
12/15/1999	12/15/1999	Severe Storm/Thunder Storm	0	0	$20,000.00	HEAVY RAIN	$26,000.03
1/10/2000	1/10/2000	Wind	0	0.08	$1,000.00	HIGH WIND	$1,253.01
1/16/2000	1/16/2000	Wind	0	0.04	$107,692.31	HIGH WIND	$134,939.24
11/4/2000	11/4/2000	Wind	0	0	$33,333.33	HIGH WIND	$41,766.90
12/14/2000	12/15/2000	Wind	0	0	$123,529.41	HIGH WIND	$154,783.24
12/16/2000	12/16/2000	Wind	0	0	$100,000.00	HIGH WIND	$125,300.72
2/15/2001	2/16/2001	Winter Weather	0	0	$500.00		$604.65
3/13/2001	3/13/2001	Wind	0.2	0	$6,400.00		$7,739.56
8/21/2001	8/23/2001	Severe Storm/Thunder Storm	0	1	$-		$-
10/23/2001	10/23/2001	Wind	0	0	$1,333.33		$1,612.41
11/14/2001	11/14/2001	Flooding	0	0	$5,714.29		$6,910.33
11/28/2001	11/28/2001	Wind	0	0.5	$-		$-
12/1/2001	12/1/2001	Wind	0	0	$75,000.00		$90,698.01
12/13/2001	12/14/2001	Wind	0	0	$80,000.00		$96,744.55
12/15/2001	12/16/2001	Wind	0	0	$150,000.00		$181,396.02
12/16/2001	12/19/2001	Flooding	0	0	$15,000.00		$18,139.60
1/7/2002	1/10/2002	Flooding	0	0	$18,181.82		$21,734.55
4/13/2002	4/14/2002	Wind	0	0	$571,428.57		$683,085.77
11/8/2002	11/8/2002	Coastal - Wind	0	0	$5,000.00		$5,977.00
12/14/2002	12/14/2002	Wind	0	0	$35,000.00		$41,839.00
12/15/2002	12/15/2002	Wind	0	0	$10,000.00		$11,954.00
12/25/2002	12/25/2002	Wind	0	0	$13,333.33		$15,938.66
12/27/2002	12/27/2002	Wind	0.11	0	$366,666.67		$438,313.37

Table 22. SHELDUS Hazard Profile for Quinault Indian Reservation and Adjacent Counties in Washington (University of South Carolina 2009).

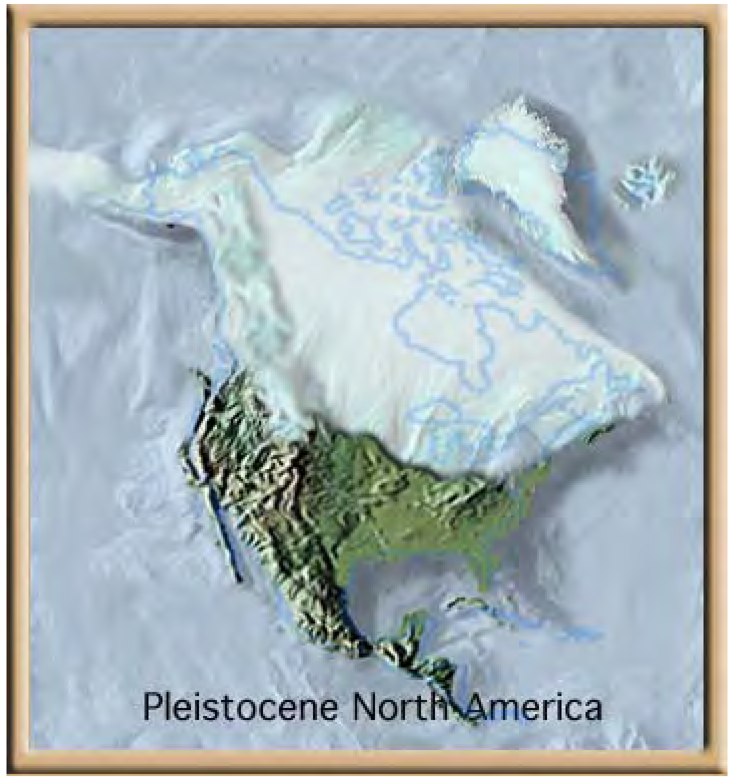
Begin Date	End Date	Hazard type	Injuries	Fatalities	Property Damage	Remarks	Property Damage 2008
1/1/2003	1/2/2003	Wind	0	0	$16,666.67		$19,475.64
1/2/2003	1/3/2003	Wind	0	0	$142,857.14		$166,934.04
1/2/2003	1/3/2003	Coastal	0	0	$12,857.14		$15,024.06
1/31/2003	1/31/2003	Flooding	0	0	$20,000.00		$23,370.77
3/12/2003	3/13/2003	Wind	0	0.09	$90,909.09		$106,230.75
3/12/2003	3/13/2003	Wind	0	0.09	$90,909.09		$106,230.75
10/16/2003	10/16/2003	Wind	0	0	$100,000.00		$116,853.83
10/16/2003	10/18/2003	Flooding	0	0	$318,181.82		$371,807.64
10/20/2003	10/20/2003	Severe Storm/Thunder Storm	0	0	$100,000.00		$116,853.83
10/20/2003	10/23/2003	Flooding	0	0	$1,357,142.86		$1,585,873.38
11/28/2003	11/28/2003	Wind	0	0	$100,000.00		$116,853.83
1/6/2004	1/6/2004	Winter Weather	0	0	$90,909.09		$103,896.10
2/24/2004	2/24/2004	Wind	0	0	$8,000.00		$9,142.86
3/18/2004	3/18/2004	Wind	0	0	$50,000.00		$57,142.86
4/27/2004	4/27/2004	Wind	0	0	$750,000.00		$857,142.86
8/17/2004	8/17/2004	Lightning	0	0	$5,000.00	Lightning	$5,714.29
11/15/2004	11/15/2004	Wind	0	0	$5,000.00	HIGH WIND	$5,714.29
11/24/2004	11/26/2004	Flooding	0	0	$9,090.90	FLOOD	$10,389.60
12/10/2004	12/12/2004	Flooding	0	0	$41,666.66	Flood	$47,619.04
1/7/2005	1/7/2005	Winter Weather	0	0	$36,000.00	Heavy Snow	$39,829.62
3/10/2005	3/30/2005	Drought	0	0	$800,000.00	Drought	$885,102.62
3/20/2005	3/20/2005	Wind	0	0	$8,875.00	High Wind	$9,819.11
11/5/2005	11/5/2005	Wind	0	0	$125,000.00	High Wind	$138,297.28
12/1/2005	12/2/2005	Winter Weather	0	0	$1,666.67	Heavy Snow	$1,843.97
12/24/2005	12/26/2005	Severe Storm/Thunder Storm	0	0	$100,000.00	Heavy Rain	$110,637.83
12/25/2005	12/25/2005	Wind	0	0	$50,000.00	Strong Wind	$55,318.91
1/1/2006	1/1/2006	Wind	0	0	$20,000.00	High Wind (G52)	$21,443.35
1/5/2006	1/14/2006	Severe Storm/Thunder Storm	0	0	$2,900,000.00	Heavy Rain	$3,109,286.04
1/28/2006	1/28/2006	Wind	0	0	$13,333.33	High Wind (G60)	$14,295.56
2/3/2006	2/4/2006	Wind	0.11	0	$833,333.33	High Wind (G68)	$893,473.00
2/4/2006	2/4/2006	Coastal - Flooding	0	0	$166,666.67	Coastal Flood	$178,694.60
2/10/2006	2/10/2006	Wind	0	0	$5,000.00	Strong Wind	$5,360.84
2/17/2006	2/17/2006	Wind	0.2	0	$240,000.00	Strong Wind	$257,320.22
3/8/2006	3/8/2006	Wind	0	0	$166,666.67	High Wind (G59)	$178,694.60
11/4/2006	11/7/2006	Severe Storm/Thunder Storm	0	0	$5,500,000.00	Heavy Rain	$5,896,921.81

Table 22. SHELDUS Hazard Profile for Quinault Indian Reservation and Adjacent Counties in Washington (University of South Carolina 2009).

Begin Date	End Date	Hazard type	Injuries	Fatalities	Property Damage	Remarks	Property Damage 2008
11/4/2006	11/9/2006	Flooding	0	0	$760,000.00	Flood	$814,847.38
11/6/2006	11/6/2006	Landslide	0	0	$33,333.33	Landslide	$35,738.92
11/12/2006	11/15/2006	Wind	0.91	0	$727,272.73	High Wind (G82)	$779,758.26
11/26/2006	11/27/2006	Winter Weather	0	0	$1,083,333.33	Heavy Snow	$1,161,514.90
12/11/2006	12/11/2006	Wind	0	0	$23,333.33	High Wind (G72)	$25,017.24
12/14/2006	12/15/2006	Wind	3	0	$4,558,333.33	High Wind (G78)	$4,887,297.31
1/2/2007	1/2/2007	Wind	0	0	$5,555.56	Strong Wind	$5,777.77
1/5/2007	1/6/2007	Wind	0	0	$166,666.67	High Wind (G56)	$173,333.06
1/9/2007	1/9/2007	Wind	0	0	$40,000.00	High Wind (G54)	$41,599.93
3/11/2007	3/11/2007	Wind	0	0	$1,750.00	Strong Wind	$1,820.00
10/18/2007	10/18/2007	Wind	0	0	$375,000.00	High Wind	$389,999.38
11/12/2007	11/12/2007	Wind	0	0	$14,285.71	High Wind	$14,857.11
12/2/2007	12/3/2007	Wind	10	1	$20,000,000.00	High Wind, M57OU	$20,799,966.72
12/2/2007	12/3/2007	Severe Storm/Thunder Storm	0	0	$3,000,000.00	Heavy Rain	$3,119,995.01
12/3/2007	12/3/2007	Wind	0	0	$500,000.00	High Wind	$519,999.17
12/3/2007	12/3/2007	Landslide	0	0	$50,000.00	Landslide	$51,999.92
1/14/2008	1/14/2008	Wind	0	0	$2,500.00	Strong Wind	$2,500.00
6/9/2008	6/9/2008	Wind	0	0	$6,250.00	Strong Wind	$6,250.00
11/12/2008	11/12/2008	Severe Storm/Thunder Storm	0	0	$500,000.00	Heavy Rain	$500,000.00
12/12/2008	12/12/2008	Wind	0	0	$50,000.00	High Wind	$50,000.00
12/17/2008	12/17/2008	Winter Weather	0	0	$57,692.31	Heavy Snow	$57,692.31
12/20/2008	12/21/2008	Winter Weather	0	0	$113,636.36	Heavy Snow	$113,636.36
12/21/2008	12/22/2008	Winter Weather	0.09	0	$550,136.36	Heavy Snow	$550,136.36
12/24/2008	12/24/2008	Winter Weather	0	0	$45,000.00	Heavy snow	$45,000.00
12/30/2008	12/31/2008	Wind	0	0	$50,000.00	High Wind	$50,000.00
12/31/2008	12/31/2008	Wind	0	0	$70,000.00	High Wind	$70,000.00

4.2. Global Climate Change

Figure XIII. Paleogeography based on The Evolution of North America (Scotese 2003) showing the glacial ice cap over North America during the last ice age.



During the initial scoping of the QIR Phase I Hazard Profile with the Planning Committee, discussions included the topic of global climate change and the resulting changes to weather, shoreline encroachment, flood, drought, and other weather changes to the cycle of life on the QIR. In response to these discussions, this planning effort has been cast in the light of potential changes to natural disasters resulting from global climate change. This chapter begins with a cursory review of historical changes to the climate, and recent impacts from those changes.

Many of the sub-sections to this chapter, begin by sharing native folklore tales to explain the natural disasters observed over the centuries of oral tradition. These legends are not intended to explain what we today understand to be weather pattern changes, seismic stability, or tsunami generated ocean waves. These legends demonstrate that the native cultures of the Pacific Northwest have dealt with the negative effects of natural disasters for the extent of human history along these shorelines. Historical responses to those natural disasters are as important to dealing with the disasters today as they were in the past.

Earthquake and flood references are common in Native oral traditions all along the Cascadia margin. Some of these stories are literal, and clearly refer to recent historical happenings. Other stories refer to earthquake or tsunami effects metaphorically. The battle between the Thunderbird and Whale is an often-told indigenous story from the Pacific Ocean coastline of this region that appears to be related to great subduction zone earthquakes along the coast of Cascadia. References to Thunderbird (or analogous wind figures) and to whale (or analogous water figures) are found in connection with shaking and flooding all along the Cascadia coast (Ludwin 2002).

About 12,000 years ago vast continental glaciers were in retreat (Figure XIII), leaving behind rounded valleys and marshy meadows. There were no dense forests during the glaciation. Elk, bison, wolves and mastodons roamed the land, and humans roamed with them (NPS 2009).

The American mastodon (*Mammut americanum*) lived in this region of North America. Mastodons are thought to have first appeared almost four million years ago and became extinct about 10,000 years ago, at the same time as most other Pleistocene megafauna. Though their habitat spanned a large territory, mastodons were most common in ice age spruce forests within and around the QIR (Crystal 2010). During the Pleistocene Epoch, 1.6 million to 10,000 years ago, much of North America was covered by great sheets of ice (Scotese 2003) (Figure XIII).

A partial skeleton of a mastodon was recovered from shorelines within a thick deposit of "blue" lake clays along the lower Quinault River. Current research into the date of these and similar clay units along the outer Washington coast suggests a non-glacial interval age (~20,000–60,000 years before present) for this find (Thackray 1996).

On August 22, 1928, a tusk from wooly mammoth was found on the Quinault River. Then on January 17, 1929, a wooly mammoth fossil was found 3½ miles below Lake Quinault on the Quinault River (Workman 1997-2010). By February, 1930, more bones were unearthed in an ancient wooly mammoth wallow on the lower Quinault River. Again on January 21, 1956, a six foot long pre-historic wooly mammoth tusk was found north of Hoquiam, on the west side of US101 (Workman 1996). On January 12, 1992, mammoth ivory was unearthed by a big landslide along the Quinault River.

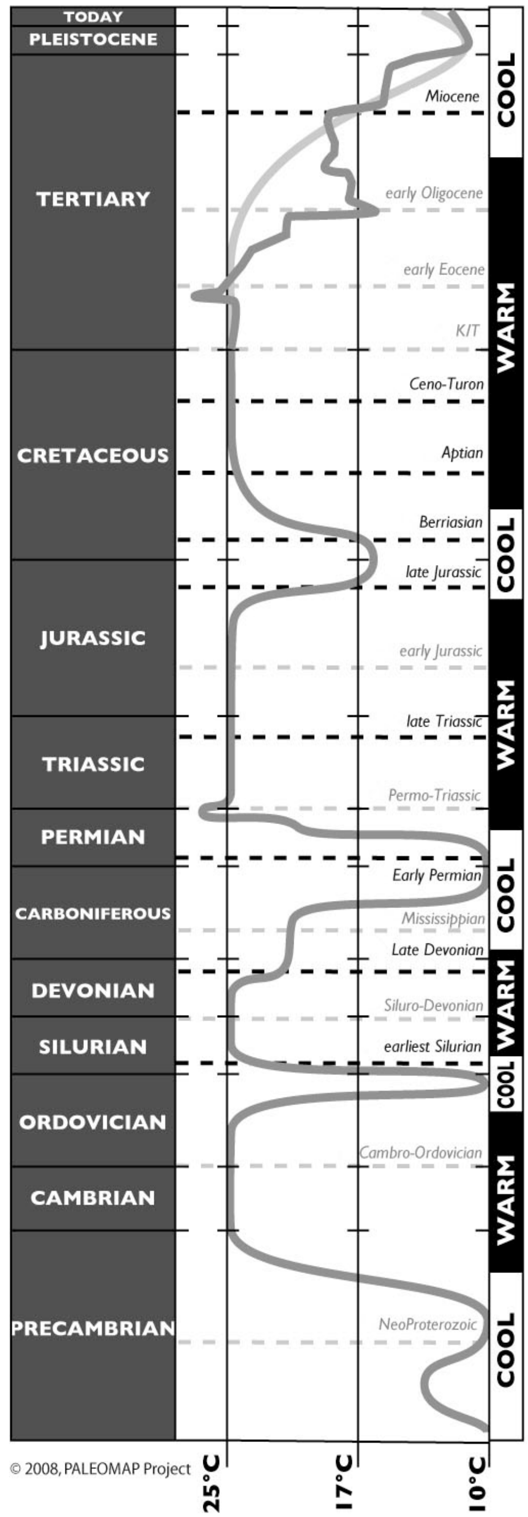
In 1977 a farmer near Sequim, WA, digging a pond, unearthed remains of a mammoth. Embedded in one of the animal's ribs was a broken piece of antler or bone resembling a spear point. The spear point, and other signs of human occupation, are the earliest evidence of human presence in this region, and proof that residents 12,000 years ago were hunters (NPS 2009).

By about 3,000 years ago, as the aboriginal human population increased, early inhabitants shifted their focus to lowland rivers and lakes. Fishing, gathering shellfish, hunting sea mammals and land mammals formed the foundation of a rich and complex culture for which the Pacific Northwest is known (NPS 2009).

Global climate is highly variable and currently it is in a cycle of warming because we are still leaving the last Ice Age (Figure XIV) and because we are adding greenhouse gases to the atmosphere (Scotese 2002). This cycle of global climate change holds the potential to disproportionately impact coastal populations.

Global warming causes sea levels to rise as oceans expand, while making storm patterns more energetic (FMI 2008). Consequently it affects most of the world's coastlines through inundation and increased shoreline erosion. Sound predictions of the development of these

Figure XIV. During the last 2 billion years the Earth's climate has alternated between a frigid "Ice House", like today's world, and a steaming "Hot House", like the world of the dinosaurs (Scotese 2002).



hazards over the next century are needed in order to manage the resulting risks. Coastal flooding is somewhat easier to predict than erosion since inundation can be estimated using coastal elevation contours (FMI 2008). However its prediction is not trivial since inundation may be followed by rapid reshaping of the shoreline by, amongst other things, waves, tidal currents and human interventions.

Figure XV. Duck Creek Diapir formation is composed of deep-sea sediments that are being squeezing like toothpaste up though a fault in the sandstone cap (Workman 2009).

Understanding coastal morphological response to climate change and sea level rise is quite underdeveloped (FMI 2008). This is partly because the timescales over which concern of its effects are greatest (annual to centennial) falls between the small scales addressed by most numerical models and the large sales described in the conceptual models of geomorphologists (Figure XIV). An additional problem is that the type of models often used to bridge this gap are based on the extrapolation of historic behavior and is not precise as the climates change.

4.2.1. Coastline Response to Accelerated Sea Level Rise

The most widely cited method of quantifying the response of a shore to rising sea levels is known as Bruun's rule (Davis 2005). This was developed to describe the behavior of sandy coasts with no cliff or shore platform. It assumes that the wave climate is steady and consequently the beach profile (average equilibrium) does not change, but does translate up with the sea level. This rise in beach surface requires sand, which is assumed to be eroded from the upper beach and deposited on the lower beach (Davis 2005). Thus, as the profile rises with sea level it also translates landward, causing shoreline retreat. These shoreline prediction responses do not adequately reflect the sandy beach to rocky cliffs topography found across the QIR ocean shoreline. The ocean shorelines in the southern reaches of the QIR, for instance at Wreck Creek, are different than the cliffs at nearby Point Grenville. These are different in composition to the shorelines at Taholah, Queets, Quinault Formation outcroppings (Figure XVI), Duck Creek (Figure XV), Cape Elizabeth (Figure XVII), Hogsback, Raft River, Tunnel Island, Pratt Cliff, or any of a hundred other locations along the QIR ocean shoreline.

Figure XVI. Quinault Formation bedrock of the QIR ocean shoreline north of Cape Elizabeth (Workman 2009).

Another constraint on the range of applicability of the Bruun rule results from its assumptions that the shore profile is entirely beach and loses no sediment. Along most of the QIR coastlines the beach is made up from a surface deposit that can only be eroded a limited amount before the land underlying it is exposed and degraded. Here the shore profile is composed of both beach sediments and rock. The rock element of such composite shores complicates its behavior because it can only erode (not accrete) and it is likely to contain material that is lost as fine sediment. In addition, being purely erosive and relatively hard, it will have a different equilibrium profile to that of the beach and will take longer to achieve equilibrium (FMI 2008).

Figure XVII. Cape Elizabeth shoreline, north of Taholah (Workman 2009).

Relatively little work has been done on the relationship between sea-level rise and the profiles of composite beach/rock shores. Recent results indicate that such profiles do change, becoming steeper as the rate of sea level rise increases (Walkden & Hall 2005).

Shore wave heights are normally limited by water depth, so an increase in sea level might be expected to increase waves at the shore. This appears to be true at composite beach-rock shores, however it does not necessarily occur this way at all beach shores. The impact within the QIR's highest population center, Taholah, will likely see changes to the sedimentation retained at the mouth of the Quinault River to the ocean, the accumulation of heavy, coarse woody debris along the shoreline, and the wave activity to the shoreline because of up-shore and down-shore wave interactions.

4.2.2. Coastline Response to Changed Storm Patterns

The form of a shoreline depends strongly on the climate of wave conditions it is exposed to. Larger waves are able to erode both beach and land. The angle at which waves arrive has a strong effect on the rate at which beach material is redistributed along the shore. A shoreline may therefore represent a dynamic balance between the wave climate, land erosion and the distribution of beach sediment. Changes to the wave climate, such as a shift in average direction or a general increase in height, will disturb this balance, and a period of shoreline adjustment would be expected (FMI 2008).

Interaction of neighboring coasts makes such shoreline adjustment complex and difficult to predict. It appears that the high dependency of shoreline shape and parent material in reaction to wave angle strongly increases the sensitivity to changes in shorelines from wave action, relative to composite beach-rock shores.

It is generally accepted that climate change leading to increasing ocean levels, changes to global weather patterns, and the distribution of precipitation as rain or snow, will bring noteworthy adjustments to the impacts of natural disasters on the QIR. Direct predictions lead to concern for the ling-term durability of the Village of Taholah because of the sea-level elevation of this village, the immediate closeness to the ocean shoreline, and the ménage of parent materials that include both river and ocean deposited sediments, coarse woody materials, unconsolidated river and glacial gravels, peat, and isolated erosion resistant outcroppings. When considering all of the population centers of the QIR, the Village of Taholah is at the highest risk to structural damage and potential loss of life resulting from rapid coastline changes due to climate change and natural disasters such as tsunami (as detailed in 4.6 "Tsunami" of this report).

4.3. Severe Weather

Severe weather is always defined locally and in respect to local preparedness. The QIR is no different in this respect as the land and the people have developed traditions and a culture accustomed to the 10 feet of annual rain, the storm surges from the ocean, and the high winds that hit the region. Preparedness is always a critical component to natural disaster survival.

Neumann *et al.* (1997) relates an account of severe weather on the QIR from 1921:

> "A severe windstorm struck the Olympic Peninsula in January 1921 threatening to disrupt plans for the first major timber sale on the Quinault Reservation. Forest examiners Nels Nicholson and Henry Steer surveyed the damage amid speculations that the wind thrown timber would contribute to the glut on the already depressed market through supplying mills that normally relied on private timber resources. The examiners concluded that the storm hit in streaks, with extensive damage localized to just a few areas affecting less than 5% of the Reservation's timber. Hemlock was the hardest hit, followed by white fir, spruce and Douglas-fir. Cedar did not seem to be affected much. They concluded that the damage was not sufficiently wide-spread to affect future timber sales. Nicholson and Steer worried more about the increased fire dangers posed by the downed wood and recommended that money be allocated quickly to clear trails and roads, and to hire three additional fire guards for the summer season. Decaying timber from the 1921 storm affected unit sale conditions for the next 20 years as cruise estimates were repeatedly revised to reflect the damage."

4.3.1. Tribal Legends

4.3.1.1. Speelyai Fights Eenumtla

(Bagley 1930)

Eenumtla, or Thunder, was a very mighty god in the days of the Wat-tee-tash. He lived in the high mountains and clouds. His terrible roar filled every living thing with fear; and his searching gaze penetrated from his home in the clouds to every spot on the earth. The wink of his eye was the flashing of fire; and no living thing could hope to escape his notice. This thunder god abused his power, and made himself a tyrant. Seated high in the clouds, and always watching, whenever he saw anyone, he immediately spread dark clouds over him and thundered so violently as to make the world tremble; and with a flash of lightening his victim was stricken out of existence. The people were living in a state of continued terror, and scarcely dared come out of their houses for fear of being shot by the lightning.

The Indian god Speelyai (Coyote) came along one day and found the people in great consternation. He said to them: "What is the matter? Of what are you all so fearful?" They related how they lived in constant dread of the mighty Eenumtla, and scarcely dared to go out to fish, hunt or do anything. He told the terrified people he would break the power of the dreaded storm god. After much thought he failed to come to any conclusion as to the best mode of getting at the monster. As was his custom when in need of counsel or help, he called forth his sisters; and, when they had told him what to do, he said: "That is just what I thought, my sisters; that is my plan."

Following their directions, he transformed himself to a downy feather, and floated on the wind up to the thunder god, and over him, so as to get a good sight of him. He then came down in a whirlwind and alighted on a dry sunflower stalk, and sat there watching Eenumtla. During these movements the thunder god had been watching, and kept thinking: "That looks like a feather, and yet it looks like a man." He then raised up and took a better look. Being suspicious and in doubt, he said: "It probably is a feather that I knocked from someone the other day; and the wind has blown it here. I will try a little rain on it and see what it will do." So saying, he raised up and thundered and sent a shower of rain down. The magic feather did not move. When the rain ceased all of a sudden, Coyote, in the form of a feather, rose up in the air and began to peal out thunder and flash lightning and pour rain down at a terrible rate. Eenumtla was amazed and sorely perplexed that so small an object as a downy feather should do such a wonderful thing. "I thought I was the only Thunder in the world." Feeling jealous at this usurping of his power and dignity, he flashed lightning at the little down and thundered at it, and sent down a deluge of water at his insignificant enemy. The disguised god Coyote became very angry, and began to flash lightning in the very eyes of the thunder god himself, so that he began to dodge and blink. Determined not to be outdone by so puny an antagonist, Eenumtla the thunderer shot back hot lightning, sending the fire at his eyes; yet Coyote did not dodge nor wink, but answered with lightnings more fierce and thunders more loud. The contest waged hotter and hotter. The thunderer shot thunderbolts at Coyote, and tore up the earth about him; and he in turn answered lightnings with flashes more terrific, and hurled the thunder god from his seat in the clouds. The enraged combatants then raised high up over the world, and fought amid rollings and crushings of thunder, and the demoniac play of lightnings and thunderbolts; while the storm clouds darkened the sky, and rain deluged the earth with fearful violence.

They finally came together in a fearful last death grip, in the midst of thick clouds and tempestuous elements; they fell to the ground with such force that they shook the whole world. Coyote fell on top of Eenumtla the thunderer, and began to beat him unmercifully with his war clubs. The fallen giant pleaded for mercy; but coyote continued to pummel his antagonist until all the clubs were broken; and then he pronounced sentence upon the once haughty thunderer: "You shall no more make it your business to kill and terrify people. You may live, but can only thunder on hot, sultry days. You may flash lightning, but not to destroy." From that day the power of Eenumtla has been broken; and, though he sometimes terrifies, he seldom kills.

4.3.2. Characterizing QIR Normal Weather

There is a high degree of weather variability within the QIR. Topographic variations that begin at sea level are influenced by the rising hillsides that climb to the peaks of the Olympic Mountains east of the QIR. Stream networks that traverse the QIR are fed by a combination of foothill and mountain ridge sources. Precipitation is highly variable and shows tendencies of increasing precipitation with increasing elevation (Figure XIX).

Data for this report concerning on monthly weather trends within the QIR were created using the PRISM (Parameter-elevation Regressions on Independent Slopes Model) climate mapping system, developed by Dr. Christopher Daly, PRISM Climate Group director at Oregon State University. PRISM is a unique knowledge-based system that uses point measurements of precipitation, temperature, and other climatic factors to produce continuous, digital grid estimates of monthly, yearly, and event-based climatic parameters. Continuously updated, this unique analytical tool incorporates point data, a digital elevation model, and expert knowledge of complex climatic extremes, including rain shadows, coastal effects, and temperature inversions. PRISM data sets are recognized world-wide as the highest-quality spatial climate data sets currently available. PRISM is the USDA's official climatological data (PRISM 2010).

PRISM is an analytical model that uses point data and an underlying grid such as a digital elevation model (DEM) or a 40 year climatological average (e.g. 1971- 2009 average) to generate gridded estimates of monthly and annual precipitation and temperature (as well as other climatic parameters). PRISM is well suited to regions with mountainous terrain, because it incorporates a conceptual framework that addresses the spatial scale and pattern of orographic processes. Grids were modeled on a monthly basis. Annual grids of temperature are produced by averaging the monthly grids (PRISM 2010).

4.3.2.1. Precipitation

Within the Olympic Mountain influence area of western Washington, winter storms bring moisture in from the Pacific Ocean travelling from the southwest to the northeast (Figure XVIII), and are uplifted by the terrain, creating a precipitation maximum on the windward side and a minimum on the leeward side (Mass 2008).

Figure XVIII. Direction of Weather System flow bringing rains to the Olympic Mountains and Western Washington (Mass 2008, PRISM 2010).

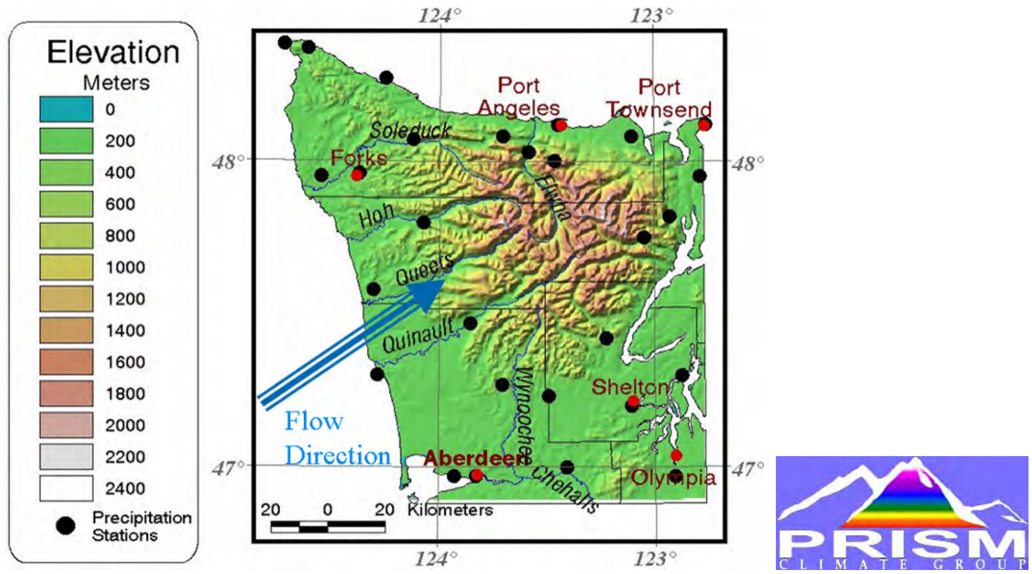
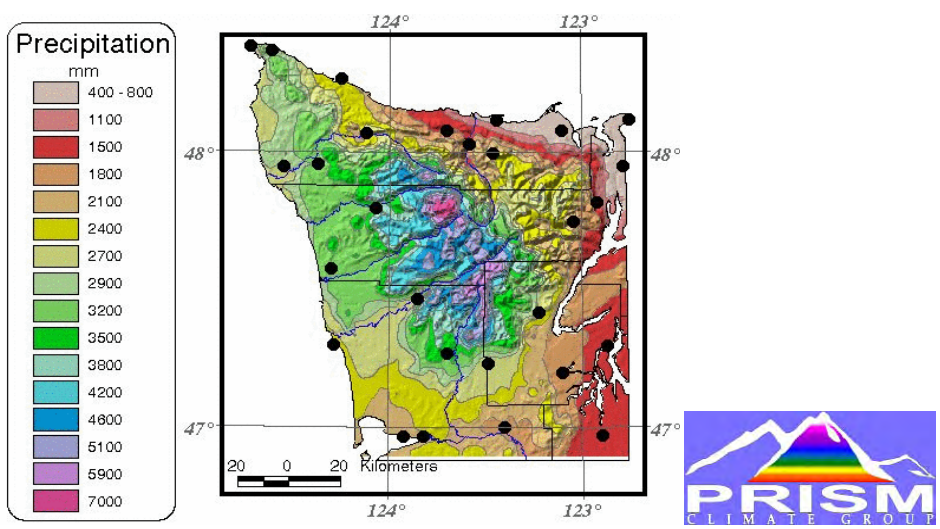
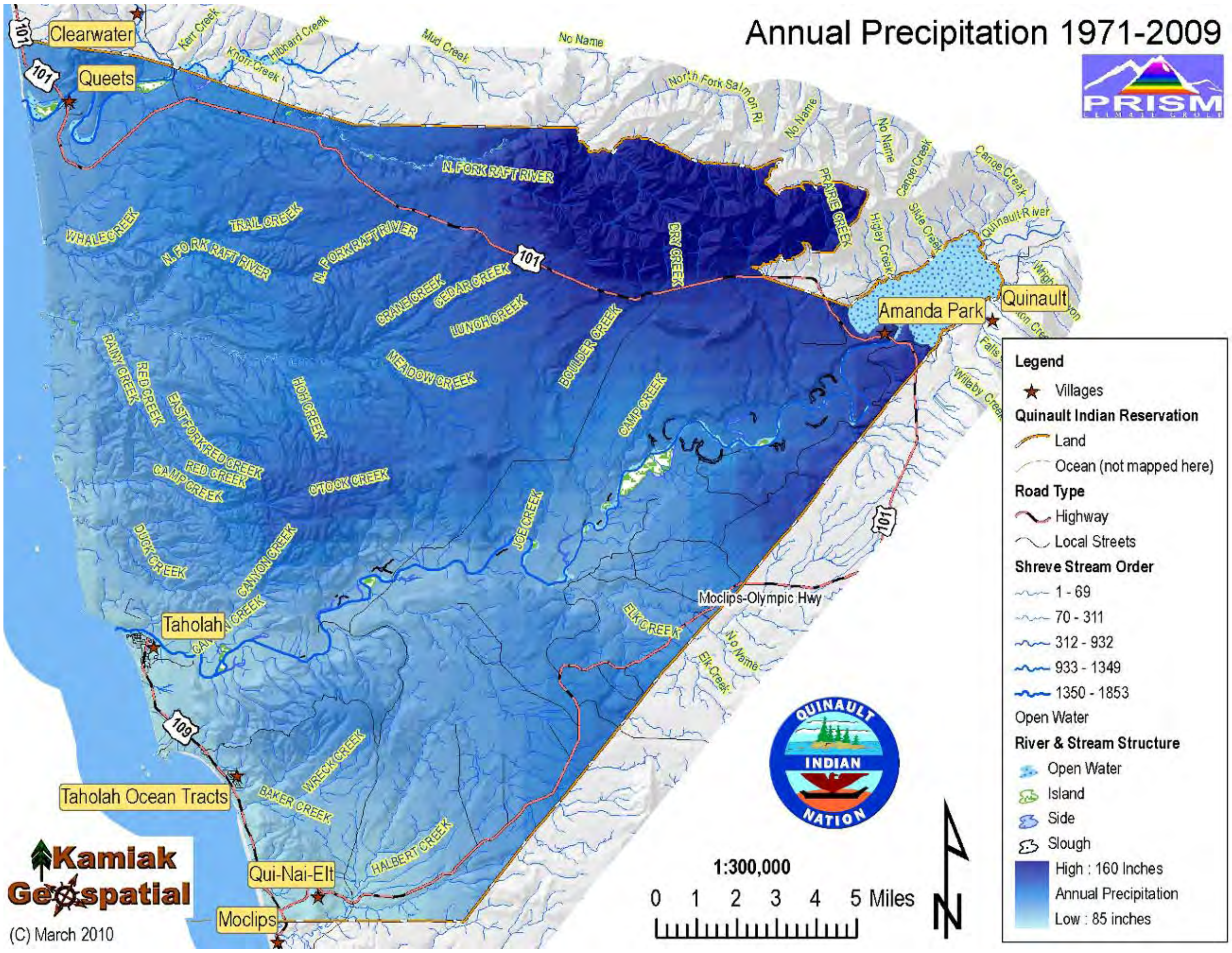


Figure XIX. Precipitation distribution within the Olympic Peninsula showing the comparative high precipitation amounts along the western coastline, lower amounts within the Puget Sound area (rain shadow effect), and the maximum precipitation amounts along the Olympic Mountain crest (PRISM 2010).



The effects of this system of regional weather patterns brings a highly variable weather pattern to the QIR. Precipitation shows monthly variations that are responsive to the topographic variation of the QIR with the lowest annual precipitation amount (85 inches per year) seen along the ocean shoreline from Raft River, south to Moclips. This pattern yields to the uplift provided by the terrain to witness the highest precipitation amounts along the North Boundary (northwest of Lake Quinault) where totals reach 160 inches per year (Figure XX) (PRISM 2010).

Figure XX. Annual Precipitation derived from PRISM datasets from 1971-2009 on the QIR.



The timing of precipitation events within the QIR is responsive to the seasons of the year. The months receiving the highest amount of precipitation include November through March when approximately 67% of annual precipitation arrives (Table 23). These reported values represent an average precipitation amount across the entire QIR, not just selected extreme precipitation locations (where higher and lower amounts can fall with every storm). For this reason, the total precipitation reported in Table 23 is different than that referenced in Figure XX. The former reference is to minimum and maximum precipitation amounts across the entire QIR while the latter references an average precipitation amount by combining all locations on the QIR.

Table 23. Average Monthly Precipitation for all of the QIR (PRISM 2010).

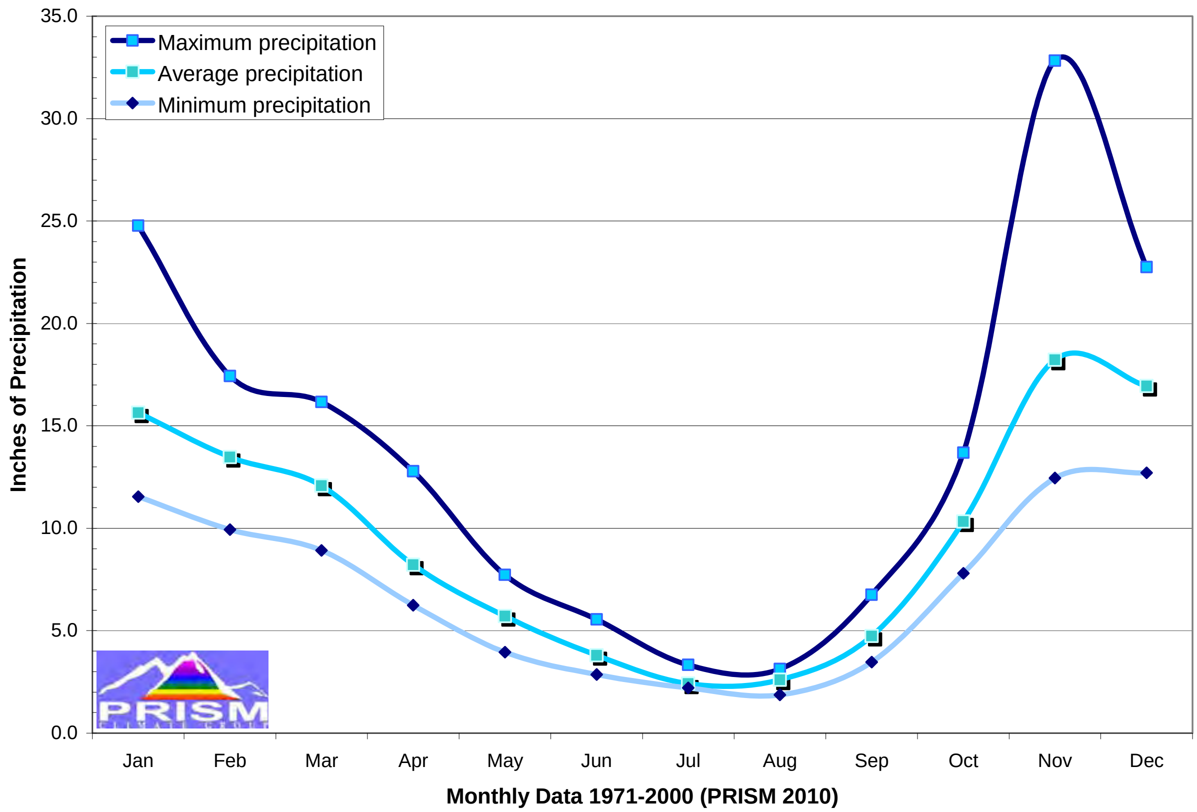
Month	Average Monthly Precipitation (inches)	Percent of Total
Jan	15.6	14%
Feb	13.5	12%
Mar	12.1	11%
Apr	8.2	7%
May	5.7	5%
Jun	3.8	3%
Jul	2.4	2%
Aug	2.6	2%
Sep	4.7	4%

Table 23. Average Monthly Precipitation for all of the QIR (PRISM 2010).

Month	Average Monthly Precipitation (inches)	Percent of Total
Oct	10.3	9%
Nov	18.2	16%
Dec	16.9	15%
Total	114.2	

The deviation within the QIR between the areas receiving the highest precipitation and the lowest precipitation is striking. The heavy November showers can deposit almost 33 inches of rainfall in the North Boundary area while at the same time the region from Taholah to Moclips may only receive 12.5 inches in November (Figure XXI).

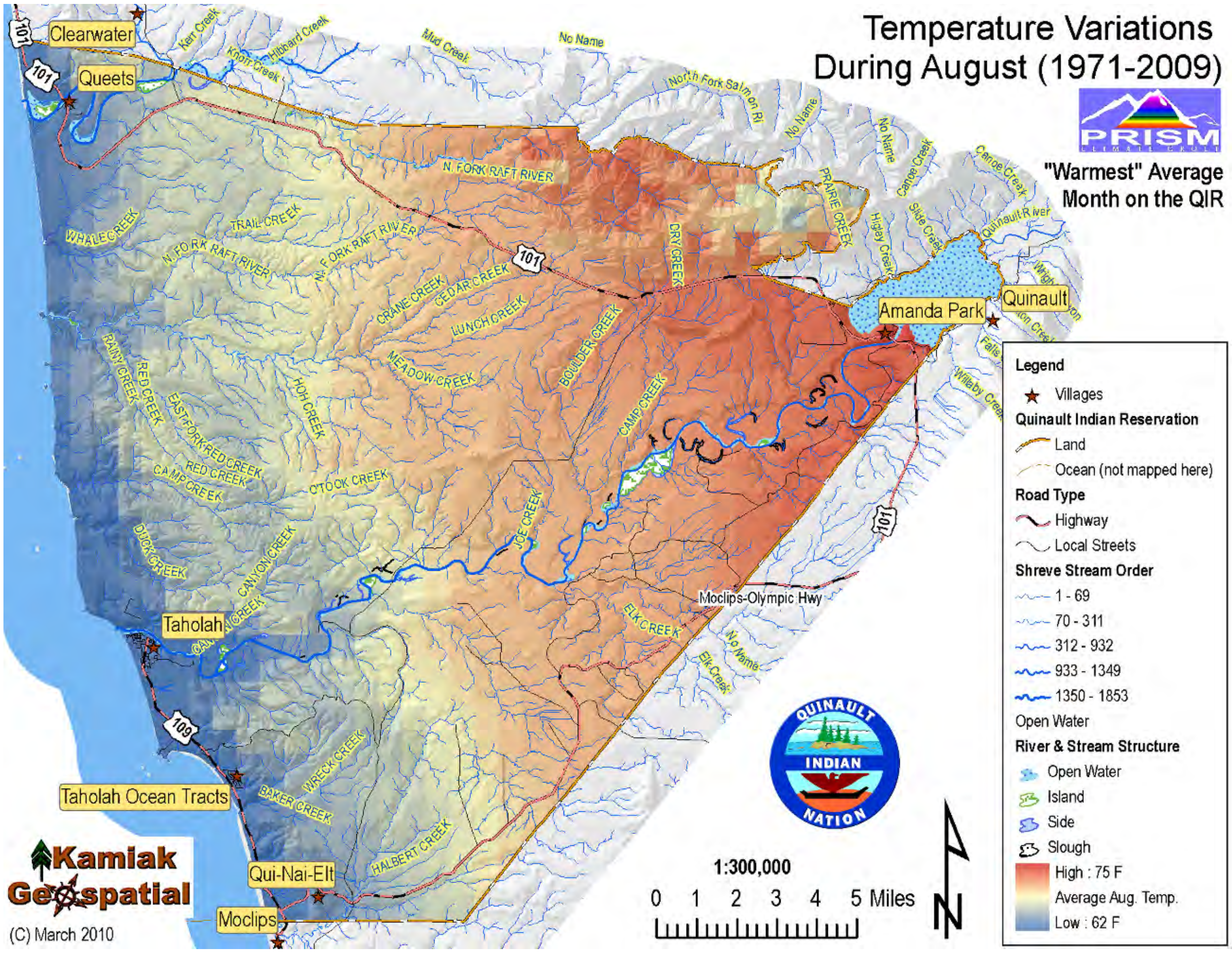
Figure XXI. Monthly precipitation showing the average normal precipitation on the QIR, as well as the maximum are minimum precipitation (PRISM 2010).



4.3.2.2. Temperature

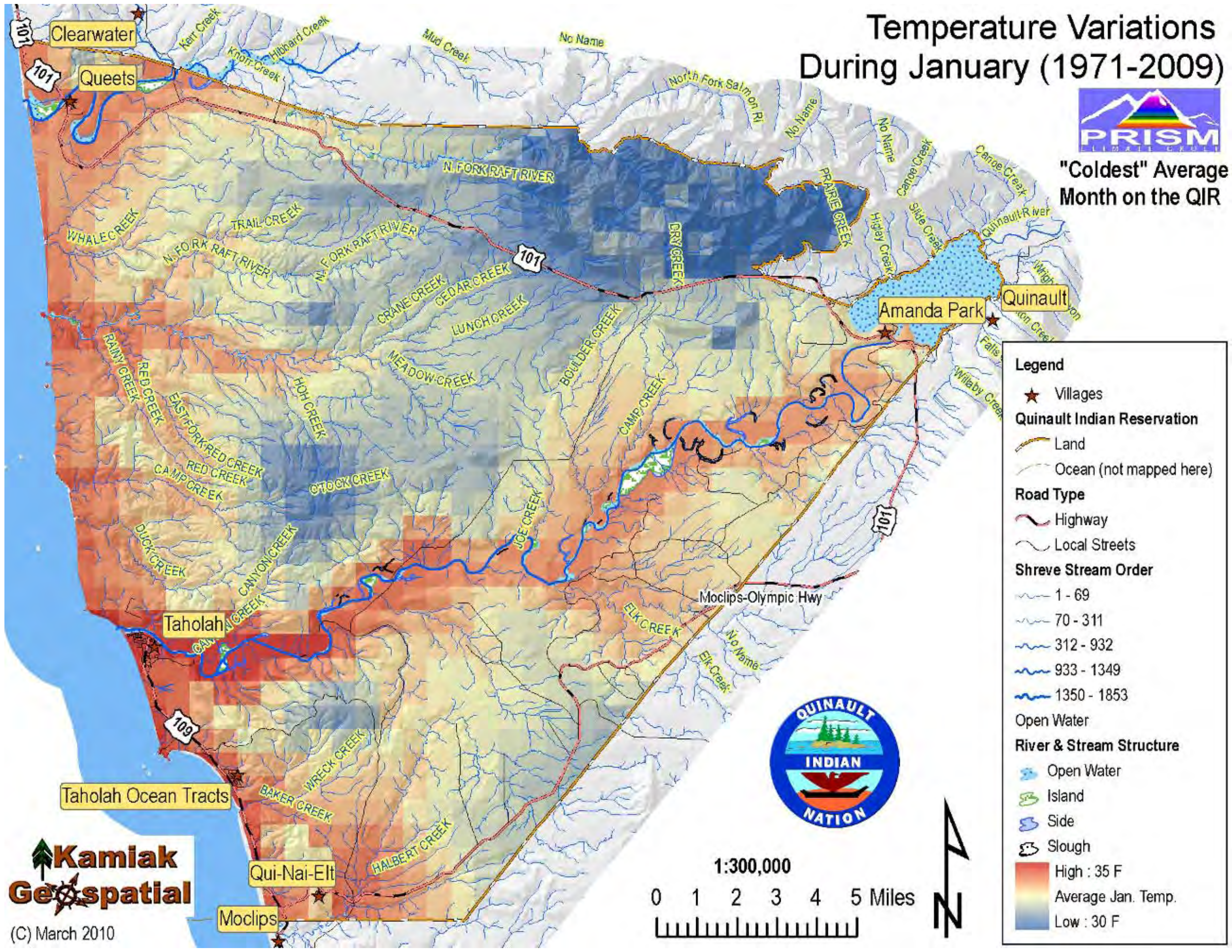
Temperature deviation is equally variable in response to topographic lift and the presence of the Pacific Ocean as a moderating force keeping the adjacent lands cool in the summer and relatively warm in the winter. The average monthly hottest temperatures on the QIR are observed in August when the thermometer can climb to an average high temperature of 75º F in Amanda Park while that same average monthly high is only 62º F in Taholah (Figure XXII). That is not to say that the temperature on the QIR does not exceed these values. The determination of the highest average temperature is completed by recording the high temperature each day of the month at observation points and then creating an average temperature based on those values.

Figure XXII. August Average High Temperatures on the QIN, the "hottest month of the year" (PRISM 2010).



Conversely, the coolest month of the year on the QIR is generally seen in January when the average monthly low temperature reaches only 30º F along the upper elevations of the North Boundary to the northwest of Amanda Park. At the same time, average monthly low temperatures in Taholah will moderate to only 35º F (Figure XXIII). The determination of these monthly low averages is determined much like the average high temperatures. In this case, the lowest daily temperatures are recorded each day of the month at each recording station and then averaged to determine the average low temperature across the QIR (PRISM 2010).

Figure XXIII. January Average Low Temperatures on the QIN, the "coldest month of the year" (PRISM 2010).



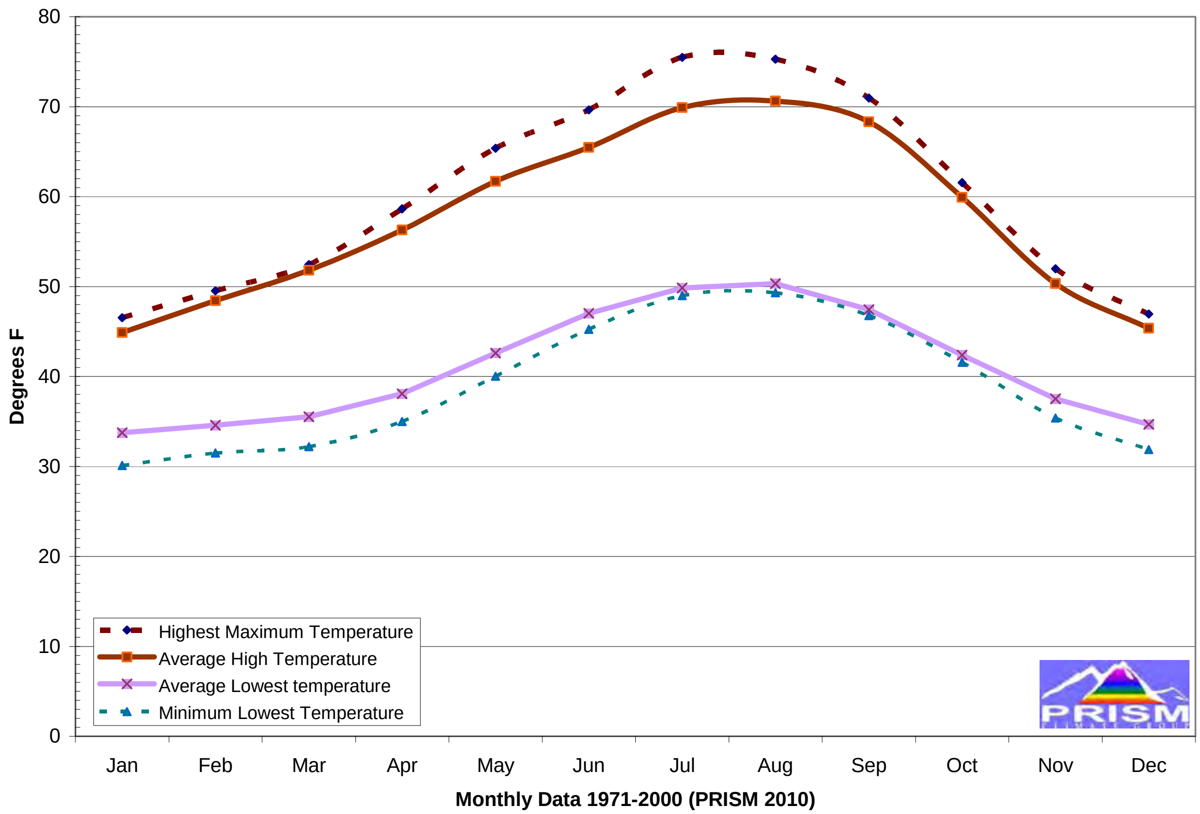
Monthly extremes of temperature show that the variation from the highest average monthly temperature in a selected month may differ from the lowest average monthly temperature on the QIR by as much as 26º F in July and August (Table 24).

Table 24. Variations in Monthly Temperature within the QIR (PRISM 2010).

	Lowest Monthly Temperature (º F)			Highest Monthly Temperature (º F)		
Month	Minimum Lowest Monthly Temperature	Average Lowest Monthly Temperature	Maximum Lowest Monthly Temperature	Minimum Highest Monthly Temperature	Average Highest Monthly Temperature	Highest Maximum Monthly Temperature
Jan	30.1	33.8	35.2	39.5	44.9	46.5
Feb	31.5	34.6	36.0	43.3	48.4	49.5
Mar	32.2	35.5	37.0	45.5	51.8	52.4
Apr	35.0	38.1	39.4	50.1	56.3	58.6
May	40.0	42.6	44.0	56.7	61.7	65.4
Jun	45.2	47.0	47.9	60.5	65.5	69.6
Jul	49.0	49.8	51.5	62.2	69.9	75.5
Aug	49.3	50.3	52.3	63.1	70.6	75.3
Sep	46.8	47.4	49.9	62.7	68.3	71.0
Oct	41.6	42.4	43.6	55.8	59.9	61.6
Nov	35.4	37.5	39.0	45.6	50.3	52.0
Dec	31.9	34.7	36.0	41.1	45.4	46.9

While precipitation variations across the QIR were presented to show the differences in monthly amounts, the same can be presented for temperature variations (Figure XXIV). The warmest temperatures seen on the QIR (Figure XXII) exhibit the greatest variation during the period May through September (Figure XXIV), when the difference between the average high temperature and the highest temperatures is about 5º F. The difference between the coolest and warmest places on the QIR can be as much as 25º F during August (lowest average low to the highest average high). These characteristics define the temperate ecotype known to this region that combine moderated temperatures (few extreme lows and few extreme highs) with frequent and high amounts of precipitation delivered every month of the year.

Figure XXIV. Monthly temperature variation showing the average temperature variations between the warmest and the coolest on the QIR (PRISM 2010).



Clouds and precipitation are greatly enhanced when air is forced to ascend the windward slopes of mountain barriers. Most major Northwest flooding events start with an extensive region of light to moderate precipitation linked to a strong Pacific low-pressure system and its associated fronts. This precipitation is then greatly increased, sometimes by factors of two to five times, as air ascends the mountains (Mass 2008).

4.3.3. Characterizing QIR Severe Weather

According to the World Meteorological Organization, severe weather refers to any dangerous meteorological or hydro-meteorological phenomena, of varying duration, with risk of causing major damage, serious social disruption and loss of human life. While types of severe weather can come in many forms, the general types of severe weather within the QIR include: thunderstorms, hailstorms, heavy precipitation, straight line winds, and damaging downburst winds. At the other extreme, drought is considered a form of severe weather that can dewater the rivers that support the main economic and cultural foundation of the QIN: salmonid species. More incidental severe weather phenomena within the QIR are characterized by ocean squalls

(Figure XXV), “heavy” snowstorms, and ice storms. The term severe weather is generally used to describe significant weather occurrences that are out of the normal range of events for the QIR.

Figure XXV. Squall moving from the Pacific Ocean onto the QIR shoreline (Workman 2009).

Several weather related events have been summarized in the region of the QIR (Workman 1997-2010) and are presented in Table 25. The most striking feature of this chronology of weather records is the extremely variable swing of weather patterns witnessed in the region over the 180 year period reported here. Many years reflect the common perception of a “rain forest” with heavy rains, cool temperatures, sporadic winter snows, and frequent winds. However, there are years that report abnormal weather patterns such as the end of 1888, “Weather for the last three weeks is the finest anyone could want. It would do honor to Southern California’s winter.” Then one year following, in December, 1889, “Flowers are blooming, grass is green as spring, and many berry bushes are in full bloom. Who wants to trade this for the frozen blizzard-cursed east?” By March 4, 1896, the weather forecast was much cooler, “snow falls six inches deep on the beach.” These weather patterns over the 180 year history summarized in Table 25 demonstrate the recordings of low temperatures coupled with deep snow fall, high winds, and elevated summer temperatures. Conversely, warm winters and mild summers have also been witnessed.

The weather patterns that cause the highest level of damage to the QIR include high winds, wet (heavy snows), and drought. The first two of these elements are fairly intuitive. The last of these conditions seems to be of a relatively low probability, but the negative impacts derived for the salmon survival in the rivers and at the fish hatcheries is a critical matter. A further discussion of the current condition and the impacts from drought within the QIR and adjacent lands is presented in Section 4.4.2.3.

4.3.4. High Wind Patterns

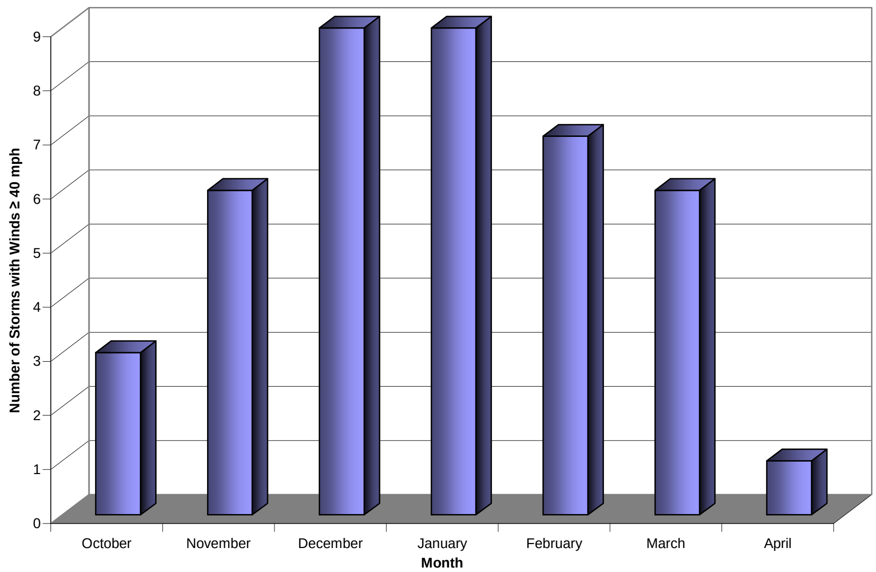
Wind damages are a common hazard within the QIR (Table 21, Table 22, Table 25, Figure XXVI and Figure XXVII). High winds are known to cause damage, depending upon their strength and pattern. Severe and sustained wind gusts can cause poorly-designed suspension bridges to sway. When wind gusts are at a similar frequency to the swaying of the bridge, the bridge can be destroyed easier, such as what occurred with the Tacoma Narrows Bridge in 1940 (Galloping Gertie). None of the bridges on the QIR are suspension bridge construction.

In describing wind events, meteorologists often use the measure of sustained winds or gusts. Wind always varies in time, with lulls of weaker winds followed by several seconds of greater speed. Gusts are identified as much larger than sustained winds, often by 25 to 50 percent, and are usually associated with the greatest damage (Mass 2008).

Wind speeds as low as 25 mph can lead to power outages due to tree branches disrupting the flow of energy through power lines. While no species of tree is guaranteed to stand up to high-force winds, those with shallow roots are more prone to uproot, and brittle trees are more prone to damage. High speed, straight line winds, and downbursts, can cause substantial damage to mobile homes, and begin to structurally damage homes with foundations. Once winds exceed

155 mph, homes can completely collapse, be torn apart, and significant damage can be done to larger buildings. Total destruction to man-made structures occurs when winds reach 200 mph (NOAA 2010).

Figure XXVI. Number of Severe Wind Storms Battering the QIR Coastline with Winds ≥40 mph, 1948-2007 (Mass 2008, updated with SHELDUS Data in Table 22).



Strong Northwest windstorms have struck this region in the months of October through April, with the largest numbers occurring November through March (Figure XXVI). Interestingly, the strongest of the windstorms since 1900, the Columbus Day blow, was the earliest storm of the year (October 12, 1962) (Table 21, Table 22, Table 25). The Columbus Day Storm, like several of the most powerful early fall events, began as a tropical storm that moved into the mid-latitudes, changing its energy source from the warmth and moisture of the tropical South Pacific Ocean to the large temperature contrasts of the mid-latitudes as it approached the Washington and Oregon coastlines (Mass 2008). In this case, the characteristics of the initial tropical disturbance transitioned into the development of intense storm circulations and high winds as it moved into the northern latitudes developing destructive force winds driven by climatic pressure and temperature differentials (Mass 2008).

One particular storm event in December 2007 (Table 21 & Table 22) was singular in several ways. First, most major Northwest windstorms are associated with intense and fast moving low pressure centers that move northward up the coast. Such rapidly moving storms generally produce strong winds for only a few hours. In contrast, this windstorm was associated with a persistent area of large pressure differences, between a slow moving offshore and much higher pressure over the continent that remained over the Oregon and Washington coastlines for nearly twenty-four hours. Another unusual aspect of this storm was the associated heavy precipitation over the west-side lowlands. Generally, fast moving windstorms do not have time to produce large rainfall totals, and heavy rain usually precedes the strong winds. In this case, the heavy inland rainfall and strong coastal winds occurred simultaneously (Mass 2008).

The QIR experiences three types of wind events of damaging formation: Straight-line winds, cyclones, and downbursts.

Straight-line winds (also known as thundergusts) are very strong winds that produce damage, lacking of a rotational damage pattern. Such rotational damage patterns are associated with cyclonic storms including tornadoes and tropical cyclones. Straight-line winds are common with the gust front of a thunderstorm or originate with a downburst from a thunderstorm. These winds often come off the Pacific Ocean as storms and make their progression onshore (Figure XXV). Sometimes they are accompanied by storm surges (Boon 2007).

Figure XXVII. Downburst wind damages in December 2007 that delivered 57 mph winds (Workman 2009).

A **storm surge** is an offshore rise of water associated with a low pressure weather system, including an extratropical cyclone. A storm surge is caused primarily by high winds pushing on the ocean's surface. The wind causes the water to pile up higher than the ordinary sea level. Low pressure at the center of a weather system also has a small secondary effect, as can the bathymetry of the body of water. It is this combined effect of low pressure and persistent wind over a shallow water body (such as the shoreline) which is the most common cause of storm surge flooding problems (Boon 2007). These events have been witnessed almost annually along the QIR shorelines and are watched most closely at Taholah where damages have the highest potential to lead to structural and infrastructure damages.

Extratropical cyclones can contain phenomena such as squall lines within their warm sector (Figure XXV), tornadoes near their warm front, snow storms within their comma-head precipitation pattern, as well as ground blizzards in their wake (Boon 2007).

Extratropical cyclones bring heavy rainfall, high winds, and significant storm surges to places near their path. Severe thunderstorms contain hazards such as high winds, hail, tornadoes, and lightning, which can also cause outbreaks of wildfires. Severe weather can occur within larger thunderstorm complexes such as squall lines and other types of mesoscale convective systems.

Midlatitude cyclones are large storms that strike the Northwest during the fall and winter (Mass 2008). Like extratropical cyclones, these storms are associated with low-pressure centers and winds that rotate counterclockwise in the Northern Hemisphere. But these storms are different than their tropical cousins. The energy source for midlatitude cyclones is the large horizontal variation of temperature found in the midlatitudes, which lie between the warm tropics and the cooler, arctic regions. On the other hand, mid-latitude cyclones are typically larger and can maintain their strength over land far more effectively than tropical storms, which weaken rapidly when they are cut off from warm water (Mass 2008).

A **downburst** is created by an area of significantly rain-cooled air that, after hitting ground level, spreads out in all directions producing strong winds (Fujita 1981). Unlike winds in a tornado, winds in a downburst are directed outwards from the point where it hits land or water. Dry downbursts are associated with thunderstorms with very little rain, while wet downbursts are created by thunderstorms with high amounts of rainfall. This latter category of downburst is common on the QIR (Figure XXVII, Neumann *et al.* 1997).

Microbursts and macrobursts are downbursts at very small and larger scales respectively. Downbursts create vertical wind shear or microburst which is dangerous to aviation. These downbursts have been recorded on the QIR in reference to standing timber damage. The downbursts hit the ground breaking mature trees, felling them, and scattering debris in all directions or in a straight line pattern away from the point of initial impact. The downburst often “vanishes” leaving a ring of trees “untouched” around the felled trees. The downburst may strike again a short distance away (like ¼ mile) or a long distance away (like 6 miles or more). These events have been documented on the QIR since at least the 19th century (Neumann *et al.* 1997).

The Pacific Northwest is particularly vulnerable to strong windstorms due to its unique vegetation and climate. The QIR's tall trees are force multipliers for regional windstorms, with much of the damage to buildings and power lines not associated with direct wind damage, but with falling trees onto the structures and power lines (Mass 2008). Heavy precipitation in October – January (Table 23, Figure XXI), which quickly saturates Northwest soils by the beginning of November, also enhances the damage potential, since saturated soils lose their adhesion and thus their ability to hold tree roots. Several species of Northwest trees, such as western hemlock, are shallow-rooted and susceptible to uprooting during periods of wet soils and strong winds. Even the Douglas-fir, which develops deep root systems in thick fertile soils, can be vulnerable to saturated soils and wind because it develops shallow roots in poorly drained or shallow soils (Mass 2008).

Heavy rainfall is often associated with warm subtropical air when the warm sector with a low-pressure center passes over the region. Extratropical cyclones are usually associated with strong winds and heavy rain on the QIR, and generally develop on the boundary between warm air from the tropics and subtropics, and cool air from northern latitudes (Mass 2008). The horizontal change of temperature across this zone is the main energy source for midlatitude cyclones. The region of warm air between the cold and warm fronts is known as the warm sector. The air in the warm sector usually comes from the southwest and, because of its warmth and low latitude origin, contains large amounts of water vapor. Frequently, a strong current of southerly wind occurs in the western portion of the warm sector, just east of the cold front (Mass 2008).

4.3.5. Heavy, Wet Snow

When heavy, wet snow with a snow to water equivalent ratio of between 6:1 and 12:1 and a weight in excess of 10 pounds per square foot piles onto trees, electricity lines, or buildings, significant damage may occur on a scale usually associated with hurricanes. An avalanche can occur upon a sudden thermal or mechanical impact upon snow that has accumulated on a mountain, which causes the snow to rush downhill en masse. Large amounts of snow that accumulates on top of man-made structures (such as homes) can lead to structural failure (Colbeck 1995).

Blizzards are forms of winter storms. Situations that occur within blizzards often include high quantities of blowing snow and strong winds. The strong winds within blizzards are able to create a severe wind chill factor. The effects of wind chills can result in frostbites and hypothermia. Strong winds can also cause problems in urban environments, where power outages may occur and pipes become frozen, cutting off fuel sources, and where roofs can be ripped away from their structure.

These weather conditions are not generally considered annual occurrences, but several such combinations have been documented on the QIR (Table 21, Table 22, Table 25) over the last 180 years (e.g., February 3, 1816). Trees that are blanketed with sticky, wet snow, and then exposed to high winds, that can follow a snow storm event, have been known to break off or fall completely crossing power lines, roads, or falling on structures. Evidence of roof damage from high winds in combination with heavy snowfall is seen across the QIR as either roofing tiles are torn away, weather stripping is dislodged from the roof, or entire sections of the roof are busted from the structure, sometimes in combination with broken tree tops and branches dropped on the structure from the combined snowfall and wind damage.

A characteristic of Northwest lowland snow shows year-to-year and decade-to-decade variability, with a trend toward less snow since the mid-1970s (Mass 2008). There are several potential explanations for the decline in lowland snow since the 1970s over the Pacific Northwest. Observations suggest that there has been warming in winter temperatures over the region, averaging about 1-2 degrees F since the mid-twentieth century. Although such warming may seem small, it could have an impact over the lowlands of western Washington, where temperatures are often borderline for snow (Mass 2008).

There are several possibilities for the origin of this warming. One is global warming associated with increasing atmospheric greenhouse gases whose effects are analogous to an atmospheric blanket (Section 4.2). Another contributor could be the Pacific Decadal Oscillation (PDO), a natural twenty- to thirty-year cycle in sea-surface temperatures and winds over the Pacific Ocean. The PDO was in its cool phase from roughly 1945 through the mid-1970s, when snowfall was greater and temperatures were lower, but switched in the late 1970s to the warm phase, which brings warmer temperatures and less snow (Mass 2008).

4.3.6. Drought

A drought is an extended period of months or years when a region notes a deficiency in its water supply. Generally, this occurs when a region receives consistently below average precipitation, but can also occur when water supplies to the rivers are altered by reduced rainfall, landuse changes reducing surface water contributions, or a combination of the two. It can have a substantial impact on the ecosystem and fisheries of the QIR. Although droughts can persist for several years, even a short, intense drought of a few weeks can cause significant damage and harm the local economy (UN 2007).

This global phenomenon has a widespread impact on forestry, agriculture, and anadromous fisheries. The United Nations estimates that an area of fertile soil the size of Ukraine is lost every year because of drought, deforestation, and climate instability (UN 2007). Lengthy periods of drought have long been a key trigger for mass migration and played a key role in a number of migrations and other humanitarian crises around the world. The minimum flow rates to rivers bring the attention of the people of the QIN in respect to the viability of the salmon fisheries. When the rivers drop to dangerously low levels, the spawning salmon, the eggs, and developing fry in the river cannot survive. When the salmon populations cannot survive, the economy of the QIR is decimated, the people of the QIN are broken. The salmon serve to define who the people of the Quinault are.

The stated goals of this Tribal Hazards Mitigation Plan includes the protection of the people, structures, infrastructure, <u>the economy, and the traditional way of life on the QIR</u>. The health and function of the aquatic ecosystem on the QIR defines the functioning of the economy and traditional way of life. Data and analyses about the fish rearing rivers of the QIR are needed to articulate the causes of extreme fluctuations in water flow rates along these rivers. Conceptually, the changes to weather patterns can be identified as the culprit of the loss and decrease of glaciers in the Olympic Mountains; but, there may be more than just this one cause. Watershed uses, road building, development, and land management activities may hold critical determinants of facilitating sustainable water flow levels for these river systems.

While short-term, and longer, drought situations can cause dewatering of streams where salmon at all stages of development and spawning are directly affected, the longer term drought conditions possible within the QIR can have extended impacts on the forestlands of the Reservation. As previously defined in this document, the forests of the QIR are defined by their characteristics of a Temperate Rain Forest. These ecosystems thrive with over 120 inches of rainfall each year. They cannot thrive with significant decreases in the precipitation dropping below about 80 inches per year. The chances of witnessing these significantly lower precipitation amounts over a duration of a year or multiple years are statistically low, and the probability that these conditions would be witnessed over consecutive years is lower still. However, when temperate rain forest tree species are exposed to drier climatological conditions over a period of three or more consecutive years, a combination of increased forest insect and disease damage can be seen. Increased wildfire occurrence under these stresses can also be expected because of the combination of a drier climate, reduced forest health owing to insect and disease mortality, and potentially higher temperatures in combination with reduced cloud cover. The economic stress this situation would cause to the QIN is substantial because of the loss of forest management and timber harvesting jobs, the loss of timber sale revenues, and the cultural importance placed on the healthy forestlands of the QIR.

Traditional uses of the western redcedar hold historical and spiritual significance for the Quinault people and holds continued importance to the traditional way of life of the QIN. Western redcedar has an extensive history of use by the indigenous peoples. The Quinault people have historically held extensive dependence on the tree for basic materials. The wood has been used for constructing housing, totem poles, and crafted into many objects, including masks, utensils, boxes, boards, instruments, canoes, vessels, and ceremonial objects. Roots and bark have been used for baskets, ropes, clothing, blankets and rings. Prolonged, severe, and sustained drought can threaten and destroy this component of the forest ecosystem and extensively damage the QIN culture.

Potential mitigation measures for this effort are identified in Table 63.

4.3.7. Probability of Future Occurrence

Predicting future severe weather events presents the same nature of predicting the weather next week, or next month. In general terms, the observer would expect that the future nature of severe weather events within the QIR would be similar to the histories documented in this planning document that illustrate extreme weather fluctuations, from occasional extreme warmth in the winter, to cold in the summer, from the expected rain-forest extreme rainfall amounts to even drought.

Generalizations about this extreme weather probability cannot be articulated as predictably as some of the other natural hazards, but conceptually it can be articulated as being responsive to the impacts of global climate change (Section 4.2, Global Climate Change). The changes to weather patterns have been observed during the past century. Unfortunately, that period of time limits our ability to make meaningful predictions about the ebb and flow of weather pattern changes. It is expected that severe weather impacts to the QIR will impact the region with the same pattern of damages, although the location and severity will be variable. It is also expected that new extremes will be witnessed during the next 50 to 100 years for all measurements of severity (e.g., wind speed and duration, rainfall daily extremes, drought intensity, river flow minimums and maximums, new high temperatures and new low temperatures).

4.3.8. Mitigation Measures

Although the QIR has witnessed several extremes of severe weather as documented here, the weather extreme of short-term low precipitation (over a span of a couple months or even less) coupled with the loss of glaciers can lead to immediate and severe negative impacts collectively considered **drought**. These negative impacts are greatly related to the loss of fish survival when river water levels drop to the point that sections of the rivers are "dewatered" leaving salmon eggs, fry, or adult salmon without the river water to survive in. The months of July and August are commonly the lowest flow months and extreme lows have been witnessed in recent records. Two charts of water flow through two QIR system are presented in Figure XXXIV and Figure XXXVII. At the Quinault River gauge station (Figure XXXIV), the number of flow rate records set during the most recent decade was 24 new low flow records. On the Queets River gauge station (Figure XXXVII), the number of new minimum flow rates set during the most recent decade was 66 new low flow records. This threat is real and is being witnessed currently. These data are repeated and expanded on, in Section 4.4.2.3. Weather Conditions Related to Flooding.

Fish mortality is immediate and the impacts can be expected to be seen over a much longer-term starting with reduced spawning runs four years later, then subsequently on a cycle of each four year return cycle. If subsequent dewatering events happen in the alternate years, then multiplicative affects against the salmon spawning can be expected. To mitigate these potential negative impacts, the QIN operates several salmon hatcheries to ensure the survival of the salmon in the rivers of the QIR and within the “normal and accustomed fishing” territories of the Quinault People. Potential mitigation measures against the negative impacts of drought and overall dewatering of the rivers, includes:

1. Continued operations of the salmon hatcheries to ensure salmon survival,
2. Curtailment of surface water diversions for agriculture or domestic uses that reduce sustained water flow to the salmon spawning rivers,
3. Protection of river riparian zones and freshwater shorelines that serve a critical role in the maintenance of sustained waterflow levels, including the promotion of native beaver activity that supports surface water retention in beaver dams.
4. Implement landuse management practices that increase wintertime snow deposition and accumulation in areas that receive reduced solar radiation late into the spring, so that surface water flows to the stream networks are delayed, resulting in increased late spring and early summer runoff.

A prophylactic method against **storm surges** is the construction of dams and floodgates (storm surge barriers) along the shorelines to the ocean. Floodgates allow for open water flow out to sea allowing free passage of outbound water but close when the land is under threat of a storm surge (closed to incoming waters). This solution would only be considered feasible on the QIR near the pour point of the Quinault River at Taholah (Figure XXVIII). The combination of a low-relief village adjacent to the Quinault River, and a low aspect flood wall to the ocean makes the creation of a dam or floodgate problematic. Waters crest the existing floodwall during storm surge and high wind events. The larger challenge for the village is to dispense with the accumulation of storm water drainage that is sometimes mixed with over-spray salt water from storm surges. This can be accomplished with the use of a floodgate with a back-flow preventer installed through the existing floodwall. At the same time, the fortification of the existing floodwall between the ocean shoreline and the village can be considered. However, this solution should be considered only as a short term fix as the sea encroachment to the village of Taholah, and the risks presented by a Cascadia Subduction Zone (CSZ) tsunami, suggest that the lower Taholah village may be a location where intensive disaster management efforts will be required to provide long-term public safety. Further complicating the matter is the presence of the Quinault River at the edge of Taholah (Figure XXVIII) preventing a floodwall’s construction between the ocean and the village. The floodwall would require an elongated formation travelling upriver.

Figure XXVIII. Two views of the seawall Taholah, on-shore looking south along the coastline (left), and along the Quinault River shoreline looking west at the river’s entrance to the Pacific Ocean (right).

Hazard exposure to the mix of high winds on the QIR has been managed through the identification and trimming of hazard trees near homes and power lines. The forests of the QIR are extensive and the western redcedar, Sitka spruce, Douglas-fir, and western hemlock grow fast and they grow tall. They quickly grow to dominate open spaces and need to be treated on a frequent cycle to keep homes safe from wind damage. Roads are blocked and power lines break during these high wind events. Emergency crews are dispatched to clear the roads and infrastructure when damages are found.

In light of high wind warnings that have hit the QIR, the QIN is recommended to initiate the service of incorporating high wind warnings to the operation of the Emergency Evacuation Center (EOC). These services would include those presented in the following sub-sections.

4.3.8.1. High Wind Safety Actions – ahead of the storm

- Verify that homes meet current building code requirements for high-winds. Experts agree that structures built to meet or exceed current building code high-wind provisions have a much better chance of surviving violent windstorms.
- Protect windows by installing commercial shutters or preparing 5/8 inch plywood panels that can be installed or disassembled as needed in the face of severe storms.
- Garage doors are frequently the first feature in a home to fail. Reinforce all garage doors so that they are able to withstand high winds.
- Once a year, assess properties in all villages to ensure that landscaping and trees do not become a wind hazard from breakage.
    - i. Trim dead wood and weak / overhanging branches from all trees.
    - ii. Certain trees and bushes are vulnerable to high winds and any dead tree near a home is a hazard.

4.3.8.2. High Wind Safety Actions – as a severe storm approaches

- Most mobile / manufactured homes are not built to withstand severe straight line or downburst winds. Residents of homes not meeting that level of safety should relocate to a nearby safer structure once QIN EOC officials issue a severe wind evacuation order for selected villages.
- Once a severe wind evacuation warning is issued, time should be sufficient to install window shutters or plywood panels.
- When a severe wind evacuation warning is issued for villages, residents should secure or bring inside all lawn furniture and other outside objects that could become a projectile in high winds.
- Residents should listen carefully for safety instructions from QIN EOC officials, and go to designated “Safe Rooms” or “Evacuation Centers” when directed to do so.
- Residents should monitor NOAA Weather Radio channels for updates.
- Residents are encouraged not to leave the “Safe Room” until directed to do so by local officials, even if it appears that the winds calmed.

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1816 February 3	29” snow in Seattle; winter ties up whole of Northwest.
1836 April 1	25º F.
1851 December 3	High winds lash coast for third day.
1862 April	*Fontleroy* having sounded the Grays Harbor bar, reports 14 feet of water at lowest tide.
1862 February	The Columbia River freezes over.
1868 January	The Columbia River freezes *over at* Fort Vancouver.
1870 February	National Weather Bureau is established by Congress.

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1872 December 14	Strong earthquake felt on Puget Sound.
1873 October	Clouds of smoke pour from the highest peak of Mount Rainier. (Last for nearly a week).
1883 December 8	Gale inundated the village of Quinault upon the arrival of the Indian Agent there.
1884 December	Owing to vast amount of snow and sleet, it has been slow work loading the vessels at Hoquiam wharfs.
1884 December	Sleigh riding which is quite a novelty of this country, is a rage with the young people the last 10 days.
1884 December 11	Jack Frost is with us again. 20º F and beautiful 6" snow.
1884 March	Quite an earthquake shock in Hoquiam was noticed about 10.00 pm lasting three seconds. No damage.
1885 February 21	Another week of stormy weather.
1885 January 5	The recent snowfall which has covered the ground for the past two weeks, disappeared under the Chinook wind and rain. Rivers are higher than ever remembered. Satsop bridge built this season, was carried away and probably entirely destroyed.
1885 October 9	Earthquake in Olympia.
1886 December 10	The weather during the last week has been unusually rough.
1886 December 3	Washington Territory is herself again and rain once more descends in the most copious manner.
1886 January 20	The late 10-20" snowstorm has stopped operations in logging camps for some time. It really looks "old-fashioned" to see sleighs and jumpers flying around.
1886 November 6	Quite a heavy frost.
1887 December 25	Whoever saw nicer weather than this past week?
1887 February 11	Snow, frost and no wood is the general cry in most of the towns on the harbor.
1887 May	What is claimed to be the heaviest storm of the season occurred last week.
1887 November 11	Evidently, a rainy season has set in. The heavy rains make the loggers hunt their driving crews.
1887 November 18	The heavy rains of the past ten days have carried away large quantities of logs. In many cases the result of the whole season's work.
1888 December 28	"Weather for the last three weeks is the finest anyone could want. It would do honor to Southern California's winter."
1888 February 12	Wind storm the heaviest of the season.
1888 January 13	14 degrees F. Coldest weather in last eleven years.. Snow reminds someone of his "back east days".
1888 January 16	Chehalis river freezes over. All mills shut down.
1888 January 27-29	Unusually strong winds blowing large quantities of timber down. "Melting snows have sent the rivers to highest mark this season. Very mild weather is prevalent, the frogs are singing and the moss back is happy for he thinks winter is over."
1888 July 4	The constant rains of the past few weeks prevent carrying out the 4th of July program as the streets are in poor condition.
1888 November 16	Beautiful weather after heavy rains.
1889 December 31	Frosty nights and sunny days. Where are the blizzards the eastern papers are saying we are subject to?"
1889 December 6	"Flowers are blooming, grass is green as spring, and many berry bushes are in full bloom. Who wants to trade this for the frozen blizzard-cursed east?"
1889 February 15	Weather is fine again. The snow has departed.
1889 February 8	Snow has come at last.
1889 January 8	Spring-like weather.
1889 June 23	Badly needed rain. The woods are filled with berries this year.
1889 May 26-31	90 degrees F. Immense strawberry crop.
1889 May 6	One of the most severe wind storms passes over the Northwest coast.
1889 November 28	Thanksgiving is a perfect summer day.
1889 September 27	Severe storm and heavy rains.

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1890 December 5	Severe weather this week.
1890 February	Rain and high water.
1890 January 1	New Year Day cold with snow.
1890 June 30	Showers and cool weather
1890 October 15	First frost of the season.
1890 September 30	Very fine weather this fall.
1891 December 28	The severest wind in many years does great damage to cities in the Harbor.
1891 December 7	Exceptionally stormy weather.
1891 January 16	Exceptionally nice weather it has been.
1891 January 23	As yet, not a flake of snow.
1891 July 30	Axford reports 102º F. reading.
1891 March 10	Glorious spring weather
1891 September 29	Rain and more rain.
1892 April 22	Fine weather.
1892 April 8	Stormy weather.
1892 August 19	It has rained for the last few days.
1892 December 2	Heavy weather.
1892 December 22	Snow has been falling heavily for the past three days.
1892 December 30	The snow and all its symptoms have disappeared. Will be remembered as the heaviest in history.
1892 June 3	The rain of the last few days came just in time for gardening as everything was drying up.
1892 May 15	Storm.
1892 November 18	The weather has been beastly this week.
1892 November 25	Stormy weather. Over 11" of rain fell in Aberdeen between Nov. 13th and 18th.
1893 April 17	The public school in Quinault opened for a six months term. The school cannot run in winter on account of the children not being able to go through the winter storms.
1893 April 23	Considerable snow still lies in the gulches and ravines in the timber of the Humptulips.
1893 April 3	Driving of the piles did not start until today on the south channel due to heavy winds.
1893 August 31	A hottest day in years.
1893 December 12, 22	Heavy storms this week. Rainstorm.
1893 February 10	"The last snowstorm has transformed all us tender feet into pioneers, and we can take great pleasure in the future inn narrating to all newcomers tales about the winter of '92-'93. In addition to the 26" of snow in the last few days of January, we had 45" in February."
1893 February 3	Severe snow and cold this past week. 10 degrees F. "Cosmopolis doubly quarantined by snow and smallpox. The storm, or rather a series of storms for the past week or two, has been the most severe reminder of the eastern winter weather".
1893 January 13	The fine weather in Hoquiam has brought out the bicycles like jay birds in corn time. A good many birds have made their appearance that never did before until spring.
1893 January 31	26"' of snow has fallen these last few days of January.
1893 March 3	The mail carrier between Hoquiam and Quinault still has to go on snowshoes about half way.
1893 March 31	Rain is finishing up the last of the snow on the Humptulips.
1893 May 1	Official weather record keeping begins in Seattle.
1893 May 12	Old Neptune is quieting down, a forerunner of good weather.
1894 August 27	97º F.
1894 December 6	Snow falls to a depth of 6".
1894 January 12	The heavy rains have swollen the streams.
1894 July 13	94º F. (Quinault)

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1894 March 2	10" of snow fell at Humptulips last week.
1894 October 2	Severe windstorm.
1894 September 20	2 ¼ " of rain.
1895 August 13	Correspondent reports 39º F. and frost at Axford.
1895 December 20	We are having very stormy weather. The river and Lake Quinault rose very rapidly, claiming several canoes that the owners thought high and dry.
1895 July 29	Quinault surveyors unable to work because of storm.
1895 November 22	Total rainfall last week was 5", making quite a rise in streams, but not enough to float logs very much.
1895 September 14	85º F.
1895 September 7	The first rain of the season worth mentioning.
1896 December 25	All the rivers on another tear. Owing to the very bad weather, there is little work in the camp.
1896 December 5	The steamer Thistle was unable to get within a mile of the wharf of Oyehut owing to the ice.
1896 January 17	Quite a calm after the storm.
1896 July 19	95º F.
1896 March 4	Snow falls six inches deep on the beach.
1896 November 6	The rains of the past few days have raised the level of the rivers.
1897 February 19	Rain, wind, snow, sleet, with bursts of sunshine is the distinguishing feature of the weather last week.
1897 November 26	Storms of the last week have been very severe.
1898 March 11	Farmers making good use of the fine weather.
1899 December 1	Storm last week did considerable damage.
1899 December 22	Stormy weather.
1900 December 21	Fiercest storm off old ocean for several years.
1900 March 18	Rainfall heavy all week.
1900 March 30	With the fish season closed on the Harbor and a big landslide near Point Grenville, the markets have experienced considerable trouble supplying the trade.
1900 November 19	Cold snap and six inches of snow. The earliest seen in 30 years.
1901 December 27	The tides have run so high for a week, that David Bilyu carried the mail on horseback and part of way on foot to Grenville (Taholah).
1901 October 24	October was free of rain and most pleasant in past ten years.
1902 December 2	Heavy windstorm.
1902 February 6	The mail carrier is obliged to pack the mail to Quinault on his back due to snow conditions.
1902 January 25	12º F.
1902 March 1	Plenty of rain.
1903 August 23	The dry spell that served to yellow gardens has broken by one of those gentile Washington rains.
1903 January 2	Harry Bail, one of the oldest rangers on the Olympic forest reserve, says the winter in the Olympic mountains is proving the hardest in recent years.
1903 January 9	The rain storm last week was one of the worst that has been experienced in many years.
1903 March 9, 13	The past two days have been the coldest, most disagreeable days so far this year on the North Beach. Storms.
1903 November 11	Heavy rains that swelled the Quinault are over and we are enjoying clear frosty nights.
1903 November 6	This has been a beautiful fall.
1904 April 1	The road around the bluff (Point Grenville) has been impassable for three weeks. The Indians have had a hard time this winter. As soon as the weather clears, we will begin to clear away the wreckage and build four new houses and put the village (Grenville) back in good shape again.

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1904 April 22-29	The road around the bluffs (Point Grenville) is still impassable, but a good northwester should put it in good shape. Quite a lot of freight has accumulated at the Mountain (Point Grenville), as the beach road is still impassable.
1904 December 24	A white Christmas at Lake Quinault.
1904 February 19	The windstorm of late Thursday was considered the hardest in years.
1904 February 6	Snow feel to a depth of 6”.
1904 March 18	The constant snowfalls of January became very tiresome, but now the incessant downpour of rain have been actually annoying.
1904 November 25	The inclement weather taking its toll.
1905 February 7	Storm ruins the wire.
1905 January 12	Ice thick enough on tidelands to support a good sized boy.
1905 January 13	Heavy snowfall; all electric cars stopped at Aberdeen.
1905 January 20	It is now possible to get through with the wagon over the road constructed by the Indians on the bluffs back of Point Grenville and they are busy corduroying it with cedar puncheon.
1905 March 3	Delightfully clear, sun shinny, dry weather on the North Beach.
1906 December 6	Much havoc with the storm.
1906 February 19	Storm causes holdup in shipping traffic.
1906 January 23	Storm stirs up lot of trouble.
1906 November 16	Violent storm falls tree across flume which supplies Hoquiam with water. Greatest storm in city’s history.
1907 January 14-17, 18	18º F. 14º F. Three inches of snow.
1907 July 3	Heavy thunderstorm.
1908 December 26	Moclips threatened with destruction if violent gale does not let up.
1908 January 5	High wind causes highest flood tide in years.
1908 March 13	Heaviest rainstorm of season welcomed by lumbermen, but impeded railway traffic.
1909 December 11	Southwest gale again sweeps Harbor.
1909 December 7	Snow covers Harbor with 8” of snow.
1909 January 11	Grays Harbor Earthquake, 4.03 pm.
1909 January 19	Gale sweeps all of Grays H arbor District.
1909 January 8	Snow and cold force Harbor loggers to quit.
1909 November 18, 29	Storm isolates Harbor from the world and effects heavy damage. Storm sets records.
1910 February 28	Storm covers Harbor area.
1910 November 10, 22	Gale sweeps Harbor. Storm puts Chehalis bridge out. Line to Moclips closed by slide.
1910 October 3	Heavy storm along the coast
1911 April 10	Snow comes to whole Harbor county.
1911 January 13, 19,25	Harbor shivers in blast from Borea’s ice cold dominions. Heavy rain over, but flood damage feared. Snow shuts down logging.
1911 July 13-15, 24	Heat wave sets records on the Harbor; more to come. Fear of fire in Harbor woods begins to haunt loggers. Another warm wave finds way to Harbor, 94º F.
1911 November 9, 20	Three inches snow. Rainfall sets records; 11” in eight days, 4’ in last 24 hours.
1911 September 15, 18	Rainfall records broken; 2,42” to date. Rain prevents heavy timber loss. Order to burn timber slash.
1912 December 16, 28	Heavy wind and rain hits the Harbor sections. Terrific storm.

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1912 December 30	Tons of dirt slide on east side of Aberdeen property.
1912 January, 23, February 8	Heavy rains. Heavy storm.
1912 July 19, August 21, Sept. 7	95º F. 86º F. Heavy rain.
1912 June 6, 26	Harbor roasts under heat wave, 91º F. Large electrical storm.
1913 August 21	85º F.
1913 January 11, 24	Lull in storm is welcomed by everyone on the harbor. Melting snow and heavy rain cause trouble..
1913 July 18	Spell of summer strikes Harbor; 90º F today.
1914 December 11, 21	First breath of winter touches Harbor; 24º F. Harbor records of 14 years broken by cold; 14º F. Longest cold dry December ever.
1914 January 7, 25	Wind and rain ravage county. Moclips hotel almost destroyed by high tides and waves. 60 mph winds.
1914 May	Driest May in 22 years; 2,15" of rain.
1914 November 12	Winter gale of great severity sweeps Harbor.
1915 January 26	21º F.
1915 July 19	88º F.
1915 November 23, 25, December 8	Biggest storm of the year. 75 mile blow sweeps Harbor. Harbor lashed by fierce storm.
1916 August 24	90º F.
1916 January 3, 11, 26, 29	5" of snow cover the ground in Aberdeen. 14º F coldest since January 1909. Snow deepest in 23 years. All logging closed. Continued cold today (13º F today).
1916 March 6	Fifth Moclips blaze in a year wipes out the Moclips Hotel.
1916 November 27, December 4	Southwester lashes Harbor. Two die as fierce storm ravages Harbor.
1916 October 28	Long delayed fall gales arrive.
1917 December 8	Storm sweeps Washington.
1917 February 23, March 23	Heavy snow closes logging camps. Raging storm.
1917 January 27-29	Snowing. 10º F.
1918 December 6, 28	Rainfall heavy first five day of this month. Harbor swept by heavy gale.
1918 September	Twenty eight days without rain this month.
1919 December 12	6º F. continues the cold spell which began before Thanksgiving.
1919 January 16	Fierce gale sweeps Harbor.
1919 July 14	92º F.
1919 November 3, 27	Loggers return to work as rain has returned water to streams.. However, still not enough water to run logs. 23º F on Thanksgiving day.
1920 December 13	Harbor shaken by severe storm.
1920 February 23	So far, no rain this month on the Harbor.
1920 January 23	9º F.
1920 October 4	6" of rain in three days in Aberdeen.
1921 December 1, 12	Many washouts; rivers high. Harbor isolated by floods.
1921 February 7, 11,	Millions of feet of hemlock were blown down in the heavy storm of January 29. Clearwater-Queets damage mounts in the wake of the January 29 hurricane.

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1921 November 19, 21,22	Harbor isolated by snowstorm. Severe storm grips Harbor. County faces flood menace.
1921 October 15, 26	Electric storm damages plants. Largest in two years. Hard southwester, Wynoochee bridge destroyed.
1922 August 3, 8	Joe Creek blaze whipped to fury. Harbor drought worst since 1910; half an inch of rain in 76 days.
1922 August 30	Electric storm a novelty in Harbor.
1922 December 16, 25, 26, 27	Mercury drops to 12º F. Snow. Log camps closed due to several snowstorms. New gale and rain whip Harbor.
1922 December 6	Snowstorm cripples Harbor.
1922 January 19	Cold wave hits.
1923 August 15	90º F.; new record.
1923 December 5, 24	Heavy rain, high tides with gale. Christmas eve gale of 80 mph with heavy rain.
1923 February 13, 14, 15	Blizzard makes the Harbor shiver. Heaviest snowfall since 1893. Coastal gale takes toll; four ships reported lost.
1924 February 11	Heavy rains.
1924 June 9	88º F.
1924 October 23, 31, November	Great gale hits Harbor. Severe series of storms appear to be over. November rainfall below normal.
1925 February 1	60 mile per hour gale sweeps Harbor.
1925 May 15, June 24,27	86º F. Fire season underway. 87º F. Moclips forest blaze believed under control. Began on 27th.
1926 January 2, 16	Clear dry weather marked 1925; 137 clear days. Harbor lashed by severe gale; 90 mph on coast.
1926 June 6	84º F.
1926 May 21	Big seas batter coast.
1926 November 12, 25	Heavy rains. Difficult to reach Taholah during high tides and storms. Still no road from Moclips to Taholah.
1926 October 26	Southwester with strong winds and heavy rain.
1927 January 3, 21, February 18	60 mph winds lash Harbor.
1927 November 7, 19	First snow on hills around Lake Quinault. Terrific gale rakes Harbor with 65 mph winds.
1928 December	Big gale and heavy rain.
1928 December 25	65 mph southwester rakes the coast.
1928 July 24	94º F.
1928 March 26	Storm feels trees, blocking roads to Quinault region.
1929 December 25	Christmas gale hits Northwest.
1929 January 30	16º F. Logging camps closed.
1929 July 29	84º F.
1929 June 18	Rain laden gale smites Harbor,
1929 May 4	Report of vast earth upheaval on the Queets near M.M. Kelly Ranch.
1930 April 30	Gale swamps three Harbor fishing boats.
1930 January 15	Snow and cold cover Harbor.
1930 November 15	Winter storm attacks Harbor.
1931 December 17	Gale wreaks havoc on Harbor with 70 mph wind.
1931 December 31	Tremor shakes up Puget Sound and Hood canal.
1931 February 17	Twelve year rainfall record set for one day.
1931 January 2	Storm lashed tide sweeps into Taholah.

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1931 January 22	Rain-laden gale smites Harbor.
1931 January 28	Sea may force Indian town Taholah to move itself inland.
1931 January 31	Nature fast repairing damage done by Great Peninsula Storm.
1931 July	Rainy wet month.
1931 June 25	June rainfall on Harbor nears record.
1931 June 5	87º F.
1931 May 11	In the 80's this week.
1931 November 14	Gale and rain sweep whole of Pacific coast.
1931 November 23	Frost blankets state. 24º F. here.
1931 November 27	Record cold weather continues.
1931 November 5	Rain laden gale assails Harbor.
1932 August 5	90º F.
1932 December 1	Heavy sea up at Taholah base. Pile driver from M.R. Smith, Moclips moved to Taholah to drive some protective pilings.
1932 December 12	Harbor shivers at 16 above zero.
1932 December 2	Vast downpour deluges Harbor.
1932 December 22	Most severe gale of the winter.
1932 February 22-27	Rain and winds. Melting snow and rain floods close roads and high damage.
1932 January 11	75 mph winds lash Harbor.
1932 July 2	Wintery storms hits Harbor.
1932 June 10	91º F.
1932 March 4	Downpour sets 30 year long record, 4 ½ inches in 24 hours.
1932 November 1, 5, 16	Southerly gale lashes Harbor. Storm ravages coast. Rain pours down on North Coast.
1932 October 12	Quinaults saying the recent rain has speeded up the salmon run.
1933 April 6	Grays Harbor hit by worst disaster in Port's history. Sudden gale traps trollermen, over 200 boats imperiled, 19 feared lost.
1933 August 14	84º F., highest of the year.
1933 January 18	6" white blanket falls here.
1933 January 5	Storm on Grays Harbor.
1933 July 14, 22	84º F. 91º F.
1933 June 8	Wintry shower deluges Harbor.
1933 September 22	Indians predict mild winter; heavy rains in early fall after a dry summer usually brings a mild winter.
1934 April 30	Driest April on record; only 2,28" of rain in Aberdeen.
1934 December 25, 27	Gale sweeps Harbor with 65 mph winds. Snow blankets Harbor for the first time in two years.
1934 January 13	74 mph gale and heavy rain.
1934 January 17	At 9.00 am, clear skies provide background for a spectacular meteor fireball, "the size of the moon", which sped over Lake Quinault, creating a flash of light and thunderous roar.
1934 July 15	Freak summer storm with heavy rains and 60 mph winds in evening.
1934 May 14	88º F.
1934 November 30	50 mph gale.
1934 October 21	Harbor ravaged by 90 mph winds and flood.
1934 October 7	Southerly gale sweeps harbor.
1934 September 11	Lightning and heavy rain in the evening.

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1935 December 21, 24	Heaviest surf in years batters beaches. George Charlie, 83 years old, was swept to his death at the mouth of the Quinault River by the surf, while dip netting. Body found 10 days later. Ten days later another fisherman, Alfred James, 21, drowned at the same place and in the same manner.
1935 January 17, 31	Four inch snowfall; 12" of rain in 24 hours at Lake Quinault. Gigantic landslide near Lake Quinault. Photos of the giant landslide five miles west of Lake Quinault.
1935 January 28	ECW workmen open detour around big landslide at Point Grenville.
1935 July 13	103º F. in Queets.
1935 March 12	Chinook storm deluges Harbor.
1935 March 25	Cold winter gale sweeps Harbor leaving 2" of snow on the Lake.
1935 November 2	Third day of 19º F. weather.
1935 October 21	19º F. and continuation of summer's fair weather.
1935 September 28	85º F.
1936 22, 26, 29	50 mph Chinook ends long cold spell. Gale freshet beset Harbor. Wet leap year day.
1936 February 2	23º F.
1936 January 1	Storm rings in 1936.
1936 March 27, 30	Winter takes belated rap on at Harbor with rain, then wet snow. Third snow in three days.
1936 November 18	Good, old-fashioned Chinook sweeps Harbor
1936 November 2	23º F, sudden frost chills Harbor.
1936 November 26	Quinault River exceptionally low and wells going dry.
1937 April 13	Gale rakes Harbor region.
1937 December 25	First white Christmas in 15 years on the Harbor.
1937 February 1, 5	Heavy snow falls on Harbor. 60 mph gale rakes Harbor, snow melting.
1937 January 1, 22	18º F. County encased in ice following heavy snow, heavy rain, then deep freeze.
1937 January 29	Snow plows open finally road between Lake Quinault and Kalaloch.
1937 July 22	Call for bids on 8,0 million feet of windfall on reservation.
1937 July 28	Heavy mist breaks dry moth record.
1937 May 1	Clear day, first following wettest April on record.
1937 November 15	Rains drench Harbor; South has blizzard.
1937 November 31	Lake Quinault has only four rainless days this month. Near record rainfall for month.
1937 October 16, 29	Gale lashes the Harbor. Terrific gale rakes Harbor.
1938 August 5, September 5	Harbor drought falls far short of 1883, shows famous Luark diary. Heavy rain ends Harbor drought on 114th day.
1938 December 2, 12	Great storm lashes northwest coast. Cold snap grips Harbor.
1938 July 9	58th day of no rain.
1938 March 14, 18, 21, 30	Wet gale hits Northwest. Coast drenched. Snow blankets Harbor on first day of spring. Coldest day of the year; 25º F.
1938 May 23	Continues hot and dry, but forest fires few.
1938 November	Harbor soaked in heavy rain.
1938 November 3	Rain torrent pelts Harbor.
1938 October 12	Wind and rain buffet Harbor.
1939 April 17	82º F.
1939 August 2	92º F. Year's record.

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1939 January 1, February 3	Gale damages Harbor. Deep snow blankets Harbor hills.
1939 July 26	87º F.
1939 May 13	92º F. Forest fires peril Northwest forest.
1939 November 30, December 8, 15	Stiff gale lashes Harbor. Gale harries coast. Terrific gale rakes Harbor.
1939 October 26	Gale and rains lash Harbor.
1940 December 13, 23	23º F. Cold snap still holds. 85 mph wind lashes Harbor.
1940 January 25, 29	Harbor snow. 60º F on Harbor.
1940 July 26	Downpour ends 40 day dry spell on Harbor.
1940 June 18	Harbor drought brings early hay crop and forest fire peril.
1941 December	Harbor buffeted by 54 mph winds and rain.
1941 December 11	Weather prediction curbed.
1941 January 15	Indian Service will survey to salvage trees which blew down near Queets in the December storms.
1941 January 25	Storm hits coast.
1941 July 14	97º F; whole state roasts.
1941 June 11	90º F; fire peril mounts.
1942 August 14	95º F.
1942 July 1	104º F.
1943 December 3	5" of rain in last 24 hours reduces Harbor risk forest fire danger.
1943 January 16, 20	Mantle of snow on Harbor. 14º F. Winter tightens grip on Harbor.
1944 September 11	Harbor loggers idle due to serious fire hazard.
1945 January 8	Rivers run high in wake of storm.
1945 July 7, 19	Forest fire threat in Grays Harbor acute. Forest fires darken arbor sky. The smoke pall recalls Black Day of 1902.
1945 November 26	50 mph southwester.
1945 October 29	60 mile southwester rakes Peninsula.
1946 April 1	A five foot tidal wave races up the Quinault River.
1946 July 29	96º F.
1946 May 2	84º F.; acute power famine hits nation due to coal strike.
1946 November 18, 22	Heavy snow cripples Harbor. Heavy rain soaks Harbor in wake of snow.
1946 October 16	28º F.
1946 October 24	6" of rain in five days.
1947 December 13, 18, 23	65 mph gale lashes Harbor. Southerly gale rakes Harbor. 70 mph gale strikes Harbor.
1947 February 1	Chinook ends the cold snap.
1947 January 14, 25 31	20º F. 60 mph gale rakes Harbor. Fifth day of snow and cold.
1947 March 15	78º F.
1947 May 23	90º F.
1947 October 17	56 mph winds.
1948 April 26	Cold and snowy.
1948 February 9	60 mph wind hits Harbor, storms continue for next six days.
1948 January 1, 7	Gale lashes Harbor. Harbor hit by electrical storm.
1948 July 1	High winds keep moats in Harbor.
1948 June 1	Northwest in Flood horror.

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1948 June 23	Columbia river floods may have affected the harbor clam beaches.
1948 March 21	Heavy damage in Northwest gale..
1948 May 25, 28	Freak hail storm Harbor. Harbor records wettest May.
1948 November 3, 29	Rain, wind, and tide buffet Harbor. Winds lash Harbor for two weeks now.
1948 September 15	Gale tangles Harbor power lines.
1949 February 12, 18, 22	Phone crews battle Taholah's snow and hunger. 50 mph winds pummel Harbor. Heavy rains, on top of snow, flood country.
1949 February 2, 4, 7, 10	Heaviest snow of the year hits beaches; one foot at Pacific Beach. New snow slows Harbor to a crawl. 36" of snow at Lake Quinault. Sudden thaw imperils Northwest.
1949 January 3, 13, 21	Heavy snow on Harbor. Cold weather breaks Aberdeen's main water line and halts work at Harbor mills. Winter's worst snow hits Harbor.
1949 January 31	Coldest January recorded in 56 years,
1949 June 14	Fire peril shuts off Harbor forest areas.
1949 November 27	Near hurricane claims 28 Northwest lives.
1949 October 7, 26	Frost coats Harbor highways. Wind and rains buffet Harbor.
1950 August 14	Rains cut down Harbor fire threat.
1950 December 6	Quinault rainfall nudges 12 feet.
1950 February 1, 2, 28	Main Aberdeen water line breaks from cold. Wishkah river freezes across. 24 days of rain this month.
1950 January 2, 9, 13	Snow, cold grip Pacific Northwest. Record snowfall bogs Northwest. Blizzard paralyses Northwest.
1950 June 23	Hundreds flee northwest floods.
1950 March 4, 23	Heavy rains the last two days. Gale winds sweep Northwest coast.
1950 October 15, 27, 28	2" of rain and 40 mph winds buffet Harbor. Great gale lashes Harbor. Pacific gale wane after four day siege.
1950 September 21, 30	84º F. 35º F.
1951 January 2	High winds, rain bombard Harbor.
1951 July	Driest July since 1944.
1951 June 28	90º F. Drought continues.
1951 March 27	Showers bring cheer to region.
1951 March 7	Swirling snow smothers Harbor for fifth day.
1951 November 15	28º F.
1951 November 26, 29, 30	Blowy weather rakes Harbor. Harbor rides out storm. 65 mph wind rakes Harbor.
1951 October 2	Rain soaks Harbor area.
1951 October 9	Summer in fall hits Northwest.
1952 April 30	Near gale lashes Harbor.
1952 December 4, 12, 30	Harbor gets drenched. 5.73" rainfall at Lake Quinault in last 24 hours. 50 mph gale hits harbor.
1952 January 3, 21, 22	Snow covers Harbor. Heavy snow. Winter grip tightens on Harbor.
1952 July 9	96º F.
1952 March 21	27º F.
1952 November 14	Electric storm, wind, and hailstones bombard Grays Harbor again.
1953 December 10, 25	Heavy rain and 55 mph wind. Heavy rain and 65 mph gale.
1953 February 13	Rain gauge dry for the first time in 50 days.

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1953 January 2, 9, 22, 31	Heavy rains. Storm forces school closures as winds and rain batter Harbor for the third day. Torrential rains. January rainfall beats 1914 record.
1953 July 11, September 4, 28	Soaring heat. Heat and wind, lighting starts 63 fires in state. Gale lashes Harbor. Quinault rainfall tops 100" for the year.
1953 March 2	Snow, small blizzard hit Harbor.
1954 August 31	4.41" of rain in Aberdeen. It is the second wettest August on record (5.16" in 1937). Only five days without rain.
1954 December 25	AN unusual white Christmas this year.
1954 February 13	Second storm in last two days has 60 mph winds and heavy rain.
1954 June 19	Violent electrical storm. Brilliant white lunar rainbow appears at 10 pm near Westport.
1954 May 7	82º F.
1954 October 7	Heavy rain and gale.
1954 September	September the most summery month of the year.
1955 December 18, 22	Harbor digs out of deep snow. Stiff winds and rain on harbor.
1955 February 18, 28	24º F. Coldest of the year. Howling storm with 70 mph gusts batters the Northwest.
1955 January 15, 27 30	Wind and rain blast Harbor. 23º F. 22 º F.
1955 June 9	94º F.
1955 March 4 21	22º F, coldest in five years. Wind and rain.
1955 November 5, 12, 17	Gale and high tide on harbor. Lake Quinault 20 feet above normal. 17º F, 30-40 mph winds. 11º F. 33º F. First day above freezing; 5 ' snowfall.
1955 October 6	Heavy rain lasts 6 days.
1955 September 5 21	88º F and acute fire danger. 36º F.
1956 April	Driest April in 65 years.
1956 December 5, 10	Arctic storm sweeps Northwest. Gale winds, heavy rain in area; 15.43" of rain in two days at Lake Quinault.
1956 February 14, 24, 28	20º F. 2" snowfall in Aberdeen. Wet snow. 54 mph winds on Harbor. End one of coldest Februaries.
1956 July 4, 19	Soggy day. 98ºF.
1956 March 3, 6	Thunderbolts, rain, snow, 65 mpg gust belt Harbor. 25º F. March rain two times normal.
1956 May 17	90º F.
1956 November 30	An unusually dry and warm month.
1956 October 20	Storm drenches Harbor with 2" rainfall.
1956 September 4	Fire danger explosive in the woods.
1957 April 30	Biggest electrical storm in 50 years shatters Harbor sleep.
1957 December 19, 21	Storms continue to hit the area. More storms.
1957 February 25	Fierce storm batters Harbor.
1957 January 27	13th day of cold snap.
1957 January 7	Heavy rains and snow pelt Harbor.
1957 September 14	Heat wave continues; fire hazard high.
1958 April 4	Heavy surf lashes Harbor beaches.
1958 December 2, 25	Steady storm lashes Harbor. Heavy wind and rain.
1958 January 23, 26	60 mph gale and rain. Storms continue to lash Harbor.
1958 July	Driest July since 1922.

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1958 May 16, 19	Dry weather closes logging on Harbor. Spectacular lightning storm.
1958 November 4, 26	Hurricane-force storm slams Harbor. 26º F.
1958 October 3	78º
1958 September 10	55 mph winds and rain.
1959 April 30	Rain of last four days exceeds 5".
1959 August 30	94º F.
1959 December 15, 31	Near record deluge causes slides and flood on Harbor. 150.13" rain at Lake Quinault.
1959 January 2, 3, 23	Winter's first snow hit Harbor. 11º F, two year low. High winds, heavy rain drench area.
1959 March 31	Heaviest rain in two years.
1960 April 14	Savage windstorm batters coast.
1960 August 8, 15	91º F. Logging closures. Heavy rain ends dry spell.
1960 December	Heavy wind, rain and tides hit harbor.
1960 January 11	Highways hazardous with snow on Harbor.
1960 July 5, 31	95º F. Total rainfall on Harbor is .06" for July.
1960 March 3, 29	Belated snowstorm gives harbor traffic bad time. Winds.
1960 November 17, 24	High wind, heavy rain lash Harbor. Heavy showers.
1960 October 17	72º F.
1960 September 9	88º F.
1961 August 12	96º F.
1961 December 4, 19	50 mph gale lashes bar. Storm howls.
1961 February	Record February rainfall.
1961 November 10	Gust hit 80 mph. Storm on Harbor.
1961 October 14	84º F.
1961 September 1, 19	Wynoochee river bed dry for three day. Fishing slow on Quinault due to low water.
1962 February 28	7" snowfall.
1962 January 19	26º F.
1962 July	Cold but dry overcast month.
1962 March 23	50 mph wind gust.
1962 October 12	Massive storm rakes Pacific coast. Near hurricane does heavy damage on the Harbor.
1963 August 8	85º F.
1963 February 1	Harbor weather returns to normal after third driest January.
1963 January 11, 14	Barometer sets all time high on Harbor; 30.86". 18º F. as massive Arctic front sweeps nation. Slippery ice-glaze covers Harbor. Area.
1963 May 2 , 20	January weather intruding on May. On harbor. 96º F; all time high for Aberdeen in May.
1963 October 22,24	Storm with 73 mph. winds. 80 mph wind storm hits harbor.
1964 December 16, 19, 30	Arctic wind keeps state in icy grip.; 15º F. Snow blankets Harbor. Harbor digs out of new snowfall; up to 16" on hills.
1964 January 19	75 mph winds.
1965 December 27	100 mph wind gusts hit Harbor with driving rain.
1965 January 1, 4, 30	70 mph gale breaks winter grip. 12" snowfall at Lake Quinault. Heavy rain the last four days.
1965 July 29	Logging halted because of fire danger.
1965 March 12	74º F and the 10th day of sunny warm weather.

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1965 November 19	65 mph winds rake Harbor.
1966 December 21	47th straight day of rain
1966 January 2	75 map winds; three drown at the mouth of Raft River.
1967 August 14	Fire threat halts logging.
1967 December 4	Year's highest tides plague Harbor in wake of storms.
1967 November 9	Wind and rain whip Harbor.
1968 August 1	92º F.
1968 December 3, 23, 28, 29	Heavy gale pummels Harbor. Rain washes away 4" of snow. Snow and ice on Harbor. Harbor gripped by cold; 13º F.
1968 February 28	70º F.
1968 January 4, 19, 29	Harbor buffeted by 55 mph storm. High wind and record snowfall on Harbor. Snow whitens harbor.
1969 December 12	70 mph winds buffet Harbor.
1969 January 15, 17, 27, 31.	Lightning crackles along with snow on Harbor. Heaviest snowfall in years. Snowstorm buries Harbor. 31" of snow this month in Aberdeen.
1969 March 17	60 mph wind and rainstorm buffets Harbor.
1970 April 9	40 mph storm lashes coast.
1970 December 2, 7, 15-16, 29	Harbor roads treacherous with ice, snow. Winds, rain lash Harbor. Near record downpour drenches Harbor. Dark rainstorm rake Harbor.
1970 January 26	17th straight day of rain.
1970 July 15	Logging shut down in wake of dry weather.
1970 June 2	95º F.
1970 November 22	Winter grips Harbor.
1970 October 21	Harbor reported as wettest spot in nation.
1971 December 9. 16	52 mph winds and rain follow snow. 13.45 feet of rainfall so far this year at Lake Quinault.
1971 February 26	Snow returns to Harbor.
1971 January 4, 11, 15, 26	Frigid weather grips harbor. Snowfall slows down activities. 100 mph gusts lash coast. Slides and floods hit area.
1971 July	A warm July after wet June. Coastal fog.
1971 March 1, 12	22º F. 50 mph wind and rain soak Harbor.
1971 May 16	52 mph winds, rain lash Harbor.
1971 November 19	45 mph winds.
1971 October 19	50 mph gale rakes coast.
1971 September 19	Fire danger high in Northwest forest.
1972 December 5, 12, 18, 22, 26	First snow of winter grips Harbor. Warming trend brings more snow. Winds, storms more.
1972 February 1, 7, 28, 29	Snow and cold continue. Thaw forces load limits. 50 mph wind whips coast. Winds batter coast.
1972 January 11,20, 22, 25, 28	Snow covers the county and melts by next day. Storm lashes Harbor. Harbor flood danger subsides. 10" snow staggers Harbor. 14º F.
1972 March 6	Heavy rains over weekend.
1972 October 16	Beautiful fall weather continues.
1972 September 3	96º F.
1973 December 3, 12	Lightning, rain, 55 mph winds. 59 mph winds and heavy rain, high tides.

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1973 January 2	Rainy Quinault records 174.28'' in 1972.
1973 January 8, 19, 24	Wind adds to 19º F chill. Storm and tides. Coastal storm brings wind and rain.
1973 June 12	Heavy rains soak Harbor.
1973 May 14	90º F.
1973 September 10	80º F.
1974 December 17, 20	Howling storm attacks Harbor. First snow hits Harbor.
1974 January 16	Strong winds and heavy rains for past three days.
1974 November 20	Weather back to normal with buckets of rain.
1974 October 18	Can this be fall? Thank you Mr. Weatherman.
1974 September 24, 30	88º F. The last two months have been clear, warm and dry.
1975 December 1,5,16,25	High tides, wind, rain combine to cause flooding. Flood threats mounting as rain continues. 40 mph winds, but portions of coast hit by much stronger freak winds causing extensive damage. Heavy rain.
1975 February 18	60 mph winds hit Harbor.
1975 January 8, 28 February 20	Wicked storm hits Harbor with 72 mph winds. Thick wet snow on Harbor. 50 mph winds followed by snow.
1975 June, July 8	80º F. Electric storm hits Harbor.
1975 March 24, 25	Winds gust 58 mph. Winds 53 mph.
1975 November 17	50 mph winds and rain.
1975 September 11	84º F. hottest day of the year.
1976 January 15	Heavy rain leads to flood threat.
1976 September 12	Pelicans appear on beach and at mouth of the Quinault river for first in anyone's memory. (David Douglas reported them in his journal south of Point Grenville in July 1825.
1976 September 26	Two freak 15' waves hit Harbor beaches causing damage.
1977 March	Heaviest rain in one year breaks drought. Storm slaps Northwest.
1977 October 25, November 2, 27	Storm pummels harbor. Howling winds hit harbor. Heavy rains bring flood threat.
1978 August 8	92º F.
1978 July 21	Threat of fire suspends forest work on the reservation.
1978 November 3, 20 December 30	Rain and wind storm. Snowfall 19º F.
1978 September 17	Rip rap replaces the old sea wall facing the ocean at Taholah.
1979 August 20	Rains return with a bang.
1979 December 14, 18	Storm hits Forks hard. Bogachiel bridge approach washes out. Flood danger high on Harbor.
1979 February 13	Storm slams coast with 70 mph winds. No power for nearly four days.
1979 January 3	Ocean shores marina frozen.
1979 July 17	97º F is hottest in years.
1979 March 5	Storm slams harbor.
1979 September 10	Most spectacular electric lightning storm for these parts.
1980 August 8	Wild and crazy storm hits Harbor.
1980 December 4, 21	Freeze due in wake of slushy snow. Rain and wind keep coming.

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1980 February 26	Soggy weather reigns over harbor as rivers rise.
1980 January 8, 28	Snow blankets harbor. Cold snap has harbor shivering.
1980 July 21	82º F.
1980 November 4, 21	Heavy rains. Storm rips into Harbor.
1980 October 6	Summery temperatures set a record across the state.
1981 August 10, 24	105º F, all time Harbor high. Storm on Harbor.
1981 December 5,11	Gusty winds, drenching rain blast harbor. Hail. High water and ice strike harbor.
1981 February 16, 19	Rivers under close watch in wake of heavy rains. Lightning-spiked storm KO' power.
1981 July 18	Hikers stream to Paradise Ice Caves (within few years, they would become non-existent). Correct name is "Paradise and Stevens Glacier Caves". Two winters in a row, 1970-1971 and then, 1971-1972 had record of all time of annual snowfall, shutting the entrance to the caves. By 1993 the caves were completely gone.
1981 July 20, 22	Rainy weather for the second year is limiting slash burning. Hoquiam high 58º F. is coldest in the nation.
1981 November 11,	Mean storm roars through harbor. Storm howls in; worst since 1934.
1981 September 16, 28	93º F; hottest September on record for Harbor. Storm drenches Harbor.
1982 December, 16, 22	Storm and high tides. Howling storm KO' power. Savage storm.
1982 February 18	Stormy weather keeps coming.
1982 January 2, 4, 23	Snow (10" at lake Quinault) persists; roads dangerous. Snow should ease up tonight. Storm douses Harbor.
1982 June 18	100º F. hits ten years high for June.
1982 October 13, 22	75º F; hottest day in state. Big storm hits Harbor with 55 mph winds.
1982 October 6	Storm brings first taste of winter to Harbor.
1983 August 28	El Nino hits Northwest coast hard.
1983 December 24, 25	Cold weather continues today, 10º F. Holiday storm slams Harbor with 50 mph winds.
1983 December 28	Load restrictions in place as result of rapid thaw; trucking grinds to halt.
1983 January 28	Moclips hardest hit by high tides.
1983 January 5	Baby, it's wet outside , even for here.
1983 July	July rain fall short of July 1916 record by ¼ ".
1983 March 21	Warm sunny weather ushers in spring.
1983 November 10, 19, 24	Storm zaps power. High winds whistle up a lot of damage. Holiday storm hits Harbor with 80 mph gusts. Soggy November; rain the first 27 days.
1984 August 27	Fire danger high despite rain.
1984 January 25	Torrential rains.
1984 January, 3	High tides and heavy rain.
1984 July	Harbor records one of the driest Julys in history.
1984 June, 21	Summer arrives after near record wet spring.
1984 November 1	Wild autumn storm.
1984 October 13	Hail and thunder hammers Harbor.
1985 January, 3	Ice wreaks havoc on roadways.
1985 April 1	Last three months of rainfall the lowest ever.
1985 August 13	90º F.
1985 August 29, 31.	Fire danger extremely high state wide. Forest fires burn a hole in budget.
1985 December	Twenty days of dry and cold (20's) longest spell for December.

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1985 December 2	Ice storm hits Harbor.
1985 December 26	1985 may be the driest year of the century.
1985 February	Howling storm with wind gusts of 51 ,ph.
1985 January	May have been the driest January ever on the Harbor.
1985 July 11, 20, 22	Largest fire fighting force ever on lines in Western US. Foresters praying for rain. Dry weather curtails logging.
1985 July 2	First six months driest in 50 years.
1985 June 6, 18	Record low rainfall in Northwest. 88º F.
1985 May 17	Harbor hot spot, 89º F in Aberdeen.
1985 November 20, 27	First snow of the year. Snow in the Puget Sound while Harbor remains in "Snow Shadow".
1985 October 27	8" of rain and more predicted.
1986 August 26	46 rainless days.
1986 January 5, 16, 19, 20	Howling storm hits Harbor with 60 mph winds. Angry storm in evening with gust to 90 mph. Heavy rain and strong winds. 100-year storm for Seattle. Swollen Chehalis could flood east county.
1986 November 24	Heavy rains swell rivers. Quinault and Queets hit hardest since 1935.
1987 April 1	80º F on harbor.
1987 August 6	Quinault reservation closed forests closed due to drought.
1987 December 1	Blustery storm hits harbor.
1987 January 31	Howling storm and heavy rain.
1987 March 3	Blustery storm.
1987 May	First week in 80º's F.
1987 September 1, 29	96º F. Most woods closed. 85º F.
1988 August 24	92º F.
1988 December 29	First full-blown monsoon of winter.
1988 January 15	84 mph wind causes havoc on beach.
1988 July 19	98º F.
1988 March 26	Sixth blustery storm this week.
1988 November 8	First week marked by blustery storm.
1988 September 1, 2	Forest closed due to dry weather.
1989 April 29	Second warmest April on record.
1989 December 14	Rainfall totals 8.35" at Lake Quinault over the weekend.
1989 February	First week with snow and cold near record lows.
1989 February 5	Report shows temperatures the warmest of decade in 1988, '87, '86, '83, '81, and '80, six of the warmest years of the 20th century.
1989 March 2	Harbor only dusted while snow buries Puget Sound .
1989 September 23	91º F.
1990 August 8	Dry weather prompts logging restrictions.
1990 December	This year's 173.30" rainfall at Lake Quinault is 3" short of 1983 record.
1990 December 3, 21	Wind and rain slam harbor. 11º F.
1990 February 7, 12	16" at Lake Quinault. Harbor receives 7" precipitation over wild weekend.
1990 January 31	This January wettest in last 26 years.
1990 November 11	Lake Quinault is at highest level in 20 years after weekend of nearly 14' rain.

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1990 November 23	70 mph gusts and heavy rain on Harbor.
1990 November 9	"Pineapple express" storm slams into state.
1990 October 9	Snow cover on the northern half of the earth dwindled in the '80s.
1990 September	One of the driest Septembers ever.
1991 April 1	It has rained almost non-stop since April 1st.
1991 August	Fierce summer storm zaps region.
1991 February 4, 19, 27	Strong wind and rain over the weekend with gusts to 65 mph. Heavy rain. Sunny and 68º F. Seventh day of sunshine.
1991 November 19	Wet blustery day.
1991 October 12	State pants for rain; high fire danger. Seattle 41 straight days without rain.
1991 September	One of the driest Septembers on record.
1992 December 17	First snow in nearly two years whitens harbor county.
1992 February 26	73º F; ties 100 year high record for February.
1992 January 31	Winds with 92 mph gusts on coast KO power; fifth straight day of deluge; 8" for week.
1992 July 19	Extreme fire danger in Western forests.
1992 March	March one of the driest on record.
1992 March 9	Winter is warmest on record so far.
1992 May 3	78º F. on beaches, 86º F in Aberdeen.
1993 August 3	95º F.
1993 December 10	Overnight rain and wind hammers harbor.
1993 February	One of driest Februaries on record.
1993 January 13	Moclips-Cook Creek road remains covered with ice in cold snap.
1993 July	One of coldest and wettest Julys on record across Washington.
1993 March 4	March rains already top February as blustery storm blows off the Pacific.
1993 November 22	Arctic blast blows into state.
1994 December 21	Rising rivers, raging surf disrupt lives on the Harbor.
1994 March 21	75 mph gusts blast the coast.
1994 November 30	Soggy storm slams coast. 7" of rain at Lake Quinault in past two days.
1994 October 26	Wind and rain batter area.
1995 August 6	One day August rainfall shattered: 1.79" in Hoquiam, 4.16" in Forks, and 3.71" in Ocean Shores.
1995 February 12	Cold and snow interrupt spring-like weather.
1995 January 25	El Nino two times as strong as in 92-93.
1995 July 18	95º F. in Aberdeen.
1995 June 29	Last two days the hottest of the year. 93º F. in Hoquiam.
1995 March	Storm KO' power, but no injuries.
1995 November	This November one of the wettest in 30 years.
1996 January 15	60-70º F. and sunny this week.
1996 January 30	15º F. Frigid weather to remain.
1996 January 5	Researchers report 1995 as the warmest year ever.
1996 January 9	East county bears the brunt of flood waters tagging across the Northwest; I-5 closed at Chehalis due to flooding.
1996 March 2	Sea-Tac Airport records soggiest four month period since record keeping began in the mid-40's.
1997 December 31	Lake Quinault has 177.75 inches of rain this year
1997 May 11	90º F. In Aberdeen.
1997 September 18	Late summer rain; nearly 7 ½ " on the coast in 5 days.

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1998 December 19	Cold and snow turn Harbor roads to ice.
1998 February 18	Daffodils get a jump on spring and begin to bloom on the Harbor.
1998 February 24	El Nino generated storms continue to devastate California and send swarms of deadly tornados over Florida.
1998 January 11	Five inches of powdery snow falls on the Harbor.
1998 January 6	Worldwide, 1997 was the warmest year of this century.
1998 May 1	A large mid-April dust storm in Asia created the gigantic cloud of dust which is filtering the sun and reducing air quality in the Northwest.
1998 November 24	Evening storm visits the beaches with 72 mph winds.
1998 September 3	Rainless August in Aberdeen. No rain since July 25th. Countywide burning ban continues.
1999 January 8	Snow whitens Harbor after “weeks” of rain and wind.
1999 March 1	Aberdeen had the four wettest months in city history: 89.87 inches.
1999 March 3	Ocean Shores hardest hit by coastal storm and tides. Winds gust to 100 mph.
2000 December 14	Ocean Shores broadsided by 90 mph winds.
2001 August 24	Heavy rains douse the coast over the past three days.
2001 February 16	The Twins Harbors' first - and possibly last - taste of snow this winter. Up to five inches in some areas.
2001 March 14	Gov. Locke declares a statewide drought emergency.
2001 November 15	Quinault received 7.21 inches of rain in last 48 hours.
2002 August 9	Most canoes in Paddle 2002 make landing at Point Grenville after high seas and fog causes havoc near Queets.
2002 March 7	4”-10” of snowfall in the Aberdeen/Hoquiam area.
2002 November 18	7” rain at Lake Quinault.
2002 October	October one of driest on record. Lake Quinault has 0.95” this year while in 2001 there was 13.98”.
2003 August 26	Seattle sets record: 50 consecutive days with a high temperature of 70 degrees or more.
2003 December 4	High winds hit Quinault.
2003 November 18	Century-old barn collapses in Humptulips during wind storm.
2003 November 28	Heavy rain and strong winds.
2003 October	One of wettest Octobers on record.
2003 October 17	Two days of wind and rain herald in the first big storm of the season.
2003 October 20	Rain storm 5.56” at Aberdeen and 5.52” at Lake Quinault. The North Shore Road washed out at Grandey Creek.
2003 September 13	Summer ’03: Driest spell in a century.
2004 January 6	Blast of cold and snow slam Harbor and Western Washington.
2004 July 23	Hoquiam beats 50-year old temperature record with 93F; 101F in Aberdeen.
2004 June 14	The East Fork of the Quinault River threatens the Enchanted Valley Chalet; it has moved to within 20 feet of the historic structure following last October’s heavy rains.
2004 March 30	Aberdeen 76 degree high breaks record.
2004 May 24	Washington’s state strawberries ripening two to three weeks early.
2005 February 3	Early harvest surprises Harbor daffodil farmers. Unseasonably warm January.
2005 January	One of wettest Januarys on record.
2005 January 23	Today marks the 37th consecutive day of measurable rain on Grays Harbor.
2005 March	Last two weeks of March are wet and cool.
2005 March 10	Gov. Christine Gregoire authorizes the Department of Ecology to declare a statewide drought emergency.

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
2006 December 15	Howling storm with 90 mph gusts lash Grays Harbor and leave a million households without power in Western Washington.
2006 February 4	60 mph winds and rain thrash the coast.
2006 July 22	Triple digits bake the Harbor area.
2006 June 22	Earth is at its hottest in 2,000 years, study says.
2006 June 26	Record hot temperatures for this date set across county; 100 degrees in Elma.
2006 November 15	70 mph winds whip the Harbor.
2006 November 28	Harbors covered from 1" to 8" of snow.
2006 November 29	25°F in Hoquiam.
2006 November 30	November second wettest month since 1891 on the Harbor.
2006 September 1	91°F in Hoquiam.
2006 September 29	Scientists find glaciers are melting fast.
2007 December 3	Devastating storm rocks the Harbor. Entire Harbor without electricity.
2007 December 7	Governor pushes for FEMA aid.
2007 February 19	Growing support to get Doppler radar in Westport to fill in "Black Hole" on weather data along the west side of the Olympic Mountains.
2007 February 2	UN panel of 113 scientists say global warming clearly caused by humans.
2007 January 1	2006 was the twelfth wettest year in Aberdeen.
2007 January 12	Cold snaps ices roads on the Harbor.
2007 July 11	Hoquiam's 99 degrees sets a record as coast sizzles.
2007 July 22	Near record July rainfall on the Harbor over past four days.
2007 November 12	Thousands lose power in storm with gusts that top 70 mph.
2007 November 18	UN panel says only urgent global action will alter the course of global warming.
2007 September 23	Seas could rise a meter in next 100 years.
2008 December 15	More snow and cold likely.
2008 December 21	Snowy winter Solstice storm hammers the Northwest and the Harbor.
2008 February 14	Quinault residents blown away by daunting timber blowdown from December storm.
2008 February 18	Winds topped 133 mph during December 2-3 storm.
2008 May 16	A mini-heat wave sends thermometers to 93ºF in Hoquiam; cause surge of Olympic rivers from melting mountain snows.
2008 November 8	15" (ONP) of rain fall in the Quinault Valley in 72 hours.
2009 August 21	World's oceans set record for warm temperatures.
2009 December 17	Bill for Doppler radar funding in Grays Harbor signed by President Obama.
2009 December 7	Cold snap cools the Harbor down into the teens.
2009 January 4	Sudden afternoon snow sends cars sliding off Harbor highways.
2009 July 29	Seattle records all time high of 103°F; east Grays Harbor County in triple digits.
2009 June 4	Heat wave lasting over a week comes to an end with 90's in east county.
2009 October 30	The Graves Creek Road (East Fork of the Quinault River) re-opens after it was damaged in many places by the storm of December 2007.
2009 September 22	85°F on the Harbor's coast marks the start of fall.
2010 January 18	Overnight, a howler of a storm (peak gust of 62 mph) knocks out power in parts of the Harbor.

Table 25. Significant Weather Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
2010 January 31	Warmest January ever recorded for most of Western Washington; second warmest at Hoquiam.
2010 January 8	Week of heavy rain and record warm temperatures in Grays Harbor.
2010 March 16	Three proposed Doppler sites announced; all in northwest Grays Harbor.

4.4. Floods

A flood is an overflow or accumulation of an expanse of water that submerges land. In the sense of "flowing water", the word may also be applied to the inflow of the tide brought about from storm surges from the ocean (see also Section 4.3.2). Flooding may result from the volume of water, within a river or lake, which flows out of the river channel (bank-full-width) or breaks over levees, with the result that some of the water escapes its usual boundaries. While the size of a lake or other body of water will vary with seasonal changes in precipitation and snow melt, it is not a significant flood unless such escapes of water endanger land areas used by humans like a village, home site, or other inhabited area.

Floods also occur along rivers, when the volume of the river is so high it flows over the bank-full-width, particularly at bends or meanders and causes damage to homes and businesses along such rivers. While flood damage can be virtually eliminated by moving structures and infrastructure away from rivers and other bodies of water, the people of the QIN have historically lived and worked by the water to seek sustenance and to capitalize on river transportation and access to fishing. Today, people continue to inhabit areas threatened by flood damage. This decision contributes to the conclusion that the perceived value of living near the water exceeds the cost of periodic flooding.

Coastal floods are caused by severe sea storms, or as a result of another hazard (e.g. tsunami). A storm surge, from an extratropical cyclone, falls within this category. The first seawall in Taholah was constructed September 1921 by the BIA, but it was not much more than a superficial effort (Workman 1997-2010). In December 1932, heavy onshore sea tides hit the beaches and heavy pilings were placed in an emergency effort to reinforce the seawall at Taholah. In September 1978, and March 1981, rip rap was placed in Taholah to replace the old wooden seawall facing the river in Taholah (Figure XXXVIII). In December 1994, rock was added to the seawall in Taholah as a response to the ocean waves that can sweep over the spit at the mouth of the Quinault River.

Workman (1997-2010) conveyed a report from January 28, 1931, that “the sea may force Taholah to move itself inland. It is difficult to reach Taholah during high tides and storms.” These conditions have not significantly improved, although the retaining wall to the Quinault River and the seawall continue to provide substantial benefits to the village.

Table 26. Significant Flood Related Events in and around the QIR (Workman 1997-2010).

Date	Information
1887 December 6-8	Storm. Heaviest blow of the season. Heavy rains and rise of streams has caused loss of booms and wharfs. Estimate that more than two million feet of logs loose on the harbor.
1894 December 14	Snow gone and rivers in flood.
1894 November 20	Heavy rains and high water.
1896 November 12	Rain and windstorm lasting three days. Quinault River three feet higher than ever known. A house washed away.
1897 December 10	More storms and high water.
1899 November 29	Heavy winds build seas to highest ever seen.
1903 November 13	The heavy rains have kept the rivers full for nearly two weeks.
1921 January 3, 29	Heavy rains flood roads. Harbor gale toll is great. Arrives at 4 pm. (This became one of the greatest storms ever to strike the west side of the Olympic peninsula.)
1923 January 1, 9, 30	Gale, High tide and rain beat Harbor region. County flood rage unabated. 14º F.

Table 26. Significant Flood Related Events in and around the QIR (Workman 1997-2010).

Date	Information
1926 December 1, 2, 4, 15, 22, 29	Quinault River raging torrent following heavy rains. Slide cuts off Aberdeen water supply. Quake shakes Northwest. Snow covers whole state. Dense fog halts Harbor traffic; 27º F. Harbor lashed by severe gale.
1933 December 11, 18, 21	Winds and 7" of rain in three days. Flood ravages Harbor; 90 mph winds and 6" of rain in 24 hours. 15'8" tide. More rain and wind, Lake Quinault at highest level in 10 years.
1935 January 22, 25	Flood waters isolate Harbor and flood Taholah. Record high flood waters begin to drop.
1951 February 9, 10, 13, 21	Rain sloshes Harbor. Moclips flooded. Floods and logs break Wishkah dam. Freeze checks floods. Relentless rains.
1954 January 4, 6	Gale whips Harbor for 4th day. Started with 1-6" of snow,, more inches fell by 18 and a foot more by the 21st. Rains and melting by the 23rd caused flooding. By the 25th it was cold again, 10-20" of new snow fell. Still more snow fell on the 27, 28, and 29th. The total in Aberdeen was 27", but there was as much as five feet in some parts of the county. All logging shut down.
1959 November 21	Torrential rains flood rivers.
1961 January 16	Torrential rains bring floods to Harbor.
1971 February 1	Evens proclaims Grays Harbor County flood disaster area.
1977 December 12	Are again hit by flooding.
1978 February 8	Floods hit harbor again.
1990 January 7	Winds and rain bring flooding. I-5 closed at Centralia due to flood.
1993 January	Officials monitoring rivers in wake of heavy rains.
1999 August 4	The Quinault River flow is as much as twice the normal due to late melting snow.
1999 November 12	High tides and heavy rain spill into Aberdeen city streets.
2004 June 15	The Hoh River erosion threatening parts of the Hoh Reservation.
2005 January 17	Nearly 12" of rain fall at Amanda Park in 24 hours. Deluge closes slew of roads.
2006 January 13	Governor declares state of emergence in 12 counties, including Grays Harbor in wake of rains with damage to Hwy 107 and floods.
2006 November 7	Record rains flood Grays Harbor over last several days. 11 inches recorded at Lake Quinault in last 24 hours.
2007 March 23	Heavy rains deluge area.
2008 November 12	Floods and slide impact county in wake of recent rain.
2009 January 2	Hoh Tribe is attempting to move village to higher ground because of flooding, but needs additional land from ONP.
2009 January 7	Pineapple Express pounds Grays Harbor and Western Washington, sending rivers over their banks.

4.4.1. Tribal Legends

Deluge legends are generally mythical stories of a great flood sent by a deity or deities to destroy civilization as an act of divine retribution, and are featured in the mythology of many cultures.

4.4.1.1. A Story of the Flood

Ludwin (2002) & Gunther (1925)

> In the beginning Kwattee created the animals of the earth. Then by the union of some of these animals with a star which fell from heaven, came the first human beings. And from these sprang the various races of men.
>
> Years came and went and all was good. Then Chief Thunderbird attempted to destroy all the good whales of the ocean. Kwattee then interfered, and a terrible drawn battle was fought between him and Thunderbird.
>
> Enraged, that bird caused the waters of the great deep to rise. For four days the sea continued to rise. It rose till it covered the very tops of the mountains.
>
> Again Kwattee joined his adversary in battle, and while the conflict was in progress, the waters receded. This engagement, too, was a drawn battle, and following it the waters

again rose. The water of the Pacific flowed through what is now the swamp and prairie westward from Neah Bay on the Strait of Juan de Fuca to the Pacific, making an island of Cape Flattery.

Again Kwattee and Thunderbird engaged in terrible conflict, and again the waters suddenly receded, leaving Neah Bay, the Strait of Fuca, and Puget Sound perfectly dry. For four days the water ebbed out, and numerous sea monsters and whales were left on dry land.

The battle was again indecisive. Then without any waves or breakers the waters again rose till they had submerged the whole country. Then Kwattee killed Chief Thunderbird. The waters were then four days receding. And since then there has been no great floods on the earth. Also each time that the waters rose, the people took to their canoes and floated off as the winds and currents wafted them, as there was neither sun nor land to guide them. Many canoes also came down in trees and were destroyed, and numerous lives were lost. And the survivors were scattered over the whole earth. One segregation of the Quileutes found themselves at Hoh, another at Chemakum (near the present Port Townsend), and a third succeeded in returning to their own home here on the Pacific.

4.4.1.2. The Flood

(Gunther 1925)

There was a man who told his people to make some canoes and to make them large and strong so they could endure storms. There was a flood coming. The people said the mountains were high and they could just go up the mountains when the flood came. He warned them again. Soon it began to rain and rained for many days. And the rivers became salt. The people said they would go up the mountains. When the flood came they took their children by the hand and packed the small ones on their backs. It became so cold that the children died. They had no way of getting to the mountains for the valleys were full of water and the rivers overflowed their banks.

The people that walked all died. Those that had canoes and water and food lived. Some who were in a canoe tied themselves to a treetop when their canoe hit the tree and split. Many died. Some tied themselves to mountains and the highest ones were saved. The flood uprooted all the trees. That is why there are no really large ones left today. All the trees of today grew after the flood.

4.4.1.3. Makah Legend (as accounted by Swan, 1868)

Tradition reported (Reagan 1934) in reference to movement among the Makahs, is relative to a deluge or flood which occurred many years ago.

"A long time ago," said by informant, "but not at a very remote period, the water of the Pacific flowed through what is now the swamp and prairie between Wyatch Village and Neah Bay, making an island of Cape Flattery. The water suddenly receded leaving Neah Bay perfectly dry. It was four days reaching its lowest ebb, and then rose again without any wave or breakers, till it had submerged the Cape, and in fact the whole country, excepting the tops of the mountains at Clyoquot. The water on its rise became very warm, and as it came up to the houses, those who had canoes put their effects into them, and floated off with the current, which set very strongly to the north. Some drifted one way, some another; and when the waters assumed their accustomed level, a portion of the tribe found themselves beyond Nootka, where their descendants now reside, and are known by the same name as the Makahs in Classett, or Kwenaitchechat. Many canoes came down in trees and were destroyed, and numerous lives were lost. The water was four days regaining its accustomed level."

4.4.2. Understanding Water Related Damages

Flooding is a natural process that occurs when water leaves river channels, lakes, ponds, and other water bodies where water is normally confined and expected to stay. It is also a serious and costly natural hazard affecting Washington when it occurs around buildings and infrastructure. Floods damage roads, bridges, and structures, often disrupting lives and businesses. Flood-related disasters occur when property and lives are impacted by the flooding water. An understanding of the role of weather, runoff, landscape, and human developments in the floodplain is therefore the key to understanding and controlling flood related disasters.

On the QIR, the legacy of a road network designed to facilitate logging traffic starting at the beginning of the 20th Century gave little concern to the environmental impacts of stream crossings, road density, and the influence on fisheries. Many of the roads were built using small diameter gravel available in the various gravel quarries in the area (Figure XXIX). These small diameter gravel foundations are generally very susceptible to water erosion because the material has a high pore space to solid material ratio, and little resistance to erosion by surface water flow.

Figure XXIX. Characteristic slumping of a QIR forestry road on the outer edge of the lane where small diameter gravels of the road base have been washed away.

Today, those concerns mean that land managers must assess the reliability of the road network to facilitate current transportation demands. This process of reassessing the road network dictates that stream/road crossings must be evaluated in terms of the impact on fisheries, water quality, and downstream influences. To further complicate this issue, the amount of annual precipitation (exceeding 10 feet a year) leads to an often hyper-saturated drainage network that finds release by leaving the stream network to flow along roadbeds.

In order to deal with some of these challenges, QDNR staff have instituted a road/stream crossing inventory on the QIR (Figure XXX). Although not completed at the time of this document's publication, initial indications reveal that over half of the culvert structures present a blockage to fish passage (Stamon 2010). This program intends to identify the limiting structures and institute a series of corrections to improve the road network interactions with the stream network. The benefits of these efforts will address fisheries, transportation, and potential downstream flood events.

Figure XXX. Legacy stream crossing of Duck Creek (7000 road) established early in the 20th century, no longer used for vehicular traffic.

4.4.2.1. Beavers

The beaver is considered a keystone species by many wildlife biologists, endowed with the ability to increase biodiversity through the creation of beaver ponds and wetlands (Wright *et al.* 2002). These riparian habitats enlarge the perimeter of the un-dammed two bank profile of a stream allowing aquatic plants to colonize newly available habitat. Insect, invertebrate, fish, mammal, and bird diversity are also expanded by the creation of these beaver dams (Rosell *et al.* 2005). Beavers perform a key role in ecosystem processes, because their foraging has a considerable impact on the course of forest succession, species composition and the structure of plant communities.

The presence of beaver dams in streams creates flood conditions behind the dam structure (Pollock *et al.* 2004). The North American Beaver builds lodges along rivers, streams, lakes, and ponds in order to insure water around their lodges that is deep enough to prevent the freezing of the site during the cold winter months. Beavers dam streams to create a pond where their lodge can be located. During this process of damming the stream, the beaver dams flood areas of surrounding forest and fields, giving the beaver safe water access to leaves, buds, and inner bark of growing trees for food (Rosell *et al.* 2005). Beaver typically prefer hardwoods (Figure XXXI) but will feed on softwood cambium as well and will also eat cattails, water lilies and other aquatic vegetation, especially in the early spring. Contrary to wide-spread belief, beaver do not eat fish (Young 2007). In areas where their pond freezes in winter, beavers will collect food supplies (tree branches) in late fall, to store them underwater (usually by sticking the sharp chewed base of the branches into the mud on the pond's bottom), where they can be accessed throughout the winter. Often the stockpile of branches will project above the pond and collect snow. This insulates the water below it and keeps the pond open at that location (Rosell *et al.* 2005).

A British fur trader, David Thompson, during the mid 19th century, described the "sagacity" of the beaver. In his written words, "Beaver dams were so cleverly constructed that no amount of water could damage them, whereas those erected 'by the art of man' – apparently a lesser art – were frequently washed away." Another fur trader from the era, Ross Cox, commented on the "dexterity in cutting down trees, their skill in constructing their houses, and their foresight in collecting and storing provisions". Cox was moved to comment on their social organization of labor: nothing could be more wonderful, he suggested, than the skill and patience shown by parties of twenty or thirty beaver coming together to build their winter lodges. A few of the older animals superintended the felling of trees and processing of logs. According to Cox, "it is no unusual sight to see them beating those who exhibit any symptoms of laziness. Should, however, any fellow be incorrigible… he is driven unanimously by the whole beaver tribe to seek shelter and provisions elsewhere." Such outcasts, the Indians called "lazy beaver", according to Cox. Those beaver were condemned to a winter of hunger, and as a result their fur was not half as valuable as that of those beaver whose "persevering industry" assured them of protection from the elements (Verbert 1997).

Figure XXXI. Beaver activity on the QIR along the shore of Duck Creek within a mile of the Pacific Ocean (photo taken from above, looking down on the creek).

On the QIR, beaver activity has been a long and persistent challenge for the maintenance of roads at stream/road crossings (Stamon 2010). The primary issue of Beaver dams on the QIR is seen when dams block the normal flow of water moving through road/stream crossing structures causing water to backup to form a pond. This occurrence does not usually lead to a disaster event, but, when beaver dams plug culverts or restrict stream flow under bridges, water cannot flow normally past the road crossing. During high flow events the water will release pressure by cresting over the road and eroding it into the stream. Small diameter gravel roads common to the forested areas of the QIR are easily eroded by moving water. The materials used for the construction of these roads were generally small rocks; nothing big enough to tolerate even moderate water flow velocities (Stamon 2010).

Examples of this problem on the QIR are seen along the Camp 7 road that is also used as the emergency US101 bypass route when trees blow down across US101 in the Natural Area (the large old growth preserve south of Amanda Park, south of the South Shore Road for about 2 miles). Beavers have become established along the south end of the Camp 7 Road, building dams in the ditches causing water to run over and down the road (Stamon 2010). There is a panel bridge that is about 20 feet long that beaver have completely plugged several times (created a dam under the bridge all the way to the base of the bridge). In 2009, QDNR crews cleaned the beaver dam restrictions manually from the bridge; overnight the beavers completely replaced it again (Stamon 2010).

Another example of beaver dam complications on the QIR is found on the Crane Creek Road (connecting access route built for logging traffic between Taholah and the Crane Creek Sorting Yard along US101). On this route, there is a nearly 4 foot high clearance of a bridge over the stream that has been completely plugged by active beaver dams. The critical issue on this access route occurs because water backs behind the beaver dam until it is to the level of the road surface and saturates the road bed with water to the point it threatens the stability of the road. When the water rises to this level, flow pressures create sufficient force to wash out the road bed leading to complete road failure (Stamon 2010).

Further complications of these beaver dams happen when beaver dam waters are found in relatively flat terrain, causing water to overtop roads. Vehicle traffic often "splashes" through these wet crossings causing sediment to be pumped off the road bed and into the streams (Stamon 2010). This causes detrimental effects to fisheries while degrading the road quality.

Another beaver dam scenario on the QIR is witnessed when a beaver dam backs up water into upland timber stands (of any age). The super-saturation of the site leads to quick forest death, especially in conifers. The QIN Forest Management Plan states that after a period of years the backed up water is considered a wetland and must be maintained and protected as a wetland (Stamon 2010).

Although a single beaver dam may have little influence on stream flow quantity, a series of dams can have a significant results (Grasse 1951) by moderating the peaks and troughs of the annual discharge patterns, including flood water events. During low flow periods of the year, Duncan (1984), working in an Oregon watershed, determined that up to 30% of the stream network's water was retained in beaver ponds. The general hydrologic pattern of the QIR, and western Washington generally, is peak rainfall and stream flows during the winter and spring months with decreasing flows in the late summer and early fall pending the arrival of rains (Figure XXXIV and Figure XXXVII). By increasing storage capacity in the form of beaver ponds, it has been suggested that large numbers of beaver dams can lead to greater stream flows during late summer during this low flow period (Parker 1986), which may result in continual flows in previously intermittent streams (Yeager and Hill 1954, Rutherford 1955).

Beaver dams, depending on their number and location, may decrease peak river discharge and stream velocity during a flood event, thereby reducing erosion potential associated with the flood event (Parker 1986) and possibly reducing flood impacts downstream (Bergstrom 1985).

Although beaver dams can reduce the severity of flooding events, they may contribute to them if dam failure occurs (Butler 1991). The failure of a beaver dam on a small stream in Alberta produced an estimated flood wave which was 3.5 times the maximum discharge recorded over a 23-year period on that stream (Hillman 1998).

4.4.2.2. Categorizing Flood Events

Two different types of water damaging events are seen within the QIR. The first is the conventional definition of floodwaters, that is water that leaves a stream channel to occupy adjacent floodplain areas. The second type of water accumulation is storm water. Storm water is rainfall or snowmelt that cannot achieve a speedy entry into a stream either through surface flow or sub-surface flow. The causes for storm water accumulation on the surface can be from a saturated soil layer, impermeable surfaces, or local depressions allowing water accumulation. When storm water accumulates around structures and infrastructure (Figure XXXII and Figure CXXI) it can cause flooding related damages.

Figure XXXII. Storm Water Accumulations in Taholah where water has nowhere to drain over saturated soils (left) and where surface drainage has been installed to protect homes (right).

Natural flood events in QIR are grouped into five general categories:

1. **Riverine Flooding:** a rise in the volume of a stream until that stream exceeds its normal channel and spills onto adjacent lands.
    a. **Slow kinds:** Runoff from sustained rainfall or rapid snowmelt exceeding the capacity of a river's bank-full width. Causes include heavy rains from monsoons, hurricanes and tropical depressions, warm winds and, more commonly in QIR, warm rainfall landing on a deep and frozen snow pack far up in the Olympic Mountains (rain-on-snow events), or non-frozen rain falling on saturated soils.
    b. **Fast kinds:** Runoff causes a flash flood as a result of an intense and often prolonged thunderstorm or a rain-on-snow event coupled with high rainfall in lower altitudes.
2. **Flash Flooding:** Flash flooding results from high water velocity in a small area but may recede relatively quickly. These floods are generally fed by low-order streams and occur in headwater areas. Streams prone to flash flooding do not possess the expansive floodwater storage area that higher order streams typically possess. Flood storage areas are identified by wide and flat valley bottoms ("U" shaped) where flood waters decrease flow velocity, drop sediment load, and then re-enter the main stream channel. Low-order streams are typically confined to steep "V" shape valley bottom lands where channel widening does not occur. The only path for water to follow is the main stream channel where volume increases with heavy rain and snowmelt, causing water velocity to increase accordingly. Flash flooding is the combination of high water volume with high water velocity delivered in a short amount of time. When a topographic widening of the valley is found, a flash flood is the result as the water moves to occupy the floodplain. The joining of two or more low order streams into a floodplain, or a floodplain with several high order streams can accelerate into a riverine flood type, often of the "fast kind".
3. **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 the Quinault River and Queets River 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. Ice jam flooding is rare on the QIR.

4. **Mud Floods or Muddy Floods:** These flood types result from super-saturated soils on moderate to steep slopes that are generally destabilized by types of development (road building, structure construction) or other disturbance (landslides, or drastic changes in vegetation cover). The flow of these super-saturated soils can follow the same path as water down ravines, and in the process displace flood zones with heavy concentrations of mud and debris. While these are most common on croplands, they can also occur on harvested forestlands, and in high-impact housing developments. Muddy floods are a hillside process and not the same as mudflows, which are a mass-wasting process discussed in Section 4.7. Muddy floods primarily lead to damage of road infrastructure (leaving a mud blanket or clogging sewage networks) and private property.
5. **Catastrophic Flooding:** These floods are caused by a significant and unexpected event such as a dam breakage or levee failure. Sometimes these floods are triggered by other natural or man-caused hazards such as an earthquake, landslide, volcanic eruption, or dam failure.

Flood damages are assessed in three related categories:

1. **Primary Effects:**
    a. Physical damage: These damages include harm to buildings, bridges, cars, sewer systems, roadways, canals, and any other type of structures,
    b. Casualties: Described as the number of people and livestock that die due to drowning, and damages that lead to epidemics and diseases.
2. **Secondary Effects:**
    a. Water supplies: Causes the contamination of water. Clean drinking water becomes scarce.
    b. Diseases: Unhygienic conditions are present. Spread of water-borne diseases occurs.
    c. Crops and food supplies: Shortage of food crops can be caused due to loss of an entire harvest.
    d. Trees: Tree species not tolerant to prolonged subsurface and surface water saturation can die from suffocation.
3. **Tertiary and Other Long-Term Effects:**
    a. Economic: economic hardship due to a decrease in fisheries, or a temporary decline in tourism, rebuilding costs, and food shortage leading to price increases.

The most commonly observed flood type on the QIR is a Riverine Flood. A “base flood” is the magnitude of a flood having a one-percent chance of being equaled or exceeded in any given year. Although unlikely, “base floods” can occur in any year, even successive ones, or more than once in a single year. This magnitude is also referred to as the “100-year Flood” or “Regulatory Flood”.

The low-relief areas adjacent to the channel that normally carries water are collectively referred to as the floodplain. In practical terms, the floodplain is the area that is periodically inundated by floodwaters. In regulatory terms, the floodplain is the area that is under the control of floodplain regulations and programs (such as FEMA’s National Flood Insurance Program [NFIP], which publishes the Federal Insurance Rate Maps, or FIRM maps).

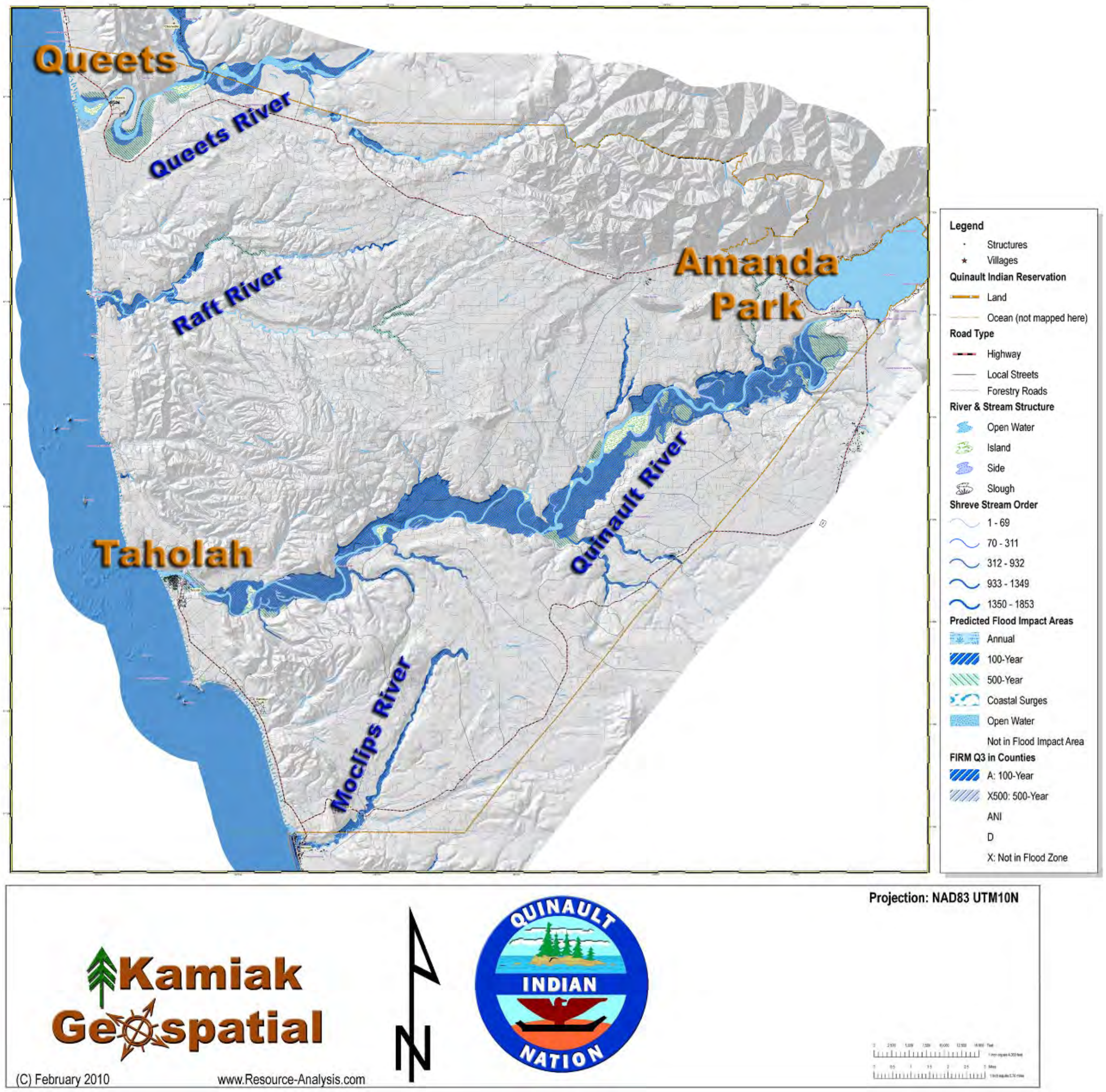
FEMA has not mapped the FIRM for the QIR. FEMA has completed FIRM mapping for both Grays Harbor County and Jefferson County, but the mapping effort in the Counties stopped at the QIR exterior boundaries. In an effort to provide the QIN with an initial regulatory basis to design floodplain protection strategies within the QIR, Kamiak Ridge developed an assessment of the floodplains within the exterior boundaries of the QIR (Figure XXXIII).

This floodplain assessment utilized soil survey data generated by the USDA Natural Resources Conservation Service, topographic data (10 meter resolution digital elevation models (DEM) developed by the US Geological Survey (USGS)), and field sampling of recent historical flood events. These field sampling events involved visits to Taholah, Queets, and Amanda Park to record the locations of past floods identified by local residents, and physical evidence, with a portable Global Positioning System (GPS) unit. The year of the flood event and the location were used to create a database to reconcile the flood magnitude with the precipitation and river flow levels when available. These data combined to create an initial assessment of Projected Flood Impact Areas within the QIR.

These data do not replace FEMA derived and approved FIRM designations of flood zones These floodplain estimates do not qualify as floodplain designations for entry into the NFIP. Those decisions must be made by the QIN leadership in cooperation with FEMA. When, and if, that happens, and if the QIN enters the NFIP, then FEMA and the QIN may enter into an agreement to create FEMA derived FIRM assessments. That process may take years to complete. The assessment completed for this planning effort is intended to allow the QIN the tools to begin regulating the development of the critical floodplains on the QIR in the support of protecting people, structures, infrastructure, the economy (especially fisheries), and the traditional way of life.

Maps of predicted flood risks are presented on large-scale wall maps and have been used for planning purposes and public display at meetings and offices on the QIR (Figure XXXIII).

Figure XXXIII. Potential Flood Impact Areas of the QIR.



4.4.2.3. Weather Conditions Related to Flooding

The rivers and forests of the Olympic Peninsula have long been important sources of natural resources. For the QIN, forests and fisheries have been the cultural and economic mainstay for thousands of years. To protect and restore these dwindling resources, the QIN is undertaking a science-based approach for land management, in which understanding of ecologic conditions and functions is developed as a basis for steering land management activities in directions that promote societal values. The Quinault, Queets, Raft, and Moclips are four rivers that flow on or adjacent to Quinault Indian Nation lands that are important for fish production. These rivers actively avulse and migrate across their floodplains, leaving oxbow lakes, anabranches, sloughs, and side channels that serve as critical habitat for many aquatic species, including rearing and refugia areas for anadromous salmonids such as Chinook, Coho, Sockeye, and Steelhead (USGS 2010). Many of these areas are also prime habitat for beaver populations.

The QIR is located within a rainforest. The amount of annual precipitation averages over 10 feet, and can exceed 14 feet in a “normal” year and has been recorded at up to 15 feet in “wet years”. Weather conditions are the main driving force in determining where and when base floods will occur. The type of precipitation that a winter storm produces is dependent on the vertical temperature profile of the atmosphere over a given area. The Olympic Peninsula experiences riverine flooding from two distinct types of meteorological events:

- Prolonged spring rains, and
- Winter rain/snowmelt events.

Floods that result from rainfall on frozen ground in the winter (especially at the higher elevations in the Olympic Mountains at the headwaters of the major river systems on the QIR), or rainfall associated with a warm, regional frontal system that rapidly melts snow at all 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.

These situations are also amplified by debris-dam flooding events common to the Quinault River and Queets River.

On small drainages, the most severe floods are usually a result of rainfall on frozen ground but moderate quantities of warm rainfall on a snow pack, 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 (Mass 2008). Most winter floods on the QIR develop under these conditions.

In general, the meteorological factors leading to flooding are well understood. They are also out of human control, so flood mitigation must address the other contributing factors leading to losses.

The major source of flood waters within the Olympic Peninsula is increased amounts of fall/winter/spring rains. In the spring, the normally accumulated winter snows in the Olympic Mountains will melt and be combined with rainfall. This combination can cause the rivers to fill to capacity and then occupy the floodplains while seeking floodwater storage. Since this is a “natural” condition, the stream channel is defined by the features established during the average spring high flow (bank-full width). Water flow peaks exceeding this level and the stream’s occupation of the floodplain are common events.

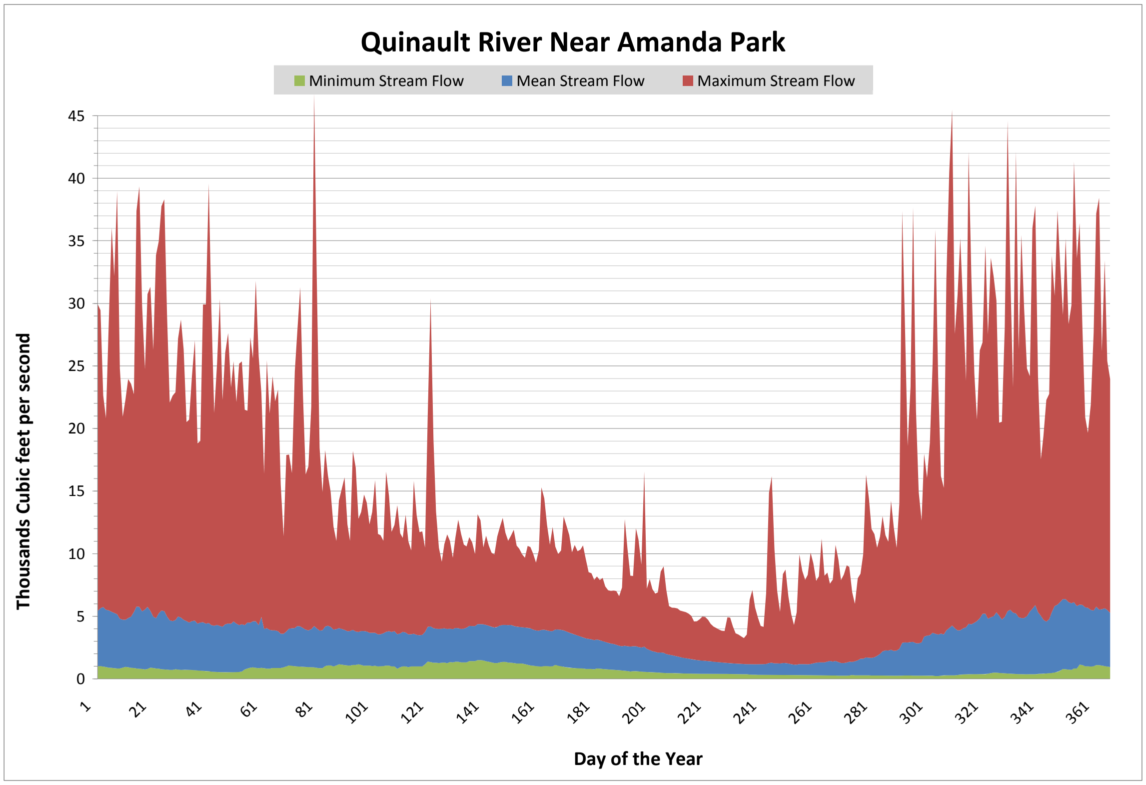
Unusually heavy snow packs or unusual spring temperature regimes (e.g., prolonged warmth) may result in the generation of runoff volumes significantly greater than can be conveyed by the confines of the stream and river channels. Such floods are often the ones that lead to widespread damage and disasters. Floods caused by spring snow melt tend to last for a period of several weeks to a month or more, longer than the floods caused by other meteorological events.

At the beginning of this Chapter, in Section 4.2, the reader was exposed to some thoughts on global climate change and the possible affects changing weather regimes could have on natural disasters. Historical river gauge data maintained by the USGS was evaluated for two of the major rivers on the QIR; Quinault River, and Queets River. The record of data collection ranged from 1912 through 2007 on the Quinault River, and 1931 through 2008 on the Queets River.

An assessment of these data is limited in respect to not having longer time series data for evaluation. Two charts of water flow through each river system are presented in Figure XXXIV, and Figure XXXVII. Three similar data series are presented on each of the two figures. The “top” series in brick-red represents the maximum stream flow recorded on each day within the range of values recorded for each site. The “middle” series in blue is the average stream flow for each day in the series. The "bottom" field in green, is the minimum stream flow recorded for each river on each day recorded in each series.

Based on the data analyzed, it appears that during the past decade, and the past two decades, the setting of new maximum flow rates and minimum flow rates has been accelerated. That is to say, the number of new maximum flow and minimum flow rates has been more frequent during the past two decades than the preceding decades.

Figure XXXIV. USGS 12039500 Quinault River at Quinault Lake, WA, US Geological Survey, Water Resources Data (2010).



At the Quinault River gauge station (Figure XXXIV), the number of flow rate records set during the most recent decade was 24 new low flow records. At the same time, the number of new maximum flow rates was reset 41 times (Figure XXXIV). On the Queets River gauge station (Figure XXXVII), the number of new minimum flow rates set during the most recent decade was 66 new low flow records. At the same time, the number of new maximum flow rates was reset 61 times (Figure XXXVII) within the most recent decade.

In a normally distributed collection of measurements, the analyst would expect that within the 100 year period considered at the Quinault River gauge station (Figure XXXIV), that new records would be established approximately 10 times each for highs and lows in a ten year period (as opposed to 24 new low flow records and 41 new high flow records). Within the Queets River network (Figure XXXVII) the analyst would expect that within the 77 year period considered that new records to be set approximately 12 times for each high and each low in the most recent 10 year period, (as opposed to 66 new low flow records and 61 new high flow records).

The Quinault River gauge has recorded the lowest flow rate within the last 100 years occurring on October 29-30, 2007, (two consecutive days) at only 250 cubic feet per second (Figure XXXIV). The Queets River has recorded a new minimum flow rate of 281 cubic feet per second (Figure XXXVII) on three consecutive days in 2005 (September 25-27).

These events have occurred at the same time that the "death of a glacier" has been documented for the Anderson Glacier on Anderson Mountain in the Olympic Mountains (Figure XXXV, Figure XXXVI, Workman 2009).

Figure XXXV. "Death of Anderson Glacier" as seen in August 1977 (left) and August 2006 (right) as Documented by Workman (2009).

Photographic evidence by Workman (2009) has documented the continuing retreat of the glacier that feeds the headwaters of the Quinault River. By the end of 2009 the glacier had evaporated (Figure XXXVI).

Figure XXXVI. "Death of Anderson Glacier" as seen in September 2009 as Documented by Workman (2009).

Workman (2009) has commented on this decline as follows:

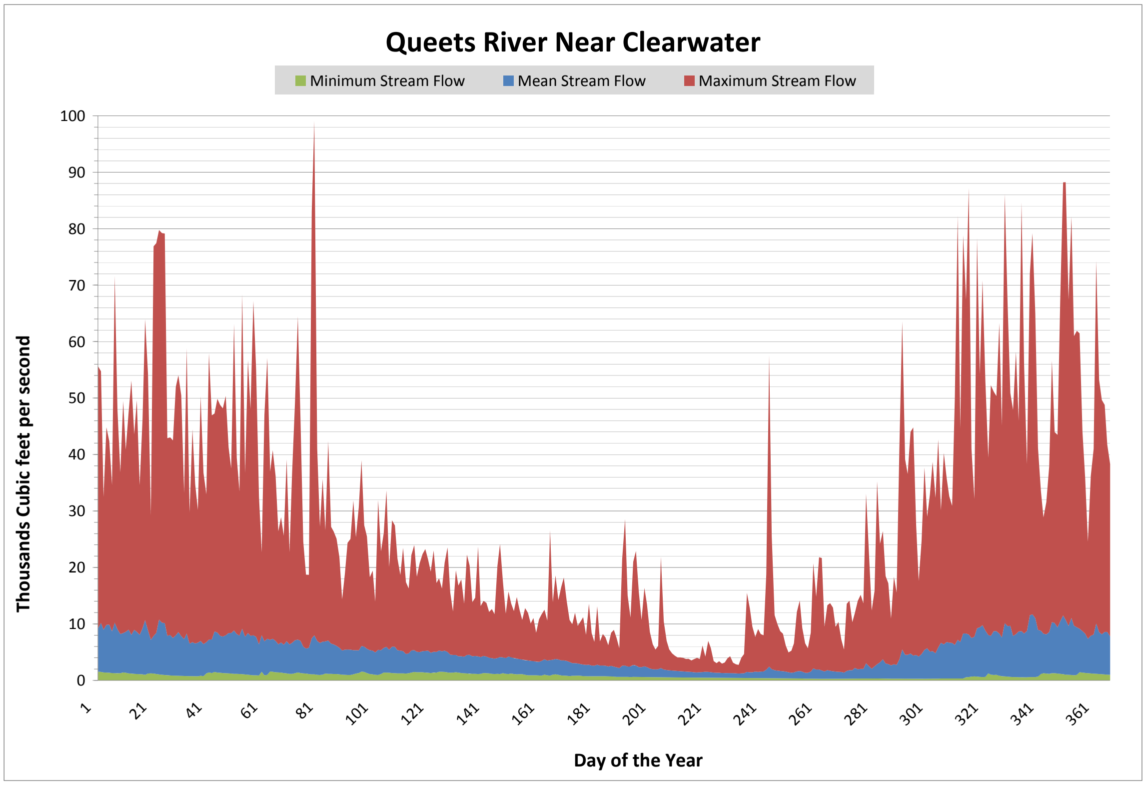
> "The glacier has been receding for many years, but the rate at which it succumbed was incredible. Once the glacier had lost much of its mass by 1974, its demise was quick in coming.
>
> "Only in 1927, the glacier still filled the entire basin in the above photo (Figure XXXVI) to the brim. As it receded over the years, it exposed a lake that became known as Valkyrie Lake. By the mid 1970s the glacier had receded to the rocks just beyond the lake.

> "The glacier has waxed and waned over thousands of years since the last ice age about 25,000 years ago when it and the other glaciers had joined to form the Quinault Glacier. That glacier flowed out of the Quinault Valley forming a piedmont glacier which graded most of the land that was to become the Quinault Reservation. This glacier was also responsible for the formation of Lake Quinault and the vast gravel deposit that are found from Grays Harbor north to the Olympic Mountains.
>
> "About 13,000 years ago there was a period that the climate grew warm enough that all the alpine glaciers disappeared in the Olympic Mountains with the possible exception of the higher and larger glaciers on Mount Olympus. Then 2,500 years ago as the climate once again cooled, the glaciers were reborn and reached their maximum growth about 200 years ago. Since then, they have been in steady retreat.
>
> "The Quinault and Queets Rivers receive much of their water in the summer from the glaciers, highland snowfields, and springs in the mountains. This spring's and summer's warm dry weather melted all but the highest snowfields and both river's flow has been far below normal through much of the summer and early fall.
>
> "In all likelihood, and despite the human effect on the environment, at some distant time in the future the glacier will be reborn as the earth continues its natural cycles."

In terms of water flow to the rivers of the QIR, this means that precipitation that historically fell as snow in the Olympic Mountains and was converted, at least in part, to glacial ice and stored for months, years, and even centuries now falls as rain and snow but is not converted to glacial ice. This glacial ice historically melted slowly to feed the rivers with a sustainable flow of water. With the disappearance of the glacial ice at Anderson Mountain, and the other mountain peaks of the Olympic Mountains, the river flow rates are expected to fluctuate dramatically.

Precipitation that historically fell as snow now falls as rain on a ground surface that is mostly saturated with water. Rainfall rapidly moves overland, down slope, to the rivers and is moved through the river system to the ocean. When this happens, new maximum flow amounts are recorded. Conversely, the late-summer river flow amounts reach new lows, because the melting snow pack is not present to sustain the river flow. Rivers such as these are rapidly approaching the ultimate minimum flow rate of zero cubic feet per second. When this happens, the ability of the salmon and other fish living in those rivers is compromised and can lead to the extinction of those species from these aquatic ecosystems.

Figure XXXVII. USGS 12040500 Queets River Near Clearwater, WA, US Geological Survey, Water Resources Data (2010).



The minimum flow rates bring the attention of the people of the QIN in respect to the viability of the salmon fisheries. When the rivers drop to dangerously low levels, the spawning salmon, the eggs, and developing fry in the river cannot survive. When the salmon populations cannot survive, the economy of the QIR is decimated, the people of the QIN are broken. The salmon serve to define who the people of the Quinault are.

4.4.2.4. Topography and Geographic Influences

The nature and extent of a flood event is the result of the hydrologic response of the landscape. Factors that affect this hydrologic response include soil texture and permeability, land cover and vegetation, land use, and land management practices. Precipitation and snowmelt, known collectively as runoff, follow one of three paths, or a combination of these paths, from the point of origin to a stream or depression: overland flow, shallow subsurface flow, or deep subsurface ("ground water") flow. Each of these paths delivers water in differing quantities and rates. The character of the landscape will influence the relative allocation of the runoff and will, accordingly, affect the hydrologic response.

Unlike precipitation and ice formation, steps can be taken to mitigate flooding through manipulation or maintenance of a normally functioning floodplain. Insufficient natural water storage capacity and changes to the floodplain landscape can be offset through water storage and conveyance systems that run the gamut from highly engineered structures to constructed wetlands.

Careful planning of land use can build on the natural strengths of the hydrologic response. Re-vegetation of wildfire burned slopes diverts overland flow (fast and flood producing) to subsurface flow (slower and flood moderating).

The amount, location, and timing of water reaching a drainage channel from natural precipitation determines the flow at downstream locations. Some precipitation evaporates, some slowly percolates through soil, some may be temporarily sequestered as snow or ice, and some may produce rapid runoff from surfaces including rock, pavement, roofs, and saturated or frozen ground. The fraction of incident precipitation promptly reaching a drainage channel has been observed from nil for light rain on dry, level ground to as high as 170 percent for warm rain on accumulated snow (Babbitt and Doland 1949). All of these factors determine how precipitation will translate into potential flood events.

Four major stream systems within QIR are the Quinault River, Queets River, Moclips River and Raft River systems. Both the Quinault River and the Queets River originate in the Olympic National Park and the Olympic Mountains. Both of these major river drainages terminate at the Pacific Ocean within the QIR. Both Raft River and the Moclips River originate within the QIR. Raft River pours into the ocean within the QIR's exterior boundary. The Moclips River terminates at a point adjacent to the southwestern extent of the QIR.

4.4.2.5. Understanding Stream Order as an Analysis Tool

Stream order classification is an analysis tool for understanding the mechanisms of stream channels and water conveyance through the network of river systems. Stream order numbers convey information about the number of streams converging as the network grows. The Shreve Stream Order is a specific variant of this tool. This method of stream ordering by magnitude was proposed by Shreve (1967) and is widely used today. All streams with no contributing tributaries are assigned a magnitude (order) of one. Magnitudes are additive down slope. When two streams intersect, their magnitudes are added and assigned to the down slope link.

Using this set of criteria, low order streams are typical of headwater streams. High order streams represent areas where potentially hundreds of "first order streams" have converged to create a large river system, such as the Quinault and Queets Rivers. Shreve Stream Order values are discussed in the flood analyses for each community in this document and are used to express flood characteristics defined above.

Conceptually, the higher the Shreve stream order value, the higher the potential for that segment of the stream to exhibit characteristics consistent with riverine floods. Shreve stream order segments with low magnitude are generally more consistent with a flash flood profile, because in most instances these segments of the system do not possess the flat valley bottom profile consistent with a broad flood zone.

4.4.3. QIR Flood Profile

Several histories of flooding events within Grays Harbor County and Jefferson County have been articulated in this planning effort (Table 21 and Table 22). However, these summaries may not completely describe the flood risk exposure of the QIR. Flooding within the QIR is typically seen around the populated places of Amanda Park, Queets, Taholah, Taholah Ocean Tracts, and Qui-nai-elt as storm water accumulations around homes (in Taholah and Amanda Park), primary access routes (such as SR109), and occasionally as flood encroachment from the rivers or lake to the villages.

Specifically, the flood risks within Amanda Park are mitigated by the presence of Lake Quinault and the pour point of the lake into the Quinault River. The Lake Quinault level annually rises in response to increasing water flow, and the homes and infrastructure are flooded annually to various degrees, especially those located close to the lake's shoreline.

Within the Village of Taholah, the Quinault River makes its final approach to the Pacific Ocean. River water levels at Taholah can fluctuate dramatically, but the back-flow pressure on the river is mostly eliminated by its entry to the ocean. When extreme high tides are combined with storm surges moving onshore, and heavy warm rains in the uplands of the Quinault River, flooding in Taholah can be seen. An existing levee structure was constructed along the bank of the Quinault River (Figure XXXVIII). This levee structure has been breached because of the factors listed above. Increased elevation of this structure is recommended as a potential mitigation measure to protect the homes and businesses of the village (Table 66).

Figure XXXVIII. The Quinault River retaining wall at Taholah.

The Village of Queets was historically selected as a building site that is greatly protected against natural disasters while still providing access to the river for fishing and travel. The village is located on terrain that is elevated above the Queets River floodplain. Locally, storm water drainage has been a problem, but these measures are generally dealt with through uncomplicated local drainage management efforts (Table 66). Rarely has the river breached the shoreline in Queets to flood homes and businesses.

Taholah Ocean Tracts faces infrastructure access problems with flood related issues. SR109 provides access to Canyon Way in order to access the homes in Taholah Ocean Tracts (Figure XCVII). This route (SR109) frequently floods or accumulates surface water drainage over the roadway during high precipitation events. The ingress and egress of SR109 moving either north to Taholah or south to Moclips can be complicated by water over the roadway. During late 2009, water over the roadway of SR109, near the turn to Taholah Ocean Tracts, led to the death of a young adult Tribal Member who could not navigate the hydroplaning vehicle as it crossed this water over the roadway and crashed.

All of the larger river drainage systems on the QIR annually move large organic debris through the river networks. This debris includes root-wads, stems, and whole trees washed downstream. This can be considered a natural process along these river networks. Problems generally arise when this large organic debris becomes lodged against the bridge abutments of significant infrastructure such as US101 or SR109. Debris accumulations against bridge supports threatens the safety of these road crossings. Currently there are no catchment devices or diversion devices installed on these crossings.

Local access crossings of both major and minor streams within the QIR are facilitated with a combination of bridges, culverts, and wet crossings. In many cases, these crossings are plagued with debris accumulation and beaver dams around pinch-points of water flow that leads to water diversion and ultimately road abutment erosion. A complete inventory of road/stream crossings is currently underway (2009-2010) by the QDNR and will identify the areas in need of mitigation measures both currently and in the near future. Based on this on-going assessment, implementation of recommended measures should be undertaken to implement the improved water flow through and from the floodplains on the QIR (Table 63).

4.4.4. FEMA Programs Concerning Floods

As of the preparation of this Tribal Hazards Mitigation Plan, the QIN is not a participant in any of the flood mitigation programs of FEMA.

The National Flood Insurance Program (NFIP) was created by the Congress of the United States in 1968 through the National Flood Insurance Act of 1968 (P.L. 90-448). The NFIP enables property owners in participating communities to purchase insurance protection from the government against losses from flooding. This insurance is designed to provide an insurance alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods (FEMA 2009). Participation in the NFIP is based on an agreement between local communities and the federal government and states that if a community will adopt and enforce a floodplain management ordinance to reduce future flood risks to new construction in Special Flood Hazard Areas (SFHA), the federal government will make flood insurance available within the community as a financial protection against flood losses. The SFHAs and other risk premium zones applicable to each participating community are depicted on Flood Insurance Rate Maps (FIRM). The Mitigation Division within the Federal Emergency Management Agency manages the NFIP and oversees the floodplain management and mapping components of the Program (FEMA 2009).

The intent of the act was to reduce future flood damage through community floodplain management ordinances and provide protection for property owners against potential losses through an insurance mechanism that requires a premium to be paid for the protection. The NFIP is meant to be self-supporting, though in 2004 Congress found that repetitive-loss properties cost the taxpayer about $200 million annually. Congress originally intended that operating expenses and flood insurance claims be paid for through the premiums collected for flood insurance policies. NFIP borrows from the U.S. Treasury for times when losses are heavy, and these loans are paid back with interest.

The program was first amended by the Flood Disaster Protection Act of 1973, which made the purchase of flood insurance mandatory for the protection of property within SFHAs. In 1982, the Act was amended by the Coastal Barrier Resources Act (CBRA). The CBRA enacted a set of maps depicting the John H. Chafee Coastal Barrier Resources System (CBRS) in which federal flood insurance is unavailable for new or significantly improved structures. The program was further amended by the Flood Insurance Reform Act of 2004, with the goal of reducing "losses to properties for which repetitive flood insurance claim payments have been made."

In order for the QIN to enter the NFIP, discussions between the Nation and FEMA Region X representatives must reach agreement on the implementation of policies, laws, and programs to be carried out by QIN to protect the structures and infrastructure located in the floodplain. At the same time, FEMA may launch floodplain mapping of the QIR to better define the floodplain.

While these programs are set in place, initial mapping of projected flood impact areas has been completed as part of this Tribal Hazards Mitigation Plan assessment and can serve the QIN to establish floodplain protection areas from development. These projected flood impact areas would be replaced by FEMA established FIRM maps if they are created, and if the QIN enters the NFIP.

4.4.5. Probability of Future Events

Flood frequency on the QIR has been recorded in conceptual models of personal accounts, news reports of the region, and physical evidence of past flooding. Although illustrative, these accounts fail to apply uniform measures of flood intensity (depth), duration (days), or location (watersheds affected). Historically, flooding was such a permanent part of Tribal life that it appeared in legends and lore of the Tribes. A cursory review of Table 26 reveals that between 1887 and 2009 approximately 40 separate “significant flood events” have been recorded within the QIR, resulting in a frequency of one major flood event every 3 years. This prediction fails to quantify the intensity of each flood in the record (Table 26), nor to determine the intensity of flooding within each QIR watershed.

This assessment does serve to quantify the high frequency of flood related events (1 every 3 years). It is likely that this frequency will continue into the future even with significant changes to the global climate weather patterns discussed here. Although frequency may remain relatively consistent, the intensity of flooding events may change. The only sure way of limiting the exposure of residents to these extreme flood events is to locate homes, businesses, and infrastructure outside of the maximum floodplain extent to avoid these catastrophic events.

4.4.6. Potential Mitigation Measures

In many western countries, rivers prone to floods are often carefully managed. Water management structures such as levees, reservoirs, and weirs are used to prevent rivers from bursting over their banks. However, these structures only influence flood properties and do not alter the actual floodplain. The floodplain is a natural storage area used by the river to store the high water levels as it drains downstream. When a levee is placed along a river, the effect is to remove this temporary storage area and displace the needed storage to other stream storage areas immediately upstream (backflow) and adjacent to the levee protected area, and then downstream of the protected area. These displacements often mean increased flooding impacts in areas other than those protected by the levee.

The potential exception to this flood displacement problem occurs when a levee is placed upstream of a managed reservoir, a large lake, or the ocean. When managed well, a reservoir can be lowered in advance of seasonal floodwater accumulation and used to receive the increased flood storage needs if required. There are no managed reservoirs on the QIR.

The existing levee system on the Quinault River at Taholah is an example of a well-placed levee to channelize water in the river while preventing catastrophic flooding in Taholah (Figure XXXVIII). This system has been extremely beneficial to the residents of the area. Since it is located at the pour point to the ocean, the displacement of downstream flood waters is nonexistent. Enhancement of this levee by increasing the height of the structure and the angle of repose is suggested. In recent years the combination of storm surges, high tides, and extreme flood waters in the Quinault River have combined to cause breaches over the top of the structure. Fortification of this structure would serve to reduce potential flood damages in the Village of Taholah.

At the current time, the QIN has not extensively exploited the floodplains with home site developments. The uses of the QIR floodplains have been seen in the form of roads, bridges, and forest management activities. Some of these activities have resulted in dubious outcomes in respect to the optimally functioning floodplain. Other activities have been executed with no realized negative results. Policies and programs to protect the optimal functioning of the floodplains within the exterior boundaries of the QIR will serve to protect salmon spawning grounds, infrastructure, and human developments.

4.4.6.1. Post Flood Safety

Cleanup activities following floods often pose hazards to workers and volunteers involved in the effort. Potential dangers include electrical hazards, carbon monoxide exposure, musculoskeletal hazards, heat or cold stress, motor-vehicle-related dangers, fire, drowning, and exposure to hazardous materials or contaminated soils and sediment. Because flooded sites are unstable, cleanup workers might encounter sharp, jagged debris, biological hazards in the floodwater, exposed electrical lines, blood or other body fluids, and animal and human remains.

A flood response plan has not been adopted by QIN for specifically dealing with flood activities on the QIR. This plan should be developed in continuation of this planning effort and is recommended in Table 63.

4.4.6.2. Benefits of Flooding

There are many disruptive effects of flooding on human settlements, infrastructure, and economic activities. However, flooding can bring benefits, such as making soil more fertile by providing nutrients in which it is deficient. Periodic flooding was essential to the Tribes of the region, who have relied, and still rely, on a productive river ecosystem for food supplies and fish spawning and rearing grounds.

4.4.6.3. Recommended Activities

The stabilization of the floodplains of the QIR is essential to the functioning of the QIN in terms of the economy (especially related to fisheries), the home sites located adjacent to and within the floodplains, and the infrastructure that provides water, sewer, power, and critical linkages between villages and to resources located off-Reservation. This stabilization of the floodplains begins with an assessment of the current functioning of the shorelines within the QIR and those shorelines draining into the QIR. The QIN has launched an effort to develop a Shorelines Management Plan for the QIR. This plan will address an initial assessment of the shorelines and the river networks on the QIR and develop a holistic approach to managing the natural resource and human interactions related to shorelines. The development of this plan, and the subsequent implementation of this plan by the QIN will serve to develop programs, practices, and implementation strategies to ensure the continued health and viability of the QIR aquatic resources (Table 63). It will also serve to solidify the position of the QIN to restrict human habitation within the floodplains from the standpoint of protecting fisheries and downstream flooding impacts. Funding issues and other resources needed to implement this planning effort are still being sought by the QIN.

4.4.6.3.1. Coastal Erosion

Coastal erosion is the wearing away of land or the removal of beach or dune sediments by wave action, tidal currents, wave currents, or drainage. Waves, generated by storms, wind, tsunami, or fast moving motor craft, can cause coastal erosion, which may take the form of long-term losses of sediment and rocks, or merely the temporary redistribution of coastal sediments; erosion in one location and may result in sediment buildup nearby.

On rocky coasts, such as those seen from Point Grenville north along the QIR coastline, coastal erosion can result in dramatic rock formations in areas where the coastline contains rock layers or fault lines with different resistances to erosion. Softer areas become eroded much faster than harder ones, which typically result in landforms such as tunnels, bridges, columns, and pillars (such as those seen at Elephant Rock at the mouth of Raft River).

These Rocky Coastlines found from Point Grenville to the Hoh River, are generally a conglomerate of rocky materials, including volcanic material, juxtaposed under and alongside more erosive ocean sediments (Rau 1973, McCrory *et al.* 2002). During uplift of the coastline that has been occurring since the last ice-age, these various tectonic plates have moved at differing rates and in differing directions. Ocean wave forces have shaped this region from the west, while surface water movement from the east has created an erosional and depositional tapestry of surface and subsurface structure. Many times, these sites are not consistent in their responses to modifications (such as road or structure placement) based on the surface structure because the subsurface response to hydrologic and compression changes can create a differential response (see Section 4.7.1, for more detail). For these reasons, the placement of roads, structures, and even forest management activities should take into account a plethora of site characteristics to insure that permanent and irreversible damages are avoided.

On coasts formed mainly by sedimentary processes, such as those seen primarily south of Point Grenville, coastal erosion typically poses more of a danger to human settlements than it does to nature itself. Human interference can increase this coastal erosion (Rau 1973). The village of Hallsands in Devon, England, was a coastal village with about 160 residents and 37 houses that was washed away over the course of several years. Following dredging off-shore of the village, the shoreline started to recede (1900). In the autumn storms of that same year, part of the seawall was washed away. On 26 January 1917, a combination of easterly gales and exceptionally high tides breached Hallsands' defenses, and by the end of that year only one house in the Village of Hallsands remained habitable (Milton and Milton 2005).

The California coast, which has soft cliffs of sedimentary rock and is heavily populated, regularly has incidents of housing damage as cliffs erode. Within the QIR, these risks are especially prevalent from Point Grenville and to the south, giving cause to limit the development of these coastlines to the construction of homes or infrastructure.

Both the rocky coastlines and the sedimentary coastlines of the QIR will respond to developments with often rapid, or prolonged, and unpredictable results. Often, wave action against the shoreline is influenced by changes to the shoreline's characteristics of hardness, debris recruitment, beach dissipation, and the ability of the shore's platform (approach to the shore and dispersal on the shore) to naturally spread and interact with natural debris accumulations. Giving a respectful buffer to the shorelines of the QIR is strongly recommended in order to protect human life, property, and the normal functioning of the aquatic ecosystems found here against coastal erosion. Other sections of this chapter includes discussions concerning additional cautions concerning these shorelines to developments.

4.4.6.3.2. River Network Flooding

The NFIP is a Federal Program that helps communities reduce flood risks and enables property owners and renters to buy flood insurance. Although the NFIP offers flood insurance to homeowners and renters, this insurance coverage does not reduce the occurrence of flooding. At this time, FIRM maps of the QIR have not been developed and discussions are on-going between the QIN and FEMA Region X to facilitate the entry of the QIN to the NFIP.

The QIN may decide to participate in the NFIP while enacting and enforcing measures to reduce future flood risks. At a minimum, these regulations govern construction in the SFHAs shown on the FIRM maps. In the interim period, while the FEMA-approved FIRM maps are not available, those areas shown on the Potential Food Impact Areas (developed for this planning effort) can be used by the QIN for internal policy development and implementation. Participation by homeowners in the FEMA insurance program is optional, but adherence to QIN Building Codes is not. It is recommended that these codes be updated to reflect NFIP guidelines on the QIR while using the existing data as a starting point. If FIRM maps are subsequently developed by FEMA and the QIN, then the use of the FEMA-approved FIRM maps can be adopted. In addition, many mortgage companies require NFIP coverage for homes in the SFHA when purchased through a mortgage loan.

These NFIP management regulations apply to new construction and substantial improvements to structures in the flood zone. QIN should consider implementing these measures while using the recently created Potential Flood Impact Areas maps to be updated when FEMA-derived NFIP maps are finalized. Structural improvements that lead to improved protection during flood events include a variety of techniques to elevate structures so the ground floor is above the base flood elevation (so called flood proofing). Small-scale levee construction is not a recognized flood mitigation technique for the NFIP program. Other potential mitigation measures are effective at reducing the negative impacts caused by flooding.

Floodplain Ordinances should be considered and enacted within QIR by the QIN. It is recommended that these ordinances define a substantial improvement as "any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50% of the market value of the structure before the 'start of construction' of the improvement." These ordinances should require all new construction or substantial improvements be made using methods and practices that minimize flood damage to the structure while not negatively impacting the floodplain where the structure is located. The QIN exercises land use and building code jurisdiction across the entire QIR and should apply the Floodplain Ordinance to all building permit requests (Table 63).

4.4.6.4. Potential Mitigation Measures by Flood Hazard Type

Beaver Dam Floods: Several techniques have been developed to limit the financial losses experienced from beaver dam flooding of culverts, bridges, roads, and infrastructure. Many of these solutions are lethal to the beaver and the QIN opposes the harvest of beaver seeing the benefit of the animal as a natural component of the environment. The QIN also recognizes the overwhelming benefit beaver dams have on fisheries. Some practitioners have experimented with protecting culverts with a device called a “Beaver Pipe” (Langlois and Decker 1997) developed in Massachusetts. The Beaver Pipe is installed through the culvert and extends into the water impoundment where intake is provided through a mesh filter and the pour point is extended well beyond the road surface it passes under to return the water to the stream channel. These devices require annual or quarterly maintenance and are not suitable to all culverts (Langlois and Decker 1997). Other efforts have installed protective “beaver fences” both upstream and downstream of culvert openings, but these structures require frequent maintenance in direct correlation with the amount of debris normally transported in the stream system, which is very high on most QIR streams.

Attempts on the QIR to trap beavers has met with limited success as new young beavers rapidly fill the void of suitable habitat with no competition (Stamon 2010). Forestry staff of the QDNR have become more knowledgeable about locating roads in areas with beaver activity. When identified, staff are trying to minimizing road crossings in these areas.

The lingering problem for the QIR is the legacy road system that did not give long-term sustainability consideration when crossing the water routes leading to the creation of road impounded wetlands. QDNR staff have recently developed a design that enhances the beaver pond by creating a new stream channel to access the main stream channel by using a flow diversion that does not require any stream gradient structures (fish ladder) to make it friendly to fish passage. It is a comparatively affordable feature to install and this solution maintains the beaver pond. This solution requires a bridge to cross the new channel as opposed to a culvert, thus, the cost is more substantial. The bridge must be designed with sufficient freeboard over the stream to prevent beavers from trying to build a dam to plug the channel. This design intends to keep the stream flow sufficient while keeping maintenance costs affordable (Stamon 2010).

A long gentle stream gradient to circumvent the stream/road crossing is better for fish and less expensive to build and maintain than a fish ladder approach that has ladder-steps to maintain and a suitable gradient the fish can navigate to insure. In-stream structures are complicated, expensive and challenging to maintain and when something fails, it can present a high risk of becoming a barrier to fish passage. This method to connect or reconnect a pond to the stream channel and improve the connectivity for fish passage is desirable to the QIN and meets the needs of maintaining the road network. The QDNR is experimenting with these structures at this time (Stamon 2010).

Riverine Floods: The mitigation of riverine flooding is mostly effective through the development of an early warning system designed to notify and evacuate people located at risk to rising waters. While family members, pets, and valuables can often be evacuated from homes and businesses, the structures rarely can be moved in an emergency. Equally at risk are the infrastructure components of the region, such as roads, bridges, water supply systems, power supply systems, and sewage treatment plants.

Another partially effective means of mitigating losses from riverine floods is the “flood proofing” of structures discussed in this section.

Flash Flooding: Because the nature of flash flooding greatly precludes advance warnings, these flood types often cause substantial damage and loss of life. Certain areas of QIR are more prone to these types of floods than others (such as Raft River, Moclips River, and Wreck Creek), where lower order streams often posses minimal flood water storage areas. Larger order streams such as the Quinault and Queets River systems generally have a substantially larger storage area and can accept these increased volumes on a short-term basis.

Caution and respect of these flash-flood-prone areas is the best defense against losses from these flood types. Development of structures and infrastructure in these locations is not recommended.

Ice and Debris Jam Flooding: These floods will impact areas where excessive debris is available for the floodwaters to recruit and transport from the point of origination to downstream locations. Often debris dams are created where the channel is narrowed due to a road crossing (under a bridge or through a culvert) or because of a natural narrowing of the waterway from topographic relief. Debris carried by the river creates a dam that restricts water flow and increases flooding around the entrapment. Ice jams are similar transient dams created by breaking ice and generally occur at the same pinch points as debris dams. Ice jams are not commonly seen within the QIR but debris dams are a common sight along the major river drainages of the QIR.

While natural topographic restrictions are difficult to moderate, debris dams against bridges and culverts are possible to avert. Countermeasures proposed by the US Department of Transportation (2008) are applicable for bridges and culverts alike, although a few are better applied to one situation than to another. Fish crossings through culverts must be addressed on a case-by-case basis to allow for adequate entry to the structure, ability of the fish to navigate the width, water depth, and velocity of the passage, and then the exit of the structure into the upper pool of the watercourse. Debris deflectors (described below) must also address the fish passage issues discussed here to insure adequate fish passage.

Culverts:

- **Debris Deflectors** are structures placed at the culvert inlet to deflect the major portion of the debris away from the culvert entrance. They are normally "V"-shaped in plan with the apex upstream.
- **Debris Racks** are structures placed across the stream channel to collect the debris before it reaches the culvert entrance. Debris racks are usually vertical and at right angles to the stream flow, but they may be skewed with the flow or inclined with the vertical. These must be manually cleaned frequently.
- **Debris Risers** are a closed-type structure placed directly over a culvert's inlet to cause deposition of flowing debris and fine detritus before it reaches the culvert inlet. Risers are usually built of metal pipe. Risers can also be used as relief devices in the event the entrance becomes completely blocked with debris.
- **Debris Cribs** are open crib-type structures placed vertically over the culvert inlet in log-cabin fashion to prevent inflow of coarse bed load and light floating debris.
- **Debris Fins** are walls built in the stream channel upstream of the culvert. Their purpose is to align the debris with the culvert so that the debris would pass through the culvert without accumulating at the inlet. This type of measure can also be used at the approach to a bridge.
- **Debris Dams and Basins** are structures placed across well-defined channels to form basins that impede the stream flow and provide storage space for deposits of detritus and floating debris.

- **Combination Devices** are a combination of two or more of the preceding debris-control structures at one site to handle more than one type of debris and to provide additional insurance against the culvert inlet becoming clogged.

The only type of non-structural measure available for ensuring culvert or bridge function is to provide emergency and semi-annual maintenance. Although not always feasible for remote culverts or culverts with small drainage areas, maintenance could be a viable option for larger culverts with fairly large drainage basins. Emergency maintenance could involve removing debris from the culvert entrance and/or an existing debris-control structure. Annual maintenance could involve removing debris from within the culvert, at the culvert entrance, and/or immediately upstream of the culvert, or repairing any existing structural measures.

Many of these measures are counterproductive to allowing uninhibited fish passage and should be used with caution and special design modifications on the QIR to allow for fish passage.

Bridges:

Various types of structural measures are also available for bridges. Some of the measures discussed above for the culvert structures can also be utilized at bridges. The various types include:

- **Debris Fins** are walls built in the stream channel upstream of the bridge to align large floating trees so that their length is parallel to the flow, enabling them to pass under the bridge without incident. This type of measure is also referred to as a "pier nose extension". This type of an in-stream structure would be well suited to both the Quinault and the Queets Rivers as the debris fins have a minimal footprint in the river and allow fish passage without interference.
- **In-channel Debris Basins** are structures placed across well-defined channels to form basins that impede the stream flow and provide storage space for deposits of detritus and floating debris. These structures can be expensive to construct and maintain. These structures are not preferred within fish passage corridors.
- **River-Training Structures** are structures placed in the river flow to create counter-rotating streamwise vortices in their wakes, thus modifying the near-bed flow pattern to redistribute flow and sediment transport within the channel cross-section. Examples of this type of structure include Iowa vanes, and impermeable and permeable spurs. These structures are not preferred within fish passage corridors.
- **Crib Structures** are walls built between open-pile bents to prevent debris lodging between the bents. The walls are typically constructed of timber or metal.
- **Flood Relief Sections** are overtopping or flow-through-structures that divert excess flow and floating debris away from the bridge structure and through the structure. These structures are compatible within fish passage corridors.
- **Debris Deflectors** are structures placed upstream of the bridge piers to deflect and guide debris through the bridge opening. They are normally "V"-shaped in plan with the apex upstream. A special type of debris deflector is a hydrofoil. Hydrofoils are submerged structures placed immediately upstream of bridge piers that create counter-rotating streamwise vortices in their wakes to deflect and divert floating debris around the piers and through the bridge opening. These structures can be installed to be compatible within fish passage corridors but must be maintained during high debris flow periods.
- **Debris Sweeper** is a polyethylene device that is attached to a vertical stainless steel cable or column affixed to the upstream side of the bridge pier. The polyethylene device travels vertically along the pier as the water surface rises and falls. It is rotated by the flow, causing the debris to be deflected away from the pier and through the opening. These structures are compatible within fish passage corridors.

- **Booms** are logs or timbers that float on the water surface to collect floating drift. Drift booms require guides or stays to hold them in place laterally. Booms are very limited in use and their application is not widely used in urban areas, but they may be used in remote forestland areas.
- **Design Features** are structural features that can be implemented in the design of a proposed bridge structure. The first feature is freeboard, which is a safety precaution of providing additional space between the maximum water surface elevation and the low chord elevation of the bridge. The second feature is related to the type of piers and the location and spacing of the piers. Ideally, the piers should be a solid wall-type pier aligned with the approaching flow. They should also be located and spaced so that the potential for debris accumulation is minimized. The third feature involves the use of special superstructure design, such as thin decks, to prevent or reduce the debris accumulation on the structure when the flood stage rises above the deck. The last feature involves providing adequate access to the structure for emergency and annual maintenance.
- **Engineered Log Jams** involve the reintroduction of large woody debris into a stream to the benefit of fisheries. This is a fairly recent stream management technique that is being experimented with in streams such as the upper Quinault River, and that occur naturally in many streams, such as the Queets River (Bates 2004). Because of river channelization and the removal of woody debris during logging operations and site developments, many streams now lack the hydraulic complexity that is necessary to maintain bank stabilization and a healthy plant/animal habitat. When mechanically introduced, engineered log jams are individually designed to meet the needs of specific restoration projects. One element is to anchor logs along the stream bank in order to create a physical blockade against erosion. A second element of engineered log jams is to improve fish habitat. Log jams add diversity to the water flow by creating ripples, pools, and temperature variations. This is vital to fish because it provides the improved habitat to spawn, rest, feed, hunt, and hide (Bates 2004). These structures are not necessarily flood control structures, but they do impact water flows by increasing the meander of stream channels and reduce the channelization of the stream bed. In practice, these structures can reduce riverine floods from exhibiting flash flood characteristics. These structures can also reduce the amount and timing delivery of large organic debris transported down the river.

There are generally two types of non-structural measures available for bridges. The first type of non-structural measure is emergency and annual maintenance. Emergency maintenance involves removing debris from the bridge piers and/or abutments; placing riprap near the piers and abutments or where erosion is occurring due to flow impingement created by the debris accumulation; and/or dredging of the channel bottom (not recommended within fish passage areas). Annual maintenance could involve debris removal and repair to any existing structural measures.

The second type of non-structural measure is management of the upstream watershed. The purpose of this measure is to reduce the amount of debris delivered to the structure by reducing the sources of debris, preventing the debris from being introduced into the streams, and clearing debris from the stream channels. The type of management system implemented varies depending on the type of debris. For organic floating debris, the management system could involve removing dead and decayed trees and/or debris jams; providing buffer zones for areas where logging practices exist; implementing a cable-assisted felling of trees system; and stabilizing hillside slopes and stream banks.

Muddy Floods: Preventive or curative measures can be implemented to control muddy floods. Preventive measures include limiting runoff generation and sediment production at the source. Curative measures generally consist of installing retention ponds at the boundary between cropland and inhabited areas, or by leaving ample stream buffer zones when logging. These measures are best implemented upstream of the QIR boundaries to the Queets River, along the

Clearwater River, where farming practices are implemented. These farming areas are outside of the regulatory authority of the QIN. Within the QIN, streamside buffer zones where no trees are logged, are used to limit unrestricted overland flow into the rivers.

Catastrophic Flooding: Within the Olympic Peninsula, examples of catastrophic flooding have included severe weather, engineering blunders, and dam failure. A review of past hazard events detailed in Table 21, and Table 22 provide the reader with a long list of historical flood events within both Grays Harbor and Jefferson Counties. Many of these events have escalated to the level of a catastrophe.

Within the QIR, flood impacts have not risen to the level of catastrophic results. The reasons for this include the historical habitation patterns of the QIR that have avoided the intense settlement of the floodplains. That is not to say that historically long houses and human habitation avoided the floodplains, they did not. Traditional building sites were responsive to the natural movement of the river channels and the floodplain. Sites such as Queets were selected for the easy access to the river, the stability of the general area to stream side movements, and its elevated position in reference to the floodplain. The site of the highest potential to catastrophic flooding on a large scale within the QIR is Taholah.

The aforementioned on-going program being implemented by the QDNR to inventory and assess all road/stream crossings on the QIR will prove to be an instrumental tool in the implementation of debris catchment devices. It is recommended that this inventory be used to identify the road/stream crossings in need of catchment device installation. With these data a program of maintenance can be developed, funded, and implemented for the QIR (Table 66).

4.5. Earthquakes

All discussions of earthquakes and tsunami within the coastal communities of the Washington Coastline must be considered together. In this Quinault Indian Reservation Tribal Hazards Mitigation Plan the two topics will be considered together. We begin discussion of earthquakes with a presentation of the human historical perspective, native legends, the geologic setting including fault line geology, techniques to measure an earthquake, geologic processes, the types of earthquakes experienced in this region, and finally conclude these discussions with a discussion of the types of hazards these events produce. We then transition the discussion to the issue of specific tsunami risks for the region in a continuing section of this document (Section 4.5.1), especially the close-in tsunami that can be generated from a Cascadia Subduction Zone (CSZ) earthquake.

Table 27. Significant Earthquake Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1887 April 22	An earthquake shock, heavy enough in places to shake dishes from shelves, was felt in several towns in the Territory.
1891 November 30	Earthquake shock slight on Harbor, but heaviest ever experienced in some Sound cities.
1906 April 7	Bay City (San Francisco) ravaged by earthquake at 5:10 am and the fires that followed. (Rebuilding of the city greatly stimulated logging on Grays Harbor).
1914 June	Mount Lassen in California erupts on May 30, has 14 eruptions in June.
1914 September 5	Earthquake in Olympia felt 1,000 miles away.
1915 April 22	Tacoma rocked by an earthquake.
1939 November 13	Two tremblers rock area; millions in damage in Seattle, but little on the Harbor.
1946 February 15	Northwest shaken by violent quake. The November 12, 1939 quake was felt stronger on the Harbor.
1946 June 23	Severe earthquake shakes Northwest at 9:14 am.
1949 April 13	Quake staggers northwest with major damage in Puget Sound region. Minor damage on the Harbor.
1958 October 6	Quake jolts and monsoon-like rains break harbor’s Indian summer.

Table 27. Significant Earthquake Related Events in and Around the QIR (Workman 1997-2010).

Date	Information
1960 May 22, 23, 24	Chilean quake sends tidal wave alert on Harbor's coast. Hawaii hit by tidal wave; series of two foot tidal waves at Tokeland. Gigantic tidal waves batter Japan.
1964 March 28	The Good Friday Alaska earthquake strikes. North Beach is hit by first tidal wave destroying Joe Creek and Copalis Beach bridge. (Great damage from waves at Crescent city and elsewhere along Oregon Coast where people, camping on beaches, were drowned).
1965 April 29	Strong earthquake rocks Western Washington at 8:24 am. Over 7.0 on the Richter scale.
1971 February 9	Powerful shake hits L.A.
1980 March 20, 31, April 7, May 18, June 12	Earthquakes under Mt. St. Helens. Activity remains brisk. Volcano "perking" away. Major eruption and landslide on Mt. St. Helens. Volcano's wrath reaches Grays Harbor. Ash Sunday Volcano spews ash, then cools.
1981 February 14	Earthquake, east of Centralia, rattles Harbor.
1981 January 5	Huge lava dome is forming in Mt. St. Helens.
1982 March 19, April 5	Mt. St. Helens blows its top again. Volcano rumbles after two eruptions last night.
1989 March 7	Quake jolts Forks; third in western Washington in last three days.
1989 October 17	San Francisco battered by killer earthquake.
1994 January 17	4:31 am, 6.6 earthquake rocks Los Angles.
1995 January 28	5.0 earthquake rattles Puget Sound.
1998 January 28	Axial, a submarine volcano, 186 miles west of the Columbia River mouth, is erupting.
1999 July 2	A 25 mile deep, 5.5 earthquake near Satsop at 6:43 PM, shakes-up Grays Harbor County (later revised to a 5.9).
2001 August 23	Ocean bottom tsunami alert system now taking shape along the West Coast.
2001 February 28	6.8 earthquake 10 miles north of Olympia, causes widespread damage in Western Washington.
2001 June 10	Satsop 5.0 earthquake causes no damage.
2004 October 1	St. Helens clears throat with steam eruption after a flurry of earthquakes over the past week.
2005 December 8	Tsunami waves here could top 65' based on a computer model at the University of Rhode Island.
2005 February 7	*The Daily World* runs a weeklong series of feature articles about Tsunamis along our coast.
2005 June 15	Northern California 7.0 quake stirs tsunami fears on Washington coast.
2006 April 12	"Big One" coastal quake might be smaller than feared.
2008 November 24	*Okeanos Explorer*, a NOAA ship, finds an underwater volcano 200 miles west of Grays Harbor in 10,000 feet of water.
2010 February 27	Chiles' 8.8-magnitude "megathrust" earthquake generates tsunami watch on Washington coast.

4.5.1. Tribal Legends

The oldest earthquakes documented in Cascadia are known from geologic evidence (Atwater *et al.* 1995). The most recent of the Cascadia megathrust earthquakes occurred in late January 1700, and probably accounts for a tsunami which is documented in Japan (Satake *et al*. 1996, Tsuji *et al.*, 1998). Pacific Northwest Indian tales and legends related to the 1700 megathrust earthquake revealed a set of related stories that, taken together, indicate that strong shaking was felt over a wide area and accompanied by severe coastal flooding (Ludwin 1999).

Native accounts of a once-in-many-generations event like a great earthquake may be incorporated into preexisting myths and explanations of phenomena in a way that makes that event difficult to separate from the intertwined background. Native stories served many purposes, and were deeply embedded in the overarching Tribal cultures. Understanding the story motifs and characters that are most likely to be linked with earthquake stories, requires careful study and insightful interrogation of the material.

Haida Tribal earthquake stories (Tlingit and Haida Indian Tribes of Alaska) appear in several volumes (Barbeau 1928, Swanton 1905), and feature an Atlas-like or hero-figure who causes earthquakes by moving his hands and feet, or by stomping on the ground, or by slipping over duck grease. This figure is variously known as "Stone Ribs", "Strong Man who holds up the World", and "Sacred One both Still and Moving". The Haida areas are located at the north end of the CSZ, where earthquake activity is more frequent than on the Washington and Oregon coastal margin. Similar stories exist from the Yurok Tribe located at the southern reaches of the CSZ in Northern California.

Within this region, several Tribal Legends are clearly set in historical (not mythic) time, and are possibly related to past Cascadia earthquakes that generated tsunami waves. One such story is of the destruction of a village on Vancouver Island's Pachena Bay, "The tsunami at !ANAQTL'A or 'Pachena Bay'" related during 1964 by Louis Clamhouse, published in Arima *et al.* (1991, p. 231), and cited in Ludwin (1999).

> "They had practically no way or time to try to save themselves. I think it was at nighttime that the land shook.... I think a big wave smashed into the beach. The Pachena Bay people were lost.... But they who lived at Ma:lts'a:s, :House-Up-Against-Hill were saved. The wave did not reach there because they were on high ground... Because of that, they came out alive. They did not drift out to sea with the others."

Another story describes a great ebb and flow of the sea in Barkley Sound (Sproat 1987, Clague 1995). Hill-Tout (1978) records a story related through Cowichan tradition of strong shaking. The Cowichan Valley is located on southeastern Vancouver Island.

> "In the days before the white man there was a great earthquake. It began about the middle of one night .... threw down ... houses and brought great masses of rock down from the mountains. One village was completely buried beneath a landslide."

4.5.1.1. Thunderbird Fights Mimlos-Whale

Told by Luke Hobucket. Mr. Hobucket said that Thunderbird represented good and that Mimlos-whale represented evil (the Killer Whale) (Ludwin 1999).

> There was the great flood at that time. Thunderbird fought with Mimlos-Whale. The battle lasted a long time. For a long time the battle was undecided. Thunderbird in the air could not whip Mimlos-whale in the water. Thunderbird would seize Mimlos-whale in his talons and try to carry Mimlos-whale to his nest in the mountains. Mimlos-whale would get away. Again Thunderbird would seize him. Again Mimlos-whale would escape. The battle between them was terrible. The noise that Thunderbird made when he flapped his wings shook the mountains. They stripped the timber there. They tore the trees out by their roots. Then Mimlos-whale got away. Again, Thunderbird caught Mimlos-whale. Again they fought a terrible battle in another place. All the trees there were torn out by their roots. Again Mimlos-whale escaped.
>
> Many times they fought thus. Each time thunderbird caught Mimlos-whale there was a terrible battle, and all the trees in that place were uprooted. At last Mimlos-whale escaped to the deep ocean, and Thunderbird gave up the fight. That is why the killer whale still lives in the ocean today. In those places where Thunderbird and Mimlos-whale fought, to this day, no trees grow. Those places are the prairies on the Olympic Peninsula today.

4.5.1.2. The Valley of Peace in the Olympics

A Quinault Legend, told to Clarnece Pickernell by his great grandmother (Pickernell 1990).

> In the days long gone by, the Indians had a sacred place in the heart of the Olympic Mountains. It was a valley, wide and level, with peaks high on every side. The base of

the mountains was covered with cedar and fir and pine, which stayed green throughout the year. A small stream murmured through the valley, and flowers of many kinds grew on its banks and spread through the meadows.

It was a place of peace, for it was held sacred by all the neighboring tribes. Once every year, all the Indian nations, even those that at other times made war upon each other, gathered in the Valley of Peace. Coming from all directions, they climbed the trails to the summits of the mountains and gazed upon the beautiful valley below them.

Then they put away their weapons of war, went down to the valley, and greeted their former enemies with signs of peace. There they traded with each other and enjoyed games and contests of strength and skill.

These friendly gatherings were held for many years in the Valley of Peace. But Seatco, chief of all the evil spirits, became angry with the people who gathered there. Seatco was a giant who could trample whole tribes under his feet. He was taller than the tallest fir trees. His voice was louder than the roar of the ocean, and his face was more terrible to look upon than the face of the fiercest wild beast. He could travel by land, in the water, and in the air. He was so strong that he could tear up a whole forest by the roots and heap rocks into mountains. By just blowing his breath, he could change the course of rivers.

This demon became angry, without reason, at all the nations that gathered in the Valley of Peace. One year when they were there for trading and for contests of peace, Seatco came among them. He caused a great trembling and rumbling of the mountains. Then he caused the earth and water to swallow the people.

Not many Indians escaped. A few rushed away in time to save themselves from the anger of Seatco. They returned to their villages to warn their people away from the valley. The Indians never went there again.

4.5.2. Geologic Setting

The discussion presented here is based greatly on written data and geospatial data, provided by the Washington State Department of Natural Resources, Division of Geology and Earth Resources, Cascadia Region Earthquake Workgroup (CREW), and the USGS.

More than 1,000 earthquakes occur in Washington State annually. Washington has a record of at least 20 damaging earthquakes during the past 125 years. Large earthquakes in 1946, 1949, and 1965 killed 15 people and caused more than $200 million (1984 dollars) in property damage (WDNR 2010). Most of these earthquakes were in western Washington, but several, including the largest measured historic earthquake in Washington (1872), occurred east of the Cascade crest (USGS 2010). Using a branch of geology called paleoseismology to extend the historical record, geologists have found evidence of large, prehistoric earthquakes in areas where there have been no large historic events, suggesting that most of the state is at risk (WDNR 2010).

The crust or surface of our planet is broken into large, irregularly shaped pieces called plates. The plates tend to pull apart or push together slowly, but with great force. Stresses build along edges of the plates until part of the crust suddenly gives way in a violent movement. This shaking of the crust is called an earthquake.

The crust breaks along uneven lines called faults. Geologists locate these faults and determine which are active and inactive. This helps identify where the greatest earthquake potential exists (USGS 2010). Many faults mapped by geologists are inactive and have little earthquake induced risk-potential; others are active and have a higher earthquake induced risk-potential (WDNR 2010).

When the crust moves abruptly, the sudden release of stored force in the crust sends waves of energy radiating outward from the fault. Internal waves quickly form surface waves, and these surface waves cause the ground to shake. Buildings may sway, tilt, or collapse as the surface waves pass. Fault line information used in this report was adopted from research completed by the Washington DNR, the Cascadia Region Earthquake Workgroup (CREW), and related sources. The entire Washington coastline is swathed by a network of fault lines that have formed by the tectonic action of the Pacific Plate, the Juan de Fuca Plate and the Continental Plate. All three of these plates interact within close proximity to the QIR (Figure XL). The CSZ runs parallel to the Washington coastline and defines the movement of the Juan de Fuca Plate eastward under the continental plate. The Juan de Fuca Plate and the Pacific Plate are in a general divergent movement pattern (Figure XLI) although these two plates also show tendencies for slip-fault movement, especially along the northern extent into British Columbia (Geller 2008).

The Washington State Department of Natural Resources, Division of Geology and Earth Resources has created geospatial data containing Quaternary fault lines for the state of Washington and offshore areas (Figure XLVI). This digital dataset depicts the location of faults with known or suspected Quaternary (<1,600,000 yrs) activity in the state of Washington. Data was gathered from numerous sources, including the Washington state portion of the U.S Geological Survey's "Quaternary fault and fold database of the United States" (USGS 2008). Faults were attributed with information such as age, visibility, method of detection, and in most cases, the corresponding ID number for the fault in the USGS database, for easy correlation between the two data sources (WDNR 2010).

These data sources have been used to document the location and characteristics of fault lines in and near the QIR. Quaternary-active faults are those that have slipped in Quaternary time (the last 1.6 million years). Geologists think that these faults are the most likely source of future great earthquakes, so it is important to know where they are, and how they work (USGS 2010).

Not every crack in the ground is a fault. What defines a fault is the movement of the rock on either side of the fault. When that movement is sudden, the released energy causes an earthquake. Some faults are tiny, but others are part of great fault systems where rocks have slid past each other for hundreds of miles (Geller 2008). These fault systems are the boundaries of the huge plates that make up the Earth's crust. In the CSZ, the Quaternary-active faults are part of the boundary between the Pacific, Juan De Fuca, and North American plates.

Where the Earth's tectonic plates collide, pull apart, or slide by each other, they form and drive faults. Although the Earth seems very stable on a human time scale, over geologic time it is a very dynamic system. Rock bodies are continuously being made and destroyed. Mountains are pushed up and ground down. Huge slabs of the Earth's surface are sliding and grinding past and over one another (USGS 2010).

The powerful forces that drive this system cause huge slabs of the Earth's crust (tectonic plates), to grind and push against one another. The rocks along the boundaries of these plates are continuously being squeezed and sheared, causing them to bend and break (Wood & Kienle 1990). All the Quaternary-active faults in the Juan De Fuca plate region are part of the CSZ system and are considered active (WDNR 2010).

Geologists study faults to better understand where large earthquakes originate. The Earth's plates are constantly moving, but most faults are motionless, locked by friction, until the day when the force on the fault builds up enough energy to overcome the resistance. When that happens, the rocks on either side of the fault lurch into motion, releasing pent-up energy in an earthquake. Most earthquakes are so small that special instruments are needed to detect them, but a few release huge amounts of energy, causing widespread destruction (Wood & Kienle 1990). During most earthquakes, fault motion stays below the Earth's surface, but in large earthquakes, fault motion may break through to the surface, offsetting rocks and sediments, as well as anything built, or anchored, on the fault (USGS 2010).

Knowing the location of active faults is important so that planners and developers can avoid building houses or other structures, which would be destroyed when the fault breaks the Earth's surface, on the faults. Geologists also study the faults to find out how quickly the stress on them is building, as well as when the last large earthquake on them was and how often large earthquakes are caused by them. All of this information together gives people a general idea of how soon to expect the next “Big One” on a particular fault.

There are literally hundreds of faults in the Western Washington region alone. All faults are the result of movement in the Earth's crust, and all but the tiniest probably have generated earthquakes. Because the pattern of stress in the crust changes over geologic time, faults are formed, slip for a time, and then retire (USGS 2010). Geologists focus their studies on Quaternary-active faults, that have ruptured in Quaternary time. Faults that have not broken in the last 1.6 million years are probably abandoned, or at least they cause an earthquake so infrequently as to be less of a concern today. On the other hand, faults that have ruptured in Holocene time (the last 11,500 years) are considered the most active and dangerous faults.

Values used in this report and generated by the Washington State Department of Natural Resources, Division of Geology and Earth Resources, represent six age groups, five of them Quaternary age (1,600,000 yrs) and younger. The sixth group is listed as Unknown, for faults considered to be Class B faults. Class B faults are faults that are suspected of having Quaternary-age deformation, yet lack sufficient evidence of it.

According to those data, there are 261 Quaternary fault lines within 100 miles of the exterior boundaries of the QIR. Selected from these faults, are approximately 66 faults that are located within the QIR or to the west of the QIR all the way to the CSZ (Table 28). Some of these fault lines are very young, formed within the last 15,000 years and some of those faults are located very near the QIR (e.g., unnamed faults near Duck Creek). A series of these faults are located between Taholah and Qui-nai-elt, including Point Grenville, near to the location referenced in the Landslides section of this report (Section 4.7, Swede Hill), where long-standing landslides have plagued road maintenance efforts.

Table 28. Faults within the QIR and westerly of the QIR.

Fault Name	Age	Distance From QIR (miles)
Unnamed fault near Wreck Creek	<130,000	0
Unnamed fault zone near Raft River	<130,000	0
Unnamed fault zone near Raft River	<750,000	0
Unnamed fault zone near Raft River	<750,000	0
Unnamed fault near Wreck Creek (Class B)	Unknown	0
Unnamed faults near Duck Creek	<130,000	1
Unnamed faults near Duck Creek	<130,000	1
Unnamed fault zone near Raft River (Class B)	Unknown	1
Unnamed faults near Duck Creek	<15,000	2
Unnamed fault zone near Aloha (Class B)	Unknown	2
Unnamed fault zone near Aloha	<15,000	3
Unnamed fault zone near Aloha (Class B)	Unknown	3
Unnamed fault zone near Aloha	<1,600,000	4
Unnamed faults offshore of Queets River	<1,600,000	5
Unnamed faults offshore of Queets River (Class B)	Unknown	6
Unnamed fault zone near Langley Hill (Class B)	Unknown	7
Unnamed fault zone near Aloha	<130,000	8
Langley Hill fault	<1,600,000	9
Unnamed fault zone near Langley Hill	<130,000	9

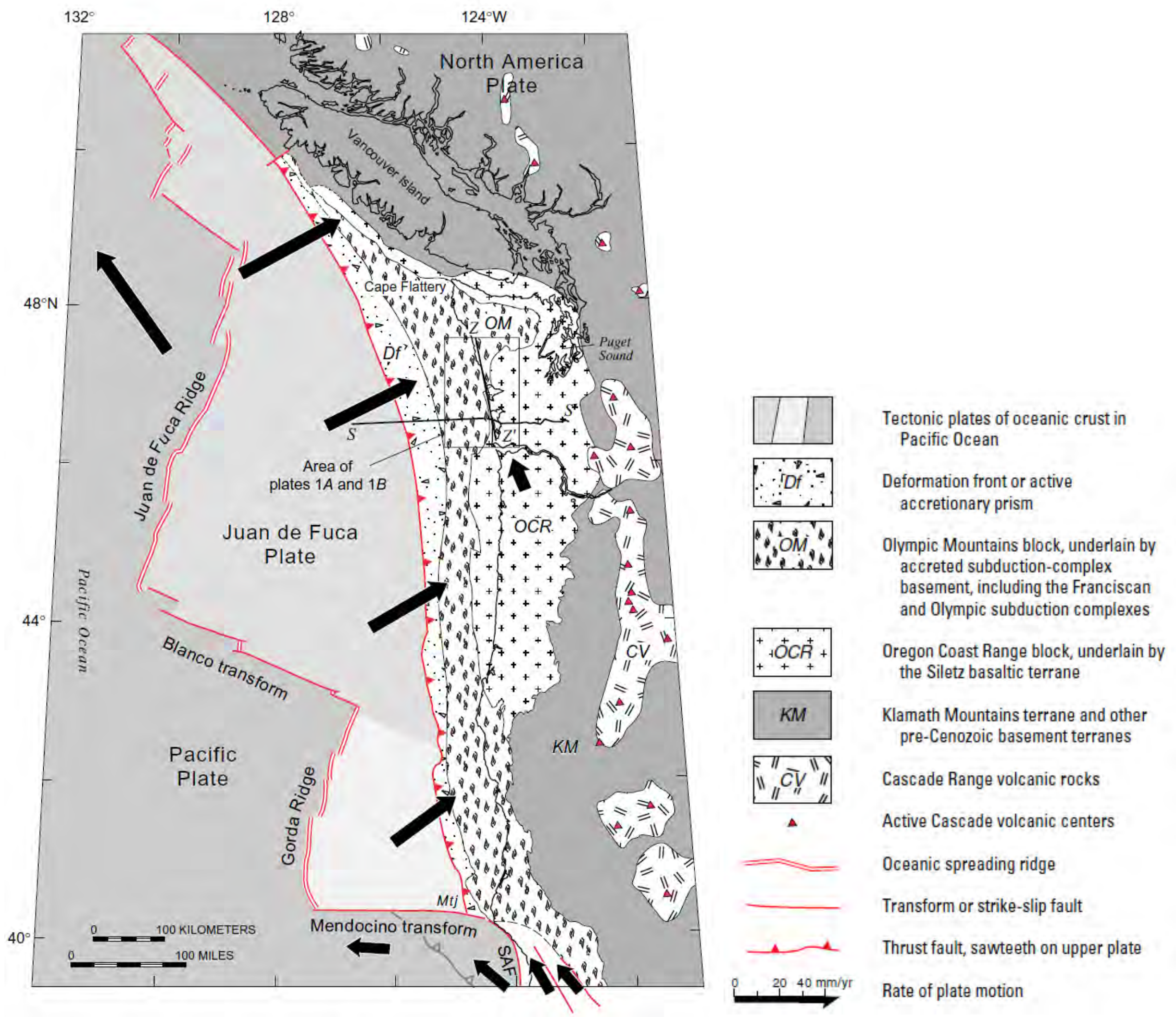
Table 28. Faults within the QIR and westerly of the QIR.

Fault Name	Age	Distance From QIR (miles)
Unnamed fault zone near Langley Hill	<15,000	11
Saddle Hill faults	<1,600,000	12
Unnamed faults offshore of Queets River	<15,000	12
Saddle Hill faults	<1,600,000	13
Saddle Hill fault zone	<130,000	13
Unnamed fault zone near Langley Hill	<130,000	14
Saddle Hill fault zone	<750,000	14
Saddle Hill fault zone (Class B)	Unknown	15
Grays Harbor fault zone	<1,600,000	16
Unnamed fault zone near Langley Hill	<15,000	16
Saddle Hill fault zone	<130,000	18
Grays Harbor fault zone	<15,000	18
Grays Harbor fault zone	<130,000	19
Saddle Hill fault zone	<15,000	19
Grays Harbor fault zone	<1,600,000	25
Unnamed offshore faults near Grays Canyon	<130,000	25
Unnamed faults near mouth of Willapa Bay	<130,000	26
Unnamed faults near mouth of Willapa Bay	<1,600,000	31
Unnamed fault zone offshore Cape Shoalwater	<1,600,000	32
Unnamed fault zone offshore Cape Shoalwater (Class B)	Unknown	33
Unnamed offshore faults near Grays Canyon	<15,000	34
Unnamed offshore faults near Grays Canyon	<130,000	35
Willapa Bay fault zone	<130,000	35
Unnamed faults near mouth of Willapa Bay (Class B)	Unknown	35
Willapa Bay fault zone	<130,000	36
Willapa Bay fault zone	<130,000	36
Willapa Bay fault zone	<130,000	38
North Ninitat fault zone	<15,000	40
Unnamed offshore faults near Grays Canyon	<130,000	41
Willapa Bay fault zone	<130,000	43
Unnamed offshore faults near Grays Canyon	<15,000	46
Willapa Bay fault zone	<750,000	51
Unnamed offshore faults near Grays Canyon	<130,000	53
South Ninitat fault zone	<750,000	53
Willapa Bay fault zone	<750,000	54
Nehalem Bank fault	<15,000	63
North Ninitat fault zone	<15,000	63
North Ninitat fault zone	<15,000	67
South Ninitat fault zone	<750,000	67
Fault J	<15,000	68
Unnamed offshore faults	<15,000	74
Willapa Canyon fault	<1,600,000	81
Cascadia fold and thrust belt	<15,000	81
Cascadia Subduction zone	<15,000	81
South Ninitat fault zone	<750,000	81
Nehalem Bank fault	<15,000	83
Cascadia subduction zone	<15,000	86

Tectonic processes active in the CSZ region include accretion, subduction, deep earthquakes, and active volcanism that has included such notable eruptions as Mount Mazama (Crater Lake) several thousand years ago and Mt. St. Helens in 1980 (Geller 2008). Subducting plate movements have produced major earthquakes in historic and pre-historic times. The so-called "megathrust" events occur offshore within the subduction fault zone and can be catastrophic (magnitude 9). The last such event occurred approximately 300 years ago and created a tsunami felt locally and in Japan. While relatively infrequent, the megathrust earthquakes have a fairly well documented return interval of 400 to 600 years. More common earthquakes occur within the subducting oceanic crust, or within overlying continental rocks, and the 2001 Nisqually earthquake with an epicenter near Olympia, provides a recent example. Researchers believe that strain within the locked zone of the subduction fault is accumulating, and as it does so, the chances of a major subduction earthquake event increase.

The CSZ separates the Juan de Fuca Plate, Explorer Plate, Gorda Plate, and North American Plate (Figure XXXIX). The oceanic crust of the Juan de Fuca plate sinks beneath the continent at a rate of about 40 mm/yr (Wood & Kienle 1990). The remaining part of the Pacific Plate that is currently converging with the American Northwest is the Juan de Fuca Plate (Figure XL), with small platelets at its northern (Explorer Plate) and southern (Gorda Plate) terminations. The Explorer Plate separated from the Juan de Fuca plate approximately 4 million years ago and is apparently no longer being subducted (Hyndman *et al.* 1979). The Gorda split away between 18 and 5 million years ago (Hyndman *et al.* 1979).

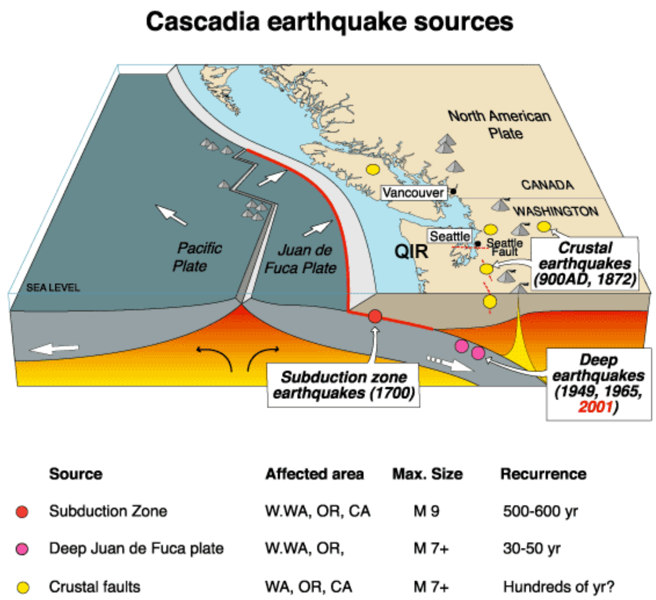
Figure XXXIX. Generalized Tectonic Map Offshore of Washington and Oregon Coastlines, Reproduced from McCroy *et al.* (2002).



The width of the Cascadia subduction zone varies along its length, depending on the temperature of the subducted oceanic plate, which heats up as it is pushed deeper beneath the continent. As it becomes hotter and more molten, it eventually loses the ability to store mechanical stress and as a result it generates earthquakes.

The CSZ runs from triple junctions at its north and south ends. On the north just south of Queen Charlotte Island in British Columbia, it intersects the Queen Charlotte Fault and the Explorer Ridge. On the south, just off of Cape Mendocino in California, it intersects the San Andreas Fault and the Mendocino fault zone at the Mendocino Triple Junction.

Figure XL. Cascadia subduction zone and shifting plates along the Pacific Ocean shoreline to the North American continent (reproduced from USGS 2010).



4.5.3. Measuring an Earthquake

Earthquakes are measured in two ways. One determines the power; the other describes the physical effects. Magnitude is calculated by seismologists from the relative size of seismograph tracings. This measurement has been named the Richter scale, a logarithmic-numerical gauge of earthquake energy ranging from 1.0 (very weak) to 9.0 (very strong). A Richter scale earthquake of 5.0 is ten times stronger than a 4.0 earthquake. The Richter scale is most useful to scientists who compare the power in earthquakes. Magnitude is less useful to disaster planners and citizens, because power does not describe and classify the damage an earthquake can cause. The damage we see from earthquake shaking is due to several factors including distance from the epicenter, local rock types, and the magnitude of the earthquake. Intensity defines a more useful measure of earthquake shaking for any one location. It is represented by the modified Mercalli scale (Table 29). On the Mercalli scale, a value of I is the least intense motion and XII is the greatest ground shaking. Unlike magnitude, intensity can vary from place to place. In addition, intensity is not measured by machines. It is evaluated and categorized from people's reactions to events and the visible damage to man-made structures. Intensity is more useful to planners and communities because it can reasonably predict the effects of violent shaking for a local area.

Table 29. Modified Mercalli Earthquake Intensity Scale (IGS 2008).

Intensity	Description
I.	Only instruments detect the earthquake
II.	A few people notice the shaking
III.	Many people indoors feel the shaking. Hanging objects swing.
IV.	People outdoors may feel ground shaking. Dishes, windows, and doors rattle.
V.	Sleeping people are awakened. Doors swing, objects fall from shelves.
VI.	People have trouble walking. Damage is slight in poorly built buildings.
VII.	People have difficulty standing. Damage is considerable in poorly built buildings.
VIII.	Drivers have trouble steering. Poorly built structures suffer severe damage, chimneys may fall.
IX.	Well-built buildings suffer considerable damage. Some underground pipes are broken.
X.	Most buildings are destroyed. Dams are seriously damaged. Large landslides occur.
XI.	Structures collapse. Underground utilities are destroyed.
XII.	Almost everything is destroyed. Objects are thrown into the air.

4.5.4. Geologic Processes

The Olympic Peninsula is situated between the easterly moving Juan De Fuca Plate and the semi-stationery North American continental plate to the east (Figure XL, Figure XLI). Millions of years ago, the Juan De Fuca Plates' predecessor, the Farallon Plate, moved northwesterly and was subducted beneath the continental plate (Williams 2002). The rigid layers of basalt that made up the ocean floor, were tilted up on edge and bent into the compressed zone between Vancouver Island and the North Cascades as this process unfolded. This created a rim of basalt, turned on its side and folded together, along the inner core of the Olympic Mountains and on the east and north sides of the Olympic Mountains. During this compression, the ocean floor was pushed against the continental plate, the basalt folded, tilted, and shaped the Olympic Mountains (Figure XLI). These layers were folded, compressed, broken, and uplifted and today what was once ocean bottom layers are to be found at the peak of Mount Olympus (Williams 2002). This process continues today and maintains the high mountain peaks of the Olympic Mountains even though these peaks are not volcanic mountains like the Cascade Range to the east (Eaton & Frederiksen 2007).

For the most part, the North American Plate moves in roughly a southwest direction away from the Mid-Atlantic Ridge. The motion of the North American Plate cannot be driven primarily by subduction as no part of the North American Plate is being subducted, except for a very small section comprising part of the Puerto Rico Trench; thus other mechanisms continue to be investigated (Eaton & Frederiksen 2007).

Washington is situated at a convergent continental margin, the collision boundary between multiple tectonic plates. The CSZ, which is the convergent boundary between the North America plate and the Juan de Fuca plate, lies offshore from northernmost California to southernmost British Columbia. The plates found here cause complex seismic strains to accumulate. Earthquakes are caused by the abrupt release of this slowly accumulated strain.

Historical Damaging Wadati-Benioff Zone Earthquakes in Washington (PNSN 2010).

- 1949 Mag: 7.1 Depth: 53 km Loc: Olympia
- 1965 Mag: 6.5 Depth: 63 km Loc: Sea-Tac
- 1999 Mag: 5.5-5.8 Depth: 41 km Loc: Satsop
- 2001 Mag: 6.8 Depth: 52 km Loc: Olympia (Nisqually)
- 2001 Mag: 5.0 Depth: 40 km Loc: Matlock

All types of earthquakes can trigger landslides and liquefaction (when soil liquefies during shaking). Each type, however, starts at a different depth underground and has different characteristics.

4.5.5. Types of Earthquakes Expected Along the CSZ

This entire section (4.5.5) is summarized from reports published by CREW (2005) and is reproduced here with modifications to the QIR situation.

4.5.5.1. Shallow / Crustal Earthquakes

Most earthquakes in this zone are a result of fault line movements in the crust, a relatively thin layer on the Earth's surface.

- Shallow quakes are usually less than magnitude (M) 7.5.
- The strongest shaking in crustal earthquakes typically occurs near the rupture plane of the fault on which the earthquake occurs.

- Most Cascadia quakes are shallow, such as the quakes centered at Vancouver Island, British Columbia in 1946 (M7.3) and Scotts Mills, Oregon in 1993 (M5.6).
- Small, shallow earthquakes are recorded every day in Cascadia; damaging quakes occur every few decades.
- Strong shaking generally lasts 20-60 seconds, although it could be longer in localized areas.
- Damage is most likely to occur in vulnerable structures located relatively close to the fault on which the earthquake occurs, where the shaking is strongest.
- Aftershocks are common and may cause further disruption.
- There could be a local tsunamis from landslides, or from shallow earthquakes occurring under Puget Sound, the Strait of Georgia, or other bodies of water including lakes and rivers.

4.5.5.2. Deep / Intraplate Earthquakes

These are caused by a zone of earthquakes occurring below 18 miles (30 kilometers) in depth on fractures in the subducting Juan de Fuca plate.

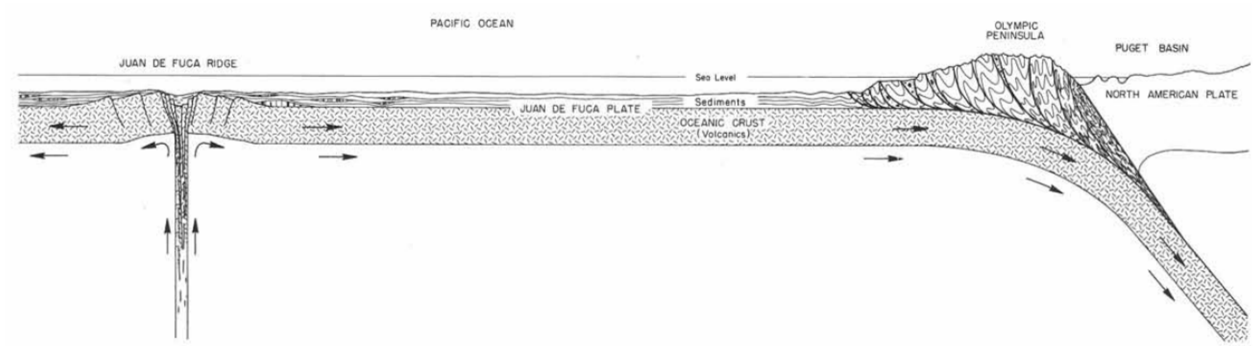
- Deep quakes are usually less than M7.5.
- The 2001 Nisqually, Washington quake (M6.8) and 1949 Olympia quake (originally measured M7.1, now revised to M6.8) were deep earthquakes.
- Damaging deep earthquakes generally occur every 10-30 years.
- Because the original earth movement is so deep, the seismic energy disperses over a much larger area than in a shallow quake. The shaking is felt over a large area and is less intense near the epicenter. Damage is less than in a similar-sized shallow quake.
- Few, if any, aftershocks occur.
- No tsunami is expected, although landslides could trigger local tsunami-like waves.

4.5.5.3. Subduction Zone Earthquakes

The subducting seafloor of the Juan de Fuca plate is being pushed beneath the continental North American plate (Figure XL and Figure XLI). The contact between these two plates periodically ruptures in large, subduction zone earthquakes.

- Earthquakes centered along the CSZ can reach M9.0
- The last major CSZ earthquake was January 26, 1700. This event resulted in the deaths of 2 people in a sailing boat along the shore of Japan while they were attempting to dock the boat (NGDC 2010) – see the text in section 4.5.1 for more information on this event. Previous quakes were in the years (approximately) 900, 750, and 400 AD.
- Geological evidence suggests an average of 500 years between events.
- Depending on location, strong shaking might be felt for several minutes.
- Injuries and fatalities could number in the thousands, and hundreds of buildings could be destroyed.
- A destructive tsunami will quickly hit the Cascadia coast and travel across the Pacific Ocean.
- Aftershocks up to M7 are common, creating the potential for additional damage.

Figure XLI. Cross section showing how the structurally complex rocks of the Olympic Mountains and the west coastal area may have been formed (reproduced from Rau 1973).



4.5.6. Types of Hazards from a CSZ Earthquake

4.5.6.1. Ground Response from a CSZ Earthquake

Earthquakes release energy that travels through the earth in waves. Subduction quakes are richer in long-period waves, which are most dangerous for tall buildings, long bridges or long, above-ground pipelines. This is a different pattern than in a typical shallow quake, where the greatest effect is on short buildings. Some soil types cause earthquake waves to amplify, causing increased shaking and damage. The risk of amplification increases when you are on deep, soft soils, especially on valley bottoms and areas of artificial fill.

These soils can be identified before an earthquake, as one measure of the risk a community might face. Most areas at risk are already identified with soil studies in land use planning and development. Following a large subduction quake, there can be months of aftershocks, some perhaps as large as M7. Some of these aftershocks could cause significant new damage.

The entire QIR and adjacent lands are classified by the Washington DNR, Division of Geology and Earth Resources to assess conformity with the 2006 International Residential Code (International Code Council, 2003). The IRC was adopted in 2007 by the Washington State Legislature as the official state building code for one- and two-family dwellings and townhouses not more than three stories in height with separate means of egress. Poelstra and Palmer (2004) published seismic design category maps, based on 1996 IRC using the 1996 National Seismic Hazard Maps (Frankel *et al.* 1996), to assist local building officials, property owners and developers for residential constructions in Washington. The 2006 IRC, adopted for use in Washington beginning on July 1, 2007, required changes in previously determined seismic design categories and are used in this assessment (Cakir and Walsh 2007). The QIN adopted the 2006 IRC on June 10, 2008.

This planning effort adopted the seismic design category digital map data to determine the seismic design classification for the QIR. These classifications are prepared to assist QIR building officials, property owners and developers. These digital data were provided on statewide extents to include seismic design categories. The data are intended to aid in the implementation of the 2006 IRC, specifically in seismic provisions and incorporates site class information (Palmer *et al.* 2007).

This dataset identifies site classes for approximately 33,000 polygons statewide and 145 polygons within the QIR, derived from the geologic map of Washington (Figure XLII). 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 the project (WDNR 2010).

The entire QIR is classified within the categories B, C, C-D, D, D-E, and open water (Table 30). The higher the letter rank of the seismic design class (E is higher than B), the more restrictive the required building code provisions, which increases the cost of building design and construction. The 5 percent design spectral response acceleration (S_{DS}) at short periods is determined as $0.83 < S_{DS} < 1.17$. S_{DS} values for assigning the seismic design categories are represented as the probability of exceedance in a 50 year period.

Table 30. Seismic Design Site Classes on the QIR (Palmer *et al.* 2007).

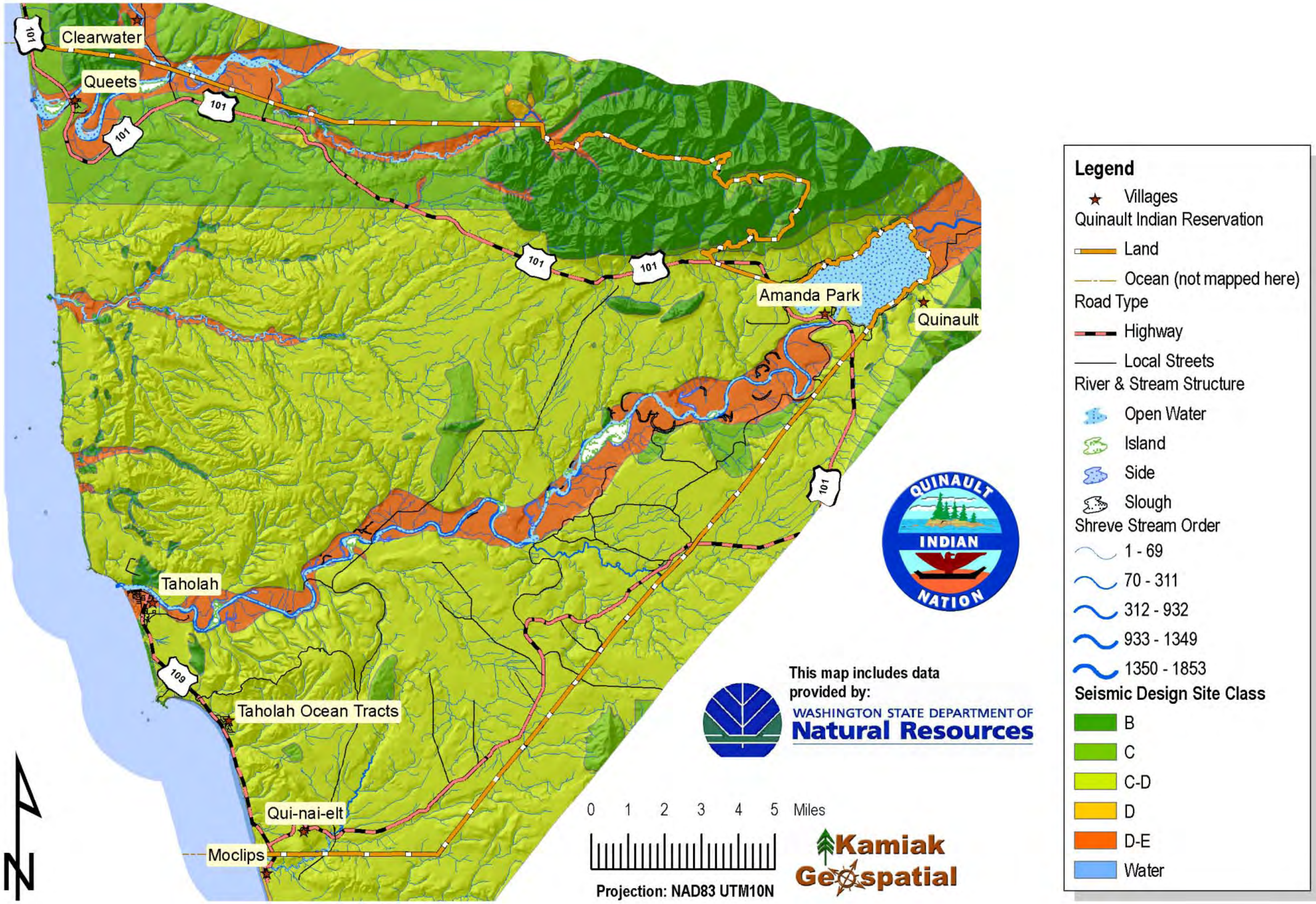
Site Classes	Description
B	Average shear wave velocity in the upper 100 feet (30 meters) is >2500 to 5000 feet/second (760 to 1520 meters/second)
B-C	Mean shear wave velocity in the upper 100 feet (30 meters) corresponds to a B site class and the mean shear wave velocity minus one standard deviation within the upper 100 feet (30 meters) corresponds to a C site class.
C	Average shear wave velocity in the upper 100 feet (30 meters) is >1200 to 2500 feet/second (360 to 760 meters/second)
C-D	Mean shear wave velocity in the upper 100 feet (30 meters) corresponds to a C site class and the mean shear wave velocity minus one standard deviation within the upper 100 feet (30 meters) corresponds to a D site class.
D	Average shear wave velocity in the upper 100 feet (30 meters) is 600 to 1200 feet/second (180 to 360 meters/second)
D-E	Mean shear wave velocity in the upper 100 feet (30 meters) corresponds to a D site class and the mean shear wave velocity minus one standard deviation within the upper 100 feet (30 meters) corresponds to a E site class.
E	Average shear wave velocity in the upper 100 feet (30 meters) is <600 feet/second (180 meters/second)
F	Soils susceptible to potential failure under seismic loading, such as liquefiable soils or sensitive clays, peats, or organic clays thicker than 10 ft (3 m); thick sections of clays. Special category indicating a geotechnical evaluation should be performed to assess amplification potential.

Seismic Design Category assessment was generated by the Washington DNR first by using the 2003 revision of the U.S. Geological Survey's 2002 short-period (0.2 sec.) accelerations (SS) with two percent probability of exceedance in 50 years (Frankel *et al.* 2002), which represent the maximum considered earthquake (MCE) (ASCE 2006). Second these guidelines were established to describe in the 2006 International Building Code (for the calculation of the Sds values), incorporating the NEHRP site class map (Palmer *et al.* 2007). Third, the design specifications reflect seismic design category classification given in Table R301.2.2.1.1 of the 2006 International Residential Code.

Given the aspect of the entire state, the QIR is amongst highest risk rated areas in terms of seismic design categories (but not the absolute highest – there are no category E or F sites). Although these factors represent extreme caution for the residents of the QIR, the positive note for the residents of the QIR is the total absence of multistory, un-reinforced masonry (URM) buildings on the QIR. Virtually all structures are assembled from wood frame construction and are single and double story buildings. The few masonry buildings on the QIR (school houses) are built within the time period of structural reinforcement.

The largest risk represented by the seismic design categories presented here is the existence of URM chimneys attached to homes within the QIR. This topic will be addressed in discussions for each village and populated place in Chapter 5.

Figure XLII. Seismic Design Class Map of the QIR (Palmer *et al.* 2007).



4.5.6.2. Ground Failure from a CSZ Earthquake

Sandy soils saturated with water can liquefy, or behave like a liquid, during an earthquake. Major earthquake destruction is often found on these soils that are prevalent along rivers, streams, and lakes. Liquefaction can seriously damage buildings, bridges, pipelines, and roads by undermining their foundations and supports.

Liquefaction is a natural phenomenon in which saturated, sandy soils lose their strength and behave as liquid. Liquefaction is caused by severe ground shaking during earthquake events. Liquefaction risks were articulated by the Washington DNR, Division of Geology and Earth Resources to identify the relative liquefaction potential for the entire state of Washington. Igneous and metamorphic rock were assumed to have no liquefaction potential and are designated as "bedrock". Water and ice were also designated and peat, which requires site-specific analysis in the International Building Code, is also separately designated. All other sites were classified as having very low- to high-liquefaction potential based on criteria described in Palmer *et al.* (2007).

The entire QIR has been considered for liquefaction risks. Although most of the land area of the QIR is rated at low to very low scales, with some significant outcroppings of bedrock, much of the land area surrounding and within the villages of Taholah and Queets and along the river shorelines are rated at moderate to high risks for liquefaction. The village of Amanda Park and the communities of Taholah Ocean Tracts and Qui-nai-elt are all rated at very low liquefaction risks scales.

Earthquakes can also trigger landslides. A subduction zone earthquake can trigger landslides and rockfalls on the steep slopes of the Coast. Other areas might also be at risk to landslides as well. A complete discussion of landslides is addressed in Section (4.7).

4.5.6.3. Tsunami from a CSZ Earthquake

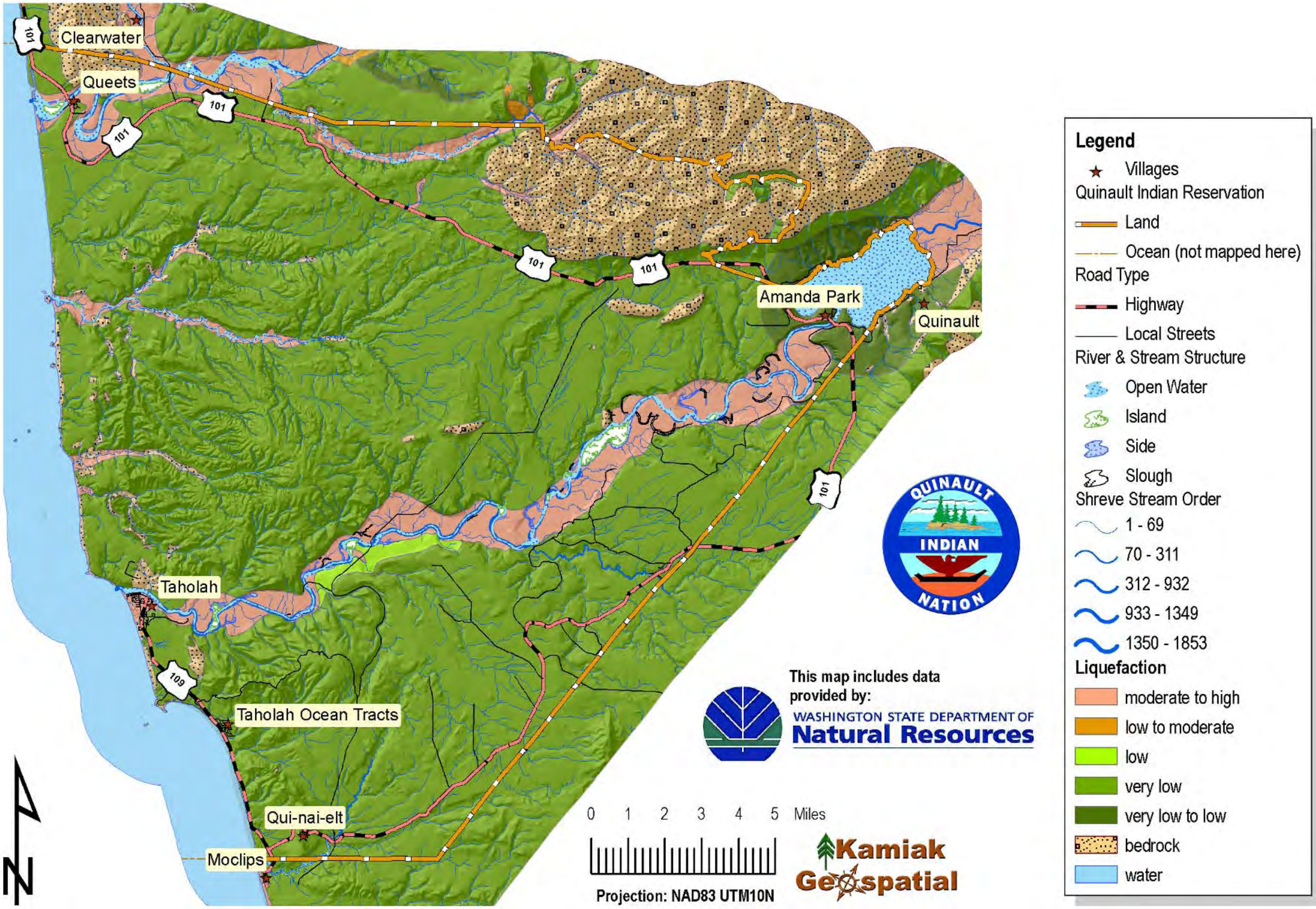
A CSZ earthquake could generate a tsunami. The number of large waves and their height will depend on local conditions. In some cases, waves may be up to 30 feet (10 meters) high, flooding everything in their path. The sequence of the waves sweeping inland, then out again, could last 10 to 12 hours. The first wave could arrive a few minutes after the earthquake, again depending on local conditions.

Casualties and damage from tsunamis may be high. Deaths can be minimized if people evacuate to higher ground or move sufficiently far inland immediately after the ground stops shaking. An extensive discussion of tsunami risks on the QIR is presented in Section 4.5.1, the reader is encouraged to read through that section for a complete understanding of the earthquake and tsunami interaction on the QIR.

4.5.6.4. Liquefaction from a CSZ Earthquake

While the exposure to earthquakes within the entire Western Washington region is well established, the composition of the soils and underlying geology of the region is critical to understanding the level of risk the residents of this area face. In the event of a major CSZ earthquake, the entire region of the QIR will face extreme geologic risks from liquefaction, seismic instability, and infrastructure failure. These topics are discussed in more detail in Section 4.7. The reader is encouraged to read through that section to understand the combination of risks posed by a CSZ earthquake on the QIR.

Figure XLIII. Liquefaction Risks on the QIR.



4.5.1. Probability of Future Events

Earthquake frequency on the QIR has been recorded through personal accounts, news reports of the region, and physical evidence of earthquakes. Although illustrative, these accounts fail to consistently apply uniform measures of earthquake intensity, duration, or specific focal point location. Earthquakes are felt within the QIR from a variety of vectors of seismic activity including the volcanic Cascade Mountain range, the Cascadia Subduction Zone and the crushing of the tectonic plates felt across this entire region. Earth tremors that are not focally situated within the QIR are frequently felt here.

A cursory review of Table 28 reveals that there are approximately 261 Quaternary fault lines within 100 miles of the exterior boundaries of the QIR. Historical Damaging Wadati-Benioff Zone Earthquakes in Western Washington (detailed here) include five major earthquake events, all felt within the QIR, between 1949 and present time. This frequency, of a major earthquake felt on average once every 12 years should be expected into the future. It has been approximately 9 years since the last major earthquake in the region (2001 – Mag: 5.0 Depth: 40 km Loc: Matlock), but to predict, with any expectation of accuracy, that only 3 years remain before another major earthquake is expected would overstate the precision of these data.

The only sure way of limiting the exposure of residents to earthquake events is to build homes that incorporate earthquake resistance into the structure, locate them on stable soils, and build infrastructure outside of the zones of maximum seismic shaking risk exposure to avoid the negative impacts of these catastrophic events.

4.6. Tsunami

A Federal Indian Agent report written on May 7, 1887, reads, “Something like a tidal wave struck the Quinault Agency at midnight. Some of the Indian houses were waist deep in water, the inmates yelling in terror as they were submerged during sleep on their low sleeping places. The water receded as rapidly as it came, carrying everything portable in its exit” (Workman 1997-2010).

On December 24, 1920, media reports state, “a small tidal wave sweeps beaches, washes 12 Sunset Beach cottages from their foundations” (Workman 1997-2010).

Workman (1997-2010), includes reports that were conveyed from local media, that “a five foot high tidal wave races up the Quinault River” on April 1, 1946. This tsunami event was recorded as a result of an earthquake at Unimak Island in Alaska (Table 31). On April 1, 1946, at 12:29 [Alaska time] a rather strong magnitude 8.1 earthquake occurred with a source at the south side of Unimak Island, causing one of the most destructive tsunamis (at that time) in the Pacific Ocean (NGDC 2010).

The Unimak Island earthquake, with a rift that occupied a 100 mile by 50 mile block between Scotch Cap and Sanak Islands, produced a Pacific-wide tsunami disproportionate to its zone of rupture. Approximately 30-40 seconds of shaking were reported at the U.S. Coast Guard Direction Finding station on Unimak Island, but the extensive property damage and loss of life associated with this event were a result of the associated tsunami not from the earth shaking. Houses and structures throughout the area were destroyed, including the Pankof and Scotch Cap lighthouses; the latter resulted in five deaths and a 100 foot high antenna was washed away. Hawaii experienced the worst damage from the tsunami, with 159 deaths (96 at Hilo) and $26 million in property loss (1946 dollars). Total property damage in Alaska was $250,000 (1946 dollars); while California experienced one death and $10,000 damage (1946 dollars) from the tsunami. These events led to the development of tsunami travel time charts for the Pacific and the Pacific Tsunami Warning Service (NGDC 2010).

All as reported in Workman (1997-2010): May 22, 1960, “Chilean quake sends tidal wave alert on Harbor’s coast”. And on May 23, 1960, the report continues, “Hawaii hit by tidal wave; series of two foot tidal waves at Tokeland.” Then on May 24, 1960, “Gigantic tidal waves batter Japan.”

The March 28, 1964, tsunami was felt strongly along the QIR shorelines where bridges were washed out, roads were made impassable from debris and seawater. “The Good Friday Alaska earthquake strikes. North Beach is hit by first tidal wave destroying Joe Creek and Copalis Beach bridge. (Great damage from waves at Crescent city and elsewhere along Oregon Coast where people, camping on beaches, were drowned” (Workman 1997-2010). The height of the run-up along the shore was highly variable with Wreck Creek and Moclips witnessing the highest waves locally at 11 feet and 15 feet respectively (Table 31). Slightly to the north of these shorelines, at Taholah, the run-up height was only 2.4 feet (Table 31).

Also reported in Workman (1997-2010): July 3, 1965, “Tidal wave alert causes thousands to flee beaches, but no tidal wave develops.” May 16, 1968, “Grays Harbor beaches evacuated in Tidal Wave Alert.” On September 26, 1976, “Two freak 15 foot waves hit harbor beaches causing damage.” May 7, 1986, “Tsunami fails to appear”. October 4, 1994, “Undersea earthquake off Japan sets off Tsunami warning here.”

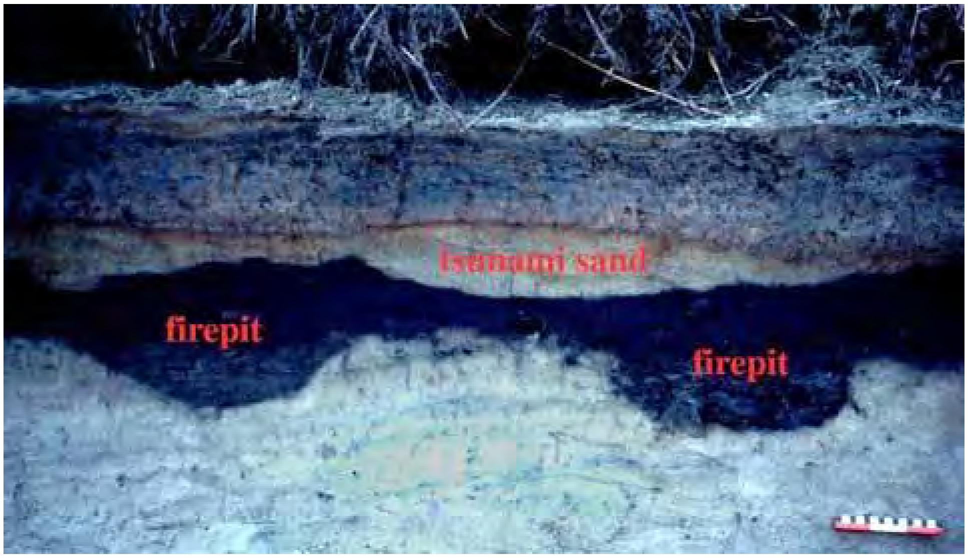
The Washington coastline has witnessed approximately 21 tsunami events from 1900 to present time (Table 31). Since the development of tsunami travel time charts for the Pacific and the Pacific Tsunami Warning Center’s development after 1964, the ability to track tsunami events in real time has increased the accuracy and reporting of these data. Tsunami events reported prior to 1964 rely mostly on printed records and reports concerning tsunami events and on scientific investigations to ascertain where tsunami events were initiated and where data indicate that tsunami run-ups were witnessed (often times using tsunami deposits as an indicator).

For instance, evidence of a CSZ earthquake on January 26, 1700, led to a Pacific Ocean basin-wide tsunami that traveled to impact Japan. Japanese written history pinpoints this event to the evening of January 26, 1700, when the tsunami began in the middle of the night and continued until the following evening. Its waves drove villagers to high ground, drowned rice paddies and crops, damaged their salt kilns and fishing shacks. It also destroyed dozens of buildings, including 20 houses consumed by a fire that was attributable to the flooding. High waves prevented a boat from entering the river-mouth port of Nakaminato. Lost were all the boat's cargo, including 28 metric tons of rice, and two crew members (Atwater 2005). These reports were collaborated with tsunami deposits around the Pacific Ocean basin.

Coastal field work in northern California, Oregon, Washington, and British Columbia has uncovered overwhelming evidence of the CSZ earthquake from 1700 (USGS 2009). The cause of the earthquake (or earthquakes) has been attributed to the sudden slip of the Pacific plate beneath the North America plate along the CSZ.

Some of the most convincing and best-preserved evidence of the earthquake(s) are sand layers that cover the peaty soils of coastal lowlands. This large tsunamis deposited seafloor derived sediment layers when it inundated the coasts bordering the fault zone. One of the series of tsunami surges that probably followed the 1700 CSZ earthquake picked up sand from the beach or dunes as it came ashore and deposited the sand as it moved up the river valley (Figure XLIV). At the site of the photo, the sand bed covers the remains of two fire pits dug by Native Americans, perhaps not long before the tsunami struck. The layers are well preserved partly because much of this part of the Oregon coast permanently subsided about 0.5-1.0 m (2-3 ft.) during the earthquake. The rise in sea level produced by the subsidence allowed tidal sediments to quickly bury the sand layers, protecting them from later erosion (USGS 2009).

Figure XLIV. This photo (USGS 2009) shows a sand layer in an exposure near the mouth of the Salmon River along the central Oregon coast about 8 km (5 mi) north of Lincoln City with tsunami delivered sand overtopping fire pits.



The 1700 tsunami has been linked with flooding that drowned entire forests along the Washington, Oregon, and British Columbia coastlines, and deposited sand on marshes and in lakes along the southern part of the CSZ coast. It is believed that a sand sheet at Discovery Bay in the Straights of Juan de Fuca also resulted from the CSZ generated 1700 tsunami (WSMD 2009, Atwater 2005).

Table 31. Tsunami Run up Events Recorded along the Washington Coastline from 1900 through 2010 (NGDC 2010).

Event Date	Event Magnitude	Source Location	Run-up Location	Distance From Source (miles)	Run-up Height in Feet
3/30/1904		CSZ at Victoria, British Columbia	GRAY'S BAY, WA		
3/30/1904		CSZ at Victoria, British Columbia	HOH RIVER, WA		
3/30/1904		CSZ at Victoria, British Columbia	QUEETS RIVER, WA		
3/30/1904		CSZ at Victoria, British Columbia	QUINAULT RIVER, WA		
3/30/1904		CSZ at Victoria, British Columbia	WISHKAH RIVER, WA		
4/1/1946	8.1	Unimak Island, Alaska	NEAH BAY, WA	1,696	0.49
4/1/1946	8.1	Unimak Island, Alaska	TAHOLAH, WA	1,741	4.92
3/4/1952	8.1	S.E. Hokkaido Island, Japan	NEAH BAY, WA	4,200	0.33
11/4/1952	9	Kamchatka, Russia	ABERDEEN, WA	3,275	
11/4/1952	9	Kamchatka, Russia	FRIDAY HARBOR, WA	3,242	0.20
11/4/1952	9	Kamchatka, Russia	NEAH BAY, WA	3,188	0.49
3/9/1957	8.6	Anfreanof Islands, Alaska	NEAH BAY, WA	2,237	0.49
5/22/1960	9.5	Central Chile	ECHO BAY, WA	6,778	
5/22/1960	9.5	Central Chile	FRIDAY HARBOR, WA	6,769	0.46
5/22/1960	9.5	Central Chile	GRAYS HARBOR, WA	6,708	0.98
5/22/1960	9.5	Central Chile	ILWACO, WA	6,672	
5/22/1960	9.5	Central Chile	NEAH BAY, WA	6,803	1.21
5/22/1960	9.5	Central Chile	TOKELAND, WA	6,693	2.00
3/28/1964	9.2	Prince William Sound, Alaska	ABERDEEN, WA	1,355	
3/28/1964	9.2	Prince William Sound, Alaska	BEAVER, WA	1,281	1.25
3/28/1964	9.2	Prince William Sound, Alaska	CAPE DISAPPOINTMENT, WA	1,389	5.71

Table 31. Tsunami Run up Events Recorded along the Washington Coastline from 1900 through 2010 (NGDC 2010).

Event Date	Event Magnitude	Source Location	Run-up Location	Distance From Source (miles)	Run-up Height in Feet
3/28/1964	9.2	Prince William Sound, Alaska	COPALIS, WA	1,343	
3/28/1964	9.2	Prince William Sound, Alaska	FRIDAY HARBOR, WA	1,292	1.15
3/28/1964	9.2	Prince William Sound, Alaska	GRAYS HARBOR, WA	1,351	4.86
3/28/1964	9.2	Prince William Sound, Alaska	HOH RIVER, WA	1,314	1.71
3/28/1964	9.2	Prince William Sound, Alaska	ILWACO, WA	1,388	4.59
3/28/1964	9.2	Prince William Sound, Alaska	JOE CREEK, WA	1,332	7.87
3/28/1964	9.2	Prince William Sound, Alaska	KALALOCH BEACH, WA	1,305	
3/28/1964	9.2	Prince William Sound, Alaska	LA PUSH, WA	1,281	3.51
3/28/1964	9.2	Prince William Sound, Alaska	MOCLIPS, WA	1,330	11.38
3/28/1964	9.2	Prince William Sound, Alaska	NEAH BAY, WA	1,256	2.69
3/28/1964	9.2	Prince William Sound, Alaska	OCEAN SHORES, WA	1,348	9.51
3/28/1964	9.2	Prince William Sound, Alaska	PACIFIC BEACH, WA	1,332	7.51
3/28/1964	9.2	Prince William Sound, Alaska	TAHOLAH, WA	1,320	2.40
3/28/1964	9.2	Prince William Sound, Alaska	WESTPORT, WA	1,351	
3/28/1964	9.2	Prince William Sound, Alaska	WRECK CREEK, WA	1,326	14.90
10/17/1966	8.1	Central Peru	NEAH BAY, WA	4,946	0.33
5/16/1968	8.2	Hokkaido Island, Japan	NEAH BAY, WA	4,286	0.33
5/7/1986	7.7	Anfreanof Islands, Alaska	NEAH BAY, WA	2,198	0.30
5/7/1986	7.7	Anfreanof Islands, Alaska	TOKE POINT, WA	2,275	0.16
5/7/1986	7.7	Anfreanof Islands, Alaska	WASHINGTON COAST		1.51
10/4/1994	8.1	Southern Kuril Islands, Russia	NEAH BAY, WA	3,993	0.13
10/4/1994	8.1	Southern Kuril Islands, Russia	TOKE POINT, WA	4,079	0.10
7/30/1995	8	Northern Chile	NEAH BAY, WA	5,984	0.10
12/3/1995	7.9	Southern Kuril Islands, Russia	NEAH BAY, WA	3,878	0.13
6/10/1996	7.9	Anfreanof Islands, Alaska	NEAH BAY, WA	2,315	
6/10/1996	7.9	Anfreanof Islands, Alaska	TOKE POINT, WA	2,394	
12/26/2004	9	Coast of northern Sumatra	NEAH BAY, WA	8,116	0.23
5/3/2006	8	Tonga	LA PUSH, WA	5,613	0.20
5/3/2006	8	Tonga	NEAH BAY, WA	5,636	
11/15/2006	8.3	Southern Kuril Islands, Russia	LA PUSH, WA	3,660	0.52
11/15/2006	8.3	Southern Kuril Islands, Russia	NEAH BAY, WA	3,644	0.30
11/15/2006	8.3	Southern Kuril Islands, Russia	WESTPORT, WA	3,718	0.16
1/13/2007	8.1	Southern Kuril Islands, Russia	LA PUSH, WA	3,623	0.43
1/13/2007	8.1	Southern Kuril Islands, Russia	NEAH BAY, WA	3,608	0.10
9/29/2009	8	American Samoa	LA PUSH, WA	5,266	0.56
9/29/2009	8	American Samoa	NEAH BAY, WA	5,288	0.13
9/29/2009	8	American Samoa	PORT ANGELES, WA	5,317	0.30
9/29/2009	8	American Samoa	WESTPORT, WA	5,238	0.26
10/7/2009	7.6	Chile	NEAH BAY, WA	5,962	0.10
2/27/2010	8.8	Chile	LA PUSH, WA	6,614	0.36

Based on geologic evidence and scientific interpretation, the CSZ has experienced major ruptures and created tsunamis at least 7 times in the past 3,500 years and has a considerable range in recurrence intervals, from as little as 140 years between events to more than 1,000 years. The last confirmed CSZ-related earthquake occurred in 1700 and researchers predict a 10 to 14% chance that another tsunami generating earthquake could occur in the next 50 years (Wood and Soulard 2008, WSMD 2009). Research on the QIR indicates that the communities of

Taholah and Queets are at the greatest risk exposure to tsunami waves. Taholah Ocean tracts and Wreck Creek area homes (along the shoreline) are most vulnerable with a 100% exposure to extensive damage from a 10’ high wave caused by a CSZ event. The village of Queets would face 100% damage exposure from a 20’ high wave caused by a CSZ event. All of SR109 between Moclips and Point Grenville, and again at Taholah faces severe compromise from a 10’ high wave caused by a CSZ event, while US101 at Queets faces similar damages at the Queets River crossing from a 15’ high tsunami wave caused by a CSZ event.

4.6.1. Tribal Legends

Tribal Legends of Tsunamis in the Pacific Northwest relate stories to describe earthquake effects: shaking, tsunamis, and subsidence. Native peoples have inhabited the Cascadia coast for many thousands of years and witnessed cycle after cycle of great earthquakes. Some stories are myths, others are historical.

One northern-California story describes a huge earthquake in which elders tell the young to run for high ground because of ensuing floodwaters. After spending a cold night in the hills, the young people return to find that all trace of their village has been washed away.

Other stories depict supernatural beings that caused the earthquake while at battle. Stories from the Hoh and Quileute Tribes describe an epic battle between the supernatural beings Thunderbird and Whale.

> "The great Thunderbird finally carried the weighty animal to its nest in the lofty mountains and there was the final and terrible contest fought. There was a shaking, jumping up and trembling of the earth beneath, and a rolling up of the great waters."

Thunderbird holding Whale is a prominent theme in Tribal art along the coastline of Oregon, Washington, and Vancouver Island, along the CSZ (Figure XLV). Stories of thunderbird and whale are associated with shaking and tsunami. The Nootka memorial was erected in 1902-1903 to honor Chief Moqwinna (Mowachaht/Muchalaht First Nations in Canada, a member nation of the Nuu-chah-nulth Tribal Council). The memorial depicts the thunderbird and the whale in front of Conuma Peak (Vancouver Island), a snow-capped peak on which the thunderbird dwelt in one version of the thunderbird and whale legend (Ludwin 2002) (Figure XLV). Other depictions of the epic battles have been reproduced and are part of the local culture’s lore. At the Ocean Crest Resort in Moclips, Washington, (adjacent to, and south of, the QIR), a wooden carving hangs in the swimming pool of the recreation center (signed by Judy McVay ’83) illustrating the Thunderbird and Whale legend (Figure XLV).

4.6.1.1. Quileute Legend of a Great Tsunami

(Curtis 1913)

The Quileute possess a fragmentary deluge legend. Taken with the fact that no such story is found in the lore of the Salish Tribes, this seems to indicate that it came to the Quileute from the Makah. According to the tale the people began to notice that when the sun neared the western horizon it passed behind something that extended as far as the eye could reach, like an opaque wall, and the sun was hidden. What this was they did not know. It proved to be a great wall of water coming in from the ocean, and it swept toward the land. The people got into canoes with their possessions, and bound the craft together as if they were making ready to tow them in a long line. The lead line they fastened to the top of a tall tree, just as the earth was being covered with the water. The flood constantly rose, but there was no current. A portion of the line of canoes broke loose from the others, and when the waters began to subside it settled back to the ground far away. The others, still moored to the tree, came to the ground at the place from which they had started, that is, at the mouth of the Quileute River. Thus it was that the people were separated into two tribes with one language.

Figure XLV. Thunderbird and Whale shown in their epic battle by Judy McVay (left), and at the Nootka Memorial (right).

A Hoh version of the Thunderbird and Whale legend was transcribed (Reagan 1934) to explain the epic battle leading to much of the region's geologic formations (Forks prairie, Quileute prairie, Little prairie, Beaver prairie, Tyee prairie) and the episodes of tsunami along the Pacific Ocean shoreline where the Hoh and Quileute Indians lived.

4.6.1.2. A Hoh Version of the Thunderbird Legend

This legend is accounted in Reagan (1934) and presented by Ludwin (2002).

> "Recall the Forks prairie, Quileute prairie, Little prairie, Beaver prairie, Tyee prairie and all the other prairies of our country. These are the places where the great, elder thunderbird had terrible battles with the killer whale of the deep.
>
> "This whale was a monster destroyer of the whales that furnished oil to the children of men. It slaughtered the oil producing whales till none could be obtained for meat and oil. What were the people to do? There was no oil to drink and dip their bread and dried berries in. What were they to do! Were they to starve!
>
> "Thunderbird saw their plight and soared from her nest in yonder dark hole in the mountains. She soared far out over the placid waters and there poised herself high up in the air and waited for the "killer" to come to the surface of the water as it chased its fleeing prey. It came and as quick as a flash, the powerful bird darted and seized it in her flinty talons. Then above the watery surface she lifted it and with great effort soared away toward the land areas.
>
> "Passing beyond the oceans with her ponderous load, she, tiring, was compelled to alight and rest her wings; and each and every time the bulky beast was allowed to reach solid land there was a terrible battle; for it was powerful and fought for its life with terrible energy. In addition, each time they fought in desperate encounter, they tore all the trees up by the roots and since that time no trees have grown upon these places to this day; they have been prairies ever since. Furthermore, the great thunderbird finally carried the weighty animal to its nest in the lofty mountains, and there was the final and terrible contest fought. Here in this death struggle, they uprooted all the trees for many miles around the nest and also pulled the rocks down the great Hoh valley. Since then there has been no timber on the up-country; and the heap of debris they pulled down that valley is known as the bench; (the last terminal moraine of the Olympic glacier). Thunderbird, however, finally triumphed. It killed the beast and tore its great and mighty body to pieces; and, then, finding that it was not good to eat, it hurled the pieces from its nest in all directions, where the respective pieces turned to stone under the curse of the enraged bird. You can see them there now. They are the projecting points and rocky ridges of that high region. Before that time that section was practically level. Now you know what a broken-up rocky place it is.

"That is not all. Killer whale had a son, called Subbus. So after thunderbird had killed the parent whale, it set out to capture and destroy this beast also.

"This young monster was much smaller than its father, smaller on account of its not being fully developed. Nevertheless, it was more agile and wary. Consequently it took days and days of hovering over the sea before the bird of the upper sky could drop down upon it and seize it in its talons. But the unfortunate day came to it also, as it had to the parent, "killer." It was chasing a school of sperm whales and was just in the act of making an onslaught on the largest fellow of the school when there was a rustling noise and then before it could dive to the lower depths of the watery ways, it felt itself being lifted into the air, as at the same time it felt the excruciating pain caused by the huge claws of the bird being sunk deep into its body. It fought, but it was no match for its adversary.

"High into the air the bird carried it over the land, finally dropping it to the land surface at Beaver prairie. Then at this place there was another great battle. Subbus was at length killed and his body torn to pieces; Moreover, its huge body damned the original channel of the Soleduck river and caused it to make the big bend to the southwestward at that place. And the huge pieces of blubber, now stone, cover the ground in the direction of its longitudinal extension. (This is a lateral moraine of the Selkirk-Mt. Baker glacier that crosses the region here--Reagan.) You can see the line of rock (boulder train) there at any time.

"My father (father of the medicine man who related this story to the writer) also told me that following the killing of this destroyer of the food-animals of mankind, there was a great storm and hail and flashes of lightning in the darkened, blackened sky and a great and crashing "thunder-noise" everywhere. He further stated that there were also a shaking, jumping up and trembling of the earth beneath, and a rolling up of the great waters."

4.6.2. Relating Tsunami to Earthquake Events

Tsunami-causing quakes usually occur where shards of the earth's crust, tectonic plates, meet. Magma rises from deep inside the earth, causing the plates to move. They slip-slide past each other, sometimes get stuck, then jerk forward again, producing a quake. Subduction zone earthquakes occur along the interface between tectonic plates. Scientists have found evidence of great-magnitude earthquakes along the CSZ. These earthquakes are very powerful, with a magnitude of 8 or 9 or greater. This type of earthquake occurs at intervals between every 100 to 1,100 years. The last of these greatest earthquakes struck Washington in 1700. Scientists currently estimate that a magnitude 9 earthquake in the CSZ occurs about once every 350 to 500 years (WSMD 2009).

Because tsunami events move such a large amount of water, certain tsunamis, known as deep-water tsunamis, can traverse an entire ocean basin in less than 24 hours such as the Chile earthquake on February 27, 2010, did as it reached the Washington Coastline within 14 hours and Japan within 24 hours. The 2004 tsunami created by the Chile earthquake was in this category as well. These waves hit a coast like a rapid, powerful tide. Most tsunamis strike in a group of three to 10 waves, separated by troughs.

Tsunamis are ocean waves produced by earthquakes or underwater landslides. The word is Japanese and means "harbor wave," because of the devastating effects these waves have had on low-lying Japanese coastal communities. Tsunamis are often incorrectly referred to as tidal waves, but a tsunami is actually a series of waves that can travel at speeds averaging 450 (and up to 600) miles per hour in the open ocean (NOAA 2010).

In the past century, several damaging tsunamis have struck the Pacific Northwest coast, from southern British Columbia to northern California. All of these tsunamis were distant tsunamis generated from earthquakes located far across the Pacific basin and are distinguished from tsunamis generated by earthquakes near the coast, termed local tsunamis (USGS 2010).

In the open ocean, tsunamis would not be felt by ships because the wavelength would be hundreds of miles long, with an amplitude of only a few feet. This would also make them unnoticeable from the air. As the waves approach the coast, their speed decreases and their amplitude increases. Unusual wave heights have been known to be over 100 feet high. However, waves that are between 5 and 20 feet high are more common and can be very destructive and cause many deaths or injuries (NOAA 2010).

From an initial tsunami generating source area, waves travel outward in all directions much like the ripples caused by throwing a rock into a pond. As these waves approach coastal areas, the time between successive wave crests varies from 5 to 90 minutes. The first wave is usually not the largest in the series of waves, nor is it the most significant. Furthermore, one coastal community may experience no damaging waves while another, not that far away, may experience destructive, deadly waves. Depending on a number of factors, some low-lying areas could experience severe inland inundation of water and debris of more than 1,000 feet.

On the Washington Pacific coast, people and property are at risk both from distantly and locally generated tsunamis (Table 31). Recent studies indicate that about a dozen very large earthquakes (with magnitudes of 8 or more) have occurred in the CSZ west of Washington. Computer models indicate that tsunami waves generated by these local events might range from 5 to 55 feet in height and could affect the entire coastal region (WDNR 2010).

4.6.3. Close-in and Far-Out Tsunami

From the perspective of the QIR, a close-in Tsunami can be generated along the CSZ. Tsunami generated from Alaska, Chile, Russia, and Japan are all considered far-out tsunami. The differences in the actual impact of the tsunami can be substantial.

4.6.3.1. Close-in Tsunami

A CSZ tsunami can be expected to combine the complications of a major, deep-seated earthquake shaking homes, compromising infrastructure, felling trees, and causing widespread and immediate panic. This scenario is combined with the potential for a forceful tsunami to be formed and directed at the coastline. In this event, the warning period before the impact of the tsunami wave might be only minutes (less than 5 to 15 minutes). These tsunami types are the biggest concern to the people of the QIR and all of the northwest Pacific Ocean shoreline. In the CSZ there is a 10% to 14% chance of a magnitude 9.0 earthquake and tsunami in the next 50 years (CREW 2005). Other estimates have put this probability at 27% for this portion of the CSZ (Goldfinger 2010).

4.6.3.2. Far-out Tsunami

The far-out tsunami scenario has been witnessed at least 21 times since 1900, with the most recent happening on February 27, 2010 (Chile). These tsunamis generally take hours to move to the Washington coastlines, but the force can be substantial. Two distinct vectors of approach have been witnessed along the QIR coastline. The first vector of approach example came from Prince William Sound in Alaska in 1964. The epicenter of the earthquake was relatively close to the northern edge of a long and fairly straight continental shelf. When the tsunami wave was generated, the base of the wave travelled along the undersea ridges, expanding as it moved away from the epicenter. Off the coastal shelf of North America the relatively shallow ocean floor drops abruptly to deeper sea topography. The CSZ is located at the base of this deep sea shelf (Figure XLVI). Although the tsunami wave moves with extreme force, the shape of this deep sea shelf serves to keep the energy of the wave diverted from the British Columbia and Washington shorelines: the energy is mostly diverted southerly and westerly.

This off shore shelf serves that purpose until it encounters a feature called the Taholah Trench. The apex of this undersea trench is located approximately 25 miles west of the village of Taholah and opens widely as it nears the CSZ. When the tsunami wave, spreading from a near-continent epicenter, encounters the Taholah trench it comes into contact with a westward jetting ridgeline perpendicular to the direction of the wave. This has caused the wave to divert, compress, and flush eastward in the direction of the coastline. This is where the energy is forced in the direction of Point Grenville, Wreck Creek, Moclips, and other communities south of there. That helps to explain why Taholah received a tsunami wave of only 2.4 feet while Wreck Creek was hit with a nearly 15 foot wave height and Moclips received 11.4 feet from the Prince William Sound earthquake (Table 31).

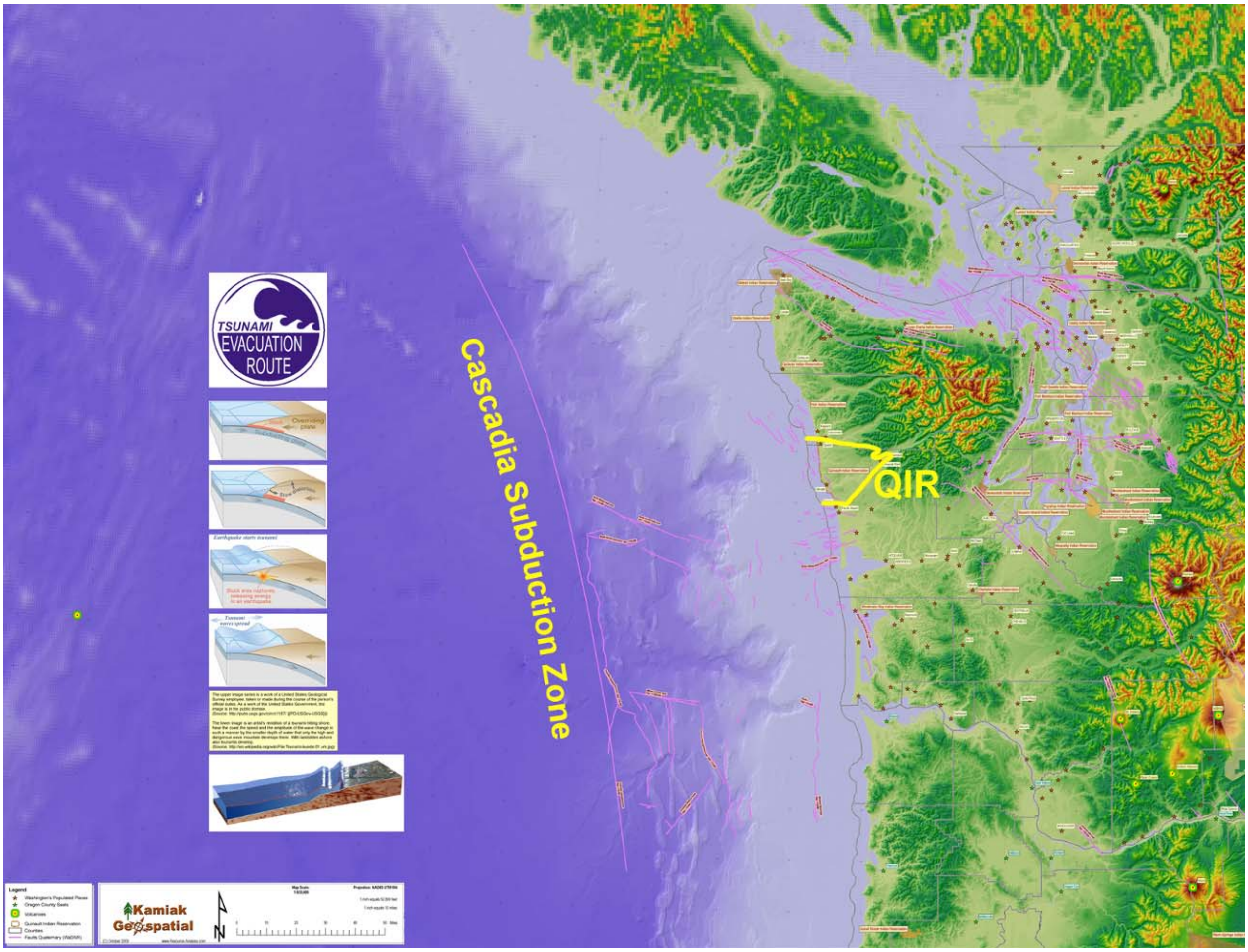
A similar example can be drawn from the Chile earthquakes and resulting tsunamis. The epicenters from those earthquakes are also located along the edge of the continent and the shorelines serve to divert the tsunami wave's energy away from the Washington coastline. It is because of this "tight angle of approach" that these tsunami have less impact on the Washington Coastline, while the energy delivered to Hawaii and Japan were directed from a much more perpendicular approach.

The second vector of approach example can be demonstrated by the 1946 Unimak Island, Alaska, earthquake and tsunami. During the early morning of April 1, 1946, an earthquake of magnitude 7.4 occurred in an area of the Aleutian Trench located approximately 90 miles south of Unimak Island, part of the Aleutian Island chain (Table 31). During the quake, a large section of seafloor was uplifted along the fault where the quake occurred, producing a large, Pacific-wide tectonic tsunami.

The effects of the tsunami were felt along the QIR shorelines. The community of Taholah was struck by an approximate five-foot surge, which damaged several boats (Table 31). Coo's Bay, Oregon reported a ten-foot wave. In California, Fort Bragg reported five- to nine-foot waves, and a 13.5-foot wave hit Muir Beach. The 1946 Aleutian Tsunami crossed the Pacific, producing waves up to 30 feet high in some locations at the Marquesas Islands in French Polynesia, and even had the power to damage fishing boats in Chile.

The difference between this example and the 1964 example has to do with the angle of approach to the Washington coastline. Unimak Island is located on a nearly perpendicular aspect to the QIR. Because of this open seafloor approach to the coastline, the topography of the undersea floor served to lift the tsunami wave as it approached the shoreline, instead of diverting it.

Figure XLVI. Cascadia Subduction Zone offshore of the Quinault Indian Reservation.



4.6.4. Exposure of QIR to Tsunami

The Pacific Ocean is an eternal source of life for the QIN. The ocean pulses with an endless rhythm of aquatic life, fills the air with its cool salty breath, and its vast power is tamed only by the inevitable shoreline. The ocean also carries risks to the people of the QIR. When earthquakes happen anywhere within the Pacific Rim, from Alaska to Chile, or Russia to Indonesia, there is a potential for a tsunami wave to be created. Its energy can be massive, taking thousands of travel miles to dissipate. The shorelines are the only “terminal” way these powerful waves can be dispelled.

Not all earthquakes cause a tsunami to be generated. On October 21, 2009, an earthquake with a magnitude of 4.0 struck the Oregon coast about 130 miles west of Coos Bay. Two days later, and within hours of a Papua, Indonesia, earthquake happening at the same time, another earthquake struck off the Oregon coast, at a depth of 6.2 miles with a magnitude of 4.1. None of these recent earthquakes generated a tsunami wave.

4.6.4.1. Factors Influencing a Tsunami Wave’s impact on the QIR Coast

Tsunami waves are generated by seismic activity, the depth of the ocean above the seismic event, the shape of the ocean floor the wave travels over, and the ability of wave energy to dissipate as it travels. Tsunami waves are generated along a subduction zone when one tectonic plate is abruptly snapped above an adjoining plate displacing a vast amount of overlying water in the process. Subduction zone related earthquakes generate the majority of all tsunamis.

The movement of the Juan de Fuca Plate under the North American Plate is not smooth. It is a forceful, jerky, and energy-packed process. When the plates do snap, one over the other, the result is a moderately shallow earthquake that causes a vertical displacement of the water column over the seismic activity.

4.6.4.2. The Cause for Concern about Cascadia Earthquakes

In less than 50 years, a number of great Cascadia-like earthquakes have occurred around the Pacific Rim, including Chile (1960 & 2010), Alaska (1946 & 1964), and Mexico (1985). The focus on a CSZ is due to the proximity of the fault line to the QIR shoreline (Figure XLVI). Located less than 90 miles to the west, and potentially generating a tsunami capable of moving at a water travel speed of over 450 miles per hour, a wave could impact the coastline in less than 15 minutes of the earthquake. That leaves little time to respond.

CREW, working with the Washington State Department of Natural Resources, has estimated the impact of a magnitude 9.1 Cascadia earthquake to the Washington coastline from the Columbia River to Neah Bay. These predictions estimate a tsunami wave of as much as 25 feet high impacting the shoreline of the Quinault Indian Reservation. This size of a tsunami will be larger than anything seen locally in recent memory, and it would arrive within minutes of the earthquake that causes it.

4.6.4.3. Predicting Impact Areas within the QIR

Building the Tsunami risk inundation and prediction profile for the QIR utilized several different environmental datasets. The profile is highly variable and impacted by several factors including the location of the tsunami generating earthquake and the angle of approach of the wave to the shoreline (Figure XLVIII).

By combining these factors, the predictions of potential tsunami risk during a magnitude 9.1 CSZ event were made. The form of the predictive model developed by Kamiak Ridge scientists is presented in Figure XLVII.

Figure XLVII. Mathematical Tsunami Inundation Prediction Model from a M9.1 CSZ Earthquake.

TSUNAMI_R = *ln* (100 - {0.10 * [FDG_Factor] * [SLOPE_Deg]} – {0.10 * [VEG_Factor]} – { *ln*([DEM] + 1) * ([DEM] + 1] * 1.25 }] * 21.72

Where:

- TSUNAMI_R = Tsunami Risk Impact of a CSV tsunami wave hitting the coastline
- *ln* Is the natural algorithm of the result
- FDG_Factor is the categorical adjustment to the Surface Flow Direction Grid (GIS)
- SLOPE_Deg is the slope of the ground surface in degrees
- VEG_Factor is a value assigned to vegetation in reference its ability to slow wave velocity
- DEM is the digital elevation model measured in meters of elevation

Using information provided by researchers from around the globe, Kamiak Ridge, has generated a prediction of the on-shore inundation within the QIR. These data utilize:

- Elevation Models (on-land and off-shore),
- Slope
- Direction of surface water flow
- Elevation
- Vegetation Cover
- Predicted Flood Zones
- Distance from Shore
- Height of the Tsunami Wave

Figure XLVIII. Prediction of CSZ M9.1 Earthquake Creating Tsunami Wave (to the right).

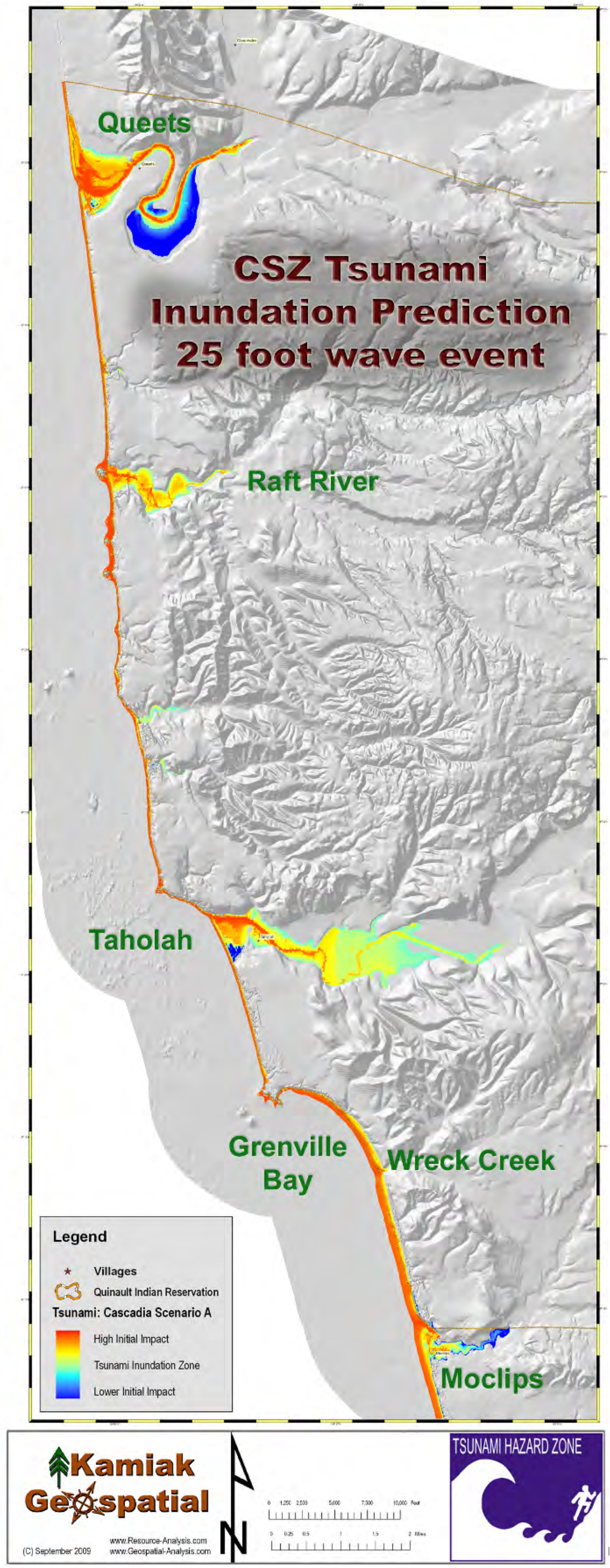


Figure XLVIII shows hot colors (red and orange) where the impact will be seen as fast moving and forceful waters, deep and immediate water accumulations, and lingering waters. Cooler colors (blues and greens) show where the initial impact is predicted to be slower velocity waters, but deep accumulations often augmented by flood water.

The secondary impact of this tsunami scenario will be seen mostly in Queets, Taholah, Point Grenville, and Moclips as these areas form the terminal locations of major river drainages and human habitation. When tsunami waves cross the shoreline, they are predicted to travel up river channels causing immediate flood-like water accumulations aggravated by additional secondary tsunami waves. In addition, the waters normally flowing down the rivers will spill over the floodplain to cover areas well in excess of normal flood water predictions.

Tsunami waves generally create high-velocity surges that also rip trees out of the ground. As this debris accumulates and jams against natural barriers and other obstacles (such as destroyed bridges), debris dams may be formed causing even wider-scale flooding.

The initial 25-foot high tsunami wave may result within hours in excessive flooding over 35 feet deep near the major river drainages. These waters will ultimately drain, but considerable damage will be done in the process.

4.6.4.4. Preparations

Taholah is a participant in the TsunamiReady program and has a tsunami warning siren mounted and operational to inform people of an impending tsunami. Tsunami warnings are tested monthly, signage shows the route for evacuation (to higher ground), weather spotter training activities are ongoing (Figure XLIX), and all-weather posters are standing at the community park near the Taholah Community Center. On February 27, 2010, when the Chile earthquake struck, a tsunami warning was issued for the Washington Coastline. The QIN EMS Coordinator activated the EOC, sounded the tsunami warning siren, cleared the beaches from Moclips to Taholah, and put the residents on alert. When the tsunami waves appeared, they were minor, less than 1.0 foot, but the preparedness system was effective and preparations worked.

Figure XLIX. TsunamiReady Activities to Prepare Emergency Responders to Tsunami.

Residents are directed to travel up the hill out of the lower village to where the Tribal Center buildings are located (at nearly 100’ elevation). This area is out of the tsunami impact area and the trail from the Taholah High School leads directly to the “safe place”. Residents are warned not to flee the area in vehicles. Most of SR109 crosses low elevation areas where tsunami waves can wash out the road and any vehicle on it. Traffic jams will only cause the problem to be worse.

Taholah ushers the Quinault River to its termination in the Pacific Ocean. This majestic river maintains a long and wide river basin where high waters accumulate. A CSZ earthquake could very easily push initial tsunami waters as far as 7 river miles inland. Secondary impacts may see flood waters in the Quinault River accumulating as far inland as 15 river miles.

Other primary impacts may see extensive destruction to the village of Taholah. A tsunami wave in excess of 5 feet will easily crest the floodwall of debris and earthen breakwater. At 10 feet high a powerful tsunami wave could destroy homes, buildings, and infrastructure in the village. Even the SR109 bridge crossing the Quinault River is at risk to damage or destruction from a powerful tsunami wave.

Moclips, located south of, and adjacent to the QIR, is located where past tsunami events have witnessed larger waves than other areas in the region. In 1964, the Great Alaskan Earthquake produced a tsunami wave of 2.4 feet in Taholah, and a 11.4 foot tsunami wave in Moclips. At the terminus of the Moclips River the wave would be expected to travel up-river ripping out the SR109 bridge crossing. Homes, businesses, and other buildings located below 25 foot elevation will be expected to be hit the hardest by a CSZ tsunami.

Queets village is located at a slightly higher elevation than either Moclips or Taholah. The homes and most structures in Queets may not be directly impacted by a 20-foot tall tsunami wave, but the 25-foot wave would enter the lower elevation edges of the village. Secondary impacts from flood waters will cause flooding upstream of the village. There is a potential that flood waters could reach the village if more than one tsunami wave hits the shoreline (as is expected), or if the tsunami happens during an otherwise high-water or flood event.

The US101 bridge at Queets could suffer substantial damage from a powerful tsunami wave reaching heights of 25 feet and more. Fortunately, the bridge is over 1 mile from the shoreline, and the approach is not straight-line. The bridge is of a construction style and span that would pose problems to the bridge from the combination of an earthquake and high-velocity tsunami wave.

When a tsunami warning is issued for the region, the inhabitants of Queets are advised to evacuate to the south along US101. They are cautioned not to cross the US101 bridge as this piece of infrastructure should not be relied on during a combined earthquake and tsunami event. Only after it has been cleared, will it be safe to cross.

Other homes along the Pacific Ocean shoreline are located in very precarious locations. Many of these buildings are barely above sea level. Each resident of this area should identify "high ground" and flee to it when a tsunami warning is issued. There is little that can be done to save these homes, but with education and clearly identified escape routes, the residents of these areas have a chance of being spared.

The best preparation against tsunami losses along the ocean shorelines would be to limit develop of shoreline areas. The warning – do not develop here – is equally applied to low elevation homes and business structures as to those that are positioned at the crest of the shoreline cliffs. These elevated locations are susceptible to landslides and displacement during and after major earthquake events and when tsunami waves erode the toe of the cliffs these structures are situated at the top of.

4.7. Landslides & Mass Wasting

From "Land of the Quinault", Storm *et al.* (1990):

> "Nature can wreak havoc on its sea creatures as much as man and at times even more than man. For example, in 1934 in the upper Quinault Valley during the peak of spawning season, three giant landslides tumbled into the river and its feeder creeks. They covered spawners and redds (new [salmon egg] nests) and moved silt downstream to smother more redds, effectively erasing an entire year's run."

A landslide is a geological phenomenon that includes a wide range of ground movement such as rock falls, deep failure of slopes, and shallow debris flows. Although the action of gravity is the primary driving force for a landslide to occur, there are other contributing factors affecting the original slope stability. Typically, pre-conditional factors build up specific sub-surface conditions that make a slope prone to failure, although the actual landslide often requires a trigger before being released.

The term "landslide" covers a variety of processes and landforms known as rockslide, rockfall, debris flow, liquefaction, slump, earthflow, and mudflow. The Washington DNR and QDNR have identified and plotted 237 landslides on the QIR (Table 33). Landslides are a recurrent menace to waterways, highways, shorelines, and a threat to homes, schools, businesses, and other facilities.

Landslides may be triggered by other natural hazards such as earthquakes and floods (discussed earlier in this document). Weather and climate factors such as melting snow and rain that increase the water content of earth materials may fuel slope instability. The activities of urban and rural living with excavations, roads, drainage ways, landscape watering, and logging may also disturb the stability of landforms.

In addition to terra-based events, offshore landslides can and do occur along the continental shelf in the Pacific Ocean. Larry Workman (2010-03) provided a probable account of one such event:

> "When waking on the beach near Duck Creek late in the 1970s, the ocean was near low tide. Suddenly a set of two waves chased us clear up onto the banks. There was no

recorded earthquakes or anything in the news about it. I think it could have been rogue waves or waves generated by a submerged landslide which affect a localized area. In my reading and watching documentary programs, it seems that if a large slide occurred in or around the Quinault Canyon, we could experience a sizable wave with little or no warning."

Landslides can be costly. One nightmare for the QIR is maintaining major travel routes such as SR109 and US101. Redirecting local and through traffic around a landslide is not an option in many places. Alternative routes often do not exist, and detours in steep terrain are difficult or impossible to construct. The unimpeded movement over roads, whether for commerce, public utilities, school, emergencies, or police, is essential to a normally functioning society. The disruption and dislocation caused by landslides can quickly jeopardize that freedom and vital services.

Landslide appears to be a permanent hazard along SR109 between Moclips and Taholah (Figure L). This two-lane road is the primary access route for travel between Moclips and Taholah. Several QIR homes are accessed along this route including all QIN government facilities located in Taholah. This particular stretch of the road climbs from the ocean shoreline to the top of the Point Grenville formation in the route to Taholah. The Moclips to Taholah road construction was first completed in December 1927. In January 1928, 30 Tribal crew members worked to clear a big slide blocking that road. In 1931, another landslide halted all traffic along this route. Gravel was added to the road in 1931 and the Tribe widened the road in 1933 (Table 16).

Figure L. A long-term fixture along SR109 near Point Grenville at Swede Hill.

SR109 was then rebuilt by the BIA in 1939 (Table 16). The road was paved by the BIA in 1957 and turned over to the Washington State Department of Transportation for maintenance (Table 16). At approximately the same time (1957) the Wreck Creek Bridge was rebuilt.

Personal accounts (Workman 2010-03) describe that in 1974 SR109 was basically a one lane road with the outside lane frequently sinking or sliding down slope. The Washington State Department of Transportation addressed this problem by tearing out the road and "it seems they filled the area with cedar chips then soil and then built the road on top of that".

Today, SR109 at Swede Hill near Point Grenville shows the signs of "layered pavement" that has sloughed down the hillside through successive shallow undifferentiated landslides. After failure, the roadway has been rebuilt by stacking new fill over the top of the failed section of the highway. The road has inadequate drainage upslope of the slide area and only marginal vegetative stability (Figure LI).

Figure LI. Shallow Undifferentiated Landslide on the uphill side (northeastern side) of SR109 at Swede Hill.

Although this example of prolonged landslides along critical infrastructure is an isolated example, there are other illustrations of problematic landslide areas within the QIR.

Although the news media reporting on landslides was minimal in the region, there have been a few reports worth mentioning (Table 32). One reported in 1934 that landslides had negatively affected the salmon spawn on the Quinault River.

Table 32. Significant Landslide Related Events in and Around the QIR (Workman 1997-2010)

Date	Information
1904 April 15	Story about Quinault landslide grows in size as story spreads.
1904 December 23	Mr. Bilyeu the mail carrier, reports a bad landslide on the south side of Dan' mountain (Point Grenville) and blocks the road so he cannot pass with wagon.
1934 November 29	Three big slides on upper Quinault have reduced salmon egg survival.
1935 January 21	Gigantic landslide near Lake Quinault (see Section 4.7.1 below).
2007 March 24	Landslide blocks State 109 on Swede Hill (QIR) for nearly 15 hours.
2007 April 21	Long term solution sought for erosion above Lake Quinault on the Quinault River.

4.7.1. Personal Account of Landslides from 1935

Elizabeth Marston lived all her life in the big green woods of the Pacific Northwest. The book she wrote tells about her life in the area and the hardships the people encountered. It is a true story of the local people coming to terms with nature in their everyday survival. Mrs. Marston did not sell many books but give them away to friends and people who passed by the little café she owned. She lived along Highway 101, northwest of Amanda Park, about ¼ mile north of the current day QIR boundary.

In Chapter 17 of her book, she describes a winter event of heavy snowfall turning to torrential rain causing water levels to rise drastically and flooding the area, eventually causing a mudflow presumably along Milborne and Prairie Creeks. The time of the event was about 1935.

Extracts from Marston (1969):

> "A day or two after the beginning of the new year, the bleak winter rains turned to snow. Three and a half inches of the stuff piled up. The road grader went plowing up and down the main highway, making frantic attempts to keep the road open, and people everywhere were shoveling off paths and roofs.

“Then the weather changed as a Chinook wind blew up out of the southwest. It raced across the land, melting the snow from the mountains to join with the warm, soaking rains of the lowlands and valleys. Creeks and rivers were running bank full, some overflowing and endangering the weakening bridges. Slushy snow, well packed and heavy with water, had to be shoveled from drains and ditches. Sandbags were filled and placed to protect bridges and property.

“Going home we found the water had risen several inches, and we were forced to drive slowly through lake water that had backed over the low spots in the south shore road. Torrential rain was pouring down, the wind lashed the trees, and branches covered the ground.

“For a moment there was a lull; a vast stillness against the rain. Then a terrifying rumbling started, accompanied by increasing crashing and earth shaking vibrations. It sounded and felt like the whole side of the mountain had let go.

“What John said to those women (from California) about the mountain being up there for centuries wasn’t true. It has slid before. Your father told me a long time ago that there are different layers and formations to the ground, proving it. What will we do if it comes this way?

“The log jam was still holding against the standing timber at the foot of the mountain. How much more pressure it could take was to be seen. … Then it happened. The heavily saturated earth could hold no more. With a tremendous cracking, crashing, explosive roar, the mountain came down over the lowland.

“That night we all slept the sleep of total exhaustion. The worst had happened, and everybody was safe. But bright and early I got up and dressed, and went out to see the damage by daylight. Douglas met me on the porch, and together we looked on a sorry sight.

“The Behm’s cabin was still standing, but it had been moved about a hundred feet closer to the highway. A haystack and other debris were piled up against it. The barn was halfway standing, but both ends were gone, and so was the hay mow. Right in the middle of what had been the highway was the remains of the little service station. And all over, as far as we could see, the deep mud was littered with tubs, buckets, cans, fruit jars, and every other movable thing, sailing idly through and around the forest of shattered limbs and tree trunks.

“The next morning the rain had stopped, and the rumblings had ceased. Glenn Groseclose, the road supervisor, and his road crew were on the job. Joe Fulton, our district ranger, was there with his crew. Telephone connections to the Queets and Clearwater were broken, and Joe was making an effort to reestablish the communication lines. He had to get a line across that lake of juicy mud. A husky southern boy promptly said, “I’ll go.”

“I’ll give a dollar to the man who gets that line across,” Joe said.

“The boy did well at first, where the ground was more solid, but as the mud got deeper and softer, he had to slow down and watch his footwork to keep his balance on the slippery logs. Suddenly he came to a dead stop, looking for his next foothold, and in he went, mud up to his hips. To the laughter of the observers, he floundered free and took the wire the rest of the way across. Then he came back and collected his dollar.”

Canyons drain toward the network of river systems and cut through the underlying substrate. These substrate layers are interbedded with loose, unstable unconsolidated river deposits, and glacial debris deposits that are exposed in the incised river valleys. Exposure of these layers increases landslide potential wherever these deposits are present on steep slopes. Weathering and climatic events lead to landslide activity, with the scale of the event largely dependent on the environmental conditions leading up to the event. Roads and structures in any area within the Reservation where roads have cut through the substrate are at increased risk (Figure LII).

Figure LII. This landslide (Winter 1997/98) on the 7000 Road near Taholah along the Quinault River endangered the Taholah village's water system at Shale Slough (Workman 2009).

A detailed and comprehensive record of landslides in QIR has only recently been developed. Most of the landslides recalled in memory by local government officials and Planning Committee members have occurred along County or Forest Service roads and may in some cases be a result of road construction, timber harvest, or maintenance activities. A few re-occurring slide areas cause damage to the paved road surface and require cleanup of slide debris on a fairly regular basis – even annually or twice every three years.

4.7.2. Types of Landslides

Debris flow

Slope material that becomes saturated with water may develop into a debris flow or mud flow. The resulting slurry of rock and mud may pick up trees, houses, and cars, blocking bridges and tributaries, and causing flooding along its path. Debris flow is often mistaken for flash flood, but they are entirely different processes.

Muddy-debris flows in alpine areas cause severe damage to structures and infrastructure and often claim human lives. Muddy-debris flows can start as a result of slope-related factors, and shallow landslides can dam streambeds, resulting in temporary water blockage. As the impoundments fail, a "domino effect" may be created, with a remarkable growth in the volume of the flowing mass as it takes up the debris in the stream channel. The solid-liquid mixture can reach densities of up to 3,350 pounds per cubic yard and velocities of up to 46 feet per second (Luino 2004; Arattano and Marchi 2005).

These processes normally cause the first severe road interruptions, due not only to deposits accumulated on the road, but in some cases to the complete removal of bridges, roadways, or railways crossing the stream channel. Damage usually derives from a common underestimation of mud-debris flows. In high elevation valleys, for example, bridges are frequently destroyed by the impact force of the flow because their span is generally calculated to accommodate water discharge.

Earth flow

Earthflows are down slope, viscous flows of saturated, fine-grained materials, which move at any speed from slow to fast. Typically, they can move at speeds from 500 feet per hour to 15 miles per hour. Though these are a lot like mudflows, overall they are slower moving and are covered with solid material carried along by flow from within. Clay, fine sand and silt, and fine-grained, pyroclastic material are all susceptible to earthflows. The velocity of the earthflow is all dependent on how much water is contained in the flow itself. The greater the water content in the flow, the higher the velocity will be (Arattano and Marchi 2005).

These flows usually begin when the pore pressures in a fine-grained mass increase until enough of the weight of the material is supported by pore water to significantly decrease the internal shear strength of the material. This thereby creates a bulging lobe that advances with a slow, rolling motion. As these lobes spread out, drainage of the mass increases and the margins dry out, thereby lowering the overall velocity of the flow. This process causes the flow to thicken. The bulbous variety of earthflows is not that spectacular, but they are much more common than their rapid counterparts. This variety develops a sag at its head and is usually derived from slumping at the source.

Earthflows in QIR can occur during periods of high precipitation, which saturates the ground and adds water content to the slope. Fissures that develop during the movement of clay-like material allow the intrusion of water into the earthflows. Water then increases the pore-water pressure and reduces the shearing strength of the material (Easterbrook 1999).

Debris avalanche and debris slide

A debris avalanche is a type of slide characterized by the chaotic movement of rocks, soil, and debris mixed with water or ice (or both). They are usually triggered by the saturation of thickly vegetated slopes, resulting in an incoherent mixture of broken timber, smaller vegetation and other debris (Easterbrook 1999). Debris avalanches differ from debris slides because their movement is much more rapid. This is usually a result of lower cohesion or higher water content and generally steeper slopes.

Debris slides generally begin with large blocks that slump at the head of the slide and then break apart as they move towards the toe. This process is much slower than that of a debris avalanche. In a debris avalanche this progressive failure is very rapid and the entire mass seems to somewhat liquefy as it moves down the slope. This is caused by the combination of the excessive saturation of the material, and very steep slopes. As the mass moves down the slope it generally follows stream channels, leaving behind a V-shaped scar that spreads out downhill. This differs from the more U-shaped scar of a slump. Debris avalanches can also travel well past the foot of the slope due to their tremendous speed (Schuster and Krizek 1978).

Sturzstrom

A sturzstrom is a rare, poorly understood type of landslide, typically with a long run-out. Often very large, these slides are unusually mobile, flowing very far over a low angle, flat, or even slightly uphill terrain. They are suspected of "riding" on a blanket of pressurized air, thus reducing friction with the underlying surface.

Shallow landslide

A shallow landslide is common where the sliding surface is located within the soil mantle or on weathered bedrock (typically to a depth from a few feet to many yards). They usually include debris slides, debris flow, and failures of road-cut slopes. Landslides occurring as single large blocks of rock moving slowly down slope are sometimes called block glides.

Shallow landslides can often happen in areas that have slopes with highly permeable soils on top of low permeability bottom soils or hardpan. The low permeability bottom soils trap the water in the shallower, highly permeable soils, creating high water pressure in the top soils. As the top soils are filled with water and become heavy, slopes can become very unstable and material will slide over the low permeability bottom soils. This can happen in QIR where a slope with silt and sand as its top soil sits on top of bedrock. During an intense rainstorm, the bedrock will keep the rain trapped in the top soils of silt and sand. As the topsoil becomes saturated and heavy, it can start to slide over the bedrock and become a shallow landslide.

Deep-seated landslide

In deep-seated landslides the sliding surface is mostly deeply located below the maximum rooting depth of trees (typically to depths greater than 30 feet). Deep-seated landslides usually involve deep regolith, weathered rock, and/or bedrock and include large scale slope failure associated with translational, rotational, or complex movement.

4.7.3. Slope Stability

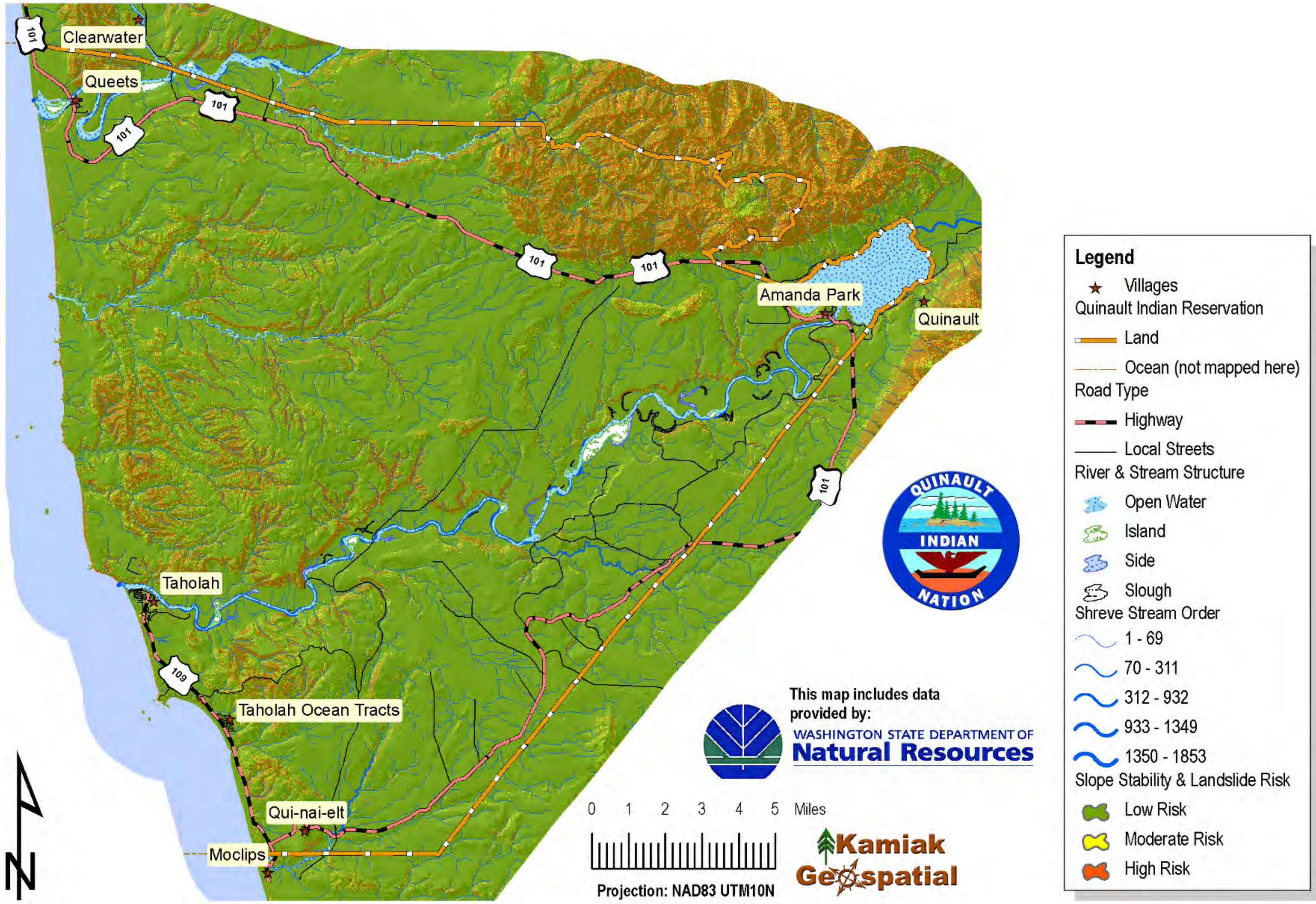
All of these landslide types can occur in QIR, although the sturzstrom variant is unlikely. The materials may move by falling, toppling, sliding, spreading, or flowing. Some landslides are rapid, occurring in seconds, whereas others may take hours, weeks, or even longer to develop. Although landslides usually occur on steep slopes, they also can occur in areas of low relief. Landslides can occur as ground failure of river bluffs, cut-and-fill failures that may accompany road construction and building excavations, collapse of mine-waste piles, and slope failures associated with quarries and open-pit mines.

The primary factors that increase landslide risk in QIR are slope and certain soil characteristics. In general, the potential for landslide occurrence intensifies as slope increases on all soil types and across a wide range of geological formations.

Soil factors that increase the potential for landslide are soils developed from parent materials high in schist and granite, and soils that are less permeable, containing a resistive or hardpan layer. These soils tend to exhibit higher landslide potential under saturated conditions than do well-drained soils. To identify the high-risk soils in QIR, the USDA Natural Resources Conservation Service (NRCS) State Soils Geographic Database (STATSGO) layer was used to identify the location and characteristics of all soils in the county. The specific characteristics of each major soil type within the county were reviewed for all of QIR.

Soils with very low permeability that characteristically have developed a hardpan layer or have developed from schist and granite parent material were selected as soils with potentially high landslide risk potential. High-risk soils magnify the effect of slope on landslide potential. Soils identified as having high potential landslide risk are further identified with increasing slopes corresponding to increasing landslide risk (Figure LIII).

Figure LIII. Slope Stability and Landslides Risk Map Predictions Within the QIR (WA DNR 2008).



These factors were combined with vegetation characteristics (type of land cover) and canopy cover (vegetation density). Through this analysis, it was determined that while an evergreen forest is a relatively stable site against landslides, it is less stable when on steep slopes and even more unstable where all vegetation has been removed (from logging or a wildfire, for example).

The features of the local topography are important to consider in terms of the potential to move under landslide forces. The top of an otherwise stable ridgeline is considered less prone to move than a similar combination of factors located lower on the hillside, or even near the bottom of the slope. In order to accommodate these factors, the amount of land surface located uphill of each site was factored into the risk profile for potential landslide occurrence.

The QIR has been evaluated for historical landslides identified by the QDNR and the Washington DNR to reveal the location of approximately 237 landslide events (Table 33). The most common landslide type on the QIR documented in this effort was the deep-seated landslide impacting 528.4 acres during 47 events. Another 108 events were cataloged as shallow undifferentiated slides impacting 68.2 acres. Approximately 57 debris flow events were recorded impacting a total of 92.3 acres (Table 33).

Table 33. Historical Landslide Events on the QIR (WA DNR 2008).

Landslide type	Number of Events	Area Impacted by Event
Debris Flow	57	92.3 acres
Debris Slide and Avalanches	22	29.2 acres
Deep-seated	47	528.4 acres
Deep-seated Earthflow	1	0.6 acres
Shallow Undifferentiated	108	68.2 acres
Unknown	2	0.3 acres

Across the entire QIR the assessment of slope stability conducted by the Washington DNR revealed a propensity of slope failure risks (Table 34 & Figure LIII). One potential use of the slope stability analysis is to make inferences about relative risk factors across large geographical regions for landslide risks. This analysis uses the extent and occurrence of past landslides as an indicator of characteristics for a specific area and its propensity to witness slope stability compromises in the future. Concisely, if a certain combination of soil types, vegetation cover type, canopy closure, aspect, and slope, have witnessed landslides with a high frequency in the past, then it is reasonable to extrapolate that they will have the same tendency in the future, unless mitigation activities are conducted to reduce this potential. In order to put these numbers in terms of probability of occurrence, the slope stability rating score can be modified to represent a probability of a landslide event occurring during a given period of time. The lower the slope stability rating score, the lower the probability of witnessing a landslide event in that area. Directly, the slope stability rating score can be converted to a probability by stating the relative score as a probability of occurrence within a 50-year period. Using the conversion defined by the Extreme Value Theory (Castillo 1988), the 50-year landslide probability event would be stated as the slope stability rating score converted to a percent. Thus, a slope stability rating score of 16-50% would represent a 16-50% probability of witnessing a 50-year landslide event. This conversion is intended for illustrative purposes only and the actual probability of occurrence may differ from these estimates.

Table 34. Slope Stability Assessment of QIR by WA DNR (2008).

Risk	Approximate Acres	Percent of Total Area
Low (0-15% probability)	185,669.8	89.2%
Moderate (16-50% probability)	8,326.0	4.0%
High (>50% probability)	14,154.2	6.8%

4.7.1. Probability of Future Events

Landslide frequency on the QIR has been recorded within this document, specifically in Table 32 and Table 33. Although not all landslides are “human induced” through anthropogenic alterations to the physical environment, several of the landslides of the QIR and surrounding areas occurred subsequent to forest management, road building, or other alterations of vegetation and geology.

Table 32 details 6 major landslide events that were seen within the last 100 years (one major event every 17 years). Table 33 provides details on 237 lesser impact landslides covering 719 acres of land within the QIR and spanning approximately 50 years (5 events each year). Past landslide frequency may represent a reasonable projection of future landslide recurrence. Those landslide events that were human induced can be reduced in frequency by implementing pre-activity mitigation measures. The 6 major landslide events detailed in Table 32 documents an event happening approximately once every 17 years. These events do not seem to carry the human-induced label of cause and their recurrence and would be expected into the future.

Road construction and human development induced landslides can be eliminated or drastically reduced when pre-construction mitigation measures are implemented consistently.

4.8. Expansive Soils and Expansive Clays

Expansive soils and expansive clays are substrates that are subject to large-scale settlement or expansion when wetted or partially dried (Bekey 1989). Expansive soils contain minerals such as smectite clays that are capable of absorbing water. When these soils absorb water they increase volume. The more water these soils absorb the more their volume increases. Expansions of ten percent or more are not uncommon. This change in volume can exert enough force on a building or other structure resting on top of them to cause damage (GES 2010).

Expansive soils such as clay, claystone, and shale can "swell" in volume when wetted and then shrink when dried (Bekey 1989). This volumetric expansion and contraction can cause houses and other structures to heave, settle, and shift unevenly, resulting in damage that is sometimes severe (PCI 2010). Cracks in building foundations, along floors and within basement walls are typical types of damage done by these swelling soils. Damage to the upper floors of the building can occur when motion in the structure is significant (GES 2010).

Expansive soils will also shrink when they dry out (Bekey 1989). This shrinkage can remove support from buildings or other structures and result in damaging subsidence. Fissures in the soil caused from differential expansion and contraction can also develop. These fissures can facilitate the deep penetration of water when moist conditions or runoff occurs. This produces a cycle of shrinkage and swelling that places repetitive stress on structures (PCI 2010).

When expansive soils are present they will generally not cause a problem if their water content remains constant. The situation where greatest damage occurs is when there are significant or repeated moisture content changes.

With significant real estate development in Washington state in the past 30 years, the problems caused by expansive soils have become painfully obvious. Many people have literally lost their homes due to extensive damage and the high costs of repair. In some cases, class action lawsuits have been brought against builders and/or developers for failure to follow the recommendations of soils engineers, or for failure to properly disclose the potential risks associated with purchasing a home built on expansive soil (PCI 2010), and from buyer and seller ignorance about the potential risks.

4.8.1. Extent of the Risk

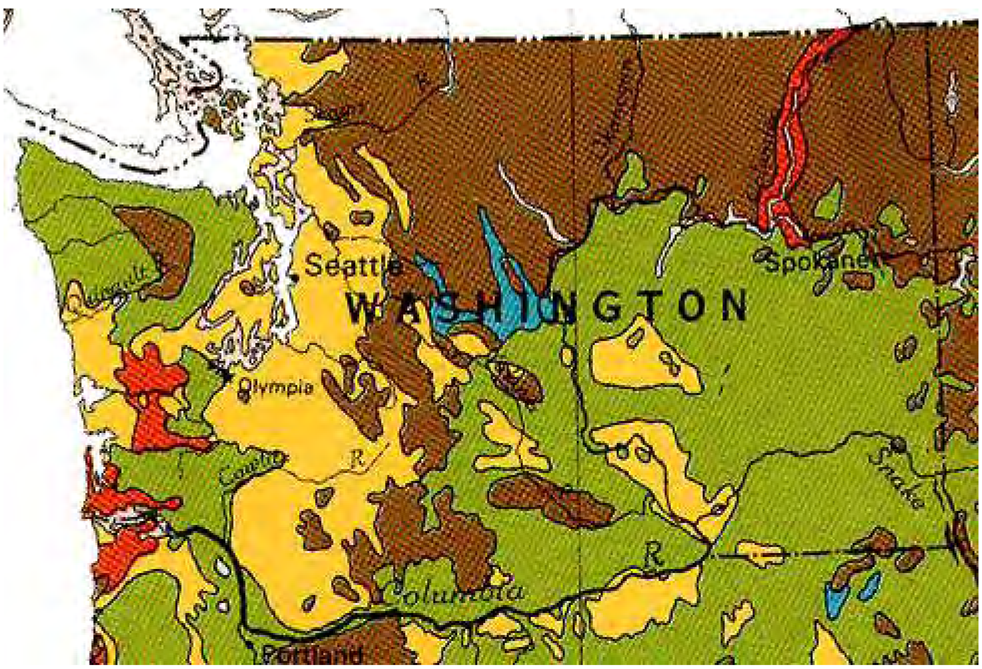
Expansive soils are present throughout the world and are known in every US state. Every year they cause billions of dollars in damage. The American Society of Civil Engineers estimates that

¼ of all homes in the United States have some damage caused by expansive soils (Snethen 1980). In a typical year in the United States they cause a greater financial loss to property owners than earthquakes, floods, hurricanes and tornadoes combined (GES 2010).

Even though expansive soils cause enormous amounts of damage most people have never heard of them. This is because their damage is done slowly and not generally attributed to a specific event. The damage done by expansive soils is often attributed to poor construction practices or a misconception that all buildings experience this type of damage as they age (GES 2010).

The State of Washington is at variable levels of risk to factors leading to damages from expansive soils and expansive clays (Bekey 1989). The QIR is in a coastal location where these factors have not been specifically determined in a wide area analysis. Between the QIR and Olympia, the highest risk categories in the USA have been identified (where the unit contains abundant clay having high swelling potential) (Figure LIV). The Villages of Taholah, Taholah Ocean Tracts, Qui-nai-elt, and Amanda Park are all within an undetermined zone in that analysis (Figure LIV). However, site inspections of houses, roads, and other infrastructure components reveals potential signs of prolonged damages consistent with expansive soils and expansive clays (cracked foundations, uneven road surfaces).

Figure LIV. Map of Washington Showing Swell Potential of Reactive Clay Soils (PCI 2010, reproduced using [USGS 1989] data).



- Unit contains abundant clay having high swelling potential
- Part of unit (generally less than 50%) consists of clay having high swelling potential
- Part of unit (generally less than 50%) consists of clay having slight to moderate swelling potential
- Unit contains little or no swelling clay
- Data insufficient to indicate clay content of unit and/or swelling potential of clay (Shown in westernmost states only)

Figure LIV shows the geographic distribution of clay soils which are known to have expandable characteristics with clay minerals that can cause damage to foundations and structures. It also includes soils that have a clay mineral composition which can potentially cause damage. Soils are composed of a variety of materials, most of which do not expand in the presence of moisture. However, a number of clay minerals are expansive. These include: smectite, bentonite, montmorillonite, beidellite, vermiculite, attapulgite, nontronite, illite and chlorite. There are also some sulfate salts that will expand with changes in temperature and moisture. When a soil contains a large amount of expansive minerals it has the potential of significant expansion. When the soil contains very little expansive minerals it has little expansive potential (PCI 2010).

Bekey (1989) reported four general soil types, beyond just the clay influenced types, within Washington State that are most prone to expansive soils characteristics:

1. Loess – wind-deposited or eolian silt, termed loess, blankets extensive parts of Eastern Washington and is not found within the QIR.
2. Peat – a very common surface and sub-surface material identified in 28 out of Washington's 39 counties. These substrate materials are common to the Pacific Ocean coastline and within the QIR specifically. Because of the physical properties of peat, any compression loading on peat results in settlement at the surface. In normal events, roughly half of the settlement occurs within 6 months to 2 years following construction. The balance of the settlement compaction can take an additional 20 years to be fully seen. Unfortunately, the rate of settlement is not consistent as expansion and contraction will neither be equal nor constant. A common technique used to manage construction of roads and structures on the top of peat materials has been to overtop the material with a fill dirt. When this has been applied, the high organic matter peat has been trapped under the less permeable layer leading, in many cases, to a bearing capacity failure. Other attempts have combined peat capping with an overtopping layer of rock. Many of these approaches have been met with variable levels of success. Construction within or adjacent to many of the meadows of the QIR face challenges of peat-related expansive soils.
3. Hydrocompaction – Hydrocompaction occurs when a dry, underconsolidated silty and clayey soil, in an arid or semiarid environment, loses strength on wetting and, as a result, settles or collapses. Although these soil types (silty and clayey soil) are not uncommon on the QIR, the physical conditions of arid or semiarid are not common.
4. Expansive Clay Soils – Expansive clay soils develop at the top of deeply weathered rocks composed on illite and montmorillonite clays. These clay types are common where volcanic ash and feldspar-rich parent materials are seen. Although these conditions are witnessed across the region, the past glaciation from the Olympic Mountains has transported most of the potentially expansive weathered soil away from its point of origin. Unfortunately, the glaciation that removed the top layer of materials, deposited those sediments at the termination of the glacier near the coastline and then along the retreat path as it moved up in elevation during its melt. This has left scattered deposits that may hold pockets of expansive clays, especially near (but not necessarily adjacent to) glacier-formed river systems such as the Quinault River and Queets River. Additionally, expansive clay materials that were transported by the glacial action may have been deposited at the shorelines and even re-deposited by wave action on the shoreline since the end of the last glacial period. Since the beginning of the current interglacial period, the QIR shoreline has been uplifted through a combination of the removal of the weight of the glaciers and the tectonic processes that have created vertical cliffs. These cliff areas may be especially prone to expansive clay soils and should be avoided as building sites for structures and infrastructure.

4.8.2. Risk Rating of Soils within the QIR.

NRCS sols survey data has been used to determine the extent of expansive soils and expansive clays within the QIR (Figure LV). Rating class terms in this analysis indicate the extent to which the soils are limited by expansive soils and expansive clays that affect building site development. Those sites determined to be "Low Risk" indicate that the soil has features that are very favorable for residential and light commercial construction. Good performance and very low maintenance can be expected. “Moderate Risk” sites represent areas where the soil has features that are moderately favorable for the specified use. Those areas identified as “High Risk” show characteristics not consistent with residential or light commercial developments without significant construction modifications prior to development.

Categorical ratings in the data assessment indicate the severity of the limitation. The ratings were determined as decimal fractions ranging from 0.00 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00). These ratings are presented on the mapping of the QIR as “Low Risk” where ratings were determined to be between 0.0 (zero) and 0.3, “Moderate Risk” where the risk rating was 0.35 – 0.65, and “High Risk” for all sites rating above 0.65 on this scale (Figure LV).

The expansive soils and expansive clays limitations can be overcome or minimized by special planning, design, and installation. Fair performance and moderate maintenance can be expected where appropriate actions are taken and where risks are lower.

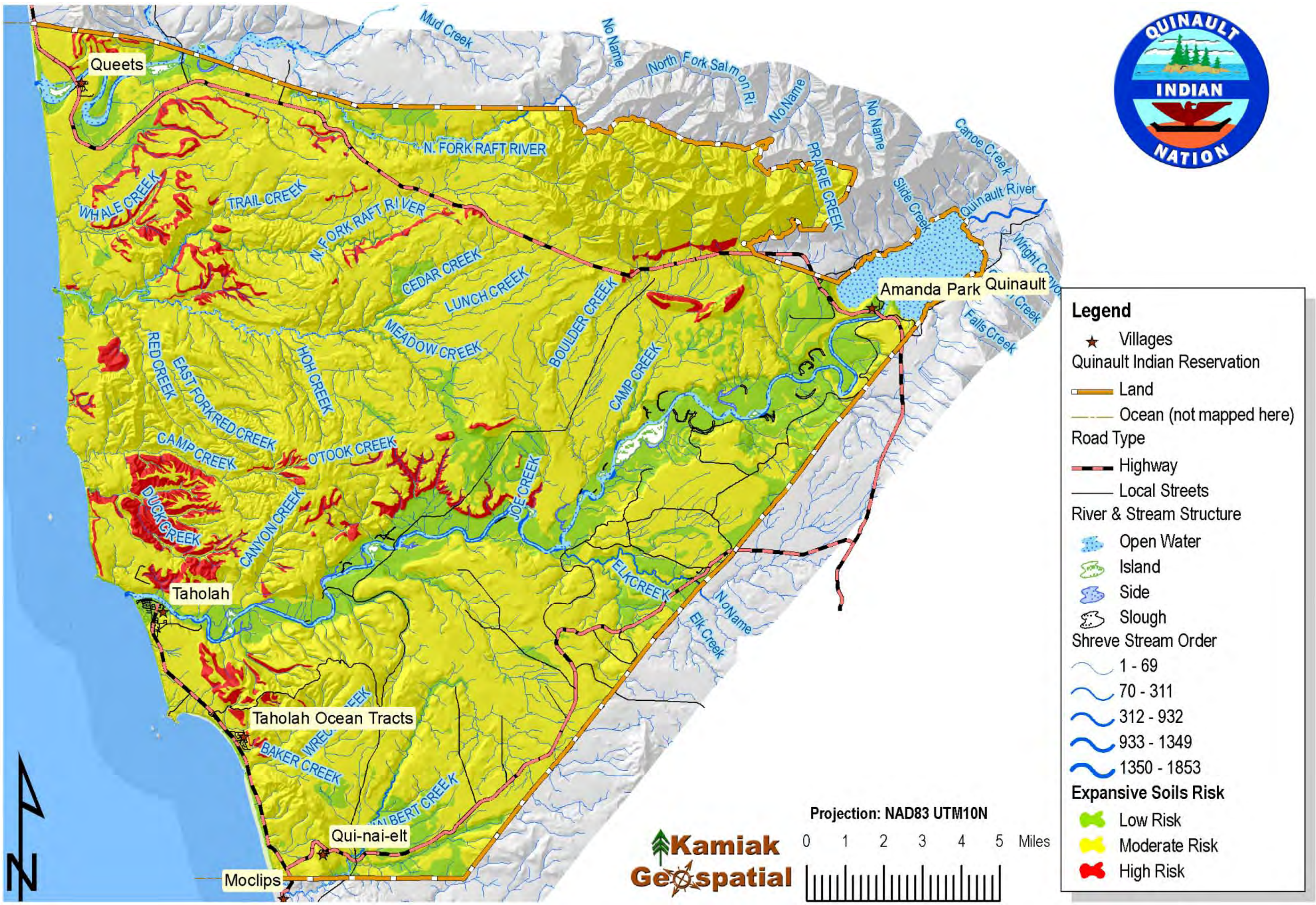
Dwellings are single-family houses of three stories or less. For dwellings without basements, the foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of 2 feet or at the depth of maximum frost penetration, whichever is deeper. For dwellings with basements, the foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of about 7 feet.

The ratings used here for dwellings are based on the soil properties that affect the capacity of the soil to support a load without movement and on the properties that affect excavation and construction costs. The properties that affect the load-supporting capacity include depth to a water table, ponding, flooding, subsidence, linear extensibility (expansive soils potential), and compressibility. The properties that affect the ease and amount of excavation include depth to a water table, ponding, flooding, slope, depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, and the amount and size of rock fragments.

Small commercial buildings are structures that are less than three stories high and do not have basements. The foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of 2 feet or at the depth of maximum frost penetration, whichever is deeper.

In response to sites with expansive soils, stabilization efforts have included the complete removal attempts of the problem materials, or isolation of the expansive soils by an adequate cap of nonexpansive, relatively impervious fill material (Bekey 1989). Where the construction project involves hillsides or the edges of cliffs (such as along the ocean cliffs), a combination of partial material removal and the installation of a buttress fill have been used to limit potential sliding of the structure (Bekey 1989). These efforts around the globe have been met with variable levels of success and some notable failures.

Figure LV. Expansive Soils and Expansive Clays Extent on the QIR, data derived from the NRCS Soil Survey of the QIR.



4.8.3. Probability of Future Events

Expansive soils represent a physical property of soils that is not dependant on outside factors to realize risks (such as an earthquake or flood). When the at-risk soil components are exposed to compression, wetting and drying, the damages to the structure placed on top of those soils can be realized. If recommended building techniques are not employed during initial construction, then damages are frequently seen. The “laissez-faire builder” may desire to “take a chance” with this disaster not affecting the house built on expansive soils, but if those actions lead to the conditions needed for damage, then the probability of damage is nearly 100% chance of failure within a 10 year period.

4.8.4. Dealing with Damages

Geotechnical engineering and structural engineering have come a long way in the last 20 years, and specific foundation systems have been devised to help counteract some of the problems for buildings inherent with expansive soils. However, the risk of damage to homes can be minimized but cannot always be eliminated (PCI 2010). Because the damages from expansive soils are variable, and often are difficult to visually confirm by the untrained eye, professional inspections of existing structures and of potential building sites is strongly recommended throughout the QIR.

Expansive soils represent a physical property of soils that is not dependant on outside factors to realize risks (such as an earthquake or flood). When the at-risk soil components are exposed to compression, wetting and drying, the damages to the structure placed on top of those soils can be realized. If recommended construction techniques are not employed during initial construction, then damages are frequently seen. The “laissez-faire builder” may desire to “take a chance” with this disaster not affecting the house built on expansive soils, but if those actions lead to the conditions needed for damage, then the probability of damage is nearly 100% chance of failure within a 10 year period.

It is possible to build successfully and safely on expansive soils if stable moisture content can be maintained or if the building can be insulated from any soil volume change that occurs. The recommended procedures are as follows (GES 2010):

- Professional geotechnical engineering testing to identify any problems,
- Design to minimize moisture content changes and insulate from soil volume changes,
- Build in a way that will not change the conditions of the soil,
- Maintain a constant moisture environment after construction,
- Ensure adequate surface water drainage around building sites and off the site,
- Avoid construction on expansive soils and expansive clays.

Expansive soil conditions are made worse if water collects around a building’s foundation. Rainfall and surface water drainage should run off the property to mitigate the worsening soil condition. Rain gutters and downspouts should direct water away from the structure, discharging it no closer than 3 feet from the foundation (PCI 2010). This drainage should also be conscious of the neighboring structures so that surface water drainage from one building is not diverted into another structure. Well-designed communities will facilitate this storm water and surface water drainage to avoid diversions into other structures and into at-risk infrastructure.

The question of the extent of the possible damages to the structures on the QIR is amplified by the extremely high amount of annual precipitation received across the QIR each year (Figure XX and Figure XXI). Many of the soils of the QIR are a combination of unconsolidated river deposits, and glacial debris deposits that are exposed in the incised river valleys. This combination gives rise to the concern for potential expansive soils damages. As a recommendation made in Chapter 6, the QIN should adopt building codes to implement geotechnical engineering and structural engineering assessments as a condition to building in new locations.

4.9. Wildland Fire

An extensive history of the forest management activities on the QIR dating back to 1855 is provided in the "The Forests of the Quinault" (Neumann *et al.* 1997) and several excerpts have been extracted from those works and placed into this document dealing with wildfire occurrence on the QIR (for the most part, these citations are taken directly from Neumann *et al.* (1997) and cited here). When combined with the efforts by Workman (1997) summarized in Table 35 and the more recent summary of wildfires compiled by the BIA, USFS, and the Washington DNR, the picture of wildfire incidence since 1855 is fairly well documented.

In 1931 (Neumann *et al.* 1997), Lee Muck and Percy E. Melis (Office of Indian Affairs) described fire protection on Quinault Reservation as:

> "Based largely on lookouts for detection, telephone lines for communication, light trucks and pack animals for transportation, and hard labor, with tools and equipment suitable to the topography and ground cover, for suppression."

On June 25, 1925, a small slash burning fire erupted near Wreck Creek on the Point Grenville Unit. The fire jumped over green timber to burn through Aloha's camp in the Moclips Unit, destroying the camp, three railroad trestles, and forestry equipment (Table 35). This fire had a six-mile front and caused at least $60,000 in damages (1925 dollars) partially destroying two to three million feet of fallen timber. Employees of lumber companies joined to fight this fire, which took more than a week to control. Steer noted that a fire in 1926 on the Cook Creek Unit had scorched 500,000 feet of downed logs (Neumann *et al.* 1997).

4.9.1. History of Fire Ignitions and Extent

According to Neumann *et al.* (1997), between 1960 and 1971, over 60 wildfires (averaging 5.5 per year) burned across approximately 1,700 acres of timberland on the QIR. According to BIA estimates, the wildfires destroyed nearly $124,000 worth of timber. On July 1, 1959, the State of Washington and the BIA entered into a contract, whereby the state agreed to provide "all fire pre-suppression and suppression activities" on over 150,000 acres of forestland on the QIR. In return, the BIA would reimburse the state for its costs and provide the state with facilities, machinery and equipment, and human resources.

Between the years of 1985 and 2000, approximately 281 wildfires burned on the QIR (averaging 18.7 per year) according to the combined database from the USFS, BIA, and Washington DNR (Figure LVI). During that same period and from these 281 ignitions, approximately 1,671 acres were burned on the QIR (Figure LVII). This 15-year period represents the highest frequency of ignitions between 1970 and 2009, with some years between 1970 and 2009, showing fewer than two ignitions in a single year.

The statistics reported in these databases is debatable for accuracy. For instance, within Neumann *et al.* (1997) the tabular data presented in Table 36 conflicts with descriptive data in the text of that same document citing the June 25, 1925, fire near Wreck Creek on the Point Grenville Unit. Table 36 shows only one event during 1925 totaling 0.5 acres. The same holds true for the combined datasets of the BIA, USFS, and Washington DNR. When reviewed by forestry staff at the QDNR during the planning meetings for the preparation of these data, the combined datasets from the BIA, USFS, and Washington DNR were corrected concerning a report of an 1,180 acre "wildfire" from debris burning that was actually the prescribed burns of the BIA and QDNR for that year – they were not wildfires at all. It can be surmised that the accuracy in terms of both total acres burned, the causes of the ignitions, and the number of actual ignitions is debatable. These data are illustrative of the trends in the wildfire profile for the QIR.

Figure LVI. Number of Wildfire Ignitions on the QIR as Reported in BIA, USFS, and WA DNR Databases (1970-2009).

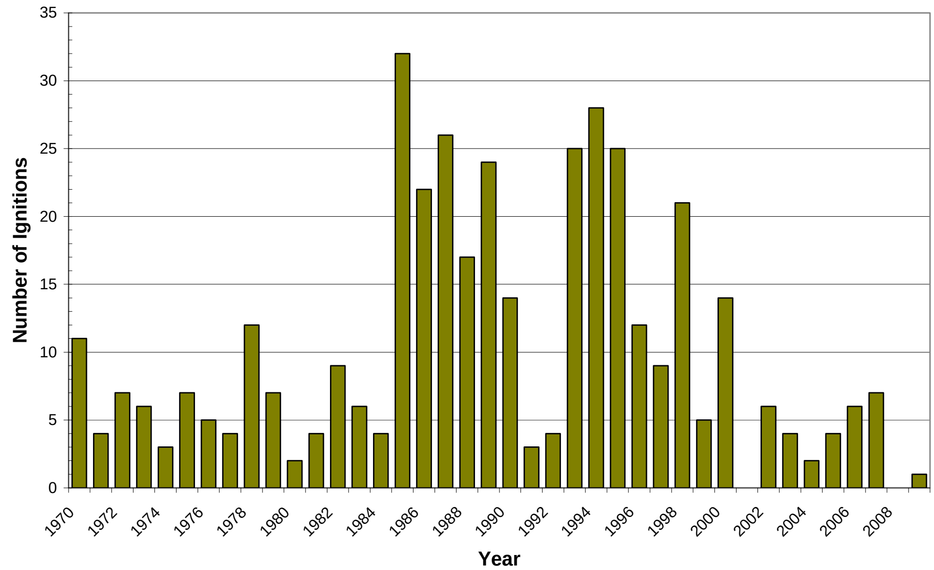
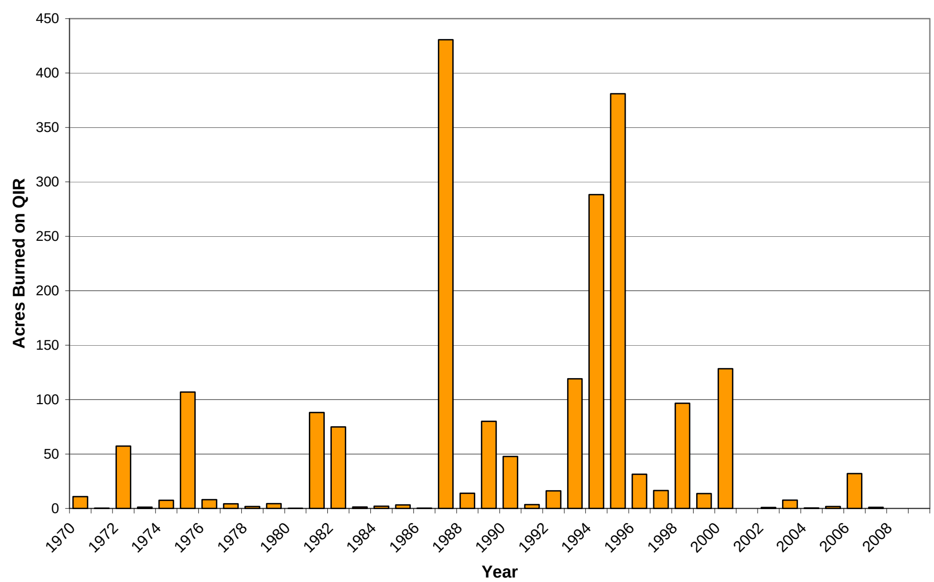


Figure LVII. Forested Acres Burned on the QIR as Reported in BIA, USFS, and WA DNR Databases (1970-2009).



4.9.1.1. Narrative of Fire Occurrences

Workman (1997) has summarized news accounts and written reports concerning wildfires in the region of the QIR (Table 35). These accounts of wildfire events are very descriptive of the weather conditions and forest management activities surrounding wildfires on the QIR. Additional accounts of wildfires have been documented by Neumann *et al.* (1997) and several of those are recounted here, for reference purposes:

The following two events are excerpts from Neumann *et al.* (1997):

Cook Creek Fire, 1933

"The Cook Creek Fire of August 1933, illustrated the difficulties faced by the Taholah Agency and lumber companies in fighting fires on the Quinault Reservation. The fire started on August 24, 1933, of undetermined but presumably human-caused origins on a steep bank of Cook Creek. The fire burned out the slope on its way to the Quinault River. It eventually jumped the river and burned green timber on uncut allotments. The fire covered 9,000 acres of cut-over and unlogged lands, and took two weeks to suppress."

Raft River Fire, 1967

"Most fires on the Reservation were scattered, small in size, and controlled with relative ease, but one merits mention because of its impact on future fire and forest management practices. On July 13, 1967, a fire started in the Raft River drainage which eventually swept across approximately 1,600 acres of trust land. The scene of previous logging operations prior to the fire, the site contained heavy accumulations of cedar slash. Immediate reforestation was recommended in the area with the view of restoring the land to productive status."

Slash Disposal

"In 1967, following the Raft River Fire, BIA foresters awoke to discover that Quinault forests lay awash in slash. In some areas of the Reservation slash accumulations dated back to logging in the 1940s. In the 1972 forest management report (Briegleb and Lund), noted the presence of "heavy concentrations" of slash on Reservation forests. According to one source, an average of 200 tons per acre of red cedar slash remained on the cut-over lands of the Taholah and Crake Creek Units."

"Heavy accumulations of cedar slash fueled the Raft River fire, igniting, what the BIA termed as, the "first serious" wildfire to strike Quinault forest lands in 25 years. The fire swept across "vast areas of slash" jumping green belts and roaring along slash piles which lined logging road in the Raft River area. Although the fire began on non-Indian land, much of the slash accumulations and road-side logging debris which fed the flames, lay on hands under BIA control."

Table 35. Significant Wildfire Related Events in and around the QIR (Workman 1997-2010).

Date	Information
1883 August 2	It is so smoky in Elma, they can taste the smoke. The drought continues.
1883 July 5	Heavy fire on the road between Montesano and Olympia.
1885 August 5	In his second annual Quinault agency report, Charlie Willoughby says that forest fires have erased some boundary markers and that whites might be encroaching on the southern boundary of the Reservation.
1885 August 6	Forest fires raging on the upper Wynoochee.
1885 July 2	On Monday night, forest fires were raging in several directions, lighting up the horizon and presenting a pretty picture to all who viewed them in Montesano.
1894 September 7	The smoke last week was the densest ever known here, but the rain has cleared it away and probably will put out the fires that caused it.
1902 September 12	Huge fires burn all about county.
1902 September 12	In the Yacolt east of Vancouver, WA, more than 200,000 acres of virgin timber burn and 35 people perish.
1902 September 13	New London destroyed. Smoke making day into night. [New London is about 5 miles north of Hoquiam]
1902 September 9	Dark as midnight at noon in Shelton because of smoke from forest fires.
1908 August 4	Fires burn 45 square miles along Wishkah and East Fork Hoquiam Rivers.
1908 July 18	Forest fire raging near Aberdeen.
1910 August 25	Fires burn logged off lands.
1910 June 16-20	Forest fires on the Wishkah. Forest fires rage on logged over lands.
1910 September 8	Rain breaks drought and stops fires.
1912 May 14	Forest fires in county and Quinault valley.

Table 35. Significant Wildfire Related Events in and around the QIR (Workman 1997-2010).

Date	Information
1914 July 29	Fire danger acute; many small slashings ablaze along Humptulips River.
1915 August 18-25, 28	Moclips swept by fire, second in a year. 90º F.
1920 May 8	Slashings set afire by sparks from a locomotive.
1922 May 31, June 1, 15, 20	Forest fires menace Copalis. Carlisle suffers most in forest fires; damage heavy in Grays Harbor County. More fires in Humptulips and Carlisle. Forest blazes under control with light rain, first since May 25th.
1924 April 24	Eleven large forest fires burning in Western Washington and Oregon.
1924 August 28	Lake Quinault Hotel destroyed by fire early this morning.
1924 July 28	Forest fires burning in Harbor forest and western WA since the 24th were quelled last night by rain.
1924 September 13	Aloha has a wildfire near Moclips. A fire is also burning near Salmon river caused by slash burnings on the road clearing project.
1925 July 2	Flames sweep 10 sections of the Reservation near Moclips.
1926 August 2	Fires line Harbor highways.
1927 August 17	Fire rages on upper Quinault; delays timber survey; 96º F.
1928 July 16, 23	Forest blazes cover wide area in Quinault timber. Sunday visitors to Lake Quinault were prevented return as flames cross road. Forest fire licks up camp and bridge near Moclips.
1929 September 16	Smoky gloom enshrouds Harbor from forest fires.
1930 October 20	Moclips hit by big blaze.
1930 September 1	10,000 acres of logged over lands ablaze on upper Wynoochee.
1931 April	County fire situation serious.
1931 August 24	Cook Creek forest fire.
1931 July 22	Aloha forest fire eclipses sun on the Harbor.
1932 July 1,4, 7, 11, 13	Big slash fire started near Cook Creek from five arson fires. Despite 2" of rain, Cook Creek fire still burning. Cook Creek fire still menacing; has burned 4 mile long and half mile wide strip. Despite weekend rains. Cook Creek fire still a menace. Rain putting damper on Cook Creek fire.
1932 October 7	Flames rage on Olympic Loop. Fire burns on 10 mile front along highway near Quilcene.
1933 September 8	Cook Creek fire under control.
1934 June 5	Reservation lookouts ready early this year because of dry spring.
1935 April 27	Fire hazard in woods is serious..
1935 August 12, 16	Tribesmen conquer dangerous fire one mile east of Taholah. 100 men fight slashing fire one mile south of Polson Camp #14.
1935 August 2	New steel lookout tower near Queets and a lookout tree on Lone Mountain supplement the tower near Point Grenville and the Cook Creek outlook.
1935 May 6	Several forest blazes north and west of Hoquiam.
1936 October 12	Fire hazard in forest acute; 82º F.
1936 September 25	State "fires" 58,000 acres of slashing in last ten days to save forest by preventing forest fires.
1937 June 5	Big fire on Quinault Reservation perils spruce plantation.
1937 June 7	Flames raze hotel at Moclips, two Aloha log bridges and 8,000 acres on Reservation.
1938 July 20	92º F. Harbor drought and forest fire crisis; 200 fires in Northwest forests.
1938 June 13	Cook Creek fires have devastated 8,000 acres.
1938 June 6	Raging fires threaten Quinault timber region.
1940 April 1	Indian fire-fighters to install two-way transmitting system.
1940 April 29	Land logged by Polson, Aloha, Hobi, and M.R. Smith on the Quinault Reservation to be closed due to extreme fire hazard.
1940 July 8	Forest fire crisis halts all logging.
1941 August 5, 6, 12, 26	Flames near Reservation Tree Farm. Wind and sunny skies renew the Reservation fire menace. Grim fight to quench Quinault fires continues. Quinault fire near control. Quinault fire nearly quenched.
1941 July 17	Lightning set 700 fires in state; 70 on Harbor.
1941 July 22, 24, 30. 31	Crews still fighting forest fires on Quinault Reservation. High winds fan Quinault fires; 3,500 acres burnt. Forest fires peril Taholah-Moclips. Wind driven inferno rolls over Quinault lands.
1941 September 22	Peninsula fire bans lifted. Quinault wildfire declared out.
1943 September 2	Harbor forest fire losses for 1943 lowest in 20 years.
1944 February 18	The 1943 fire season on the Harbor reported at a new low. Only 17 fires burned 262 acres with none on the Reservation.

Table 35. Significant Wildfire Related Events in and around the QIR (Workman 1997-2010).

Date	Information
1951 August 8	Scores of fires burn in Northwest woods.
1951 June 20	Agency FM Radio Tower near completion at Lake Quinault "will provide better fire control".
1951 October 8	Forest fires ten times those of 1950. September worst fire month, records show. 1,600 acres burn on the Harbor.
1951 September 14, 22	Mounting fire danger closes woods again. Forks fire.
1952 September 6, 22	Slash and forest fire smoke from Queets shroud Lake Quinault. Logging banned as heat mounts.
1959 July 2	Fire protection on Quinault Reservation contracted to state.
1961 August 23	Huge fire erupts in Queets area of the Olympic National Park.
1967 July 13, 14	Raft River Forest Fire starts. (Would burn 5,200 acres by 19th). 500 men battle raging Quinault fire.
1972 July 3, 13, 17	Forest fire across the river from Taholah. Many wet their roofs to keep burning embers from setting fires. 5" of rain in last two days; Lake Quinault rose four feet. 90º F.
1975 July 28	70 acres wildfire in Queets Unit contained.
1980 July 25	100 men mop up fire near Taholah.
1981 September 8	Fire fighters battle windblown blaze on Quinault Reservation.
1985 October 2	Firefighters gain on the Quinault fire in Humptulips.
1985 September 29	Bombers drop loads on Quinault fire; slash burns out of control as dry east winds come up.
2000 August	Summer forest and range fires continue to burn millions of acres in the West.
2002 June 26	Dozens of fires started by a train between Montesano and Elma.

Historical data has been summarized in Neumann *et al.* (1997) to document the ignition profile and wildfire extent profile of the QIR from 1924 through 1996 (Table 36). Geospatial databases from the BIA, USFS, and the Washington DNR have been combined to represent the incidence of wildfires on the QIR from 1970 through 2009. These two datasets overlap in time, but the correlation of the data is not well defined.

Table 36. Wildfire Ignition and Extent Recorded in Neumann *et al.* (1997) from 1924-1997.

	Fire Class (based on acres burned)							Ignition Cause				
Year	A <¼	B ¼ -10	C 10-100	D 100 -300	E 300 -999	Total Ignition Number	Acres Burned	Railroad	Brush or Debris Burning	Human Caused	Lightning	Misc.
1924	2	1				3	10.0			1		2
1925	1					1	0.5			1		
1926			3			3	1,500.0		2			1
1927			2			2	85.0			1		1
1928	1	1	1			3	104.0		1			2
1929	3		2			5	4,561.0			1		4
1930	2		1			3	61.0		1	1		1
1931	2	1	2			5	640.0			1		4
1932		1	2			3	5,720.0			1		2
1933			1			1	3,600.0					1
1934			1			1	9,030.0					1
1935		3				3	10.9	1		2		
1936		2	3			5	0.3			5		
1937			3			3	57.4	2		1		
1938		4	3			7	1.2			6		1
1939			5			5	7.6					
1940	2	2				4	106.9			4		

Table 36. Wildfire Ignition and Extent Recorded in Neumann *et al.* (1997) from 1924-1997.

Year	Fire Class (based on acres burned) A <¼	B ¼-10	C 10-100	D 100-300	E 300-999	Total Ignition Number	Acres Burned	Ignition Cause: Railroad	Brush or Debris Burning	Human Caused	Lightning	Misc.
1941					1	1	8.2			1		
1942						0	4.3					
1943						0	1.9					
1944		1				1	4.5					1
1945	1	2				3	0.2	2			1	
1946						0	88.1					
1947						0	75.0					
1948	3	2				5	1.4			3	1	1
1949	4					4	2.2			4		
1950	4	1				5	3.2			5		
1951	3	1				4	0.3			4		
1952	1					1	430.6			1		
1953	4			1		5	14.1			2	3	
1954	2	1				3	80.0			3		
1955						0	47.8					
1956		1				1	3.5			1		
1957	2					2	16.3			2		
1958	3					3	119.2			2	1	
1959	2	2	1			5	288.3			4		1
1960	2	1	1			4	381.1			1	2	1
1961	5					5	31.5			4		1
1962	1					1	16.5					1
1963	4					4	96.6			3	1	
1964	3					3	13.8			2		1
1965	7					7	128.5			3		4
1966	6	1				8	-			4	1	3
1967	4	1			1	6	1.0			5		1
1968	2					2	7.7			2		
1969	3	2				5	0.4			4		1
1970	13	2				16	1.8			13		3
1971	4					4	32.0			3		1
1972	1					1	1.1					3
1973	1	2				3	-		1			2
1974	1	2				3	-		1	2		
1975						0	10.9					
1976						9	0.3			9		
1977						0	57.4					
1978						5	1.2			5		
1979						6	7.6			6		
1980						1	106.9			1		

Table 36. Wildfire Ignition and Extent Recorded in Neumann *et al.* (1997) from 1924-1997.

Year	Fire Class (based on acres burned) A <¼	B ¼ -10	C 10-100	D 100 -300	E 300 -999	Total Ignition Number	Acres Burned	Ignition Cause: Railroad	Brush or Debris Burning	Human Caused	Lightning	Misc.
1981						2	8.2			2		
1982						6	4.3			6		
1983						3	1.9			3		
1984						1	4.5			1		
1985						5	0.2			5		
1986						0	88.1					
1987						4	75.0			4		
1988						3	1.4			3		
1989						7	2.2			7		
1990						2	3.2			2		
1991						1	0.3			1		
1992						0	430.6					
1993						3	14.1			3		
1994						5	80.0			4	1	
1995						2	47.8			2		
1996						1	3.5			1		
Total	97	36	31	1	2	235	2,085.4	5	6	167	11	43

Table 37. Ignition Causes and Acres Burned as Reported by BIA, USFS, and WA DNR Datasets from 1970 through 2009.

General Ignition Cause	Number of Ignitions	Acres Burned	Percent of Acres	Percent of Ignitions
Arson	15	31.9	1.5%	3.7%
Children	12	5.8	0.3%	3.0%
Debris Burn	38	350.2	16.8%	9.5%
Lightning	8	0.8	0.0%	2.0%
Logging	31	169.6	8.1%	7.7%
Miscellaneous	32	31.8	1.5%	8.0%
Railroad	1	0.2	0.0%	0.2%
Recreation	13	3.9	0.2%	3.2%
Smoker	13	54.6	2.6%	3.2%
Unknown	239	1,436.6	68.9%	59.5%
Total	402	2,085.4		

4.9.2. Wildfire Ecology on the QIR

A wildfire, also known as a wildland fire, forest fire, brush fire, or vegetation fire, is an uncontrolled fire often occurring in wildland areas, but also with the potential to consume houses and other rural or urban resources. Common causes are numerous and can include lightning, human carelessness, slash-and-burn farming, arson, volcanic activity, pyroclastic clouds, and underground coal fire. Heat waves, droughts, and cyclical climate changes such as El Niño can also dramatically increase the risk of wildfires (NWCG 1998).

Wildfires are common in climates that are sufficiently moist to allow the growth of trees but feature extended dry, hot periods, such as can be found in most of the western US and within the QIR specifically during summer months (Table 25). Wildfire ignitions have been documented on the QIR during the annual period from March through November (between 1970 and 2009), however, most ignitions have been documented between June and October, with July and October showing the highest frequency of wildfire ignitions (Figure LVIII).

Wildfires can be particularly intense during days of strong winds (Table 25, Table 22, Section 4.3.4) and periods of drought. Fire spread is also dangerous during the fire season where logging and natural debris accumulation of western redcedar, western hemlock and Sitka spruce are found. In 1940, Harry M. Lynch, Senior Project Manager, Taholah Indian Agency, described fire suppression in western, coastal forests as "differing from fire control east of the coastal range in one important respect: coastal fires resisted control in the one to two days typical for pine forests nationally, burning instead for two weeks or two months. Lynch emphasized the need to have plenty of water pumps and hoses, caterpillar tractors, and a large contingent of well-trained individuals that could be called into service for extended periods" (Neumann *et al.* 1997).

Wildfires are considered a natural part of the ecosystem of numerous forestlands and rangelands, where some plants have evolved to tolerate fires through a variety of strategies such as fire-resistant seeds and reserve shoots that sprout after a fire (Agee 1993). Smoke, charred wood, and heat are common fire cues that stimulate the germination of seeds (Agee 1998). Exposure to smoke from burning plants can even promote germination in some types of plants (Barrett 1979). The native tree species of the QIR and the western slope of the Olympic Peninsula are generally fire-intolerant species that tend to be highly flammable and completely destroyed by fire. Some of these plants and their seeds may simply fade from the community after a fire for long extended periods of time unless reforestation efforts are taken to reintroduce their stocking levels. Seeding from adjacent forest stands can also reforest these areas. Many of the tree species on the QIR possess "light" seeds that can be carried long distances on the fall time winds that frequent the QIR.

Wildfire causes are highly variable and dependent on the general weather patterns of the region. Within the Rain Forest ecosystem, the forestlands are susceptible to forest disturbance patterns such as logging slash accumulation, weather damage caused forest debris, and periods of prolonged drought and high temperatures. Forest debris from western redcedar, western hemlock, and Sitka spruce can be especially problematic and at risk to wildfires when slash is accumulated on the forest floor because of the tendency to resist deterioration. When ignited, these fuels can be explosive and provide ladder fuels that transition from the surface fire to a crown fire rapidly.

An analysis of the period of 1970 to 2009 reveals that about 68% of the fires on the QIR have been ignited from "undetermined" causes (Figure LIX, Table 37). This factor of indeterminacy is due to the database of the BIA used to form the combined report that did not record causes for any fires. The other databases (USFS and Washington DNR) did record ignition cause and based on these records the highest ignition cause was attributed to debris burning that escaped the prescription to burn adjacent forestlands (Table 37). Only slightly behind debris burning, the leading cause of ignitions was attributed to logging activities, generally from machinery failure or sparks. Arson, children playing with fire, and recreational users, combined, accounted for slightly more wildfire ignitions during the period record than either debris burning or logging activities (Figure LIX, Table 37).

Neumann *et al.* (1997) conveyed information from George W. Sevey, Forestry Aid, Western Washington Agency, BIA, in 1958; "From the early 1920s to the late 1950s, the BIA estimated that fire had swept across some 22,000 acres on the Reservation, burning some areas on more than one occasion. Although virgin timber stands suffered relatively little damage from fire, wildfire severely affected reproductive growth on cut-over lands. The BIA estimated in 1948 that the cost of replanting cut-over lands impacted by fire could exceed $250,000; by 1958, the estimate had risen to $500,000." Given the cost associated with wildfires, the BIA devoted more attention to fire control activities on the Quinault Reservation.

Figure LVIII. Month of Wildfire Ignition on the QIR as Reported in BIA, USFS, and Washington DNR Databases (1970-2009).

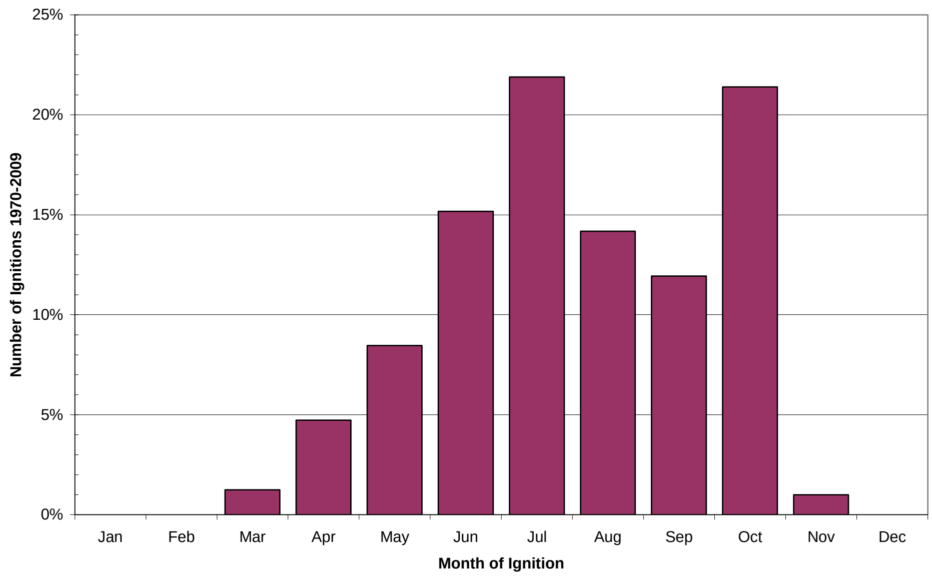
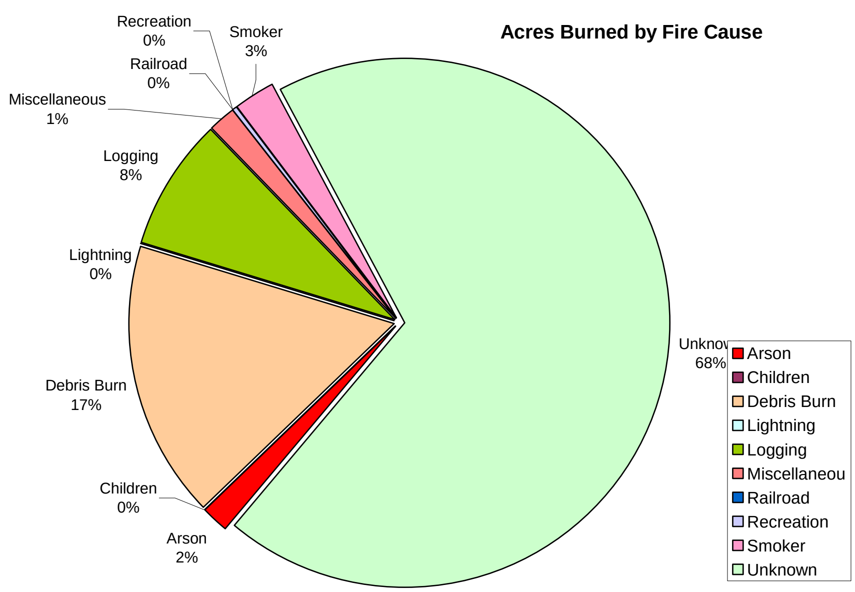


Figure LIX. Acres burned on the QIR summarized by General Ignition Cause



4.9.3. Wildfire Threats in QIR

Fires can be categorized by their fuel type as follows:

- **Smoldering:** involves the slow combustion of surface fuels without generating flame, spreading slowly and steadily.

- **Crawling:** surface fires that consume low-lying vegetation such as 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 at an incredible pace through the top of a forest canopy, burning entire trees, and can be extremely dangerous (sometimes called a Firestorm).

Smoldering fires involve the slow combustion of surface fuels without generating flame, while spreading slowly and steadily. They can linger for days or weeks after flaming 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 not exclusive to that vegetation.

Wildfires may spread by jumping or spotting, as burning materials are carried by wind or firestorm conditions. Burning materials can jump over roads, rivers, or even firebreaks and start distant fires. The powerful updraft caused by a large wildfire will draw in air from the surrounding area. These self-generated winds can also lead to the phenomenon known as a firestorm.

4.9.4. National Wildfire Management History

Wildland fire management in the west over the past hundred years has created a modified role for wildland fire. Because of a national awareness of wildfire impacts, forest managers increased protective measures to stop wildfires as soon as they are discovered.

Pre-European wildland fires of this region were allowed to burn unchecked with a fire return interval range averaging 200 years between wildfire events and burning through mixed severity fires (Brown 1995, LANDFIRE HFRG 2006). In those locations where fires were a frequent "visitor" the fire intensity was commonly low, and supported by surface fuels such as grasses, forest litter and debris. Occasionally, the fires would torch into single trees (via ladder fuels) or small groups of trees, but rarely were they sustained in the tree crowns (crown fire). Fire intensities on these sites created a mosaic of burned and un-burned areas located relatively close to each other.

In less frequent fire-return interval sites such as the QIR, the natural condition wildfires would burn with more intensity but a lower periodicity. These sites witnessed fire reoccurrence very infrequently (as many as 200 years between fire returns), where trees and other vegetation would thrive in the inter-fire period only to be destroyed by the next large event, commonly called a "Stand Replacing Fire" (Brown 1995).

Prior to about 1920, the lack of a well-developed road system in most of the Olympic Peninsula generally, and QIR specifically, hindered fire protection services from accessing fires while they were still small enough to logistically control. As the road system of the region was better developed through increased timber harvesting activities, fire response time was greatly aided. After World War II, wildland firefighting agencies added two more features to their anti-incendiary tool-belt: air attack and smoke jumpers.

A parallel sequence of events occurred with this scenario. Technology to track lightning strikes as they occur improved critical quick response time in North America in the late 1960s (Brookhouse 1999). Lightning detection systems are able to record various characteristics of lightning strikes, including the type of strike (cloud-to-ground, cloud-to-cloud), polarity, intensity, and approximate location of the discharge. Each lightning strike emanates a radio signal that has a unique signature. USFS and BLM research has been instrumental in establishing lightning detection systems all across all of the United States. The first lightning detectors in this region came into operation in 1968, with the location of ground strikes plotted manually. This manual form of triangulation was replaced by linking detectors to computers. This system is called "Automated Lightning Detection System" (ALDS).

This synergistic combination of resources and technology with the increased road and rail networks of the Olympic Peninsula, greatly reduced the average wildland fire size and therefore reduced risks to both the ecosystem and the rural and urban populations living in or near forestlands (such as all communities in QIR).

While wildland fire spread in the region has been altered, debris and normal forest fuels continue to accumulate in the forest. When fire does occur, it can burn hotter and longer than it did historically.

The urbanization of forestlands within and adjacent to the QIR leads to fires that can involve the destruction of homes located in the Wildland-Urban Interface (WUI). On many occasions, wildfires have caused large-scale damage to private and public property, destroying many homes and causing deaths, particularly when they have reached urban fringe communities. This is a risk for all of the QIR where homes are surrounded by aesthetically pleasing "towering timbers".

4.9.5. Analysis Tools to Assess Wildfire Risk Exposure

Analysis tools to assess the risk exposure to wildland fires in QIR are numerous. Each analysis tool has specific applications to unique needs and can be considered in light of the site being addressed; none of them will replace professional expertise of fire behavior analysts on the ground. These techniques are presented for consideration of the risk exposure to QIR residents. Wildland fire is a widespread hazard affecting QIR.

4.9.5.1. Mean Fire Return Interval

Broad-scale alterations of historical fire regimes and vegetation dynamics have occurred in many landscapes in the U.S. through the combined influence of land management practices, fire exclusion, ungulate herbivores, insect and disease outbreaks, climate change, and invasion of non-native plant species. The LANDFIRE Project (Landscape Fire and Resource Management Planning Tools Project) produces maps of simulated historical fire regimes and vegetation conditions using the LANDSUM landscape succession and disturbance dynamics model (LANDFIRE 2007). 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 (MFRI) data layer (LANDFIRE MFRI 2006) quantifies the average number of years between fires under the presumed historical fire regime. This data layer is derived from vegetation and disturbance dynamics simulations using LANDSUM (Keane *et al.* 2002, Keane *et al.* 2006, Pratt *et al.* 2006). 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 size characteristics. This layer is intended to describe one component of simulated historical fire regime characteristics in the context of the broader historical time period represented by the LANDFIRE Biophysical Settings layer and LANDFIRE Biophysical Settings Model Documentation.

Simulated historical MFRI were classified into 22 categories of varying temporal length to preserve finer detail for more frequently burned areas and less detail for rarely burned areas, such as those on the QIR. Additional data layer values were included to represent Water, Snow / Ice, Barren land, and Sparsely Vegetated areas. Vegetated areas that never burned during the simulations were included in the category "Indeterminate Fire Regime Characteristics"; these vegetation types either had no defined fire behavior or had extremely low probabilities of fire ignition (Keane *et al.* 2002).

MFRI is calculated from the simulation length divided by the number of fires that were measured on each pixel. The simulations used to produce this layer were 10,000 years in duration to observe the most complete representation of the fire regime characteristics within spatially complex landscapes, given computational limitations. However, it is important to note that these simulations are not intended to accurately represent the last 10,000 years of measurable history, which includes spatially and temporally dynamic factors such as climate change, vegetation species dispersal, and anthropogenic influences on vegetation and fire characteristics.

The results of the MFRI analysis for QIR (Table 38) reveal that over 62% of the land area within the QIR has been subjected to a MFRI of between 300 and 500 years. Almost 20% of the QIR land area has been subjected to wildfires on a frequency of 200 to 300 years, with the remaining 10% of the area subjected to longer MFRI stretching to as long as 1,000 years between wildfire events (Table 38).

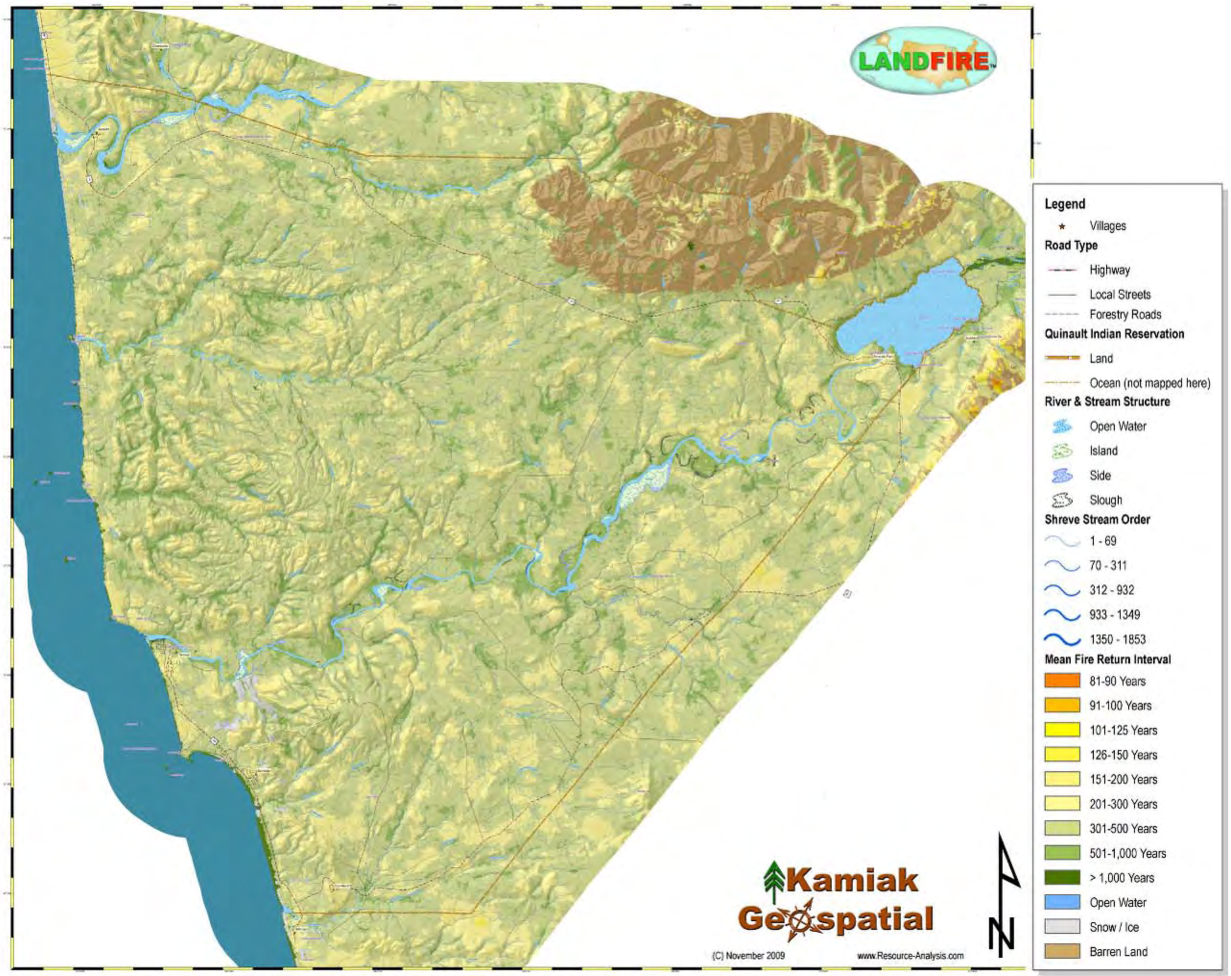
These data indicate that the role of wildland fire is slightly variable and operating on temporal scales exceeding most human planning efforts. The spatial distribution of these data is presented in Figure LX. An investigative study of these maps demonstrates the variability and distribution of this analysis component to understanding the role of wildland fire in this region. Estimated MFRI data for fire return intervals less than 126 years were not seen within the QIR, thus, Table 38 lacks any estimated data for these periods.

Table 38. Mean Fire Return Intervals in QIR (LANDFIRE 2007).

Mean Fire Return Interval	Acres	Percent of Total Area
126-150 Years	18	0.01%
151-200 Years	585	0.28%
201-300 Years	39,889	19.14%
301-500 Years	130,864	62.80%
501-1000 Years	19,584	9.40%
Open Water	6,259	3.00%
Snow / Ice	885	0.42%
Barren	10,313	4.95%

Because the LANDSUM data 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 size characteristics, the application of these data to future projections of wildfire occurrence is possible. In general terms, as natural weather pattern distributions change (Section 4.2, Global Climate Change) to drier and warmer trends, the result is predicted to be a vegetative change from western hemlock, Engelmann spruce, and western redcedar dominated forests to grand fir and Douglas-fir dominated ecotypes. At the same time, wildfire return intervals may increase in frequency (a reduction of MFRI periods) in response to the drier and hotter average temperatures. Anthropogenic influences to wildfire occurrence have been witnessed through arson, incidental ignition to industry (e.g., logging, road building, railroad, and accidents), and other factors. Wildfire abatement during the past century has reduced the spread of wildfires after initial ignition through the ALDS system, and initial attack rapid responders, to greatly reduce the average wildland fire size and therefore reduced risks to both the ecosystem and the rural and urban populations living in or near forestlands (such as all communities in QIR). In the short-term it is expected that the MFRI evaluated for the QIR will be continued, while changes to this dynamic fire regime will depend on the severity and magnitude of opposing factors, or of synergistic forces to amplify the shorten, or lengthen, fire return intervals.

Figure LX. Mean Fire Return Interval on the QIR (LANDFIRE 2007).



4.9.5.2. Historic Fire Regime

In the coastal regions of the Pacific Northwest, wildfire was historically an infrequent visitor to terrestrial ecosystems. Land managers need to understand Historic Fire Regime (HFR) (that is, fire frequency and fire severity prior to settlement by Euro-Americans) to be able to define ecologically appropriate goals and objectives for an area. Moreover, managers need spatially explicit knowledge of how HFR vary across the landscape.

Many ecological assessments are enhanced by the characterization of the historical range of variability which helps managers understand: (1) how the driving ecosystem processes vary from site to site; (2) how these processes affected ecosystems in the past; and (3) how these processes might affect the ecosystems of today and the future. Obviously, HFR is a critical component for characterizing the historical range of variability in the fire-responsive ecosystems of the Pacific Northwest. Furthermore, understanding ecosystem departures provides the necessary context for managing sustainable ecosystems. Land managers need to understand how ecosystem processes and functions have changed prior to developing strategies to maintain or restore sustainable systems. In addition, the concept of departure is a key factor for assessing risks to ecosystem components. For example, the departure from historical fire regimes may serve as a useful proxy for the potential of severe fire effects from an ecological perspective.

The Simulated Historical Fire Regime Groups (LANDFIRE HFRG 2006) data layer categorizes simulated MFRI and fire severities into five fire regimes defined in the Interagency Fire Regime Condition Class Guidebook (Hann *et al.* 2004). The classes are defined as:

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

This data layer is derived from vegetation and disturbance dynamics simulations using LANDSUM (Keane *et al.* 2002, Keane *et al.* 2006, Pratt *et al.* 2006). 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 size characteristics. This layer is intended to describe one component of simulated HFR characteristics in the context of the broader historical time period represented by the LANDFIRE Biophysical Settings layer and LANDFIRE Biophysical Settings Model Documentation.

Fire is the dominant disturbance process that manipulates vegetation patterns across the western U.S. The HFR data were prepared to supplement other data necessary to assess integrated risks and opportunities at regional and subregional scales. The HFR theme was derived specifically to estimate an index of the relative change of a disturbance process, and the subsequent patterns of vegetation composition and structure.

A historical (natural) fire regime is a general classification of the role fire would play across a landscape in the absence of modern human mechanical intervention, but including the influence of aboriginal burning (Agee 1993, Brown 1995). Coarse-scale definitions for natural (historical) fire regimes have been developed by Hardy *et al.* (2001) and Schmidt *et al.* (2002) and interpreted for fire and fuels management by Hann and Bunnell (2001).

As the scale of application becomes finer, these five classes may be defined with more detail, or any one class may be split into finer classes, but the hierarchy to the coarse-scale definitions should be retained.

General Limitations

These data were derived using fire history information from a variety of different sources. These data were designed to characterize broad-scale patterns of HFR for use in regional and subregional assessments. Any decisions based on these data should be supported with field verification, especially at scales finer than 1:100,000. Although the resolution of the HFR theme is a 30 meter cell size, the expected accuracy does not warrant their use for analyses of areas smaller than about 10,000 acres (for example, assessments that typically require 1:24,000 data).

HFR identified in QIR are presented in Table 39 and these data labels should be considered nominal data (they are not measurements).

Table 39. Historic Fire Regime Group Analysis on QIR (LANDFIRE 2007).

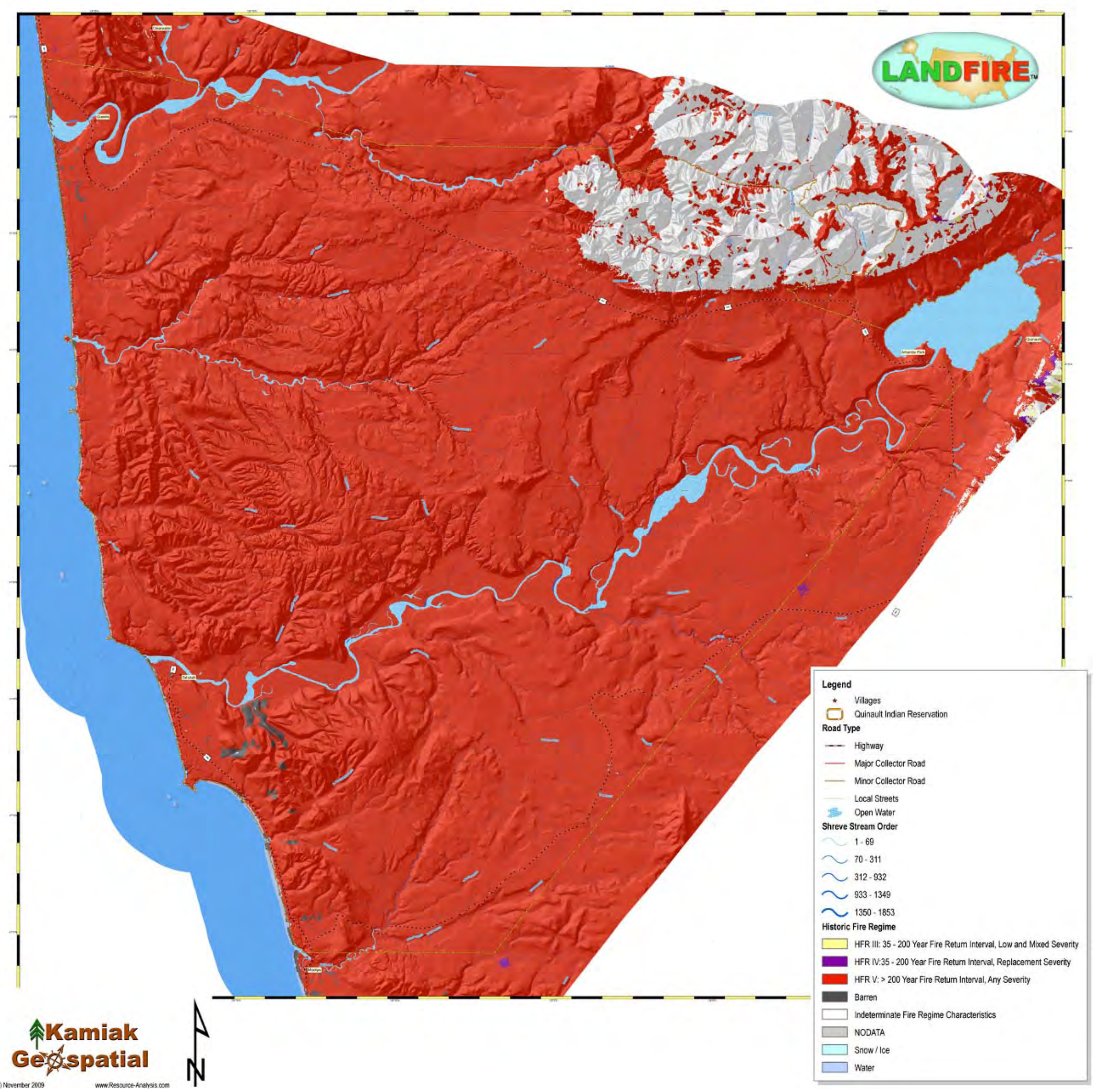
Fire Regime	Description	Acres	Percent
Fire Regime Group I	<= 35 Year Fire Return Interval, Low and Mixed Severity	0	0
Fire Regime Group II	<= 35 Year Fire Return Interval, Replacement Severity	0	0
Fire Regime Group III	35 - 200 Year Fire Return Interval, Low and Mixed Severity	11	0.01%
Fire Regime Group IV	35 - 200 Year Fire Return Interval, Replacement Severity	3	0.00%
Fire Regime Group V	> 200 Year Fire Return Interval, Any Severity	190,736	91.53%

Table 39. Historic Fire Regime Group Analysis on QIR (LANDFIRE 2007).

Fire Regime	Description	Acres	Percent
Water	Water	6,449	3.09%
Snow / Ice	Snow / Ice	8	0.00%
Barren	Barren	891	0.43%
Indeterminate Fire Regime Characteristics	Indeterminate Fire Regime Characteristics	10,299	4.94%

The most commonly represented HFR in QIR (92% of land area, 190,736 acres) is Regime V, which is characterized by 200 year and longer fire return intervals and stand replacement severity fires (Table 39). The other HFR categories on the QIR go without mention as the major ecological processes are dominated by these natural fire regime characteristics. Maps of these areas are prepared and included in separate mapping documents and reduced in size for this document (Figure LXI).

Figure LXI. Historic Fire Regime on the QIR, mostly HFR V > 200 year return interval (LANDFIRE 2007).



4.9.5.3. Fire Regime Condition Class

Fire Regime Condition Class (FRCC) is a classification of an ecosystem's amount of current departure from the HFR (Hann and Bunnell 2001). Coarse-scale FRCC classes have been defined and mapped by Hardy *et al.* (2001) and Schmidt *et al.* (2001). They include three condition classes for each fire regime. The classification is based on a relative measure describing the degree of departure from the natural HFR. This departure results in changes to one (or more) of the following ecological components: vegetation characteristics (species composition, structural stages, stand age, canopy closure, and mosaic pattern); fuel composition; fire frequency, severity, and pattern; and other associated disturbances (e.g. insect and disease mortality, grazing, and drought). All wildland vegetation and fuel conditions or wildland fire situations fit within one of the three classes.

The three classes (nominal data) are based on low (FRCC 1), moderate (FRCC 2), and high (FRCC 3) departure from the central tendency of the natural (historical) fire regime (Hann and Bunnell 2001, Hardy *et al.* 2001, Schmidt *et al.* 2002). The central tendency is a composite estimate of vegetation characteristics (species composition, structural stages, stand age, canopy closure, and mosaic pattern); fuel composition; fire frequency, severity, and pattern; and other associated natural disturbances. Low departure is considered to be within the natural (historical) range of variability, while moderate and high departures are outside this range (Table 4.22).

Characteristic vegetation and fuel conditions are considered to be those that occurred within the natural (historical) fire regime. Uncharacteristic conditions are considered to be those that did not occur within the natural (historical) fire regime, such as invasive species (e.g. weeds, insects, and diseases), "high-graded" forest composition and structure (e.g. large trees removed in a frequent surface fire regime), or repeated annual grazing that maintains grassy fuels across relatively large areas at levels that will not carry a surface fire. Determination of the amount of departure is based on comparison of a composite measure of fire regime attributes (vegetation characteristics; fuel composition; fire frequency, severity and pattern) to the central tendency of the natural (historical) fire regime. The amount of departure is then classified to determine the FRCC. A simplified description of the FRCC and associated potential risks are presented in Table 40. Maps depicting FRCCs are presented in map documents accompanying this report and are reduced for inclusion in this report (Figure LXII).

Table 40. Fire Regime Condition Class Definitions.

Fire Regime Condition Class	Description	Potential Risks
FRCC I	Sites are determined to be within the natural (historical) range of variability of vegetation characteristics; fuel composition; fire frequency, severity and pattern; and other associated disturbances.	Fire behavior, effects, and other associated disturbances are similar to those that occurred prior to fire exclusion (suppression) and other types of management that do not mimic the natural fire regime and associated vegetation and fuel characteristics. Composition and structure of vegetation and fuels are similar to the natural (historical) regime. Risk of loss of key ecosystem components (e.g. native species, large trees, and soil) is low.
FRCC II	Moderate departure from the natural (historical) regime of vegetation characteristics; fuel composition; fire frequency, severity and pattern; and other associated disturbances.	Fire behavior, effects, and other associated disturbances are moderately departed (more or less severe). Composition and structure of vegetation and fuel are moderately altered. Uncharacteristic conditions range from low to moderate. Risk of loss of key ecosystem components is moderate.

Table 40. Fire Regime Condition Class Definitions.

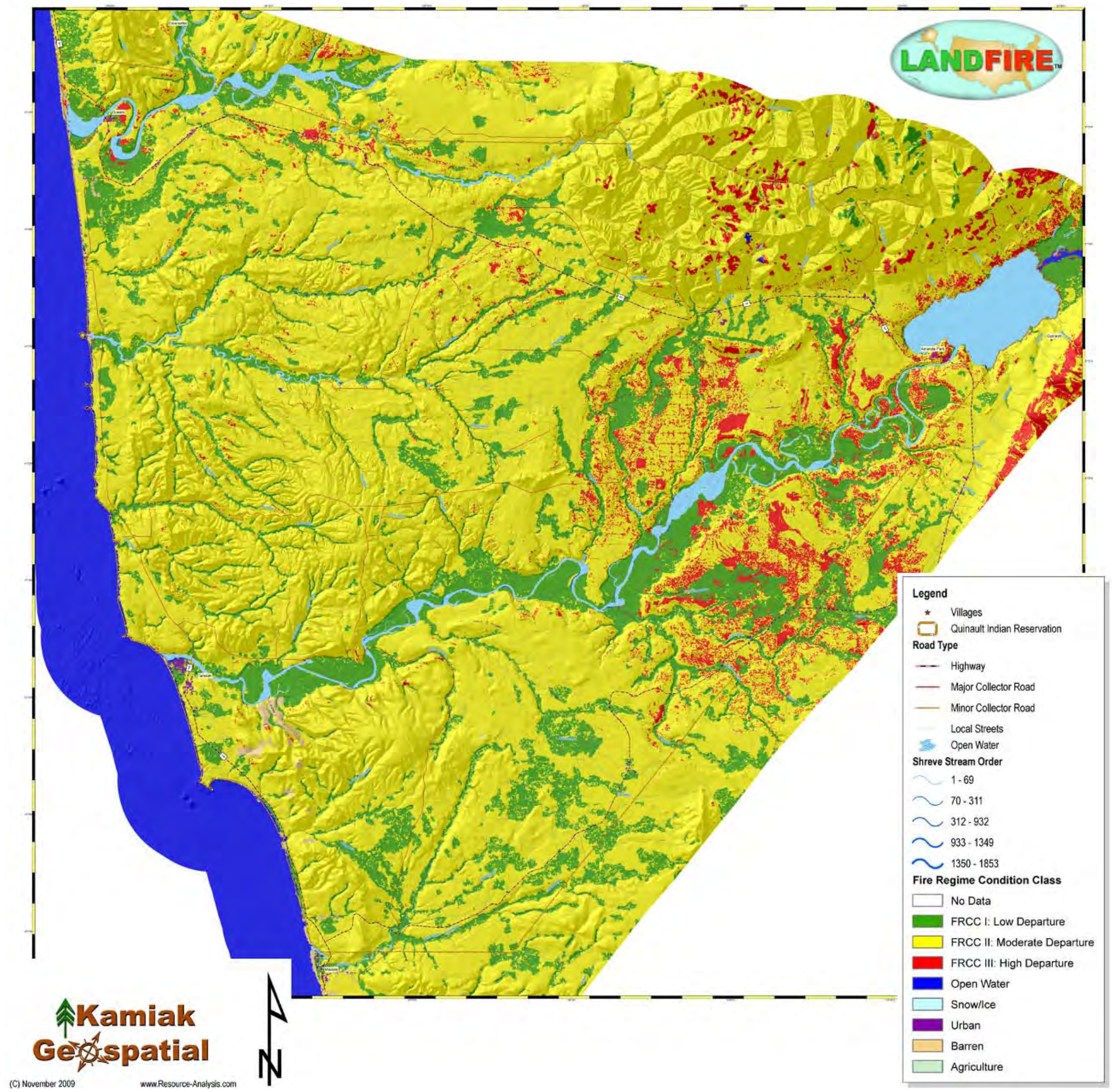
Fire Regime Condition Class	Description	Potential Risks
FRCC III	High departure from the natural (historical) regime of vegetation characteristics; fuel composition; fire frequency, severity and pattern; and other associated disturbances.	Fire behavior, effects, and other associated disturbances are highly departed (more or less severe). Composition and structure of vegetation and fuel are highly altered. Uncharacteristic conditions range from moderate to high. Risk of loss of key ecosystem components is high.

An analysis of FRCC in QIR shows that approximately 74% of the QIR is in FRCC II (moderate departure from historical), just about 18% is in FRCC I (low departure), with only 3% of the area in FRCC III (Table 41).

Table 41. Fire Regime Condition Class by Area in QIR (LANDFIRE 2007).

Fire Regime Condition Class		Acres	Percent of Area
Fire Regime Condition Class I	Low Vegetation Departure	36,680	17.6%
Fire Regime Condition Class II	Moderate Vegetation Departure	154,689	74.2%
Fire Regime Condition Class III	High Vegetation Departure	9,256	4.4%
Water		6,449	3.1%
Snow / Ice		8	0.0%
Urban		377	0.2%
Barren		891	0.4%
Agriculture		47	0.0%

Figure LXII. Fire Regime Condition Class on the QIR (LANDFIRE 2007).



4.9.5.4. Percent of Replacement-Severity Fire

The Percent of Replacement Severity Fire (RSF) analysis quantifies the amount of replacement severity fires relative to low- and mixed-severity fires under the presumed HFR. This data layer is derived from vegetation and disturbance dynamics simulations using LANDSUM (Keane *et al.* 2002, Keane *et al.* 2006, Pratt *et al.* 2006). Replacement severity is defined as greater than 75% average top kill within a typical fire perimeter for a given vegetation type (Hann *et al.* 2004). This percent is derived from vegetation and disturbance dynamics simulations using LANDSUM (Keane *et al.* 2002). The RSF analysis is intended to represent one component of the presumed HFR within landscapes based on interactions between vegetation dynamics, fire spread, fire effects, and spatial context. Conceptually, this analysis is best applied to the exposure of risks experienced by residents of the WUI where wildfires can be ignited by natural or anthropogenic causes.

The percent of RSF is calculated from the number of replacement severity fires relative to the total number of fires that affect a given mapping pixel. Simulated historical percents of RSFs were classified into 20 categories using 5% increments. Additional data layer values were included to represent Water, Snow / Ice, Barren land, and Sparsely Vegetated areas. Vegetated areas that never burned during the simulations were included in the category "Indeterminate Fire Regime Characteristics"; these vegetation types either had no defined fire behavior or had extremely low probabilities of fire ignition.

Within the external boundaries of the QIR the RSF analysis results reveal that approximately 75% of the land area is exposed to between 96% and 100% RSF. That can be interpreted as saying that three-quarters of the land area of the QIR is represented by areas that are likely to consume up to 100% of standing vegetation when fire conditions are representative of normal interactions between vegetation dynamics, fire spread, fire effects, and spatial context for wildfires in the region. That is to say, when environmental conditions are consistent with wildfire burning in this area (e.g., drought, high winds, high temperatures, and normal fuel loading) it is expected that up to 75% of the area would be subjected to burning all of the standing vegetation (Figure LXIII).

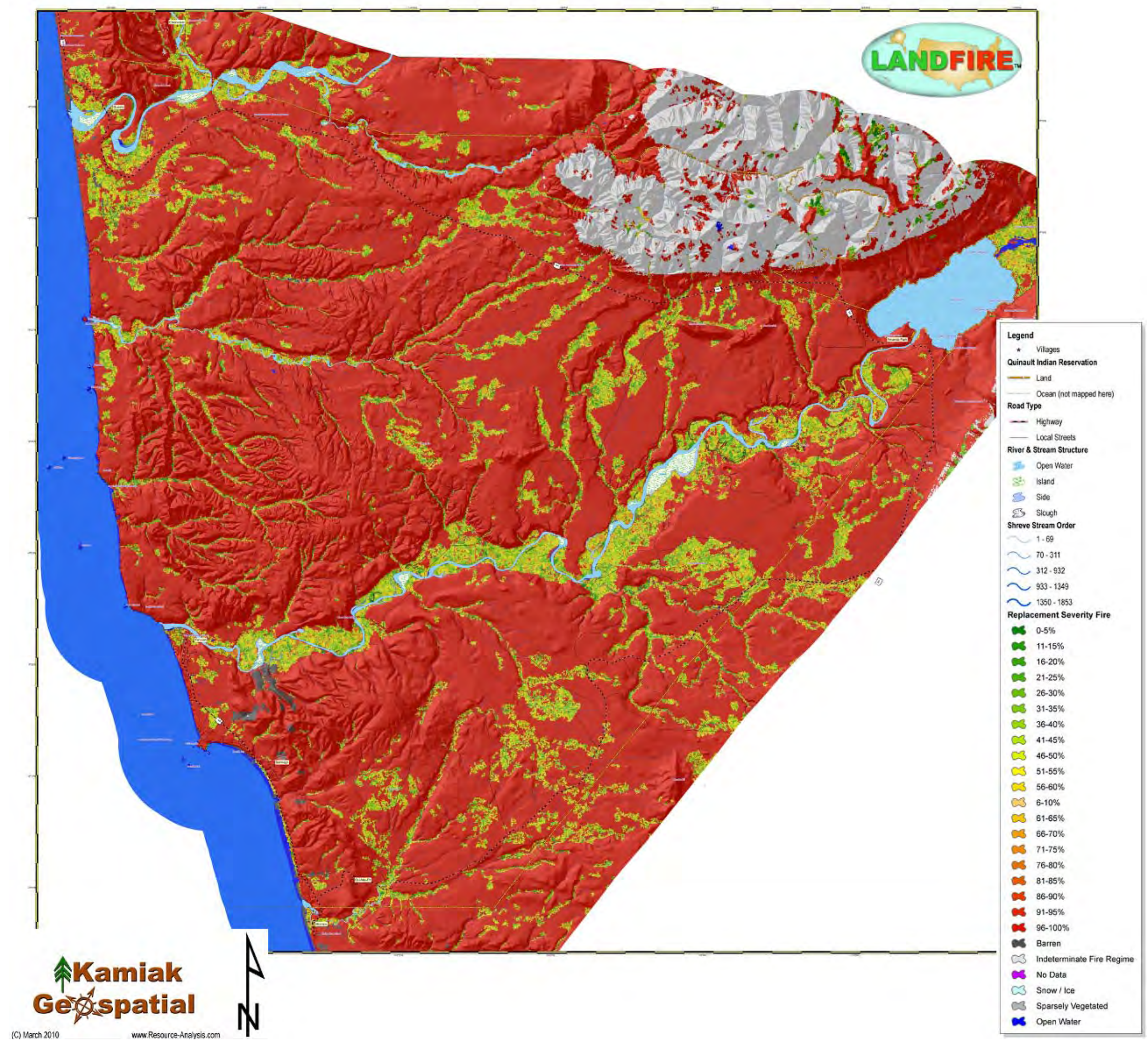
The review of past wildfire ignitions in the QIR, since 1855, demonstrates that the resistance to control in this area is extremely high. Once wildfires start, it is extremely difficult to put them out in a short time period.

The importance of this tool is the determination of relative risk to human developments within the QIR where forestlands are intermixed with houses and other developments. By analyzing these components with respect the location of homes and other structures, a relative risk to wildfire loss is made.

Table 42. Percent of Replacement Severity Fire Extent within the QIR (LANDFIRE 2007).

Percent of Stand Replacing Fires	Acres	Percent
0-5%	269	0.13%
6-10%	149	0.07%
11-15%	474	0.23%
16-20%	973	0.47%
21-25%	1,523	0.73%
26-30%	2,248	1.08%
31-35%	2,930	1.41%
36-40%	4,019	1.93%
41-45%	4,526	2.17%
46-50%	5,451	2.62%
51-55%	2,824	1.36%
56-60%	2,971	1.43%
61-65%	1,876	0.90%
66-70%	1,728	0.83%
71-75%	1,042	0.50%
76-80%	464	0.22%
81-85%	276	0.13%
86-90%	92	0.04%
91-95%	6	0.00%
96-100%	156,898	75.29%
Water	6,466	3.10%
Snow / Ice	7	0.00%
Barren	896	0.43%
Indeterminate Fire Regime	10,289	4.94%
Total	208,397	

Figure LXIII. Percent of Replacement Severity Fire Extent Map within the QIR (LANDFIRE 2007).



4.9.1. Probability of Future Events

Wildland fire frequency within the QIR is accurately expressed by the Mean Fire Return Interval analysis tool (Section 4.9.5.1). This assessment of wildfire return frequency has been developed to span an extensive timescale. The reader should consider these factors as the “general frequency” of wildfire return intervals in the absence of mitigation measures such as the removal of surface fuels, pruning of ladder fuels, and management of forest stand density. Even with these mitigative measures, wildfire frequency and severity can be severely modified by extreme weather patterns of high heat and prolonged drought, or even combined with the event of arson.

All areas of the QIR show exposure to wildfire events. Some areas within the QIR may see wildfire return intervals approaching 200 years, while others may only see wildfire occurrence once in a millennia. However, two points are important to recognize in these statistics: 1) these frequencies are based on undisturbed sites and the placement of homes, villages, and human activities have changed these frequencies (increasing the fire return frequency in many instances), and 2) the frequency in the Mean Fire Return Interval analysis is based on the time since last wildfire event, which may have happened hundreds of years ago.

4.9.2. QIR Potential Mitigation Activities

For many decades of the 20th century, the policy of federal and state agencies was to suppress all wildfires. This policy was epitomized by the mascot Smokey Bear and was also the basis of parts of the Disney produced Bambi movie. The policy of absolute fire suppression in the United States has resulted in the higher than historical buildup of fuel in some forested ecosystems.

Homes and infrastructure designed without consideration of the fire prone environment in which they are built have been a significant reason for the catastrophic losses of property and life experienced in wildfires. The risk of major wildfires can be decreased partly by a reduction or alteration of fuels present. In wildland areas, reduction can be accomplished by various methods: first, conducting controlled burns (prescribed burning); and second, the alteration of fuel mechanics, which involves reducing the structure of fuel ladders. Fuel alteration can be accomplished by hand crews with chain saws or by large mastication equipment that shreds trees and vegetation to a mulch. Such techniques can be effective within the WUI.

People living in fire prone areas can take a variety of precautions, including building their homes out of flame resistant materials, reducing the amount of combustible fuel near the home or property (including firebreaks, effectively their own miniature control lines), and investing in their own firefighting tools (hand tools, water tanks, pumps, and fire-hose). Rural communities are often threatened directly by wildfire. Expanding urban fringes have spread into forested areas, and communities have literally built themselves in the middle of highly flammable forests.

An emphasis in this planning effort is the creation of defensible spaces around homes and neighborhoods to increase the success potential of fire fighters in the case of wildfire emergency. This reduction of the “resistance to control” focuses primarily on removing vegetation immediately adjacent to homes, breaking fuel ladders (pruning), improving ingress and egress, and replacing flammable structure materials with fire-resistant materials (e.g., decks and roofing). In addition, several opportunities exist to bolster the “response ability” of the wildfire and rural fire districts on the QIR to effectively respond with appropriate equipment, staff, and volunteers to save homes and people from wildfire threat.

4.9.3. Protection

A key component in meeting the underlying wildfire control need is the protection and treatment of fire hazard in the WUI. These WUI areas encompass not only the interface (areas immediately adjacent to urban development), but also the continuous slopes and fuels that lead directly to a risk to urban developments. Reducing the fire hazard in the WUI requires the efforts of wildfire agencies and private individuals. “The role of [most] federal agencies in the WUI includes wildland fire fighting, hazard fuels reduction, cooperative prevention and education, and technical experience. Structural fire protection [during a wildfire] in the WUI is [largely] the responsibility of Tribal, state, and local governments” (Norton 2002). Property owners share a responsibility to protect their residences and businesses and minimize fire danger by creating defensible areas around them and taking other measures to minimize the fire risks to their structures. With treatment, a WUI area can provide firefighters a defensible area from which to suppress wildland fires or defend communities. In addition, a WUI that is properly thinned will be less likely to sustain a crown fire that enters or originates within it (Norton 2002).

Tools are available to emergency service responders and managers to assess wildfire fuels, structural risks, and infrastructure components. Computer programs such as RedZone® Software are written to assist fire departments and emergency services efforts to assess individual structures, communities, and regions to understand relative risk components of wildfire exposure and delineate these components of risk in a GIS map. RedZone Software’s suite of products provides agencies a comprehensive solution for data collection, visualization, and map production (Red Zone Software 2009). One of the recommendations in this planning effort is for the QIR to begin using this software to better map and mitigate relative wildfire risks in the WUI (Table 64) and then implement the recommendations with treatments around homes within the WUI (Table 66).

By reducing hazardous fuel loads, ladder fuels, and tree densities, creating new defensible space, and reinforcing existing defensible space, landowners would protect resources in the WUI, the biological resources of the management area, and adjacent property owners by:

- Minimizing the potential of high-severity surface, ladder, and crown fires entering or leaving the area around homes.
- Reducing the potential for firebrands (embers carried by the wind in front of the wildfire) impacting the WUI. Research indicates that flying sparks and embers (firebrands) from a crown fire can ignite additional wildfires as far as 1¼ miles away during periods of extreme fire weather and fire behavior (Norton 2002).
- Improving defensible space in the immediate areas for suppression efforts in the event of wildland fire.

Figure LXIV. Youth Art Contest Submission depicting a tsunami approaching the QIR shoreline, by Lauren Martin. Below, photograph at Point Grenville showing a similar view.

Chapter 5. Community Assessments

The risk exposure discussions provided in Chapter 4 of this document provide the reader with an overview of the types of hazards the QIR faces and the mechanisms of their impact. These discussions can be used for a consideration of “macro-risk assessment” when hazards such as high winds are considered, because there is little to prevent high winds from negatively impacting homes and businesses anywhere on the QIR (thus the moniker of “macro”). On the other hand, a hazard such as a tsunami shows specific risks only to structures and infrastructure within a tsunami inundation zone (a location specific risk). The same comparisons can be applied to all hazards affecting the QIR.

In this Chapter of the Quinault Indian Reservation Tribal Hazards Mitigation Plan, we will address the “Macro Hazards” first, and then articulate the risk exposure to the location specific hazards on a village by village basis. Each discussion will articulate the current exposure to existing structures as well as describe the current planning and zoning guidelines for new structures.

5.1. Planning and Zoning

The QIN has implemented a program of planning and zoning on the QIR. The primary purpose of zoning is to segregate uses that are thought to be incompatible while targeting areas of compatible uses. In practice, zoning is used to prevent new development from interfering with existing residents or businesses and to preserve the "character" of a community. It can also be used to ensure that when developments are made, attention to natural hazards is addressed in the construction plan.

Zoning on the QIR is controlled by the QIN; however, conflicts have arisen because of permits issued by Jefferson County for a development on the QIN in contradiction to the QIN’s adopted zoning. This conflict was adjudicated in a court of law recently, but that court decided in favor of the County’s issuance of the building permit without the QIN’s consent. It is the intention of the QIN to manage all future zoning policy on the QIR.

The Planning Department of the QIN has identified four discrete zoning groups within the QIN: Commercial, Residential, Forestry, and Wilderness. Section 3.3.7, Table 15, and Figure XI include discussions about the development of population density indices across the QIR. The location of all structures currently on the QIR, were evaluated in light of the current zoning policies (Table 43) and the population density indices (Table 44) developed here (Figure LXV).

Several examples can be identified of compatible land uses within properties located in Commercial and Residential Zoned properties (Table 43). It would appear that approximately 77% of the total improvement value of all improvement values on the QIR is in these two current use categories. The remaining 23% of total improvement value located in Forestry and Wilderness Zoned properties includes some QIN structures used for fisheries, forestry, a Seed Breeding Center, and other variance allowed uses. Some of these structures, however, are not consistent with the intended use and serve as recreation cabins or seasonal dwellings within the Wilderness or Forestry Zoned areas, especially along the Raft River Wilderness area.

A review of the Population Density Indices developed for this planning effort (Table 44 & Figure LXV), reveals that there are currently no structures located in the “wildland” category of population density, but this should be expected since the definition of that category is defined by the absence of current structures in the zone. The distribution of the remaining structures on the QIR is concentrated within the intermix category (69% by value), within the interface category (15% by value) and in the Remote or Rural category (16% by value). All of the Zoned properties identified for residential and commercial uses are within the population density indices for interface and intermix lands, based on current population distributions.

Table 43. Current Zoning Categories on the QIN and Value of Existing Structures.

		Value of Structures				Number of Structures			
Community Area	Structure Value	Commercial	Residential	Forestry	Wilderness	Commercial	Residential	Forestry	Wilderness
Amanda Park	$18,045,408	$5,871,863	$8,619,077	$3,554,468	$-	53	63	34	0
Cook Creek Hatchery	$7,592,491	$-	$-	$7,592,491	$-	0	0	28	0
Point Grenville	$864,555	$-	$-	$494,000	$370,555	0	0	4	9
Queets	$7,809,796	$763,006	$5,887,907	$551,403	$607,480	6	64	4	7
Queets / Clearwater	$1,978,706	$-	$-	$1,978,706	$-	0	0	20	0
Qui-nai-elt Village	$7,508,619	$-	$7,508,619	$-	$-	0	56	0	0
Quinault River	$16,000	$-	$-	$16,000	$-	0	0	1	0
Raft River Wilderness	$390,960	$-	$-	$323,425	$67,535	0	0	9	11
Taholah - Lower Village	$36,338,174	$2,167,250	$34,045,924	$125,000	$-	10	250	2	0
Taholah - Upper Village	$23,023,899	$12,397,079	$10,041,320	$585,500	$-	12	53	4	0
Taholah Ocean Tracts	$1,530,285	$-	$-	$1,231,635	$298,650	0	0	20	5
US101 Zone*	$8,386,947	$-	$-	$8,386,947	$-	0	0	21	0
Totals	$113,485,840	$21,199,198	$66,102,847	$24,839,575	$1,344,220	81	486	147	32

* The US101 Zone is that area between Amanda Park and Queets / Clearwater along US101 where developments are located.

Figure LXV. Zoning Map Created and Administered by the QIN for Developments on the QIR.

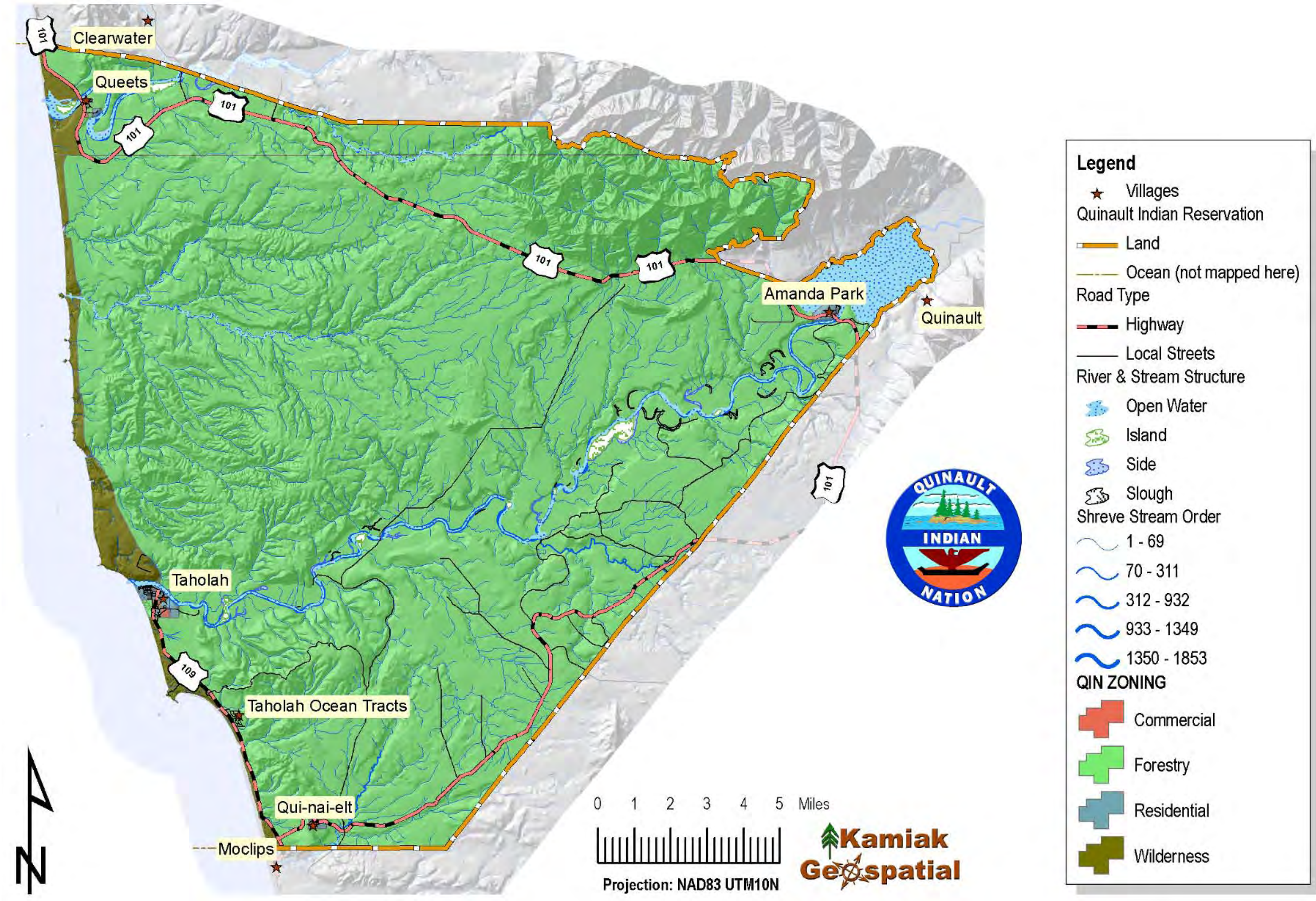


Table 44. Structure Location Identified by Population Density Indices.

Community Area	Structure Value	Value of Structures: Interface	Value of Structures: Intermix	Value of Structures: Remote/Rural	Number of Structures: Interface	Number of Structures: Intermix	Number of Structures: Remote/Rural	Total Count
Amanda Park	$18,045,408	$6,866,246	$11,179,162	$-	64	86	0	150
Cook Creek Hatchery	$7,592,491	$-	$-	$7,592,491	0	0	28	28
Point Grenville	$864,555	$854,550	$10,005	$-	10	3	0	13
Queets	$7,809,796	$7,809,796	$-	$-	81	0	0	81
Queets / Clearwater	$1,978,706	$37,320	$-	$1,941,386	3	0	17	20
Qui-nai-elt Village	$7,508,619	$-	$7,508,619	$-	0	56	0	56
Quinault River	$16,000	$-	$-	$16,000	0	0	1	1
Raft River Wilderness	$390,960	$9,500	$-	$381,460	2	0	18	20
Taholah - Lower Village	$36,338,174	$25,000	$36,313,174	$-	1	261	0	262
Taholah - Upper Village	$23,023,899	$-	$23,023,899	$-	0	69	0	69
Taholah Ocean Tracts	$1,530,285	$1,530,285	$-	$-	25	0	0	25
US101 Zone	$8,386,947	$-	$-	$8,386,947	0	0	21	21
Total	$113,485,840	$17,132,697	$78,034,859	$18,318,284	186	475	85	746

* The US101 Zone is that area between Amanda Park and Queets / Clearwater along US101 where developments are located.

5.2. Macro Hazards

5.2.1. High Wind Damage

The first hazard in this category is wind damages to structures and infrastructure on the QIR. Literally, this hazard can, and does impact every home, business, power line, and shoreline on the QIR. There is no area on the QIR that has any form of structure or infrastructure that has not been effected by historical windstorms. In addition to the structures and infrastructure of the QIR that has been impacted by high winds, the losses to standing timber volume have been substantial (Figure XXVII).

Standing trees can be felled by high winds, tops can be broken off trees, and one tree (or many) can fall against another tree (or many) to cause bark scarring or gouging of the stem. When this happens, the impacted tree might stay standing, but be damaged in a way that allows pathogens or insects to attack the standing tree, resulting in loss of vigor or even causing death to the tree within a year or, within 5 years.

When trees are felled by high winds, the damage can be in the form of trees dropped in a line (from straight line winds) or in a “jack-straw” pattern from downbursts. In either scenario, the falling trees can easily snap power lines, drop on structures, block roads, or cause river debris jams. The prevention of these episodes is difficult to accomplish without causing a vector for another high wind damage. For instance, if all trees are cut down around a group of homes to prevent wind damage from dropping trees on the homes, the winds may have a more direct access to the homes in a way that roofing materials are compromised during the high winds. At the same time, the removal of the trees from the site may cause the soils to become less stable with the loss of the tree roots leading to more erosive soils and even causing slope stability to weaken and lead to landslides.

These scenarios are not detailed to infer that nothing can be done to reduce wind damage potential, but only to elucidate the interrelatedness of hazard exposures while attempting to mitigate one hazard at a time.

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 QIR.

Around homes on the QIR, the management of the communities should address several factors, one of which is the standing timber within “reach” of structures and the power lines. Thinning of trees on the QIR may seem like an intuitive way to preserve the aesthetic pleasure of the standing trees around the homes while removing a portion of the risk exposure from falling trees. However, the soils and the forest species of the QIR may not favorably respond to a large-scale thinning by growing more stable root systems and tree stems. On the contrary, trees in this region, when they are thinned may become wind resistant and fall to a lower velocity wind. Of course, each site is unique and has a different mix of tree species, some native and some introduced, and tree husbandry must be considered on a case-by-case basis.

Other factors that homeowners, businesses, communities, and the Nation should consider, include:

- Roofing stability for the roofing materials and the edging around the roofing materials,
- Securing siding attachments,
- Protecting power supply lines from the main-line (at the road) to the structure, in terms of trees and branches that can cut the power line during a high wind,

- Conducting verification of the wooden power poles strength (due to a possible wear and tear) along roads and inside communities,
- Installing window shutters on windows exceeding a three-foot span in either direction.

There are several structures located in all of the communities of the QIR and most of them that were constructed more than 15 years ago are showing signs of roofing materials that have either been blown off the structure, or have been dislodged by high winds and falling branches. These should be evaluated and improved before more high winds continue the damage. When roofing materials are compromised, rains have the ability to cause storm damage.

Window shutters are a common fixture in the hurricane zones of the American southeast where gale force winds from hurricanes are seen. The utility of window shutters is to secure the breakable glass against the direct force of the winds. Although the force of the winds along the Pacific Ocean's coastline is directly comparable to the force of many hurricanes, the attachment of window shutters along the west coast has been adopted less. These fixtures should be considered on many homes where the force of the winds is frequently seen, and on new construction where the frequency of high winds may not have yet been documented.

5.2.2. Seismic Shaking Hazards

Seismic shaking hazards have been addressed in Section 4.5.6.1 (Ground Response from a CSZ Earthquake) to address the uniform design class risks this entire region faces. The exposure to these risks is generally seen by the preponderance of URM structures, but as has been noted earlier, there are no multi-story URM buildings on the QIR. There are however, many structures with URM construction chimneys. About half of the residential structures on the QIR use wood burning heat. The other half of homes use either electric or gas heating with no chimney present. Of those homes with brick or masonry chimneys, there is a mix of approximately 50% of homes using URM materials, and the other 50% using stove pipe construction. That narrows down the number of structures at risk to approximately 25% of the total number of structures, or approximately 187 homes (746 homes x 0.25).

Figure LXVI. Examples of URM Chimney Structures on the QIR, Point Grenville (left) and Amanda Park (right).

Mitigation measures for these homes can be constructed by installing bracing structures vertically on all four corners of the chimney, extending from the top of the chimney to the ground or the entrance to the structure. The angle iron used for the bracing can be jointed horizontally (welded in place) periodically along the chimney's height, every few feet. Then the structure is tethered to the structure's frame, through the roofing material. The intent of the structure is to ensure that during a seismic event (earthquake) the chimney does not shake apart and fall on people or assets on the ground that could be killed or damaged from the impact. These activities are recommended across all of the QIR and for all new construction (through building codes) with external chimneys extending more than three feet above the roofing structure.

5.3. Culturally Significant and Sacred Sites

Cultural Resource information and consultation is confidential information and will not be released in any form concerning location, extent, or characteristics of any article or site. The level of sensitivity of the information is bound by Tribal and Federal policies.

Cultural resources include artifacts, land use practices, traditions, language and more. Impacts to these that involve federal triggers (e.g. federal grant or agency money, permits, lands, etc.) require Tribal Historic Preservation Officer (THPO) involvement per Section 106 of the National Historic Preservation Act, 36 CFR 800, http://www.achp.gov/nhpa.html. It is prudent to involve the THPO and/or Tribal Cultural Resource program early in the process of addressing any hazard mitigation activity to avoid potential costly delays in implementation. Removing or disturbing cultural resources prior to planning/designing/implementing/funding a project in order to circumvent cultural resource law is illegal.

Natural hazards as described in this document can impact all culturally significant and sacred resources of the QIR. In some cases, it is the progression of the natural events of the earth that lends the site a portion of its significance. In other situations, the progression of a cycle of disaster may destroy the physical characteristic of a site, but not the cultural significance of it.

For example, the shoreline erosion that exposed the tsunami debris over a tribal fire pit in Figure XLIV made this site what we now consider to be culturally significant. Other natural processes that can be considered natural disasters today may be considered a part of the larger scheme of cultural significance.

The QIN THPO office is aware of the extent of natural disasters articulated within this Tribal Hazards Mitigation Plan and will monitor the occurrence of disaster events and participate in emergency response and potential mitigation measures to ensure that culturally significant and scared sites are not artificially or inadvertently disturbed.

Generally speaking, floods, ocean shoreline encroachment, tsunami, river meandering, and landslides can exert the greatest potential impact on site-based sacred sites where the site is partially defined through the physical presence of past activities such as burial sites, sites with signs of past habitation, or those sites that bear witness to pictographs or other markings. While the natural disaster may destroy or alter the characteristics of the site, the importance of the site is not diminished.

Vandalism, theft, and artificial concealment of a site's physical attributes of cultural significance or sacred nature cannot be tolerated. This form of destruction breaks the natural cycle of earthly changes and leaves scars to the cultural tapestry of the Quinault people.

5.4. Community Based Risk Exposure

Although each of five populated places will be addressed in this section of the planning document, a series of tables (Table 45 through Table 52) are offered at the end of this section to assist the reader in accessing these summaries of data for all populated places on the QIR.

5.4.1. Amanda Park & Tsa'alal

Amanda Park is located near the shores of Lake Quinault where the lake drains into the Lower Quinault River (Figure LXVII & Figure LXVIII). Although the QIR extends to encompass all of Lake Quinault, the boundary of the Reservation stops at the shoreline where homes are located above the shoreline. The Village of Amanda Park includes approximately 150 structures valued at approximately $18.0 million (Table 45) within the QIR.

As already defined in Section 5.2 (Macro Hazards), the risk exposure to high winds and seismic shaking hazards is uniformly high in Amanda Park, as well as the other populated places of the QIR. The same assessment can extend to Tsa'alal located in the northwestern corner of Amanda Park and considered a part of this community. There are several trees surrounding homes, and there are many homes with compromised roofing materials that would benefit from reinforcement from the wind and falling debris from surrounding trees. The prevalence of URM chimneys (Figure LXVI) is well noted in this area.

Amanda Park and Tsa'alal are not at any direct risk from an ocean tsunami. The area is comprised of lands designated for residential development and commercial development with forestry zoning surrounding it. Growth Management areas are concentrated from Amanda Park through Tsa'alal (Figure LXVIII).

Figure LXVII. The High School at Amanda Park with Lake Quinault (Workman 2009).

5.4.1.1. Flood Risks

Flood risks in Amanda Park are attributed to the shorelines of Lake Quinault where several homes have been built along the shorelines. During periods of high rainfall the level of the lake can rise to the level of the homes located here, especially those in the northern apex of the peninsula along the lake's southern shoreline. Approximately 21 homes in Amanda Park (out of a total of 150 structures), representing 12% of the total value of structures in this village are located in an area estimated as being within the floodplain (Table 45). Most of the homes at-risk to flooding are located along the northeastern apex of the peninsula of land jetting into Lake Quinault's southern shoreline (Figure LXX).

Residents of this area have reported periodic flooding to their homes with varying amounts of damage ranging from water under the home to water damage of the structure's ground floor. Valuables left in the yard have been damaged from rising flood waters and access into and out of the area has been complicated by water over the roadway.

Lake Quinault is not a regulated waterway; there is no dam or spillway on this river system or lake. Because the pour point of Lake Quinault into the Quinault River is located near these homes in Amanda Park, the periodicity of flooding is relatively short-lived, meaning that the flood activity is generally of a short interval, two days or less, before flood waters recede. However, this is not always the case.

Potential mitigation measures for these homes to avoid the chance of periodic flooding, includes elevating the structures above the regulatory flood level, relocating the structures away from the lake shore, or even condemning those homes to future uses. Zoning in Amanda Park should develop and enforce a setback from the lake and river flood zones to assure unimpeded and free flow of waters, and to protect future developments from flood water damage.

Storm water accumulation within Amanda Park is isolated generally to areas where rainfall accumulates within small depressions. Snowfall accumulations that are followed by warming weather and rainfall can also exacerbate this situation. These locations are not widely distributed, although several locations have been identified where this occurs. Generally, these areas can be mitigated for water accumulation damages by developing drainage ditches that link the water accumulation areas into larger drainage systems. Often times, these drainage routes must be maintained actively during and after snow events.

Caution should always be applied to reducing these surface water accumulations by draining the water directly into the lake or the river. These surface water accumulations can become contaminated by oils, detergents, salts, and other water soluble contaminants that would harm fisheries in the river. A filtration system should be applied to any such activity in this area because of the heavy traffic along US101 and the commercial enterprises operating in this village.

5.4.1.2. Liquefaction

Liquefaction risks in Amanda Park and Tsa'alal are rated as "low to very low" by the Washington DNR assessment cited in this document's risk assessment (Figure LXXI and Table 47). These risks are near the lowest on the QIR only being rated at higher risk than exposed bedrock. Caution can be exercised in Amanda Park for any developments that would potentially be placed outside of the current zoning area for residential and commercial properties, as most of the area adjacent to the Quinault River is considered "moderate to high" in liquefaction risks (Figure LXXI). These areas are currently excluded from QIN targets for expansion in Growth Management and Zoning efforts.

5.4.1.3. Slope Stability

The slope stability, or the potential for landslides, within and around Amanda Park and Tsa'alal show relatively low risks and isolated to the steep slopes adjacent to the Quinault River and Lake Quinault (Figure LXXII and Table 48). The exposure to landslides in the areas surrounding homes and businesses at Amanda Park includes approximately 4 structures (Table 48) valued at $147,000 in high risk category, 22 structures valued at $2.6 million in the moderate risk category, and 124 structures valued at $15.3 million in the "low" and "low to very low" category of risk for landslides.

Setbacks from both shorelines should serve to protect future developments in these areas from mass wasting events.

5.4.1.4. Wildfire

Assessments for MFRI and Replacement Fire Severity are summarized in Table 49 through Table 52. The MFRI for this area places the natural fire return interval at 200 years to 1,000 years (Figure LXXIII). Although human caused changes to this natural fire regime should always be considered, it is clear that the natural fire return cycle will not be a driving force for wildfire ignitions. On the other hand, these statistics can be interpreted with the Replacement Fire Severity considerations that predict that when a wildfire does ignite, and weather conditions are consistent with a major wildfire event (hot temperatures, dry weather, and high winds) that the resistance to wildfire control is predictably high. The Replacement Fire Severity Predictions for Amanda Park (Table 51 and Table 52) place approximately 88% of all structural value in the classification of 76% to 100% stand replacement fires.

One of mitigating measures in Amanda Park for these events is the placement of wildfire apparatus in the area available to stop a wildfire within a very short interval after ignition.

5.4.1.5. Expansive Soils

Expansive soils and expansive clays within the area of Amanda Park are a mix of low to moderate risks (Figure LXXIV). Current developments in this community area are mainly located within the areas identified as low risk to expansive soils. Residential structures and light commercial structures associated with a fish hatchery located east of the Quinault River and adjacent to Lake Quinault are located within areas of moderate risk.

The current QIN Growth Management Area is displayed with the Expansive Soils projection (Figure LXXIV) and displays those areas identified for desired future growth to be generally consistent with limited expansive soil and expansive clay risks. However, all of these areas should be considered as marginally verified as a low risk while considering future developments because of the intermingled soil characteristics. On-site geotechnical evaluations should be considered before new developments are placed in this area.

Figure LXVIII. Aerial Photography of Amanda Park, 2009.

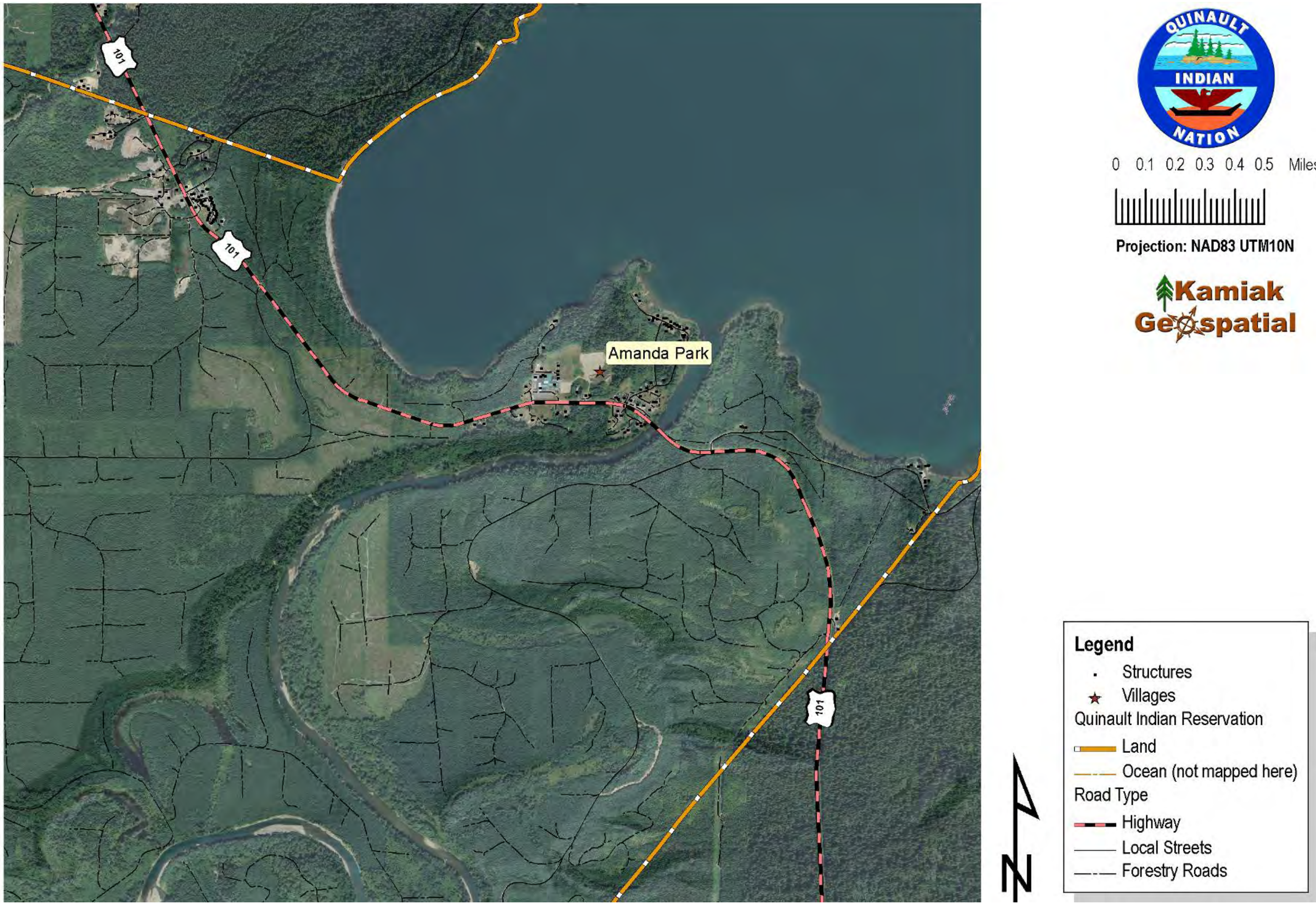


Figure LXIX. Zoning and Growth Management of Amanda Park.

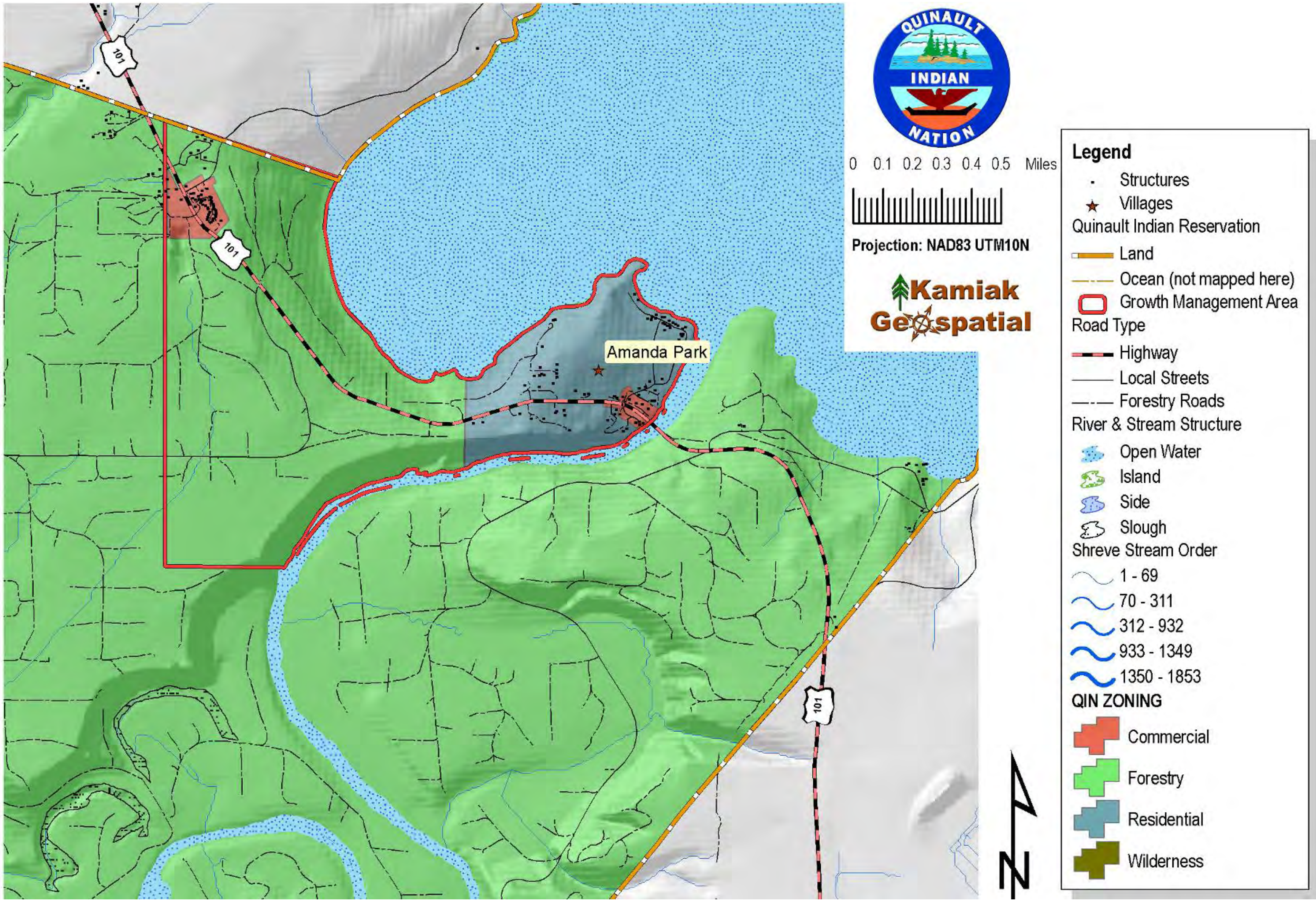


Figure LXX. Floodplain Mapping of Amanda Park.

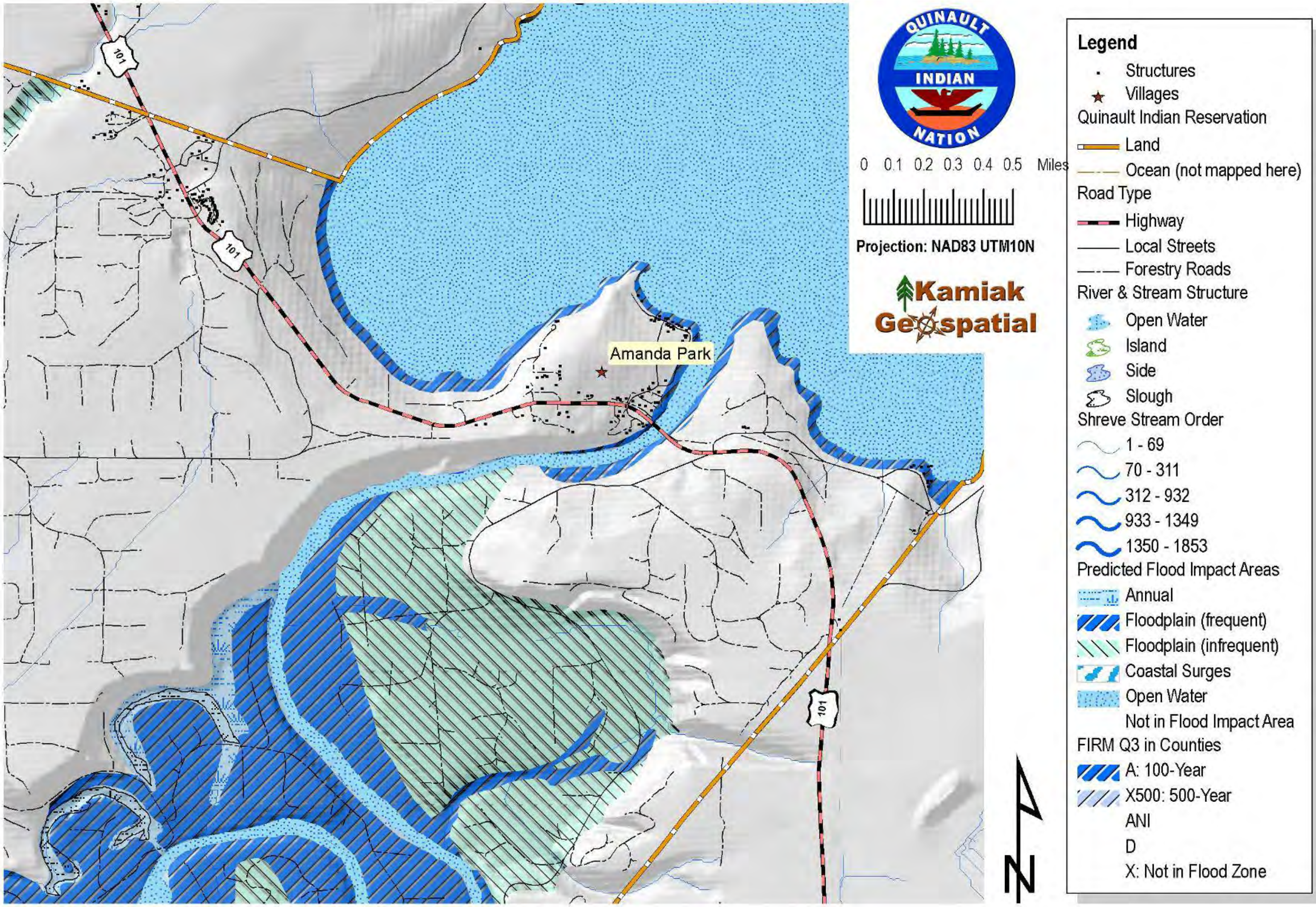


Figure LXXI. Liquefaction Mapping of Amanda Park (WDNR 2010).

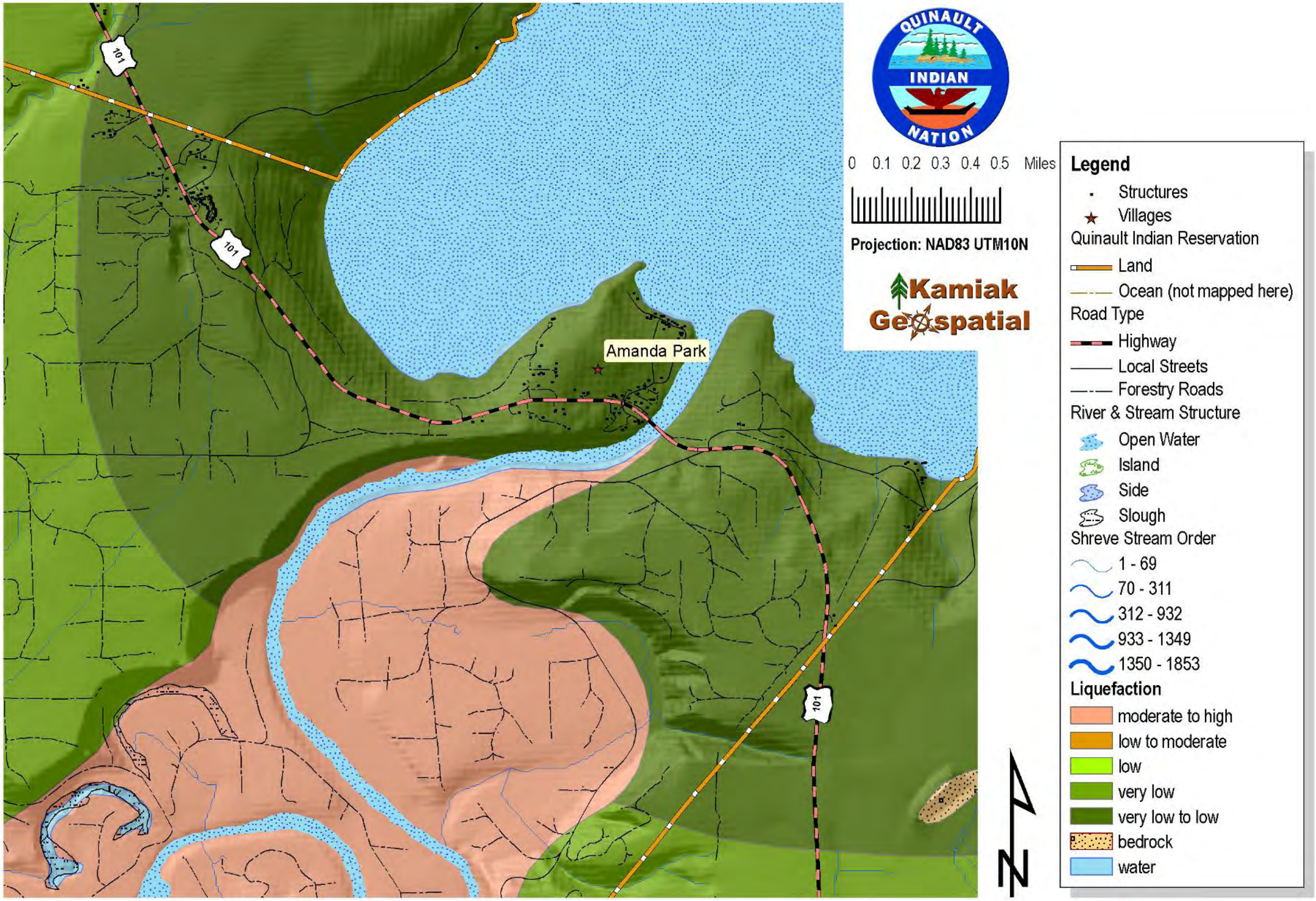


Figure LXXII. Slope Stability Predictions for Amanda Park (WDNR 2010).

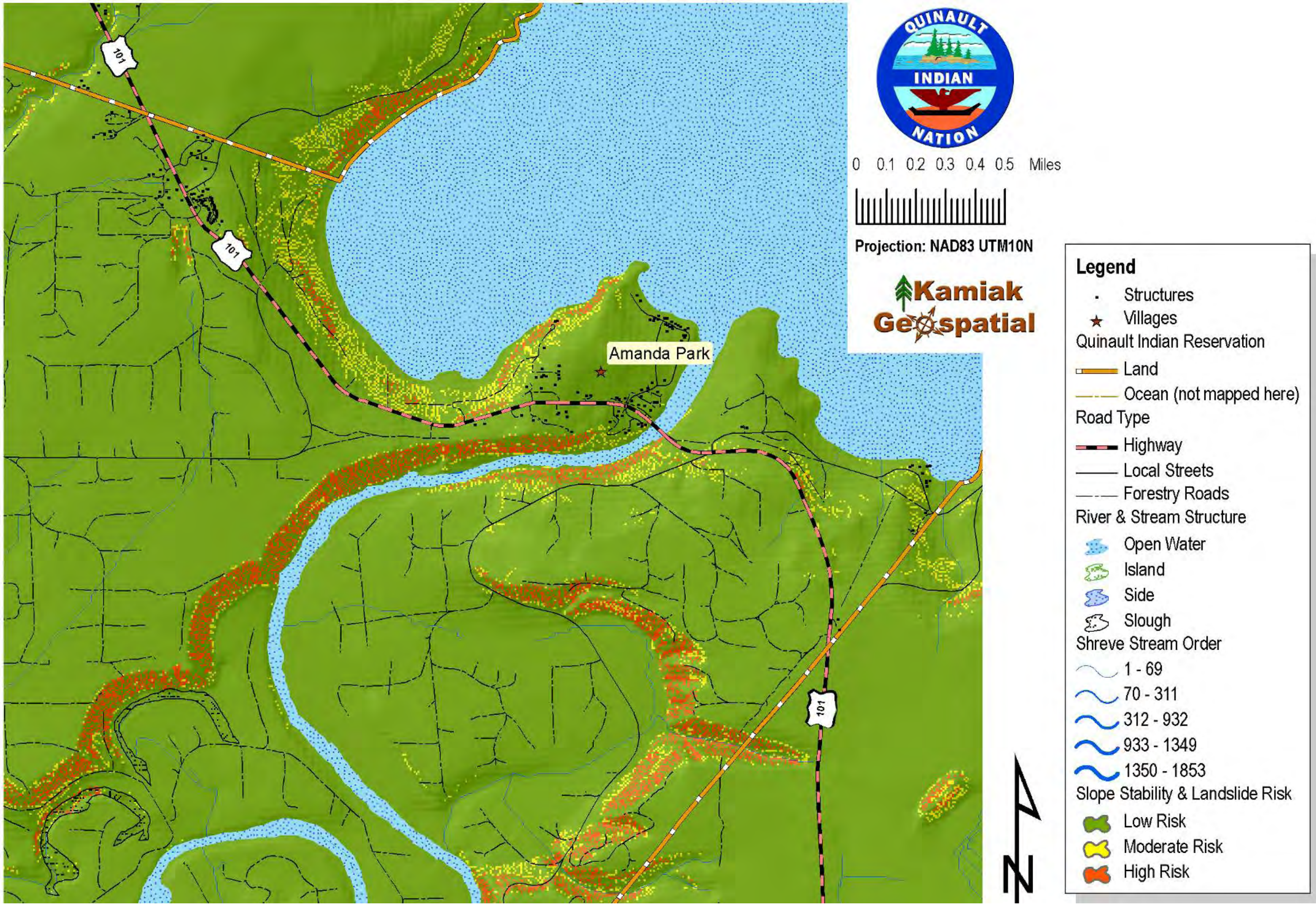


Figure LXXIII. Mean Fire Return Interval for Amanda Park (LANDFIRE 2007).

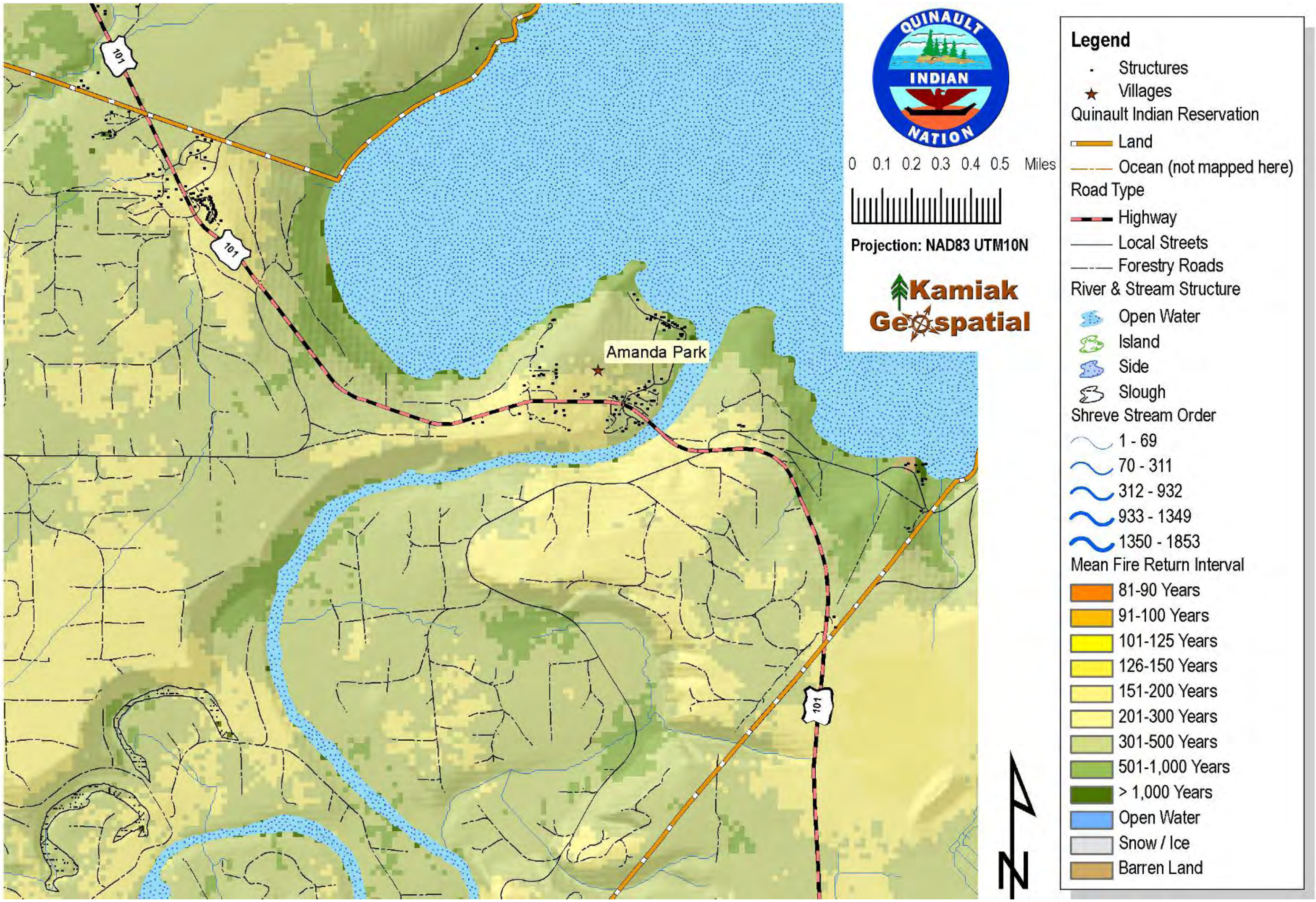
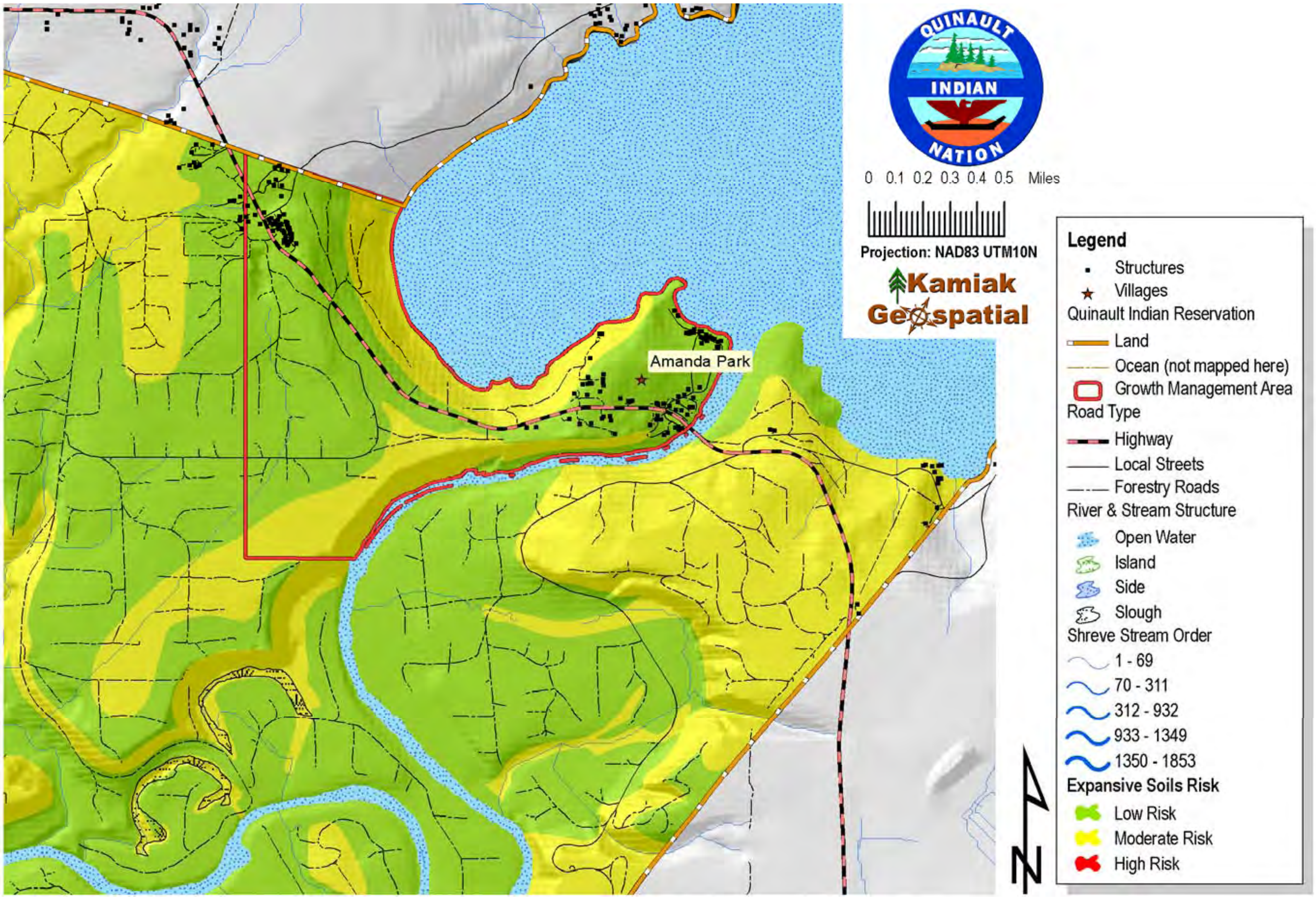


Figure LXXIV. Expansive Soils and Expansive Clays Assessment for Amanda Park.



5.4.2. Queets

Figure LXXV. Welcome to Queets greets those entering the village.

The Village of Queets is located at the northwestern extent of the QIR between the bends of a hairpin turn in the Queets River. Access is provided by US101 and the village rests only a mile from the Pacific Ocean (Figure LXXX). The Village of Queets includes approximately 82 structures valued at approximately $7.8 million (Table 15) within the QIR.

As already defined in Section 5.2 (Macro Hazards), the risk exposure to high winds and seismic shaking hazards is uniformly high in Queets, as well as the other populated places of the QIR. There are several trees surrounding homes, and there are many homes with compromised roofing materials that would benefit from reinforcement from the wind and falling debris from surrounding trees. The prevalence of URM chimneys (Figure LXVI) is well noted in this area.

Figure LXXVI. The Village of Queets overlooking the US101 bridge crossing of the Queets River (left), and the mouth of the Queets River draining into the Pacific Ocean (right and bottom) (Workman 2009).

5.4.2.1. Flood Risks

Flood risks in Queets are attributed to the shorelines of the Queets River. This village's historical placement within the elevated areas of the river banks has been called "brilliant". The structures and most access routes are located a few feet above the highest flood waters of the Queets River (Figure LXXXI and Table 45). Although one structure is located in the flood zone, this structure it is quite literally "on the edge" (of being in or out of the floodplain).

Storm water accumulation within the village of Queets is isolated generally to areas where rainfall accumulates within small depressions. These have occurred in response to road maintenance and site clearing activities. Generally, these areas can be mitigated for water accumulation damages by developing drainage ditches that link the water accumulation areas into larger drainage systems.

As was detailed in the similar discussion for the Village of Amanda Park, caution should always be applied to reducing these surface storm water accumulations by draining the water directly into the river. These surface water accumulations can become contaminated by oils, detergents, salts, and other water soluble contaminants that would harm fisheries in the river. A filtration system should be applied to any such activity. The risks of this occurrence in this area is low because of the residential nature of the village. However, there are commercial enterprises here including the fisheries activities and the gas station / mini mart.

The Queets Rose Bowl is a reference to the wastewater treatment facility for the village (Figure LXXVII & Figure LXXVIII). The existing stabilization ponds are located southwest of the village and adjacent to the Queets River. Estimates of the flood water inundation to the settling ponds is a frequency of an annual event. The Queets River, during high water flows has been eroding the access road to this facility. The road is located between the facility and the river. This has led to erosion of the road bed (Figure LXXIX).

Figure LXXVII. Oblique view of the Village of Queets, including the US101 crossing of the Queets River, and the Queets Rose Bowl featured adjacent to the river and below the village on the right-side shoreline (Haugland 2010).

Figure LXXVIII. Oblique view of the Queets Rose Bowl featured adjacent to the Queets River and showing bright green vegetation in the wastewater stabilization ponds (Haugland 2010).

When waters breach the road, the flows begin to erode the earthen berms established to separate the ponds from the river. This has not been successful and a mixing of the waters (waste water and river water) has occurred. The mapping of the area for potential flood impact areas includes approximately half of this area as being within the “frequent” flood impact zone.

Plans are proposed by the QIN Community Services Division and Indian Health Services (Port Angles office) to provide for a temporary fix to the nearly annual flood events, and a long term approach to relocate the wastewater treatment facility for the Village of Queets.

The temporary fix of this site is to build-up the roadbed to a height of an additional 2 to 3 feet using heavy rock. This roadbed would serve as a levee of sorts to hold the river’s water out of the wastewater treatment facility. Because this road provides access to fishermen in addition to access of the Queets Rose Bowl, the improvement of this road would have longer-term benefits.

Figure LXXIX. Queets River flood inundation to the access road from the Village of Queets to the Queets Rose Bowl (waste water treatment facility) (Wells 2010).

The proposed long-term improvement of the Queets Rose Bowl is to relocate the facility. Current efforts are evaluating sites out of the flood zone, away from erosion susceptible areas, and where topographic relief allows for a functional sewer main to provide treatment to wastewater from the village. Cost estimates for this project have exceeded $2.0 million and further assessments are projected into 2011.

5.4.2.2. Tsunami

The same “brilliant” site location factors of the Village of Queets that provides a level of protection from flood waters in the village populated places, can be applied to tsunami risks from a CSZ tsunami (Figure LXXXIII and Table 46). The Queets River approach to the ocean does not have any form of a protective barrier against an oncoming tsunami wave, and the mile the wave would traverse on its approach to the village is almost straight-line. However, the width of the mouth of the Queets River is wide and the river bottom continues at a moderate grade for many miles up the river. The predicted result is that a tsunami wave would be forced up the river channel and mostly bypass the village.

This is not to say that the village would escape all damages. A forceful tsunami would be expected to uproot trees, carry ocean debris, and erode the river channel quickly and forcefully. When this happens, there is a good change that the US101 bridge would be damaged beyond use (until repaired). Debris could form a dam in the river causing waters to backup into the village and cause wide-spread destruction. There are even parts of US101 that could be eroded or wiped out from the force of a tsunami hitting the coastline near this village.

The only recommendation for future development in this area is to allow for a considerable set-back from the river’s shoreline to allow for the unfortunate event of a CSZ earthquake generated tsunami. This setback from the river’s shoreline would serve the QIN well in the protection of the aquatic ecosystem for fisheries management purposes and the protection of human lives.

There are several structures currently located to the northwest of the Village of Queets, along the banks overlooking the ocean. These structures are not a part of the targeted QIN Zoning area for residential or commercial uses. However, there are structures currently located here. In the event of a CSZ earthquake generated tsunami, it is possible that the combined force of the tsunami wave on the steep hillsides (immediately following a seismic event) would result in rapid erosion and mass wasting of the hillside, dropping structures onto the ocean shoreline. These predictions are complicated by individual structure septic systems that may be saturating underlying soils and the possible presence of expansive soils. These concerns advise us to place the risk to life to error on the cautious side, and warn against future developments that would unduly exploit these sensitive ocean shoreline cliffs.

5.4.2.3. Liquefaction

Liquefaction risk assessments in the Village of Queets are met with the dividing line between “very low” to “moderate to high” risks (Figure LXXXIV and Table 47). The apex of the hairpin turn of the Queets River, and all of the river shoreline, is dominated by unconsolidated river and ocean sediments that have been deposited and eroded for millennia as the river has meandered through the landscape. The two major meandering turns in the Queets River have formed in response to the presence of erosion resistant bedrock located northeast, and across the river from the village site. This erosion resistant bedrock has served to divert the path of the river around its southern flank and has helped to develop the meander seen today.

Along the shorelines of the river, the soils are considered to be “moderate to high” in terms of liquefaction risk. There are several homes within the northern half of the northern village, and all of the southern village, located on “moderate to high” risk soils. About 34 structures are located on soils considered at “very low” liquefaction risks (Table 47).

An almost equal percentage of the “moderate to high” liquefaction risk to “very low” liquefaction risk is seen in the Village of Queets with approximately $4.2 million of structure value located in the “very low” risk category, and $3.6 million in the “moderate to high” liquefaction risk category (Table 47).

Future developments in this area should target developments to the soils rated “very low” to liquefaction risks, as there are an ample number of potential sites where these soil are more conducive for building purposes.

5.4.2.4. Slope Stability

The landslide risk within and around the Village of Queets is relatively low and isolated to the steep slopes adjacent to the Queets River and along the ocean side cliffs (in the northwestern extent of this area) (Figure LXXXV and Table 48). The exposure to landslides in the areas surrounding homes and businesses within Queets includes approximately 6 structures (Table 48) valued at $529,000 in high risk category, 8 structures valued at $641,000 in the moderate risk category, and 65 structures valued at $6.5 million in the low risk category.

Setbacks from both shorelines (river and the ocean) should serve to protect future developments in these areas from mass wasting events.

5.4.2.5. Wildfire

Assessments for MFRI and Replacement Fire Severity are summarized in Table 49 through Table 52. The MFRI for this area places the natural fire return interval at 200 years to 500 years (Figure LXXXVI, Table 51 and Table 52). Although human caused changes to this natural fire regime should always be considered, it is clear that the natural fire return cycle will not be a driving force for wildfire ignitions. On the other hand, these statistics can be interpreted with the Replacement Fire Severity considerations that predict when a wildfire does ignite, and weather conditions are consistent with a major wildfire event (hot temperatures, dry weather, and high winds), that the resistance to wildfire control is predictably high. The Replacement Fire Severity Predictions for the Village of Queets (Table 51 and Table 52) place about $3.6 million of structural value in the classification of 76% to 100% stand replacement fires, with approximately $3.9 million in the 26% to 50% stand replacement severity (Table 51 and Table 52).

As a mitigating measure to prevent these events, the placement of a structural fire station at Queets (Figure CXX) has been recently made. In addition to this piece of equipment, a wildfire apparatus in the area available to stop a wildfire within a very short interval after ignition is strongly recommended. The village has an existing fire station to house these vehicles, but personnel to respond to emergencies are in long-term need of equipment and training.

5.4.2.6. Expansive Soils

Expansive soils and expansive clays within the area of Queets are a mix of low to moderate risks (Figure LXXXVII). Current developments in this community area are mainly located within the areas identified as moderate risk to expansive soils. All of the structures located within Queets are residential and light commercial structures (Headstart, Fire Station, Recreation Center, gas station/store). All sites except the areas immediately adjacent to the Queets River are rated as moderate in their risk profile to expansive soils. Even US101 passes through a zone of high risk territory north of the Queets River (Figure LXXXVII).

The current QIN Growth Management Area is displayed with the Expansive Soils projection (Figure LXXXVII) and displays those areas identified for desired future growth to be at risk (moderate) to expansive soil and expansive clay conditions. All of these areas should be considered as limiting to future developments because of the soil characteristics. On-site geotechnical evaluations should be considered before new developments are placed in this area. Pre-construction factors to limit the amount of variation in soil wetting and drying should be implemented where practical.

Figure LXXX. Aerial Imagery of Queets, 2009.

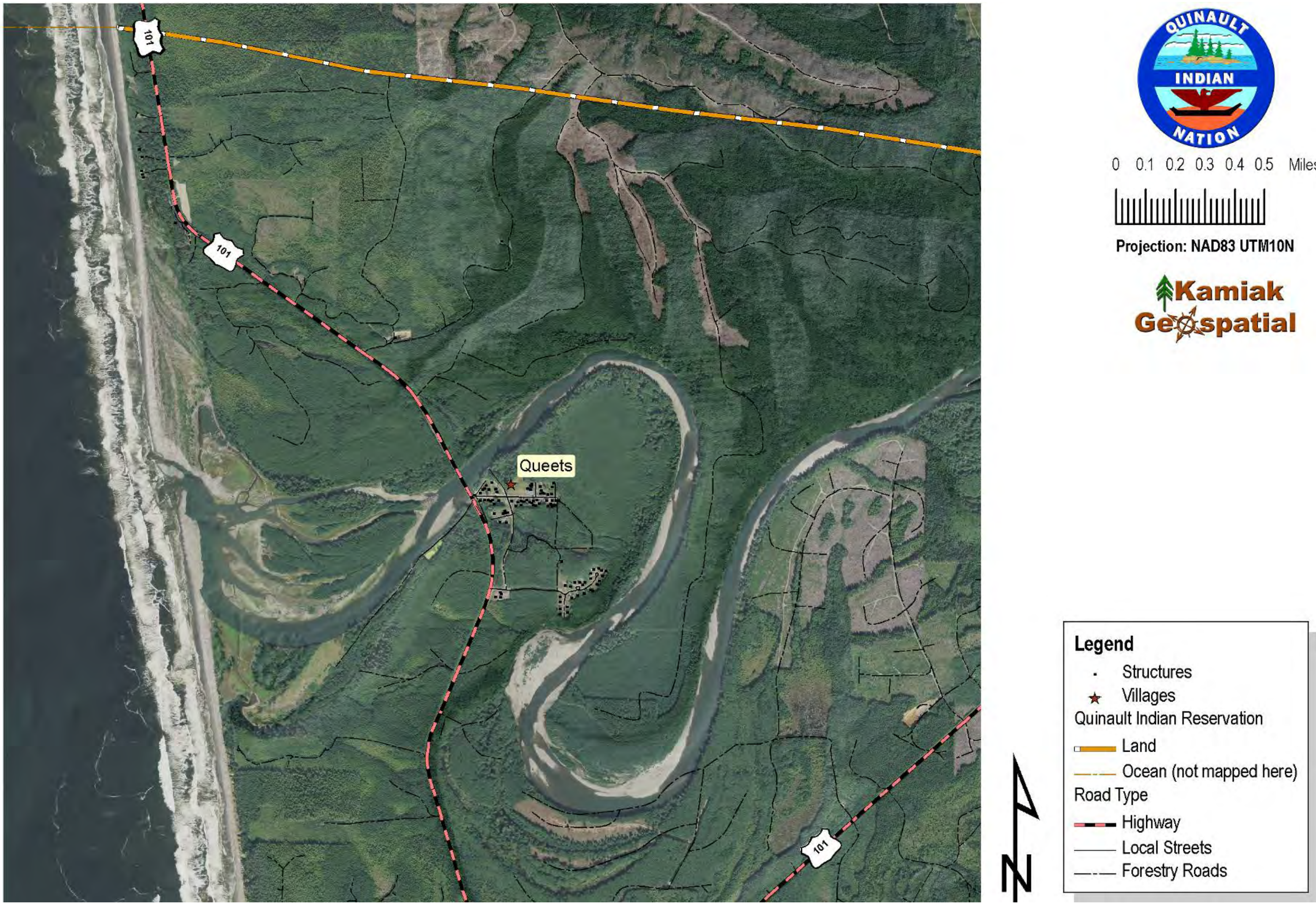


Figure LXXXI. Zoning and Growth Management Areas of Queets.

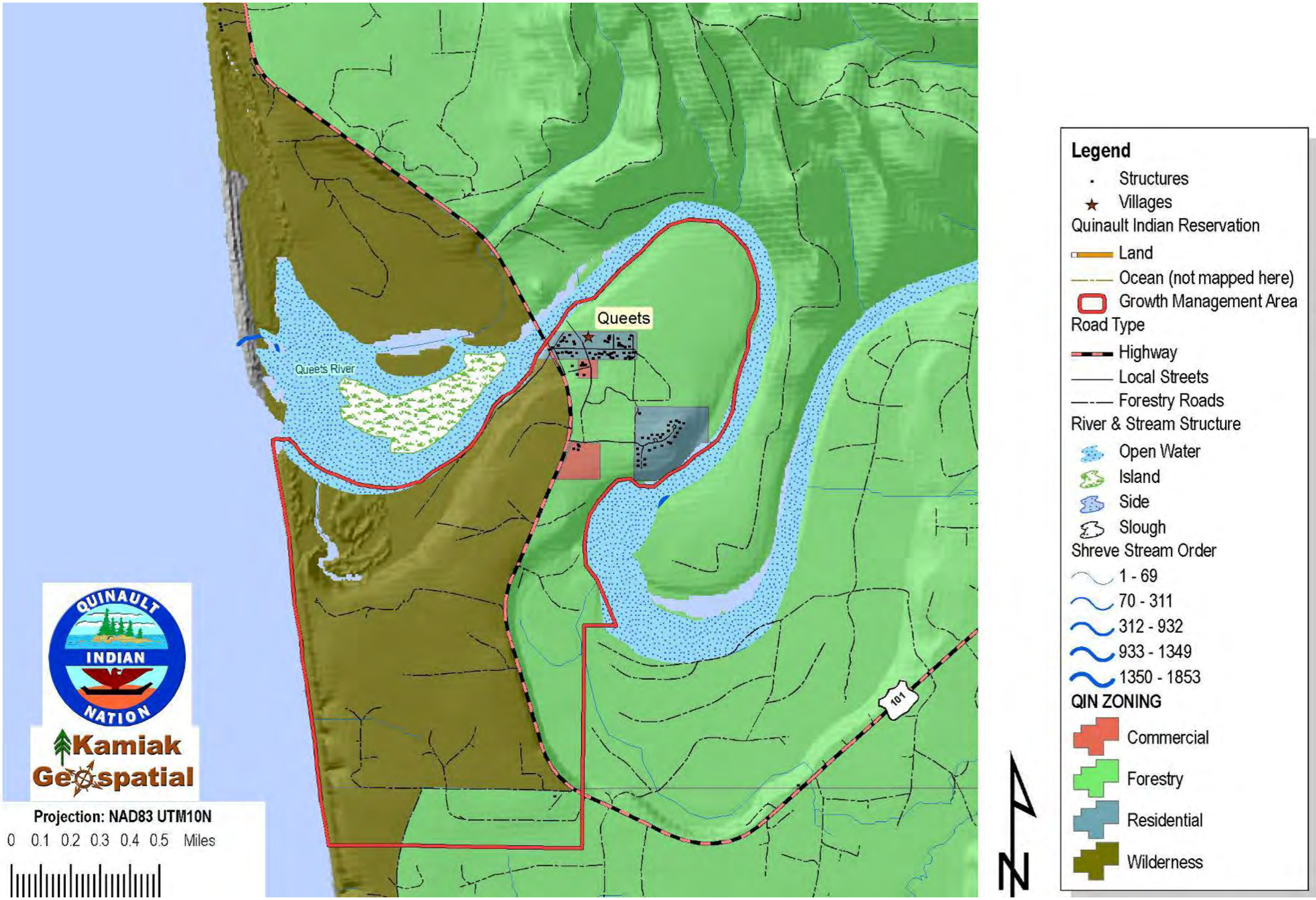


Figure LXXXII. Floodplain Mapping of Queets.

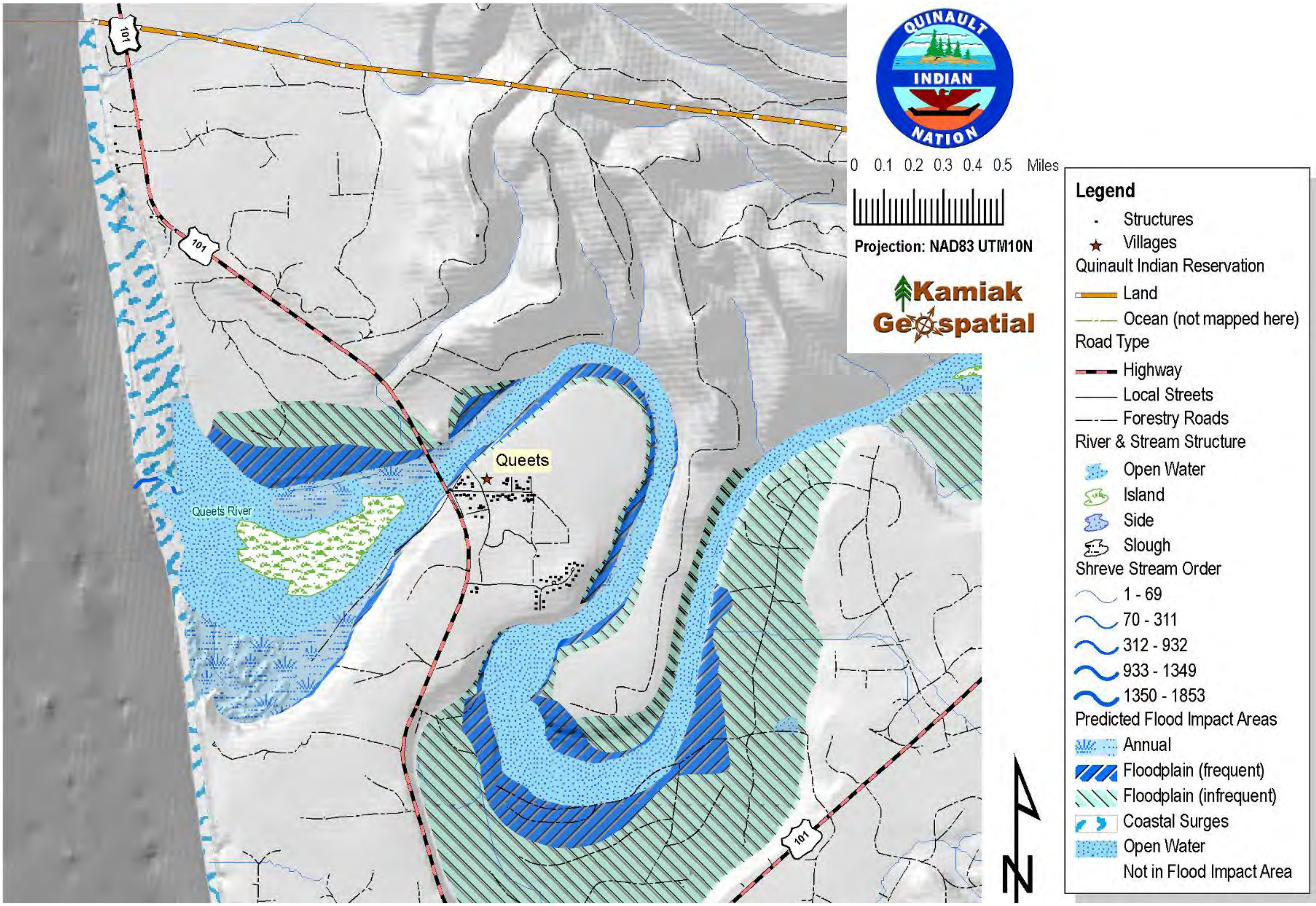


Figure LXXXIII. Tsunami Impact Areas from Cascadia Scenario A in Queets.

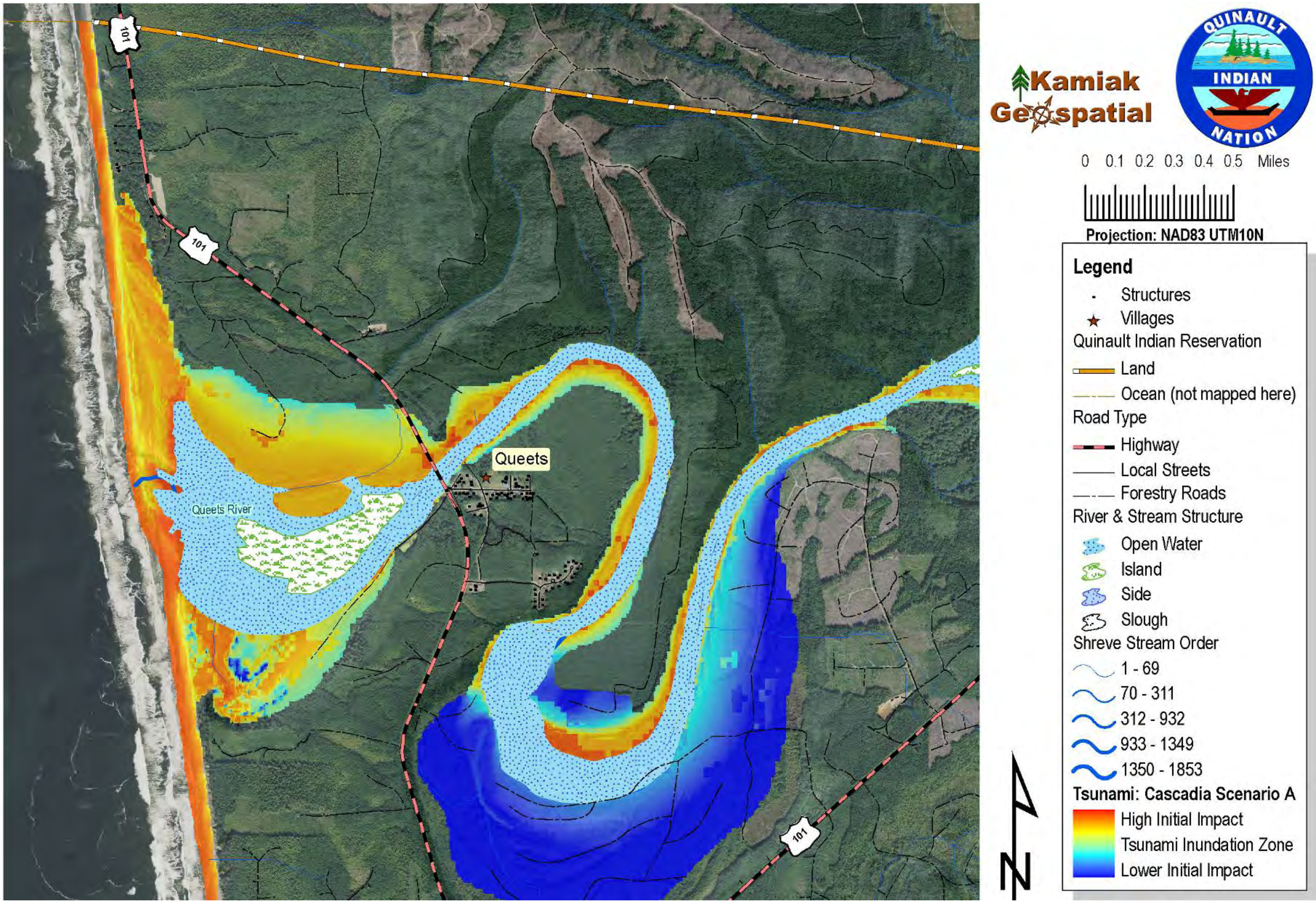


Figure LXXXIV. Liquefaction Risks in Queets (WDNR 2010).

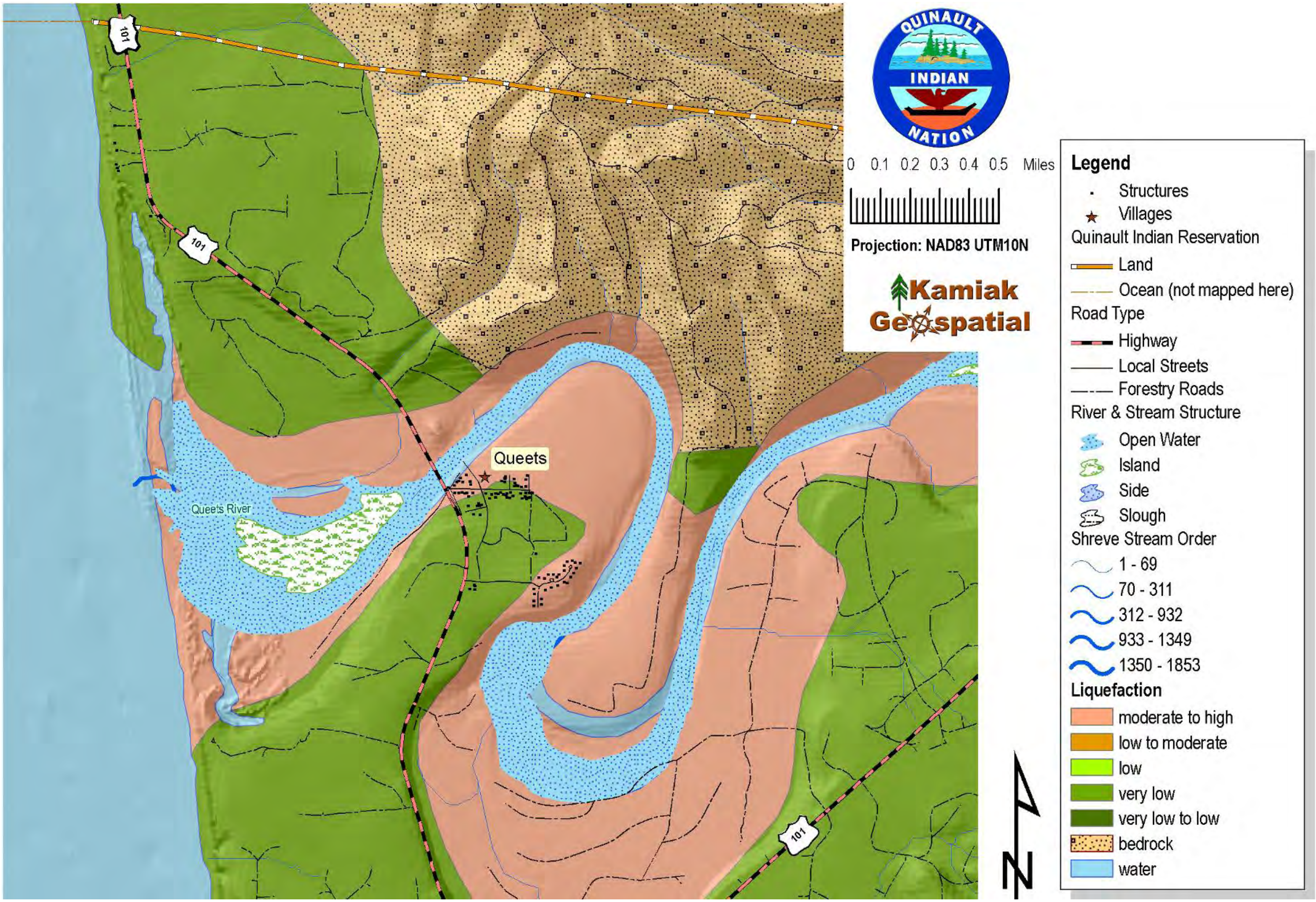


Figure LXXXV. Slope Stability Risks in Queets (WDNR 2010).

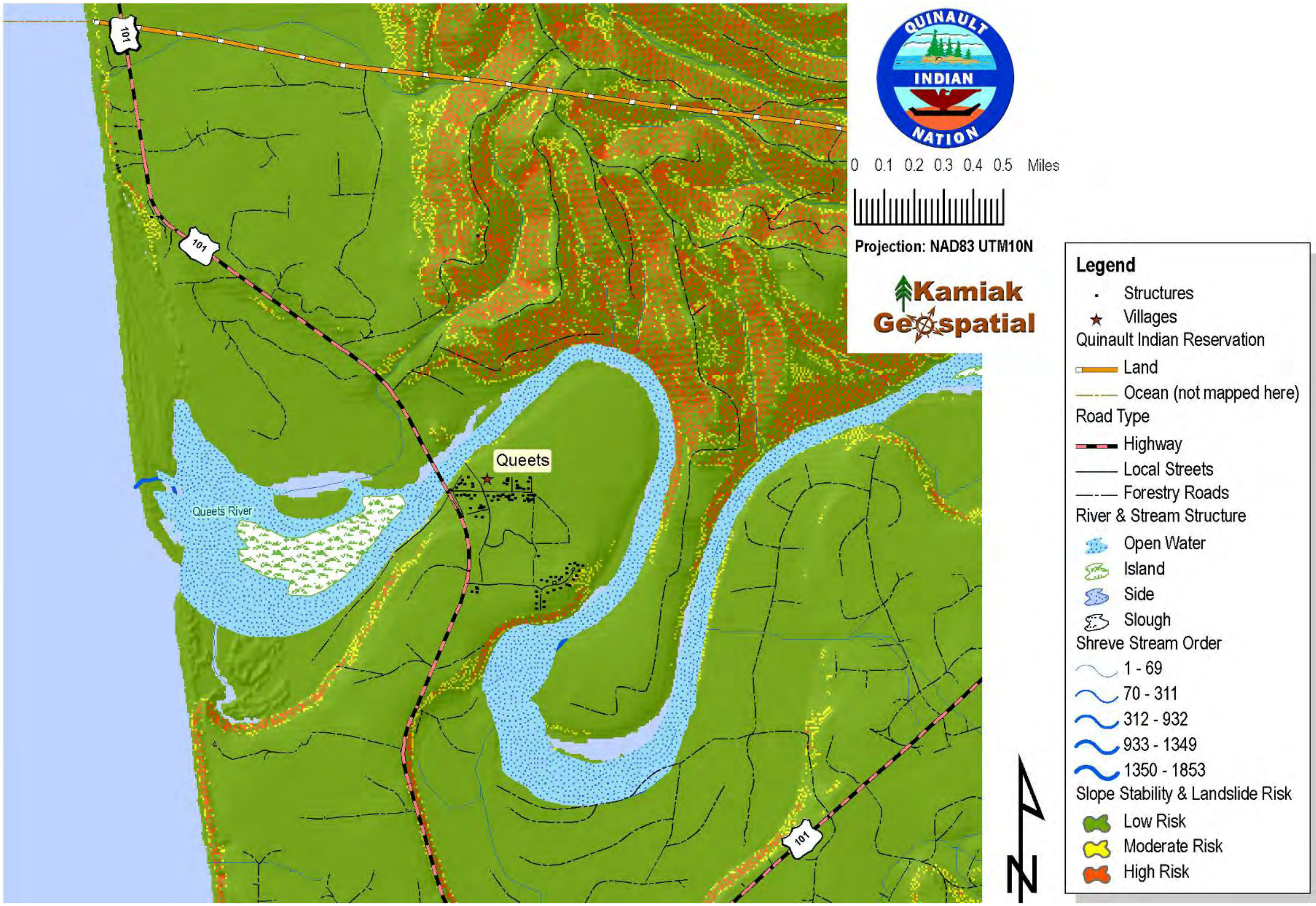


Figure LXXXVI. Mean Fire Return Interval in Queets (LANDFIRE 2007).

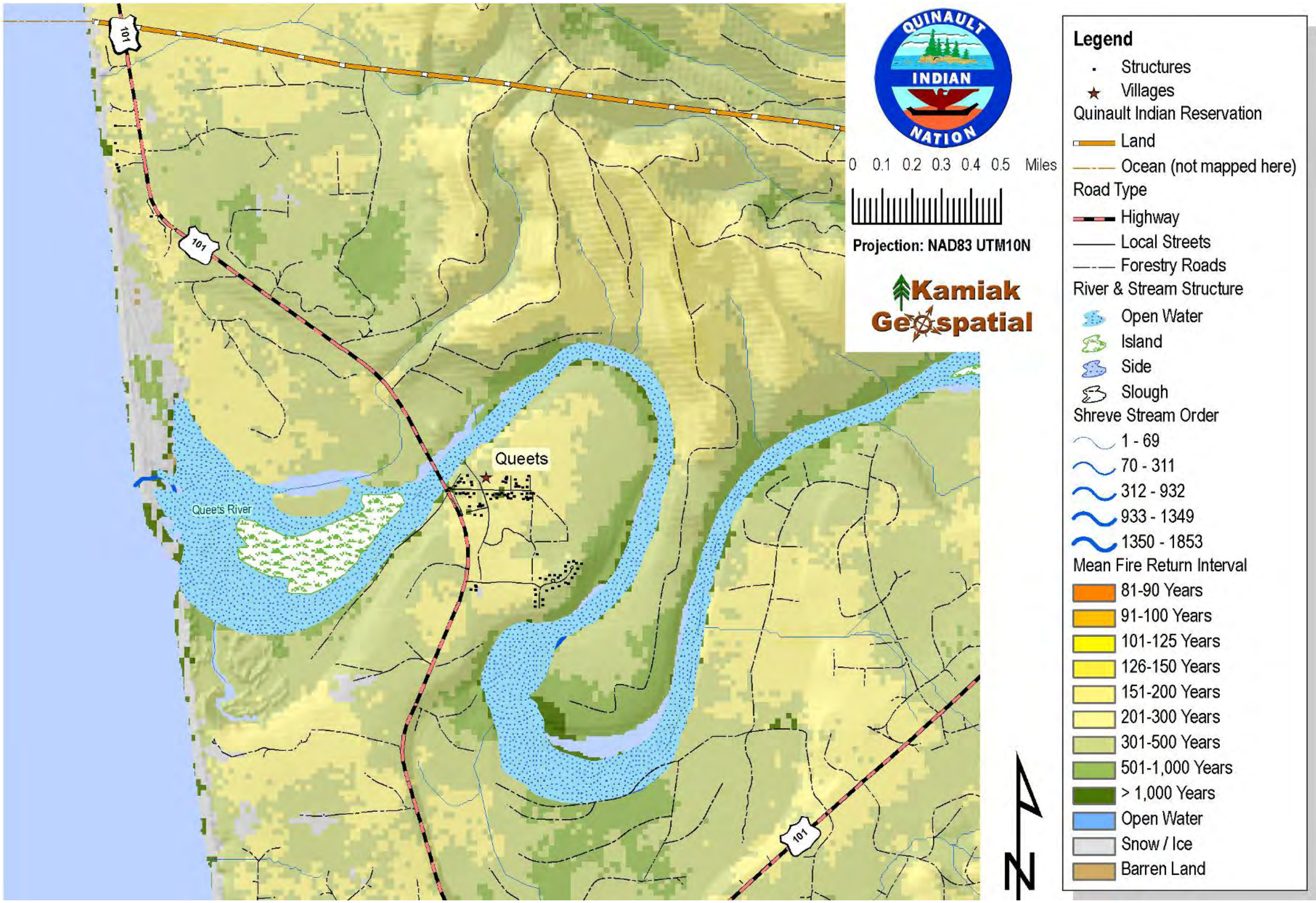
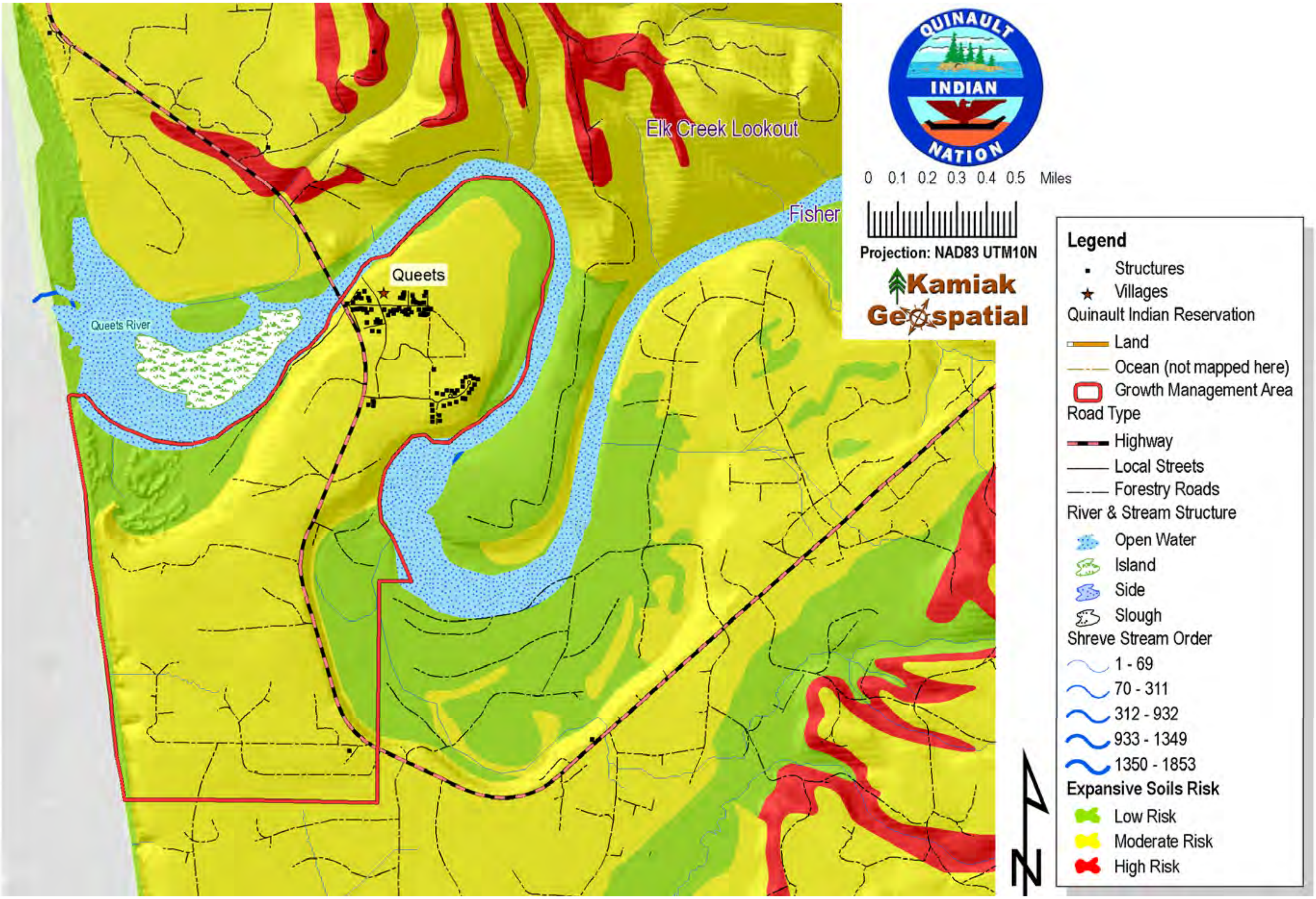


Figure LXXXVII. Expansive Soils and Expansive Clays Assessment in Queets.



5.4.3. Taholah

Figure LXXXVIII. Welcome to Taholah greets those entering the village. The high school mascot is named the Chitwhin, and means black bear in the Quinault language (Salishan).

The Village of Taholah is located adjacent to the pour point of the Quinault River to the Pacific Ocean and represents the highest concentration of structures and structural value on the QIR (Figure LXXXIX and Table 15). Access to and from Taholah is provided by SR109. The village has approximately 331 structures with a value of about $59.4 million (Table 45). For the purposes of this report, the village has been divided into a “lower village” and the “upper village”. These distinctions are made somewhat arbitrarily; the “lower village” being within a location where historical human habitation has predated any existing written documented data; and the “upper village” being where the new developments of the area have recently been made. These “upper village” developments include new homes, the Tribal Administrative Complex, and the Roger Saux Health Clinic. This is an area targeted for a mix of zoning amenities including commercial, forestry, residential, and wilderness objectives (Figure XC).

As already defined in Section 5.2 (Macro Hazards), the risk exposure to high winds and seismic shaking hazards is uniformly high in Taholah, as well as the other populated places of the QIR. There are several trees surrounding homes within the “lower village”, and there are many homes with compromised roofing materials that would benefit from reinforcement from the wind and falling debris from surrounding trees. The prevalence of URM chimneys (Figure LXVI) is well noted in this area. The occurrence of trees surrounding homes in the “upper village” is minor at this time, partially due to the relatively recent development of this area for homes.

5.4.3.1. Flood Risks

Flood risks in Taholah are completely attributed to the structures in the “lower village” (Figure XCI and Table 45). The Quinault River is bounded by a levee that extends from the Quinault Pride Fish House to the breakwater structure leading to the ocean. This levee is constructed of rip rap and serves to usher the river into the ocean (Figure XXXVIII). When events of high tides, an oncoming storm bringing storm surge conditions, and high rainfall or snowmelt in the high elevations leading to high river volumes combine with high winds, the unfortunate combination has led to waves breaking over the levee. Although this extreme combination is not frequent, it is often enough that it goes mostly undocumented by the residents of this village.

Floodwaters (water from the river entering the village) within Taholah are rare and are mainly isolated moderate severity events. A couple structures are located upstream of the levee system and on the river’s banks. The Quinault Pride Fish House is located on the river’s bank and over the river to allow for access to fishermen boats while collecting fish.

Storm water accumulation within the “lower village” of Taholah is widespread (Figure XCI). During heavy rain events, water accumulates on the surface because the soils are easily saturated and the topographical relief is minor (Figure XXXII). When the homes along the southern extent of the “lower village” were built, a drainage system was put in place to divert these storm water accumulations and divert them in the direction of the Quinault River (Figure XXXII). These ditch systems work well to protect the structures and the access routes from storm water damages. However, these ditches all terminate in a ball field that surrounds homes near the river’s mouth. The entrance of these waters to the ocean or the river is prevented by the ocean wall breakwater and the Quinault River levee. It is recommended that a one-way valve drainage pipe be installed through the ocean breakwater structure to facilitate this drainage.

As was detailed in the similar discussion for the Village of Amanda Park, caution should always be applied to reducing surface storm water accumulations by draining the water directly into the river or the ocean. These surface water accumulations can become contaminated by oils, detergents, salts, and other water soluble contaminants that would harm fisheries. A filtration system should be applied to any such activity. The risk of this occurrence in the area is low because of the residential nature of the village. However, there are commercial enterprises here including the Fish House activities, the gas station / Mercantile, and many homes.

The only structure represented within the floodplain in Taholah’s “upper village” is the Waste Water Treatment Plant. Although it is located above the river’s predicted floodplain, it is included as “infrequent” periodicity and accounted for here. The exposure to the “lower village” is within the floodplain with 10 structures valued at $2.0 million in the frequent zone, and 186 structures valued at $21.8 million in the “infrequent” zone (Table 45). The remaining 66 structures valued at $12.6 million are not considered at risk to flood waters from the Quinault River (Table 45). However, most structures located in the “lower village” of Taholah are exposed to complications from storm water accumulation and the water’s inability to enter the river or the ocean.

5.4.3.2. Tsunami

Taholah is exposed to the catastrophic damages of a CSZ tsunami within the “lower village” discussed in Section 4.5.1 of this document (Figure XCII). The risks for Taholah are double–sided: it serves as the central location of the QIN government and as the largest population center of the QIR. There are approximately 260 structures within the “lower village” valued at $36.2 million at direct risk to a CSZ tsunami hitting this village (Table 46). Virtually no homes in the “upper village” are at direct risk to a similar sized tsunami event.

If such a catastrophic event were to hit the shoreline at Taholah, the effects would be disastrous in terms of structures damaged by the combined force of the tsunami wave and the accumulated debris along the shoreline that naturally serves to protect the shore from excessive wave action erosion. In case high speed waters were to mobilize these root wads and tree stems into the village, the destruction would be substantial. At the same time, the SR109 bridge at Taholah could be damaged severely. Fortunately, this access route does not currently provide ingress and egress to homes or businesses.

A CSZ tsunami wave would be expected to inundate the Quinault River for up to seven miles upstream causing excessive damage and leading to flood water accumulations in excess of any prediction for any flood event.

Fortunately, the QIN has taken precautions by 1) providing a paved foot path to flee to the higher ground of the “upper village” at the Tribal Administrative Complex, 2) posting tsunami evacuation route signs, and 3) installing and operating a tsunami alarm installed in the village center. When the February 27, 2010, tsunami warning was activated in response to the earthquakes and tsunami warning originating in Chile, the alarm was sounded, the beaches were cleared, and the residents were put on warning that a far-out tsunami approach was possible. In the event of a CSZ tsunami the warning times would be drastically shorter, but the basic infrastructure for protecting the people of the Taholah is in place and has been tested in real-world situations.

A tsunami event impacting the Village of Taholah is expected to be disastrous in terms of lives lost, structures destroyed, and the compromising of QIN government operations. There are several QIN services housed in the Lower Village of Taholah. All of these services would be expected to face a stoppage if structures and lives were lost in such an event. An orderly and long-term progression of services, houses, and businesses to the Upper Village is strongly recommended.

5.4.3.3. Liquefaction

Just as liquefaction risks in the Village of Queets are defined by the route of the Queets River, the liquefaction risks in the Village of Taholah are defined by the path of the Quinault River (Figure XCIII). This meandering path of the Quinault River has deposited unconsolidated river sediments along its route for millennia. On the opposite Quinault River shore from the village, there is an erosion resistant rock outcropping that is an anchor against the river's movement in that direction. The sweeping path of the river historically has left those "moderate to high" liquefaction risk soils where today homes and businesses are located. Almost all of the structures in the "lower village" are in the "moderate to high" liquefaction risk category representing a value of approximately $36.2 million (Table 47).

Within the "upper village" the risks are considerably lower with all structures rated in the "very low" liquefaction risk category, representing $19.2 million of value (Table 47).

Future construction in this area should target developments to the soils rated "very low" to liquefaction risks in the "upper village" as there is ample number of potential building sites where these favorable soil traits can be found.

5.4.3.4. Slope Stability

The dividing line between the "upper village" and the "lower village" is witnessed by a sharp increase in slope between the two. The potential for landslides, within and around the Village of Taholah is relatively low and isolated to these steep slopes (Figure XCIV). The exposure to landslides in the areas surrounding homes and businesses within Taholah includes approximately 5 structures (Table 48) valued at $621,000 in high risk category, 6 structures valued at $999,000 in the moderate risk category, and 320 structures valued at $57.7 million in the low risk categories (Table 48).

Setbacks in the "upper village" area from the steep slopes in the direction of the northern approach to the Quinault River and maintaining development pressure on the east side of the SR109 will serve to maintain this area to a low risk to landslides.

5.4.3.5. Wildfire

Assessments for MFRI and Replacement Fire Severity are summarized in Table 49 through Table 52. The MFRI for this area places the natural fire return interval at 200 years to 1,000 years (Figure XCV). Although human caused changes to this natural fire regime should always be considered, it is clear that the natural fire return cycle will not be a driving force for wildfire ignitions. On the other hand, these statistics can be interpreted with the Replacement Fire Severity considerations which predict that when a wildfire ignites, and weather conditions are consistent with a major wildfire event (hot temperatures, dry weather, and high winds) the resistance to wildfire control is predictably high. The Replacement Fire Severity Predictions for the Village of Taholah (Table 51 and Table 52) place the highest concentration of structural value ($23.8 million) in the classification of 76% to 100% stand replacement fires.

The mitigating measure for these events is the placement of a structural fire station in Taholah and wildfire apparatus in the area available to stop a wildfire within a very short interval after ignition.

5.4.3.6. Expansive Soils

Expansive soils and expansive clays within the area of Taholah are a mix of low to moderate risks (Figure XCVI). The lower village of Taholah, located adjacent to the Quinault River, is dominated by sites that are considered “low risk” to expansive soils. The “upper village” where developments have been recommended to escape the risks of flooding, storm surges, and tsunami, are all ranked as “moderate risks” to expansive soils and expansive clays. Areas both north of the village and southeast of the village are partially assessed as high risk areas to expansive soils and expansive clays, but there are currently only forestry roads in these high risk areas.

At this time, residential structures and light commercial structures, including the QIN Administrative Building located in the Upper Village, are located on the moderate risk sites for expansive soils and expansive clays. Future developments in this area should accommodate additional pre-construction design and geotechnical reviews to maintain a constant soil moisture profile or use construction techniques that do not rest the structure’s foundation directly and solely on surface soils.

The current QIN Growth Management Area is displayed with the Expansive Soils projection (Figure XCVI) and shows those areas that are identified for desired future growth. These areas are at risk (moderate to high) to expansive soil and expansive clay conditions. All of these areas should be considered as limiting to future developments because of these soil characteristics. On-site geotechnical evaluations should be considered before new developments are placed in this area. Pre-construction factors to limit the amount of variation in soil wetting and drying should be implemented where practical.

This area has also been suggested as a potential site for a non-commercial airport and heliport (Section 5.6). The design of this facility and the runways should incorporate geotechnical design components to provide runway landing strips that do create a “wavy profile” after continued uses as is often the situation in this risk category of soils when pre-construction mitigation is not incorporated.

Figure LXXXIX. Aerial Imagery of Taholah (2009).

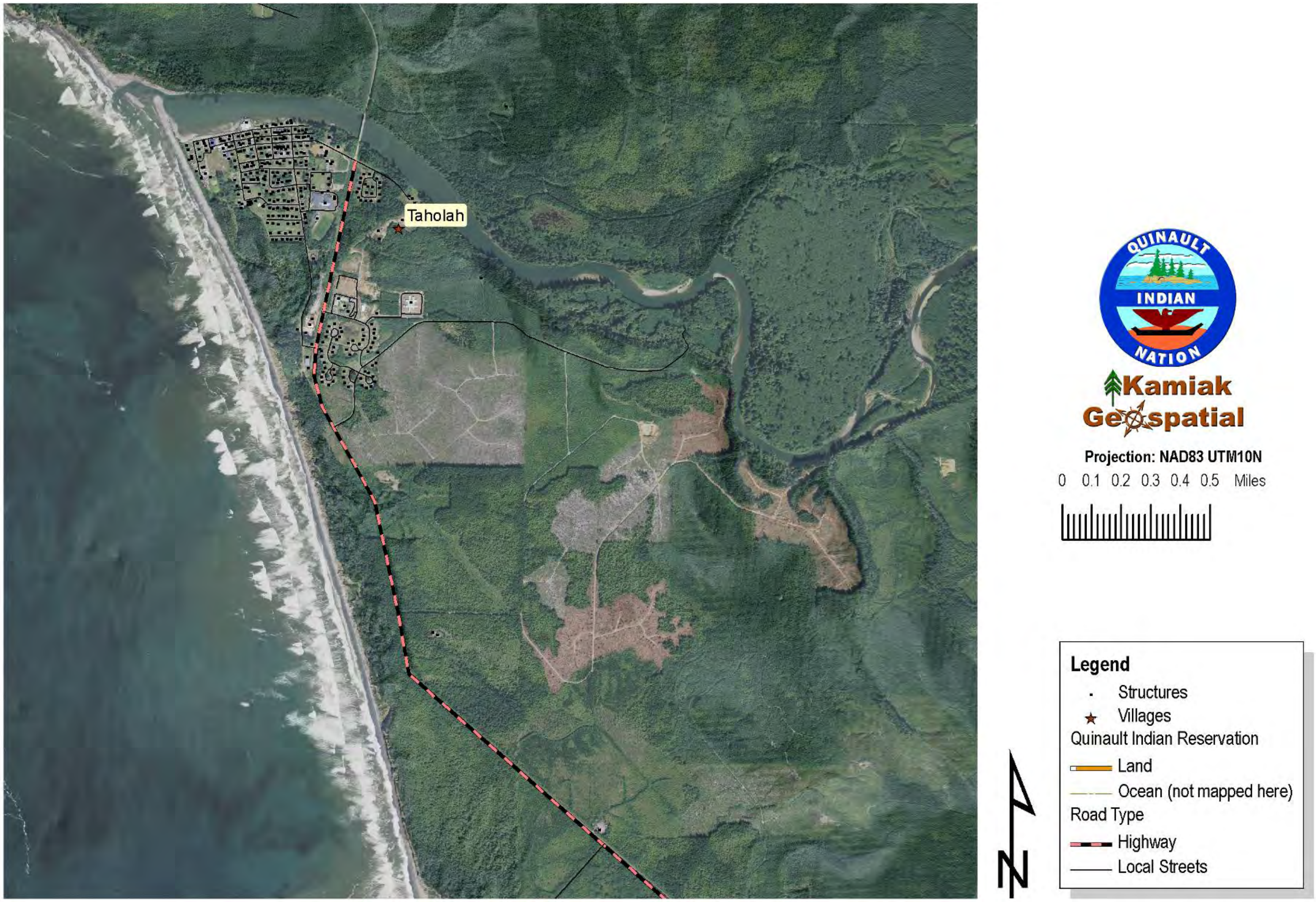


Figure XC. Zoning and Growth Management Areas of Taholah.

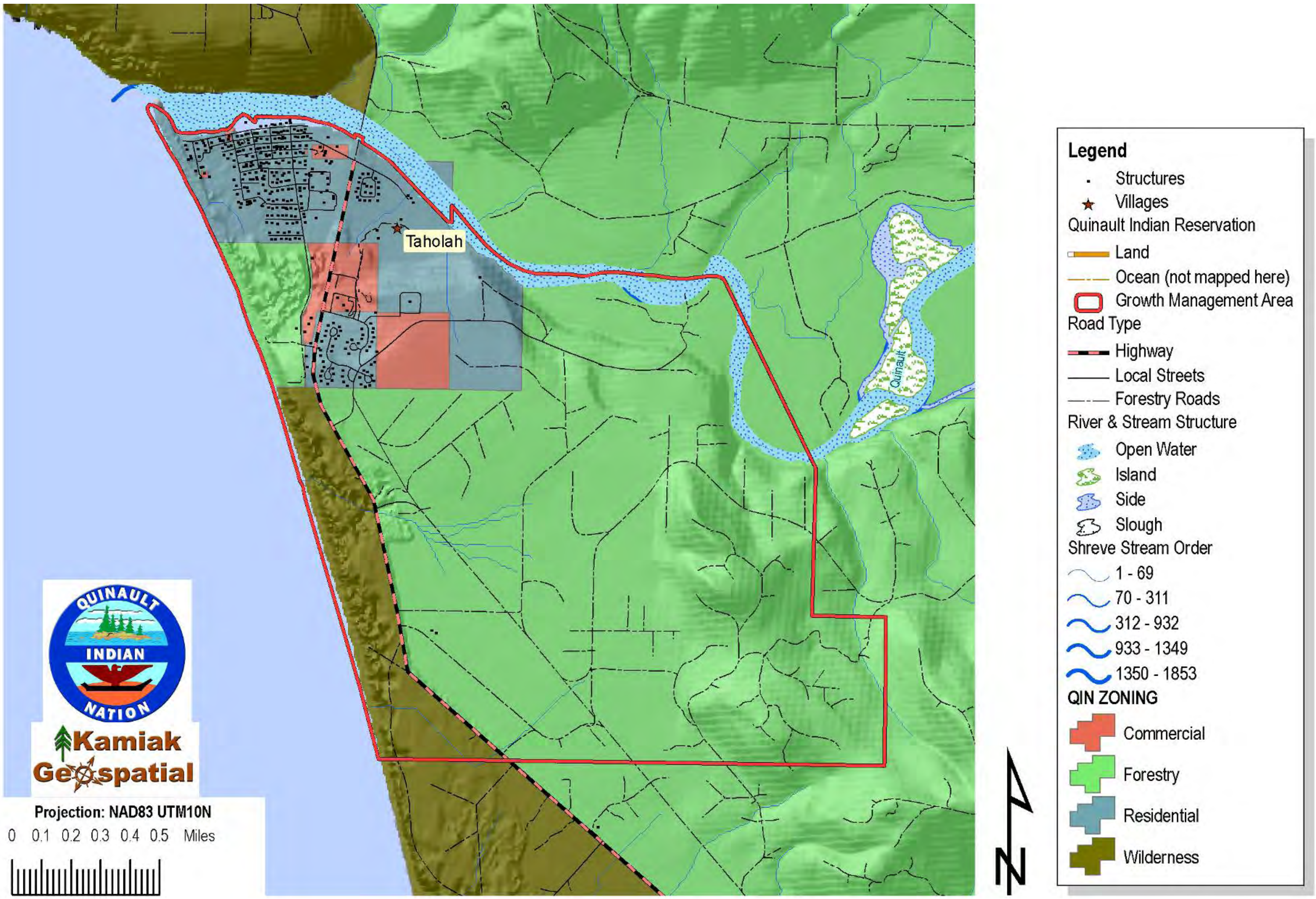


Figure XCI. Flood Impact Areas of Taholah.

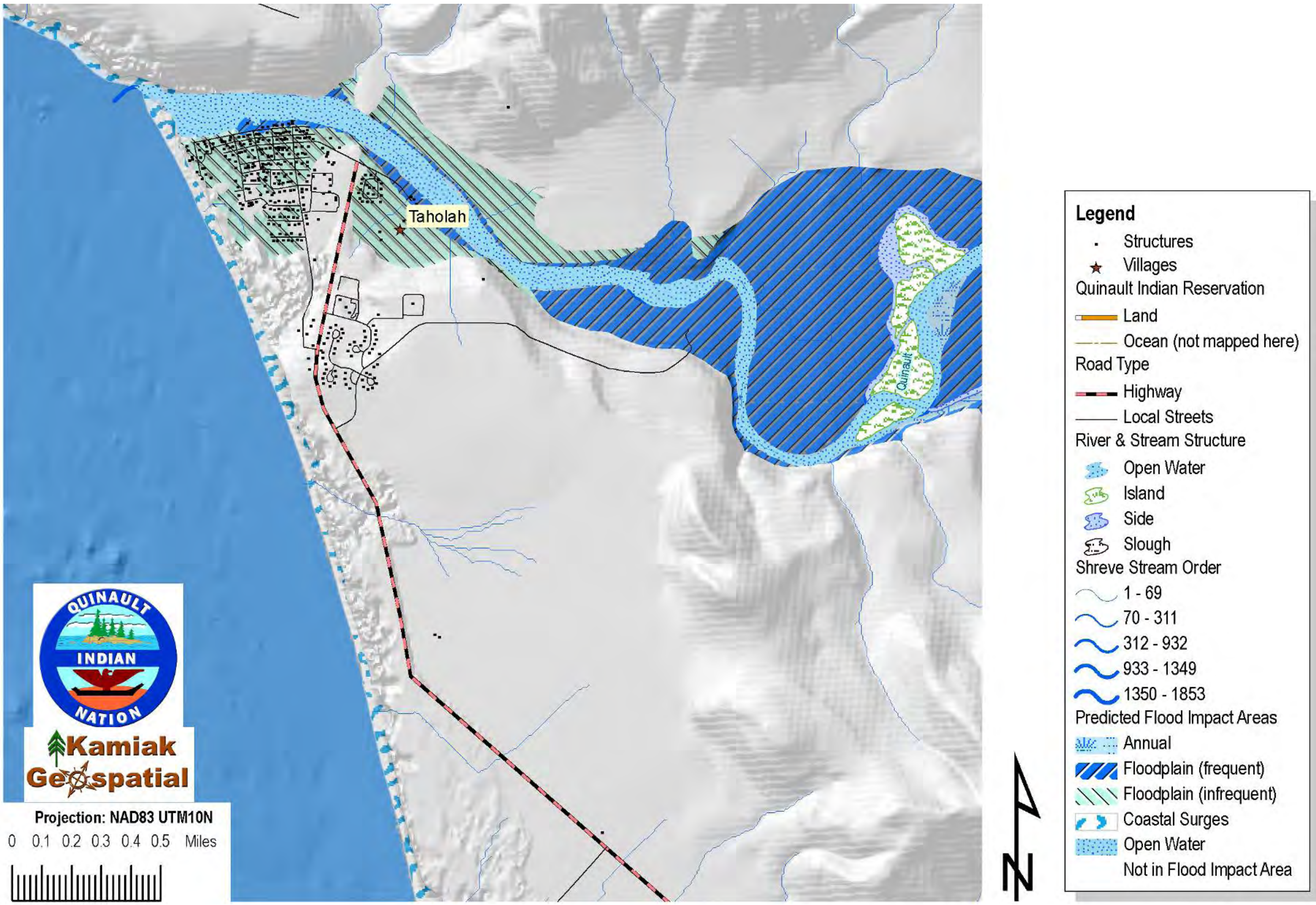


Figure XCII. Tsunami Risks in Taholah.

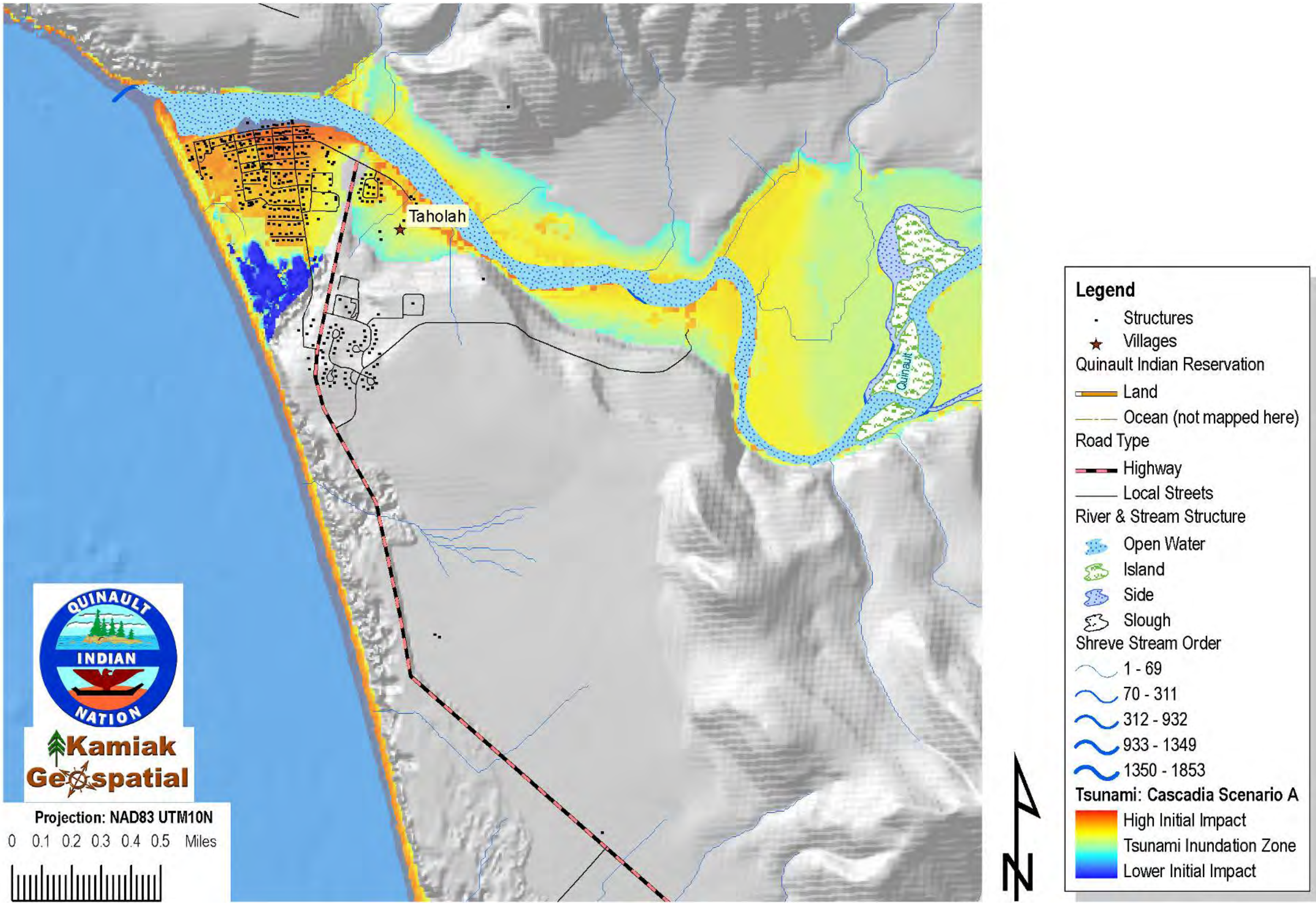


Figure XCIII. Liquefaction Areas of Taholah (WDNR 2010).

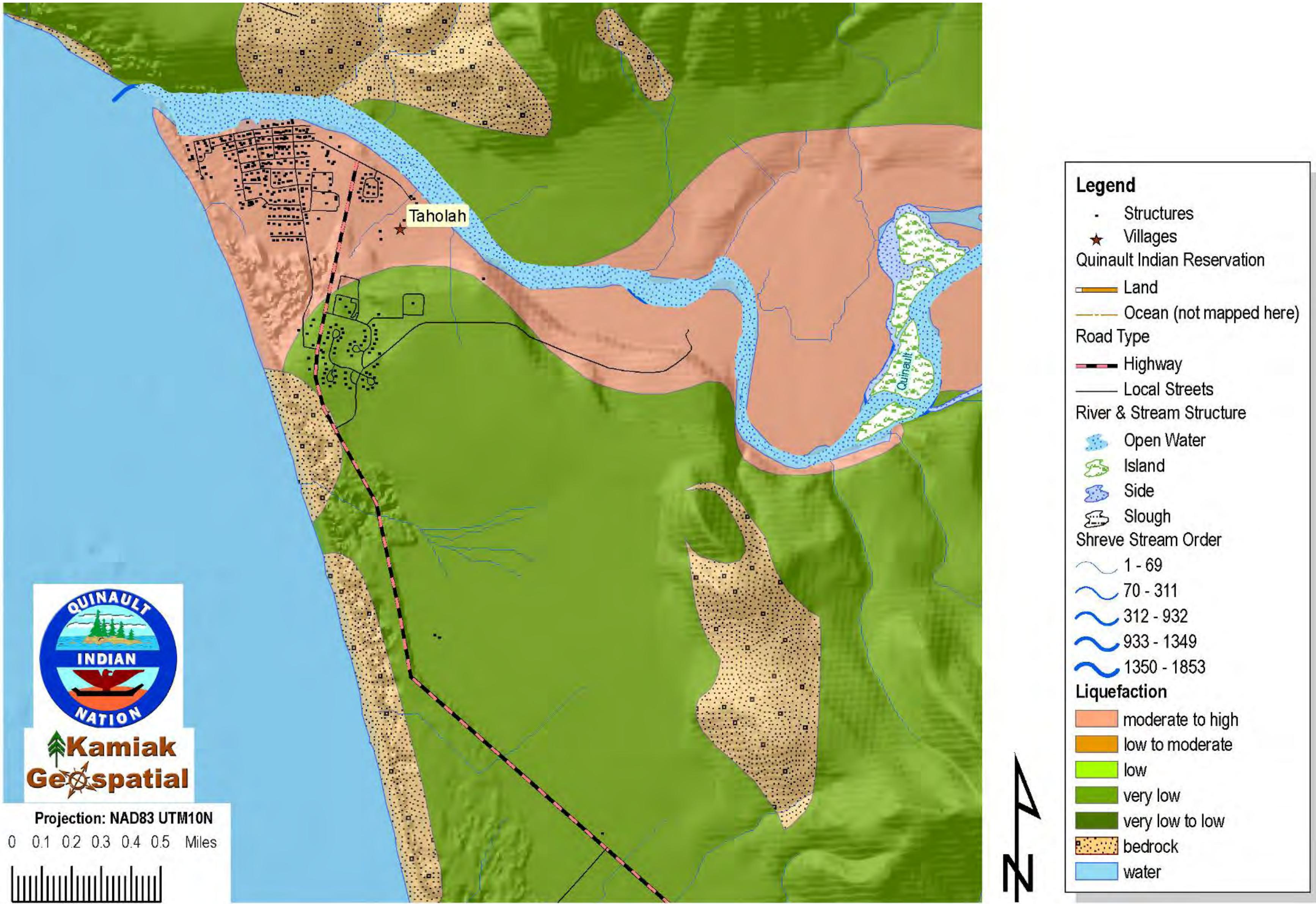


Figure XCIV. Slope Stability Areas of Taholah (WDNR 2010).

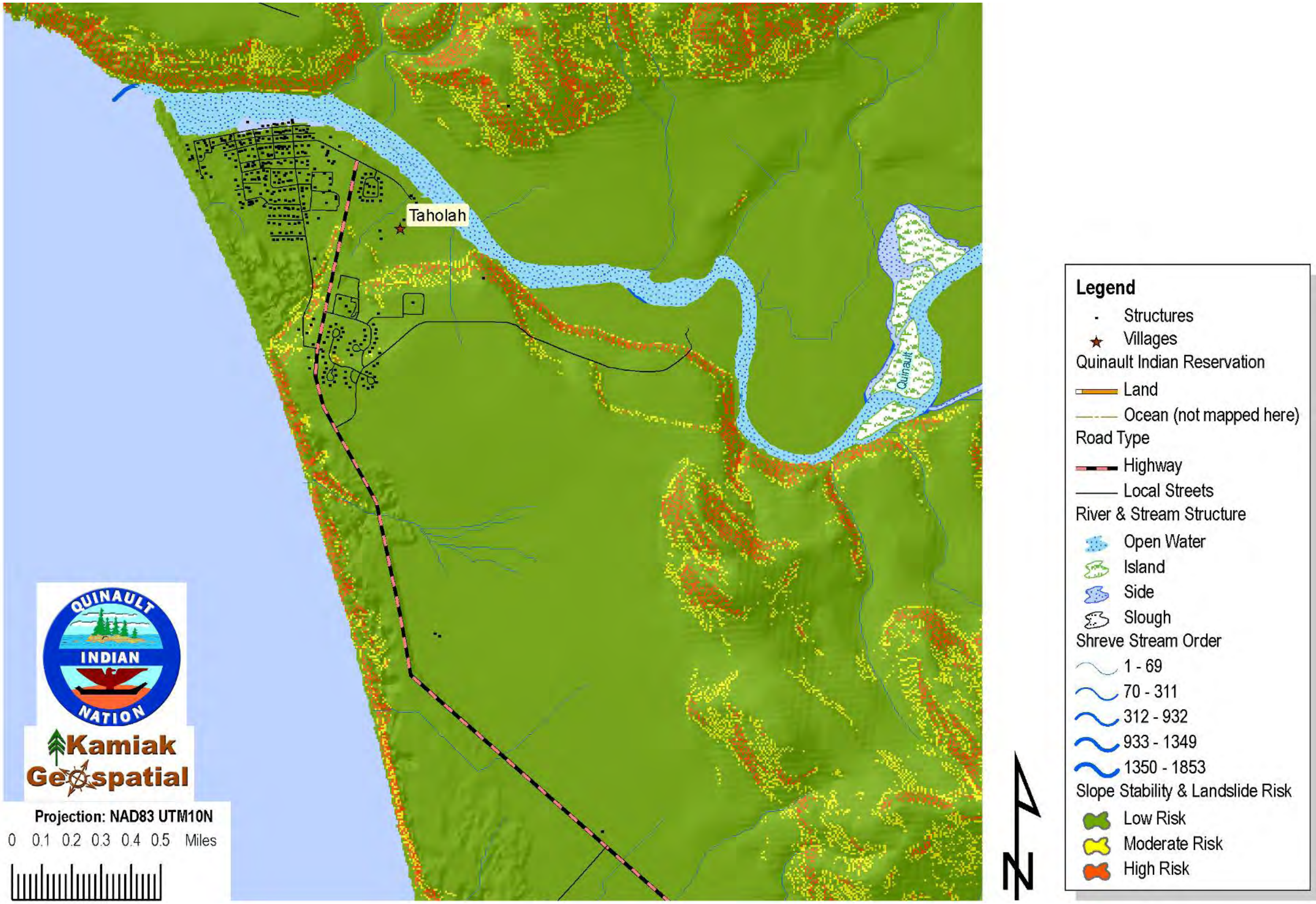


Figure XCV. Mean Fire Return Intervals of Taholah (LANDFIRE 2007).

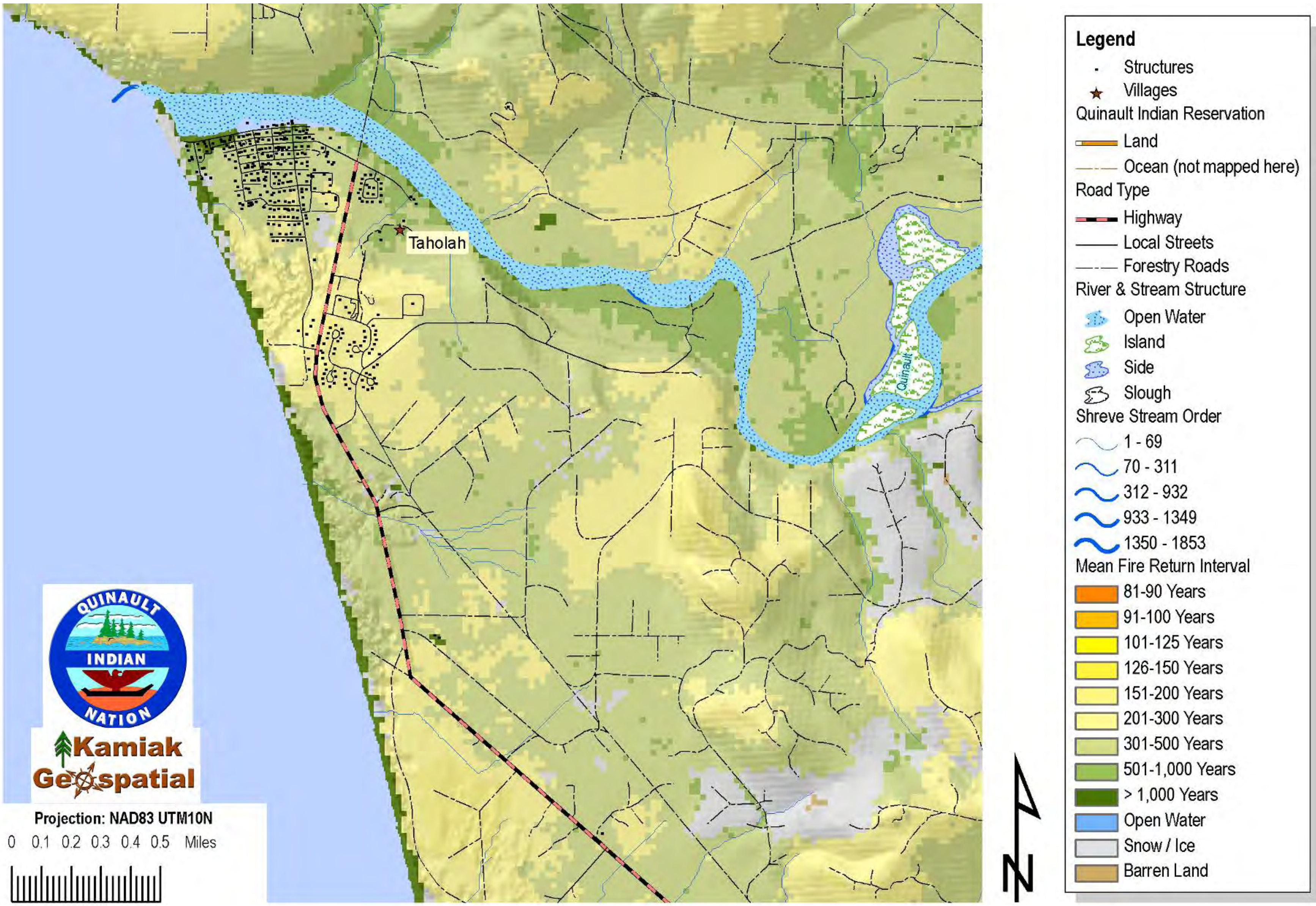
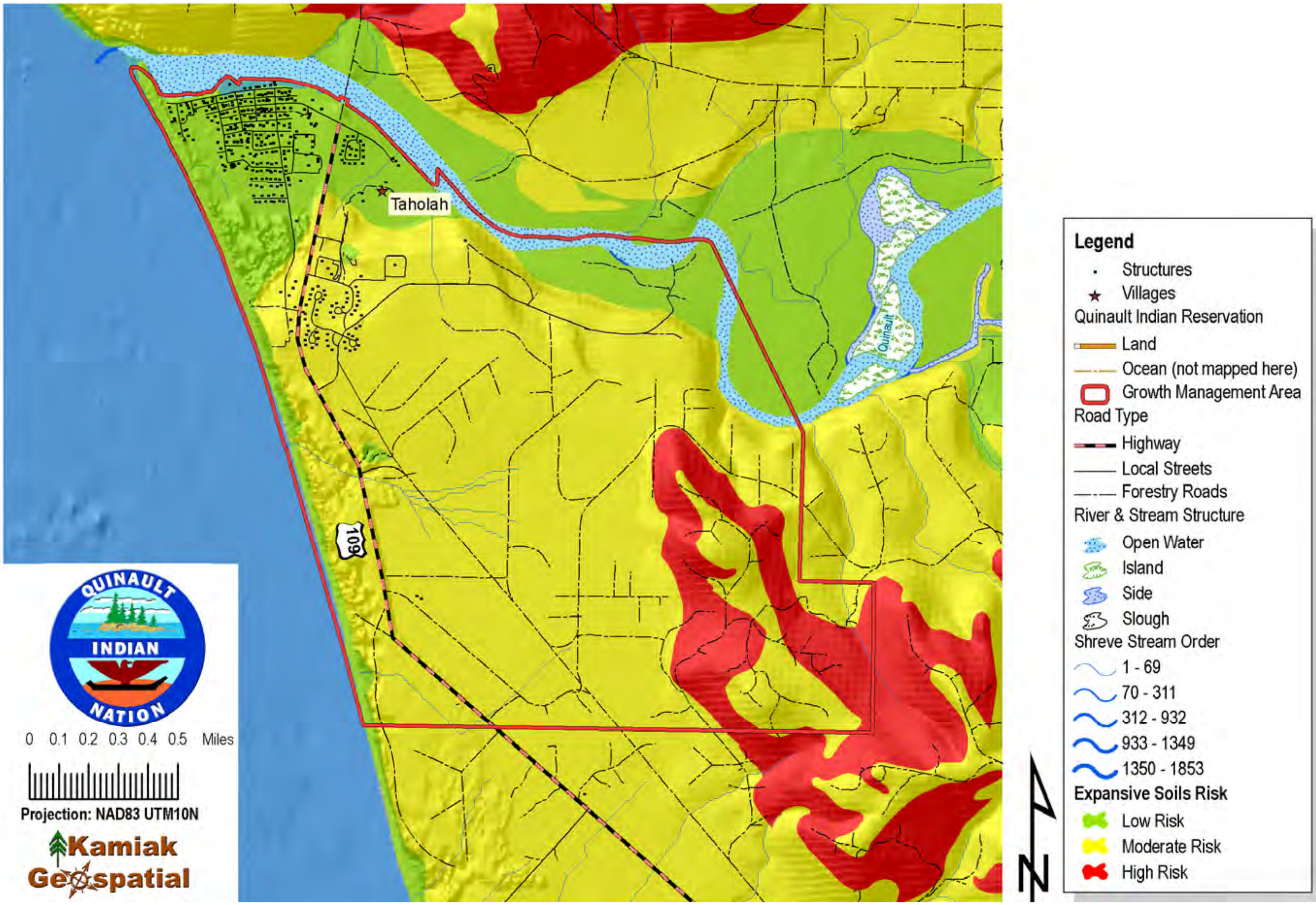


Figure XCVI. Expansive Soils and Expansive Clays Assessment of Taholah.



5.4.4. Taholah Ocean Tracts and Point Grenville

Figure XCVII. A non-descript sign marks the turn off of SR109 to Canyon Way and access to Taholah Ocean Tracts' homes.

Located midway between Taholah and Moclips to the south of the QIR, the village of community of Taholah Ocean Tracts is accessed by Canyon Way from the SR109 access along the shore of Point Grenville. There are approximately 25 homes in Taholah Ocean Tracts, 4 more along the shorelines south of Point Grenville, and another 10 structures located within the peninsula termed Point Grenville (Table 15). The total combined value of homes and businesses in this area is approximately $1.5 million.

Currently, the only access to these homes is provided by SR109 with local surface streets providing access to individual homes.

As already defined in Section 5.2 (Macro Hazards), the risk exposure to high winds and seismic shaking hazards is uniformly high in Taholah Ocean Tracts, as it is in the other populated places of the QIR. There are several trees surrounding homes, and there are many homes with compromised roofing materials that would benefit from reinforcement from the wind and falling debris from surrounding trees. The prevalence of URM chimneys (Figure LXVI, left photograph is taken along Point Grenville) is well noted in this area. The occurrence of trees surrounding and overtopping homes along this entire corridor is also well noted (Figure XCVIII).

Figure XCVIII. Wreck Creek in Winter (Workman 2009).

5.4.4.1. Flood Risks

Water damages within this area are restricted to ocean delivered storm surges along the coastline and complications of surface water drainage along SR109 (Figure CI and Table 45). Earlier discussions in this document have documented the catastrophic effects of water accumulation over SR109 that claimed the life of a Taholah adult in January 2010 when she lost control of her vehicle along SR109. Surface sliding along the road and inadequate ditchwater drainage leads to the accumulation of surface waters from the stream networks in this area.

Storm surges have been witnessed by residents of this area reaching as far inland as the Wreck Creek Bridge and other points within Point Grenville reaching SR109. Adequate ditch networks to convey surface water to the ocean are needed to protect the infrastructure of this area and the ability of residents to have access to Taholah and Moclips (and beyond).

5.4.4.2. Tsunami

Historical tsunami run-ups hitting the coastline at Point Grenville have resulted in the closure of SR109 and the compromise of the Wreck Creek Bridge along SR109. The Alaska Earthquake of March 28, 1964, led to a tsunami wave of nearly 15 feet high at Wreck Creek (Table 31).

A CSZ tsunami as described here, can be expected to cause substantial damage to the homes located along the Point Grenville coastline and to close SR109 pending repairs (Table 46). The Wreck Creek Bridge and shoreline homes are not expected to survive a CSZ earthquake as described here.

5.4.4.3. Liquefaction

The risks to liquefaction adjacent to Point Grenville and Taholah Ocean Tracts is rated at the “very low” liquefaction risk category representing a value of approximately $1.5 million (Table 47). Future construction in this area should target developments within Taholah Ocean Tracts; they will be greeted by soils rated “very low” to liquefaction risks as there are no higher risk rated soils in this area.

5.4.4.4. Slope Stability

Slope stability issues along the rim of Point Grenville and the community of Taholah Ocean Tracts witness several areas of increased slope instability (Figure CIV and Table 48). These “pockets” of instability have been well documented in this report in reference to SR109 and the long standing road failures resulting from landslides above and under the road.

Many of the homes located in Taholah Ocean Tracts are perched at the edge of steep cliffs to better overlook the ocean to the west. Unfortunately, these homes rest at the top of cliffs where the risk from landslides increases.

Aesthetically, the appeal of ocean views dictates that homes are placed close to the cliff line, however, from a hazard mitigation standpoint, new construction should favor setbacks from the rim of the steep slopes to protect homes from landslide damages in this area. Future infrastructure development in this area should also recognize these slope stability complications during placement and construction.

5.4.4.5. Wildfire

Assessments for MFRI and Replacement Fire Severity are summarized in Table 49 through Table 52. The MFRI for the Taholah Ocean Tracts and Point Grenville areas place the natural fire return interval where homes and businesses are located at 200 years to 500 years (Table 49). Although human caused changes to this natural fire regime should always be considered, it is clear that the natural fire return cycle will not be a driving force for wildfire ignitions. On the other hand, these statistics can be interpreted with the Replacement Fire Severity considerations which predict that when a wildfire ignites, and weather conditions are consistent with a major wildfire event (hot temperatures, dry weather, and high winds) the resistance to wildfire control is predictably high. The Replacement Fire Severity Predictions for the Village of Taholah Ocean Tracts (Table 51 and Table 52) place the highest concentration of structural value in the classification of 76% to 100% stand replacement fires. The few structures located along the shoreline of Point Grenville are distributed at considerably lower wildfire risk categories with two structures located in the classification of 0% to 25% stand replacement fires, and the remaining two structures located in the average classification of 50% stand replacement fires.

5.4.4.6. Expansive Soils

Expansive soils and expansive clays within the area of Taholah Ocean Tracts are a mix of low, moderate, and high risks (Figure CVI). The lower access route to this community is along SR109 where it follows a route of low to moderate risks while all of the populated places of Taholah Ocean Tracts are located within the moderate risk areas. All of these structures serve a residential purpose. Future developments in this area should accommodate additional pre-construction design to maintain a constant soil moisture profile around homes.

The current QIN Growth Management Area is displayed with the Expansive Soils projection (Figure CVI) and displays those areas identified for desired future growth to be at risk (moderate to high) to expansive soil and expansive clay conditions. All of these areas should be considered as limiting to future developments because of the soil characteristics. On-site geotechnical evaluations should be considered before new developments are placed in this area. Pre-construction factors to limit the amount of variation in soil wetting and drying should be implemented where practical.

This area is also suggested as the starting point for the development of an emergency by-pass route to be used when access along SR109 is compromised from flooding, tsunami, or storm surges (Section 5.5.1.1). This route, the “McBride Aloha Cutoff”, crosses several locations where the soils are moderate to high in risk categories to expansive soils and expansive clays. While construction of roads can be accomplished along these routes, the formation of the roadbed should incorporate several site specific geotechnical techniques to increase the durability and serviceability of this proposed emergency access route. The site already has forestry roads in place, but additional precautions must be accounted for, before increased use and reliability on this access route can be made.

Figure XCIX. Aerial Imagery of Taholah Ocean Tracts.

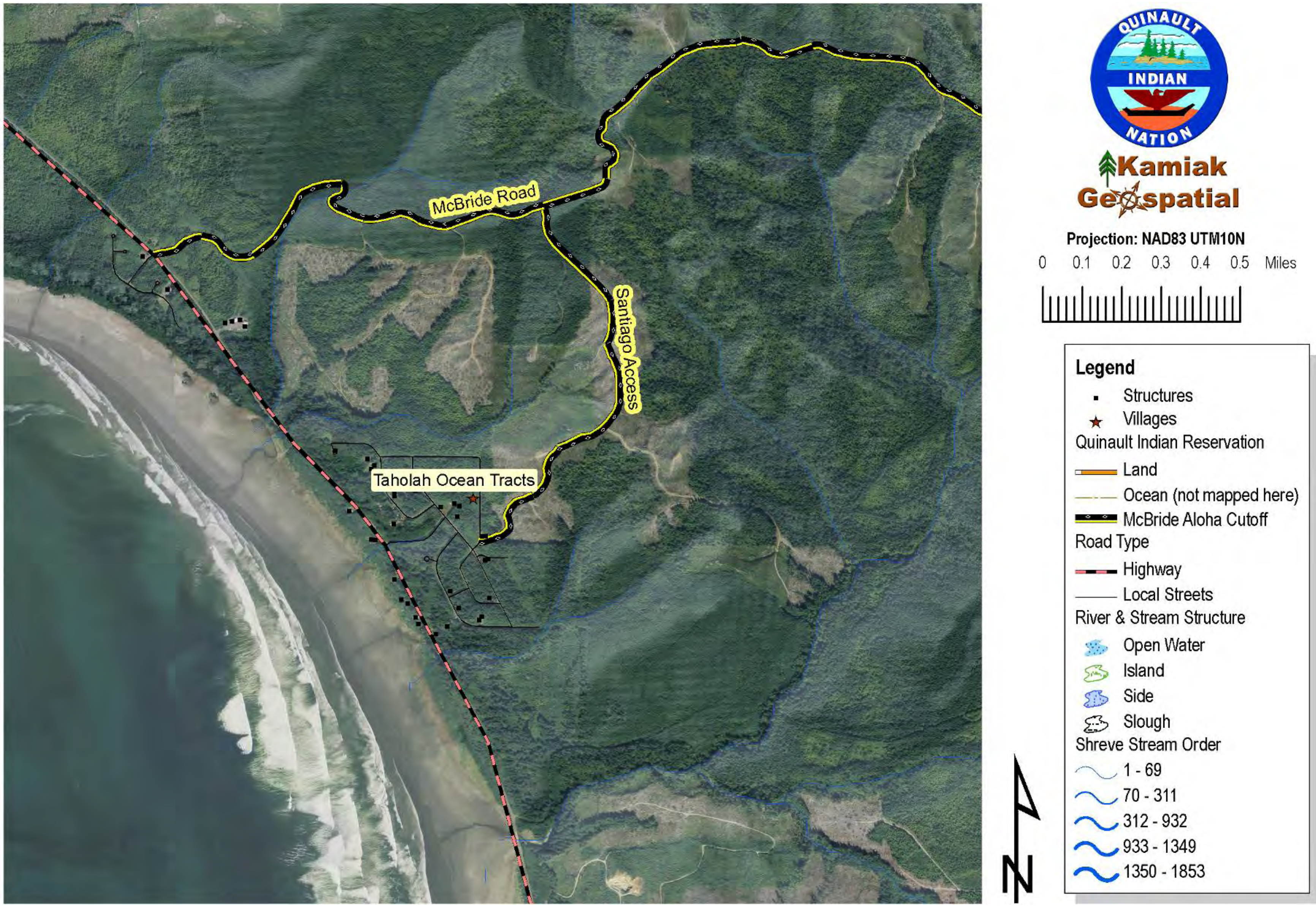


Figure C. Zoning and Growth Management Areas of Taholah Ocean Tracts.

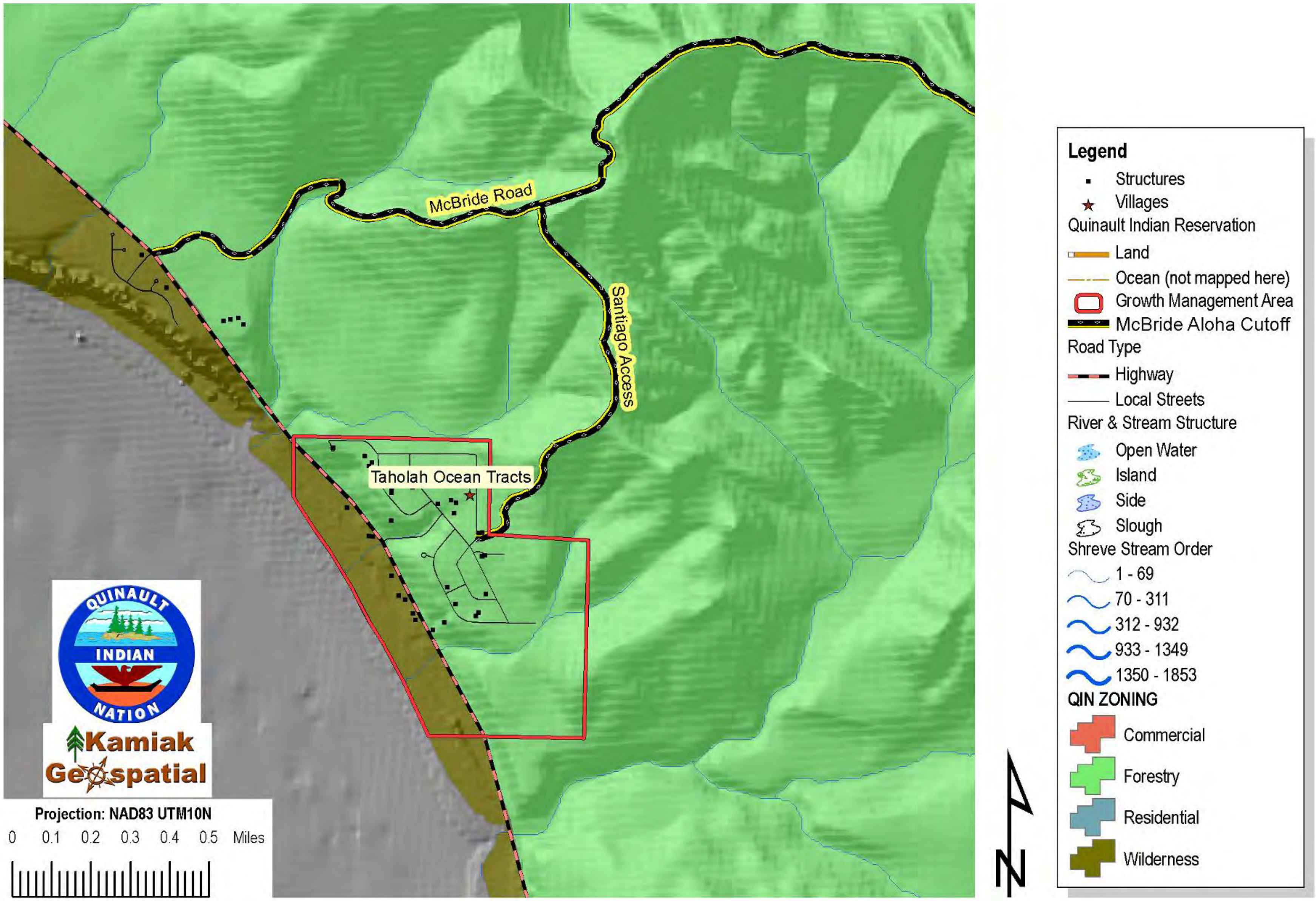


Figure CI. Coastal Surge Areas of Taholah Ocean Tracts (no floodplain areas).

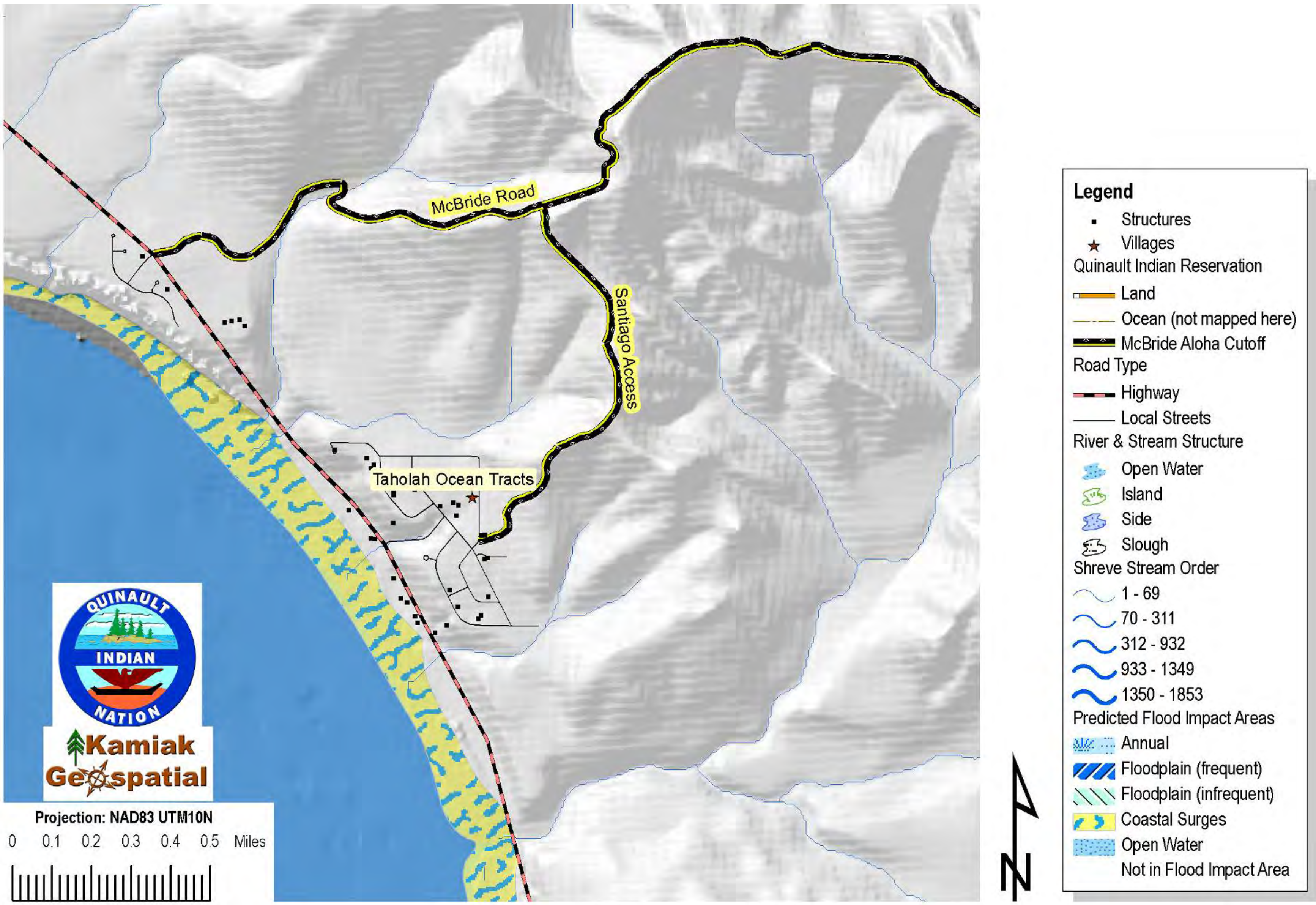


Figure CII. Tsunami Risk Areas of Taholah Ocean Tracts.

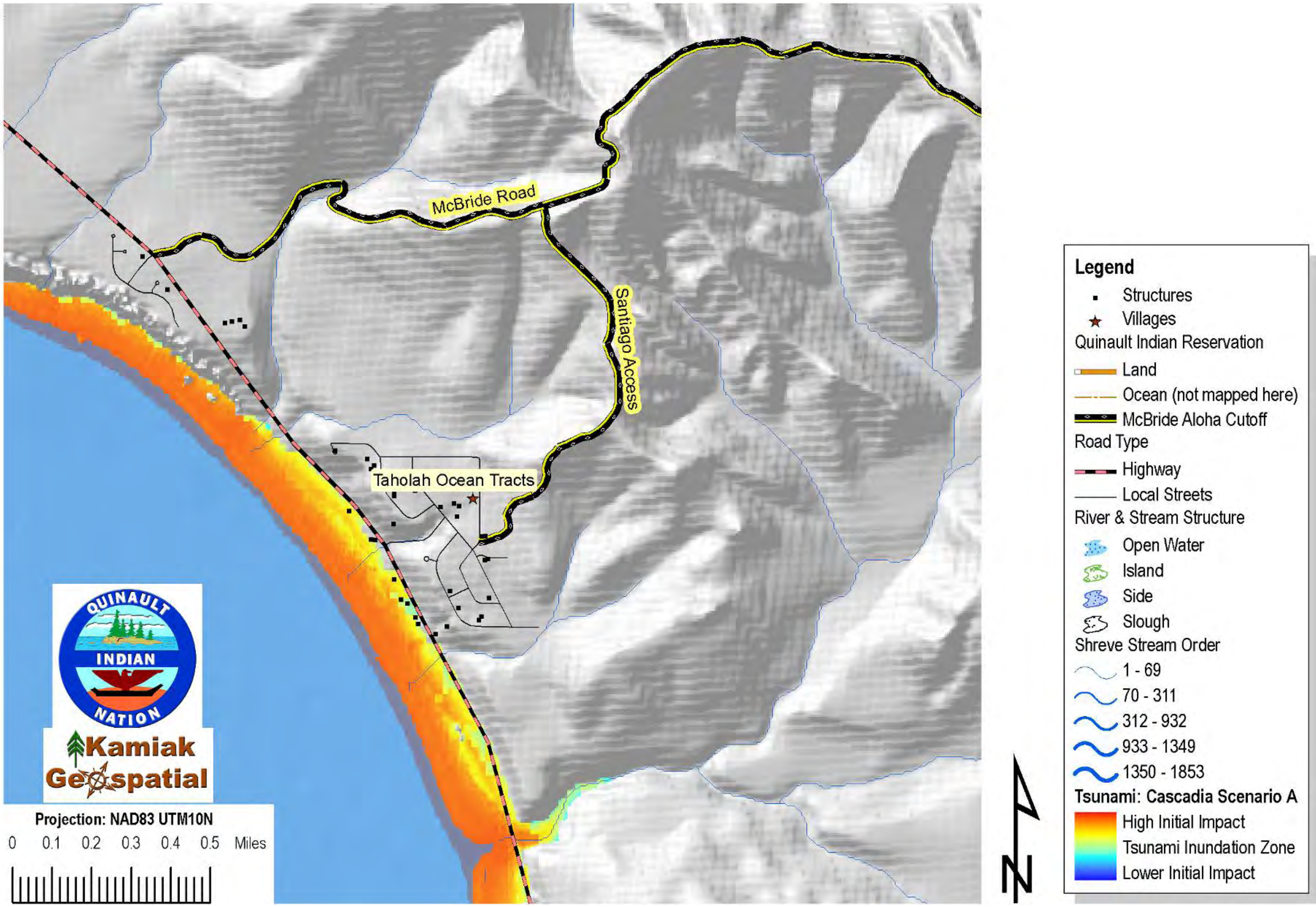


Figure CIII. Liquefaction Risk Areas of Taholah Ocean Tracts (WDNR 2010).

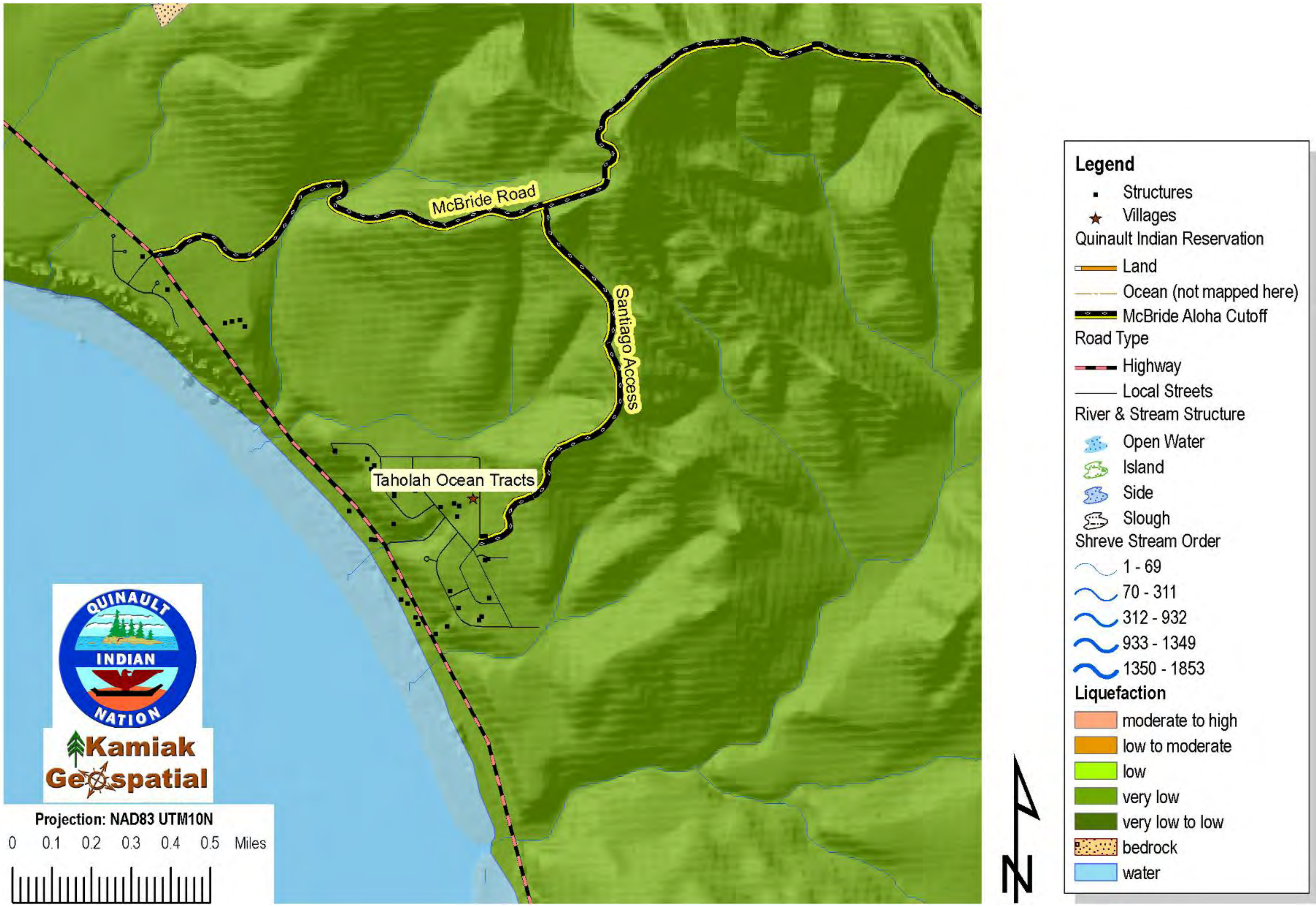


Figure CIV. Slope Stability Risk Areas of Taholah Ocean Tracts (WDNR 2010).

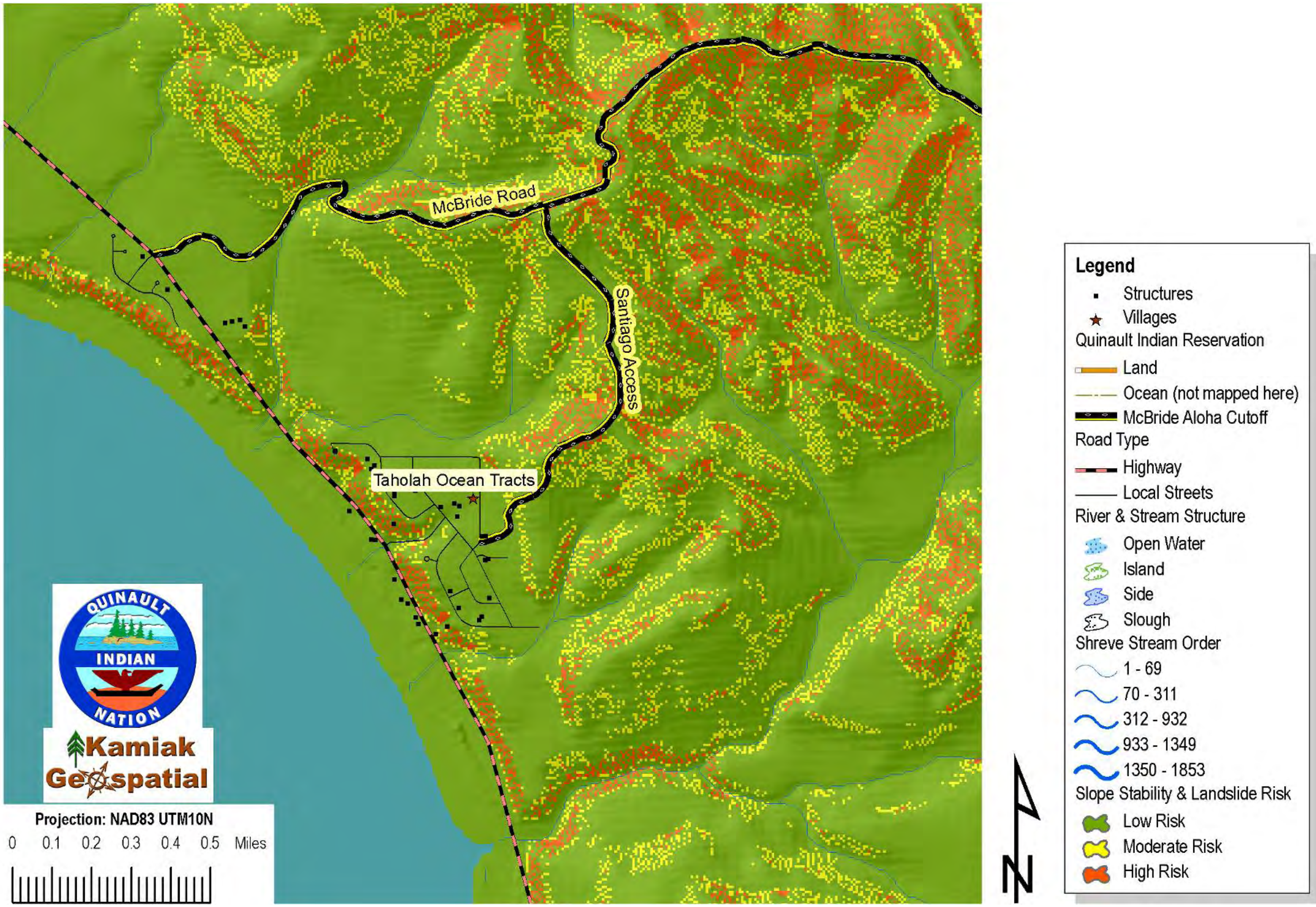


Figure CV. Mean Fire Return Interval of Taholah Ocean Tracts (LANDFIRE 2007).

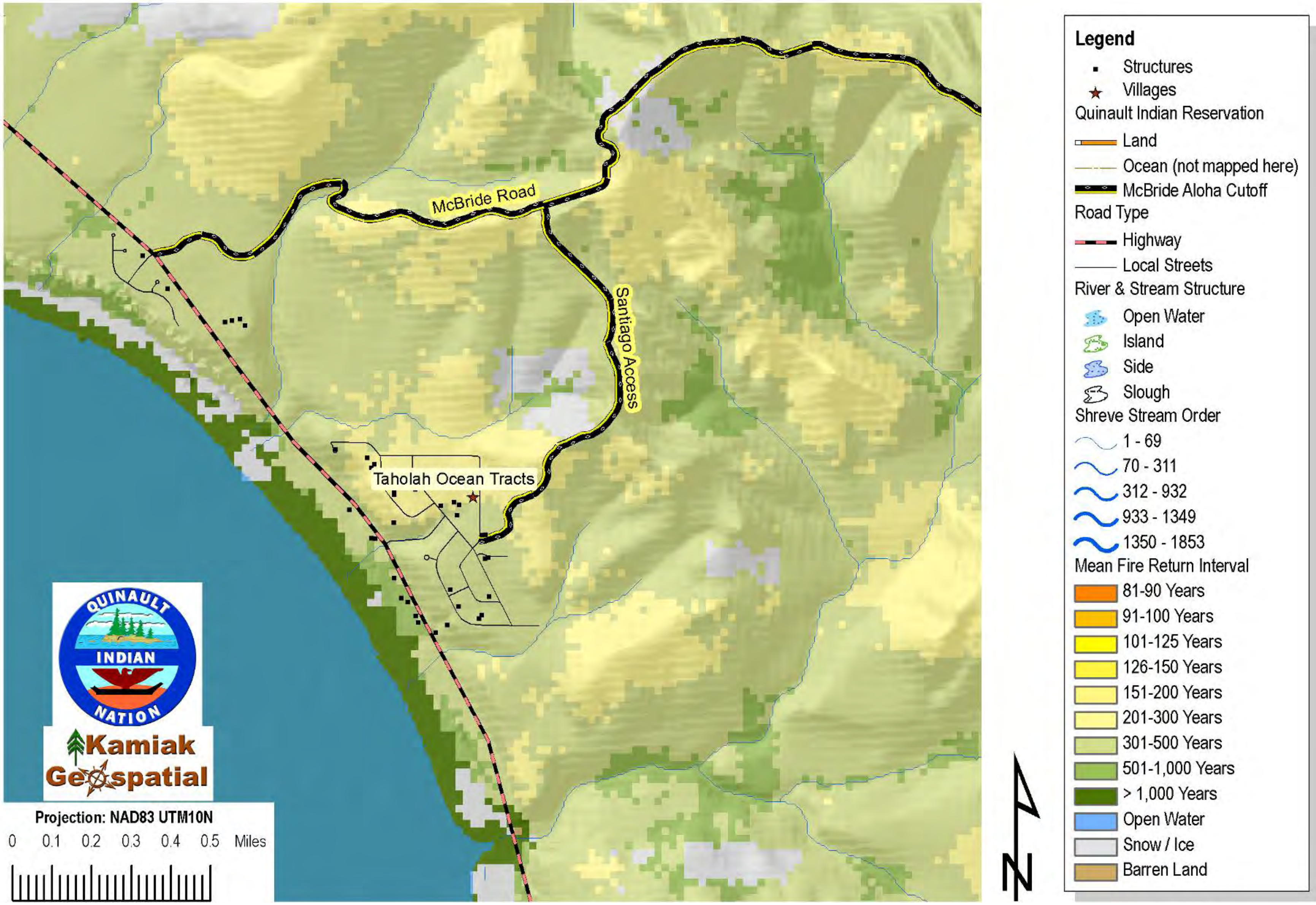
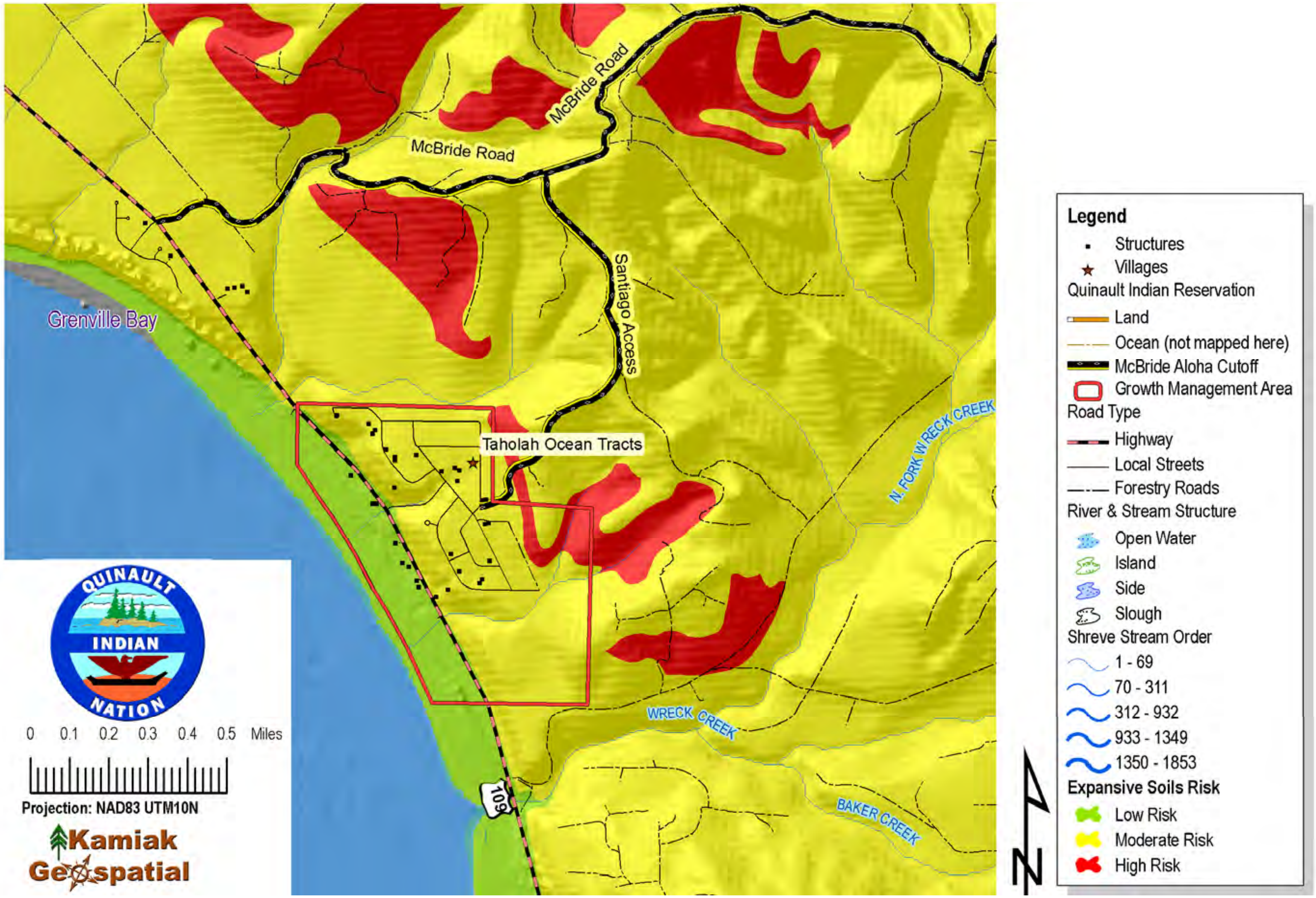


Figure CVI. Expansive Soils and Expansive Clays Assessment of Taholah Ocean Tracts.



5.4.5. Qui-nai-elt Village

As the youngest planned community of the QIR, the Village of Qui-nai-elt has been designed well from the outlook of reduced natural hazard vulnerability, with excellent access, and community services such as water and waste water treatment, power and telephone services, and other amenities (Figure CIX & Figure CX). It also has an aesthetically pleasing view of the surrounding terrain (Figure CVII & Figure CVIII). Located within the southwest extent of the QIR, it is only a two-mile drive to Moclips and ten miles to Taholah.

As already defined in Section 5.2 (Macro Hazards), the risk exposure to high winds and seismic shaking hazards is uniformly high in Qui-nai-elt, as it is in the other populated places of the QIR. Roofing materials have favored metal and composite roofing tiles, while eve fortification is suited for the high winds and heavy rainfall.

Structures in this village do not seem to utilize wood burning heat, as evidenced by the few number of homes with brick chimneys. The occurrence of trees surrounding and overtopping homes within this village is noted, but the age of the surrounding forests do not place the tall timbers in close proximity to the structures where wind damages could extract damages currently.

Figure CVII. Homes located within the Qui-nai-elt Village.

5.4.5.1. Flood Risks

The Village of Qui-nai-elt is located outside of predicted flood impact areas and storm water drainage (surface water) accumulations do not seem to be a challenge for this community. Access from the Moclips / Olympic Highway (Cook Creek Road) is unimpeded (Figure CXI).

Access along the Cook Creek Road crosses on a bridge over the Moclips River as travelers leave the village and travel eastward to access US101 and Amanda Park. While the Moclips River supports a wide floodplain, the bridge crossing over this river is substantially elevated above the river's base flood elevation although large organic matter transported by this river system must be cleared periodically. Travelers leaving the Village of Qui-nai-elt heading westerly to connect to SR109 to drive to Moclips must leave the QIR and cross the SR109/Moclips River bridge. During high flood events, and tsunami events, this access can be compromised. The free-board over the top of the river to the bottom of the bridge is minimal and large organic debris can easily become lodged against the bridge.

5.4.5.2. Tsunami

The Village of Qui-nai-elt is located outside of direct tsunami inundation zones. Access in and out of the Village of Qui-nai-elt must pass through areas to the west that are within the tsunami inundation zone (Figure XLVIII).

5.4.5.3. Liquefaction

The risk to liquefaction around the Village of Qui-nai-elt is rated in the "very low" category affecting 56 homes with a value of approximately $7.5 million (Table 47). Future construction and existing homes in this area should not be limited by liquefaction concerns (Figure CXII).

5.4.5.4. Slope Stability

Slope stability issues within the Village of Qui-nai-elt are limited to the steep micro-slopes of the area (Figure CXIII and Table 48). Of highest concern are the slopes to the southeast of the community leading to the banks of the Moclips River. Slopes along this steep slope buffer are prone to landslide characteristics. Currently, there are no homes located along this buffer near the river. This area is, however, currently within the area zoned for residential home development (Figure CX). It is recommended that these slope stability areas be removed from future home site placement.

All around the village, to the north and west of the current perimeter, there are several sites with steep slopes that show characteristics of landslide potential. Currently, physical home site locations have avoided these high risk areas, but many are located in moderate landslide risk areas. It is desirable that these high risk sites be identified and avoided in the future when placing new homes to be built in this community.

There are currently 56 structures in the Village of Qui-nai-elt and approximately $1.8 million (14 homes) are located in moderate slope stability risk areas, and $5.7 million (42 homes) are located in low landslide risk areas (Table 48).

5.4.5.5. Wildfire

Assessments for MFRI and Replacement Fire Severity are summarized in Table 49 through Table 52. The MFRI for the Village of Qui-nai-elt places the natural fire return interval where homes are located at 200 years to 300 years (Figure CXIV and Table 50). Although human caused changes to this natural fire regime should always be considered, it is clear that the natural fire return cycle will not be a driving force for wildfire ignitions. However, in comparison to the other populated places of the QIR, the MFRI within the Village of Qui-nai-elt is on a shorter scale and can result in lower accumulations of highly flammable forest communities.

These statistics should be interpreted with the Replacement Fire Severity considerations which predict that when a wildfire ignites, and weather conditions are consistent with a major wildfire event (hot temperatures, dry weather, and high winds) the resistance to wildfire control is predictably high. The Replacement Fire Severity Predictions for the Village of Qui-nai-elt (Table 51 and Table 52) place 100% of the structural value in the classification of 76% to 100% stand replacement fires.

5.4.5.6. Expansive Soils

Expansive soils and expansive clays within the area of Qui-nai-elt are mainly moderate risk soils (Figure CXV). The main access route to this area and all structures in this community are located within the moderate risk areas. This same observation is consistent with the current QIN Growth Management Area – moderate risks to expansive soil conditions. All of these structures serve a residential purpose. Future developments in this area should accommodate additional pre-construction design to maintain a constant soil moisture profile around homes.

All of the Qui-nai-elt area should be considered as limiting to future developments because of the soil characteristics. On-site geotechnical evaluations should be considered before new developments are placed in this area. Pre-construction factors to limit the amount of variation in soil wetting and drying should be implemented where practical.

This area is also suggested as the termination point for the development of an emergency by-pass route to be used when access along SR109 is compromised from flooding, tsunami, or storm surges (Section 5.5.1.1). This route, the “McBride Aloha Cutoff”, crosses several locations where the soils are moderate to high in expansive soils and expansive clays. While construction of roads can be accomplished along these routes, the formation of the roadbed should incorporate several site specific geotechnical techniques to increase the durability and serviceability of this proposed emergency access route. The site already has forestry roads in place, but additional precautions must be accounted for, before increased use and reliability on this access route can be made.

Figure CVIII. Qui-nai-elt Housing design with Moclips in the background (Workman 2009).

Figure CIX. Aerial Imagery of Qui-nai-elt Village.

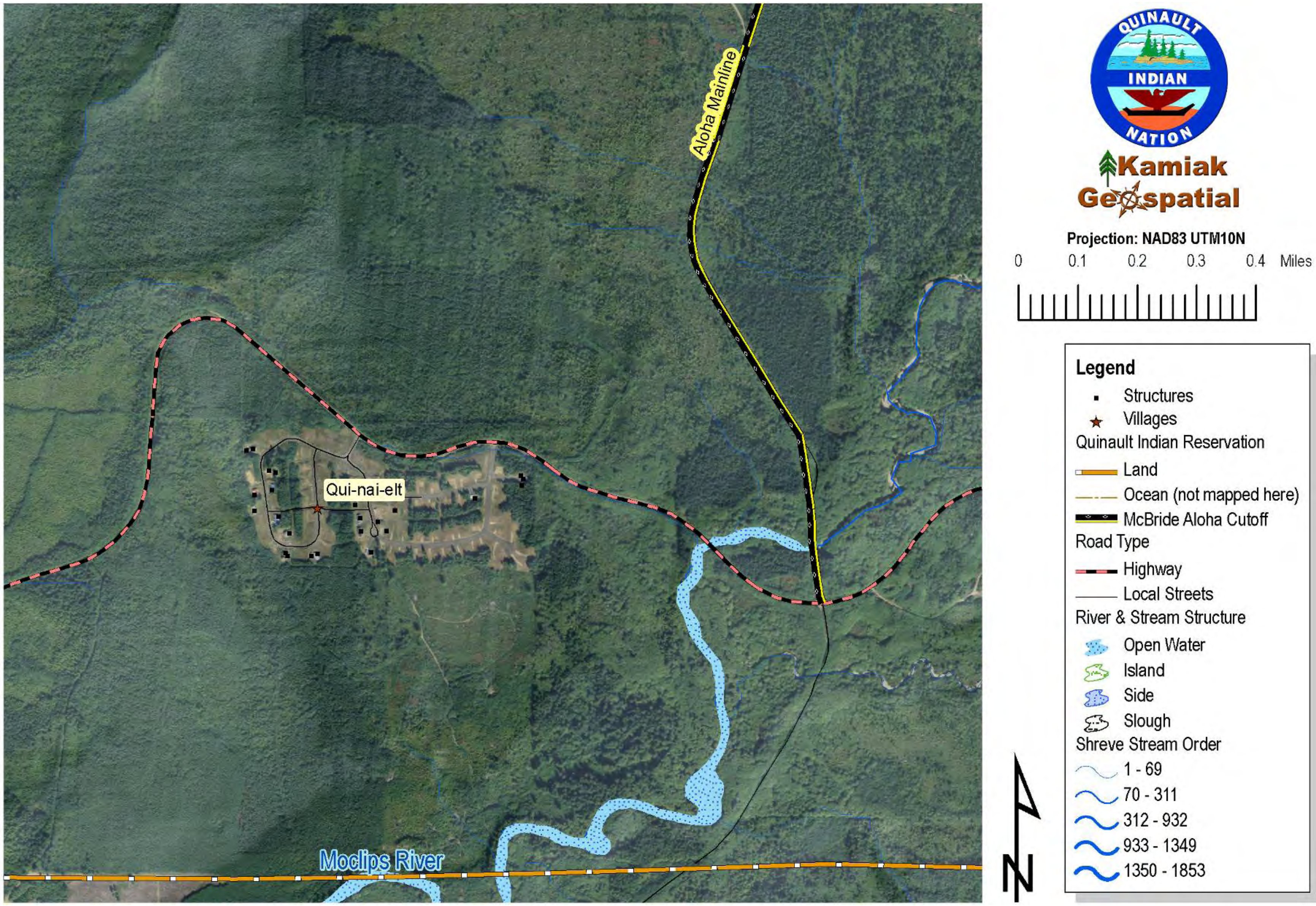


Figure CX. Zoning and Growth Management Areas of Qui-nai-elt Village.

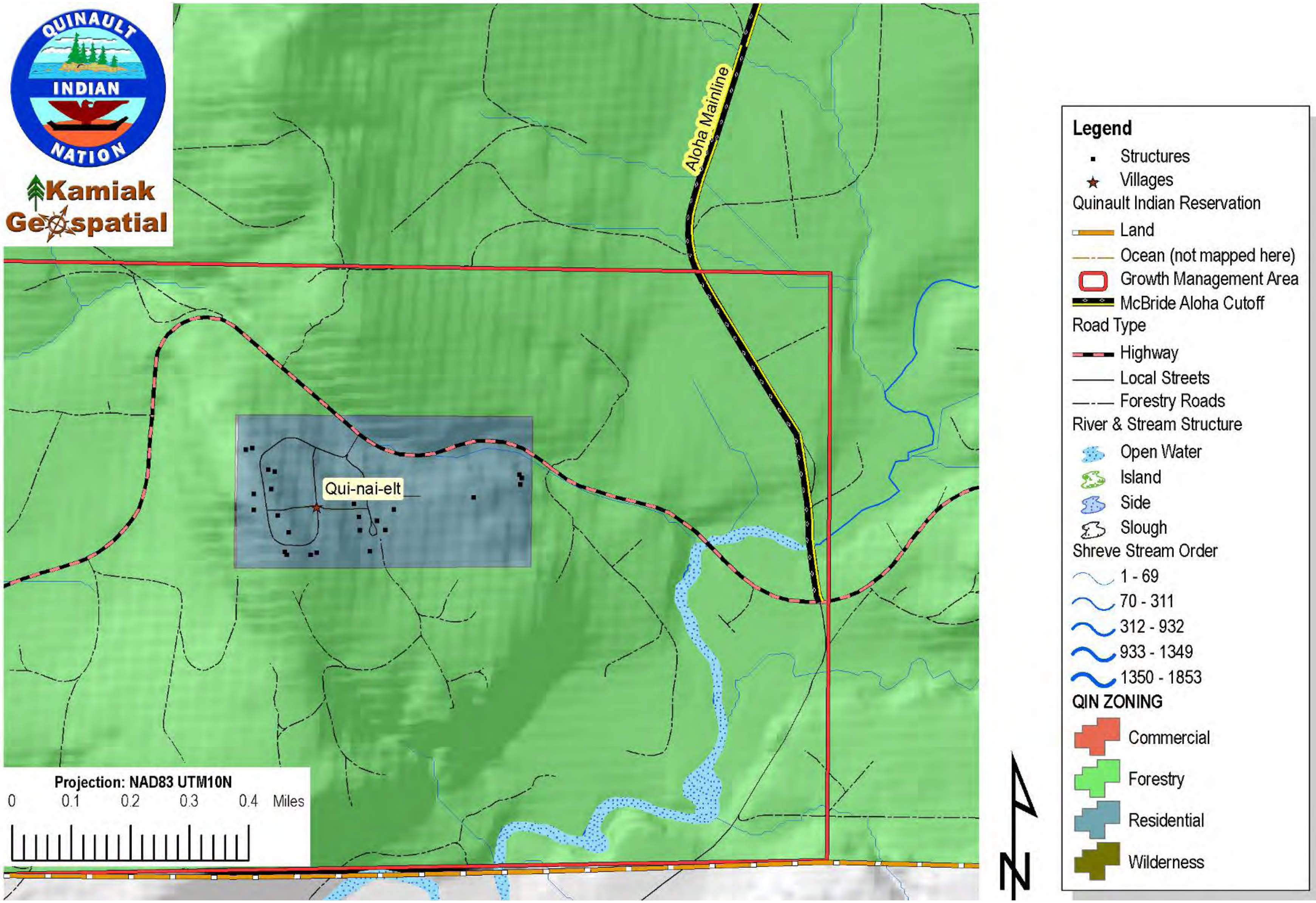


Figure CXI. Flood Zones of Qui-nai-elt Village.

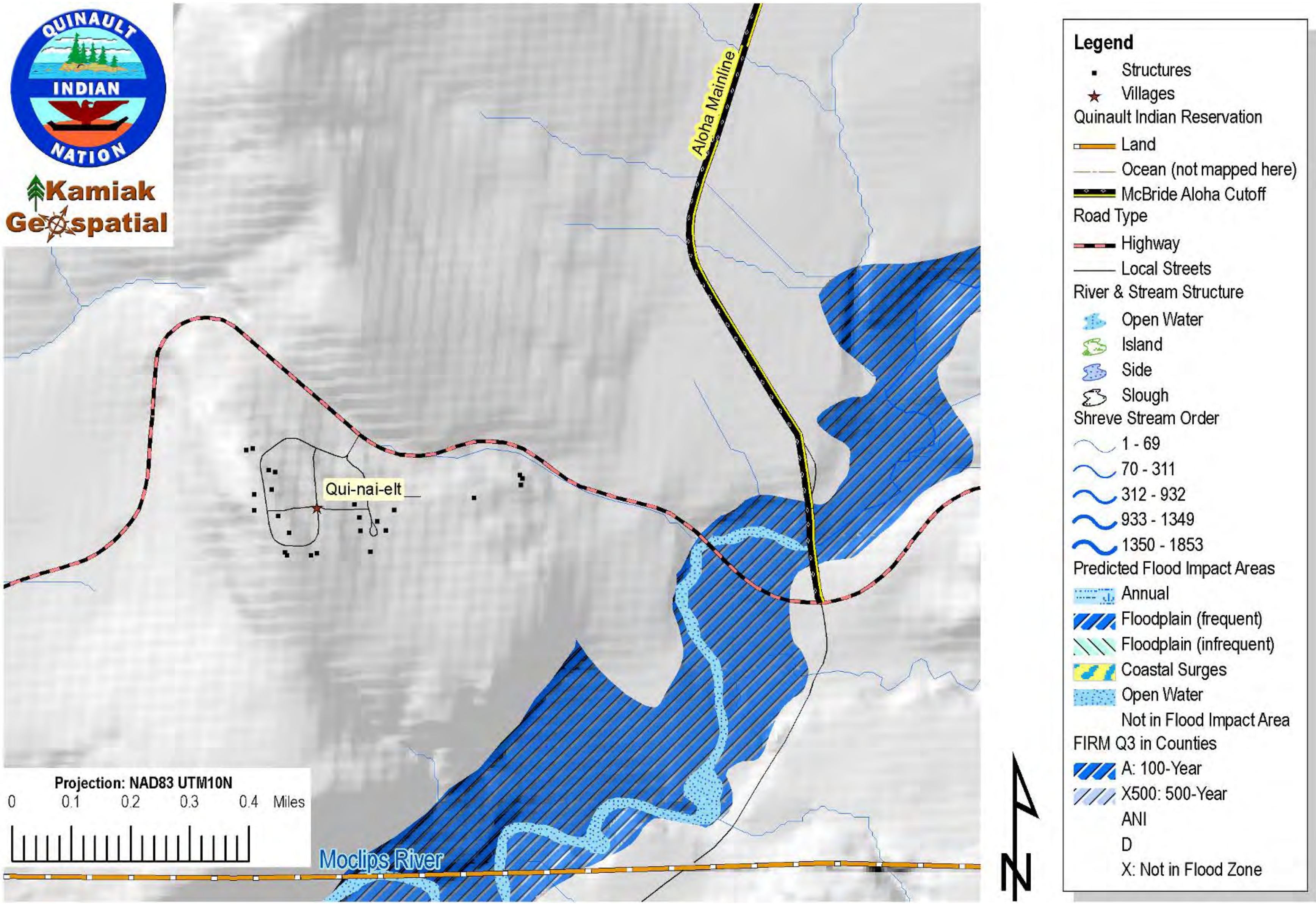


Figure CXII. Liquefaction Risks of Qui-nai-elt Village (WDNR 2010).

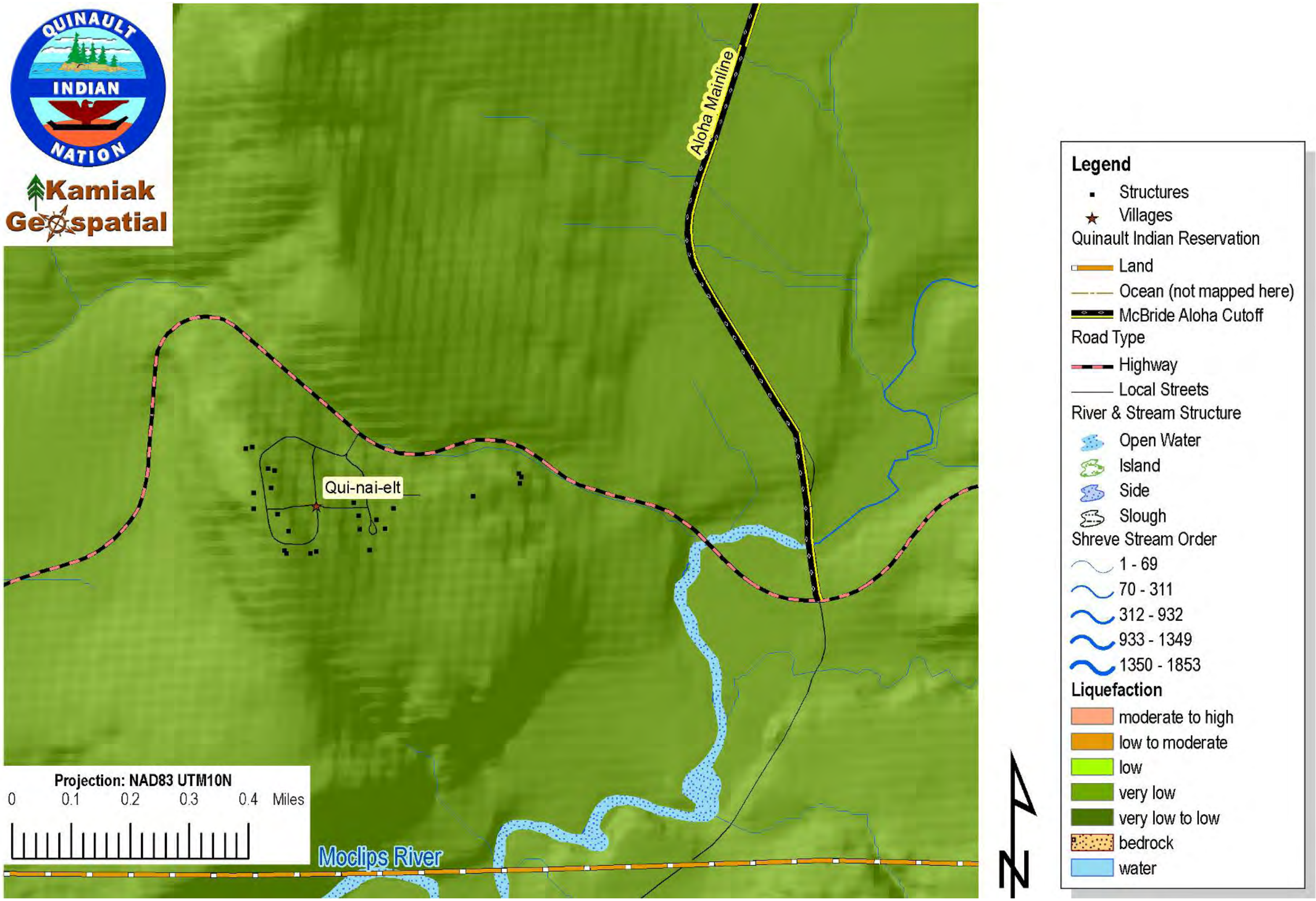


Figure CXIII. Slope Stability Risks of Qui-nai-elt Village (WDNR 2010).

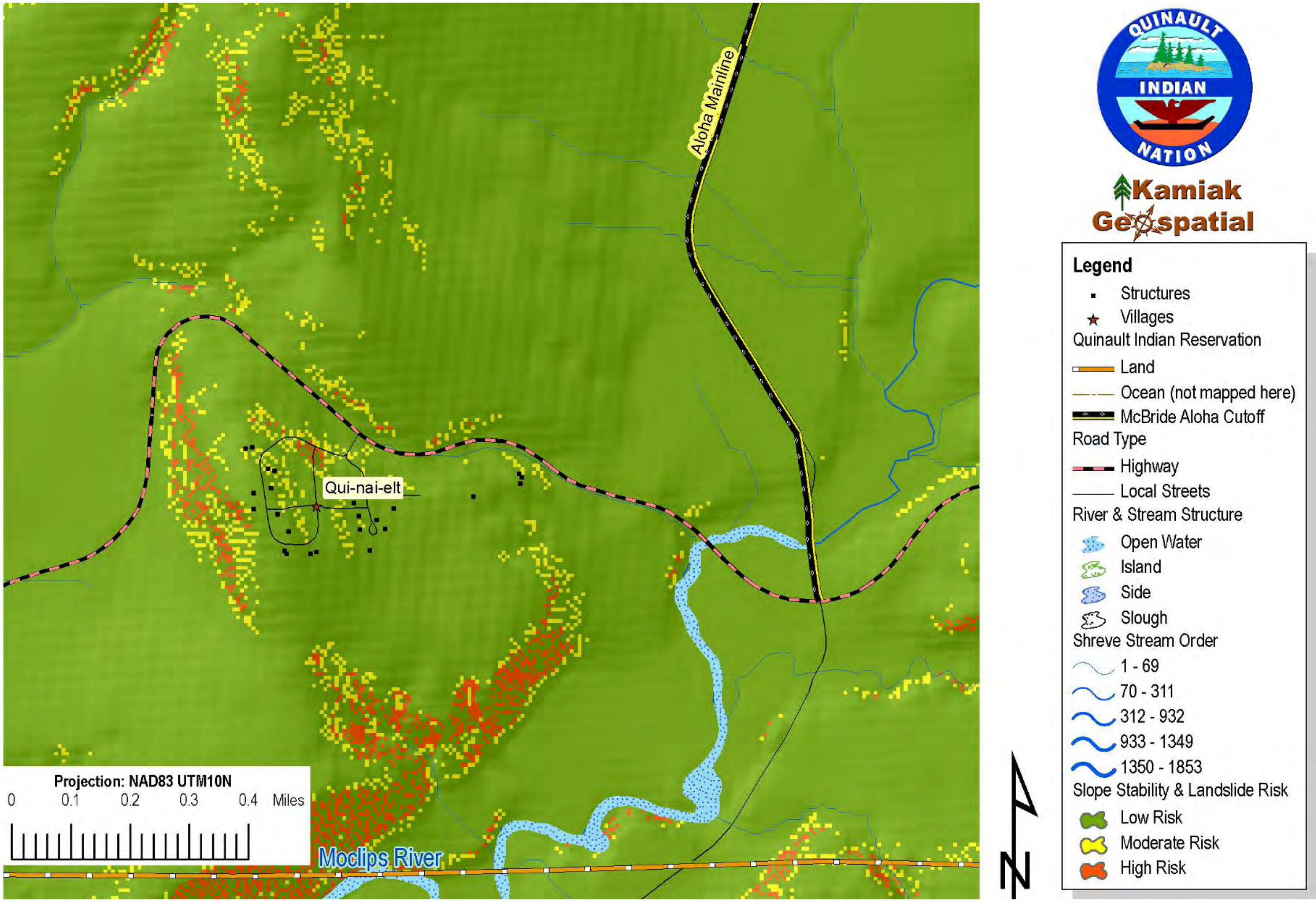


Figure CXIV. Mean Fire Return Interval of Qui-nai-elt Village (LANDFIRE 2007).

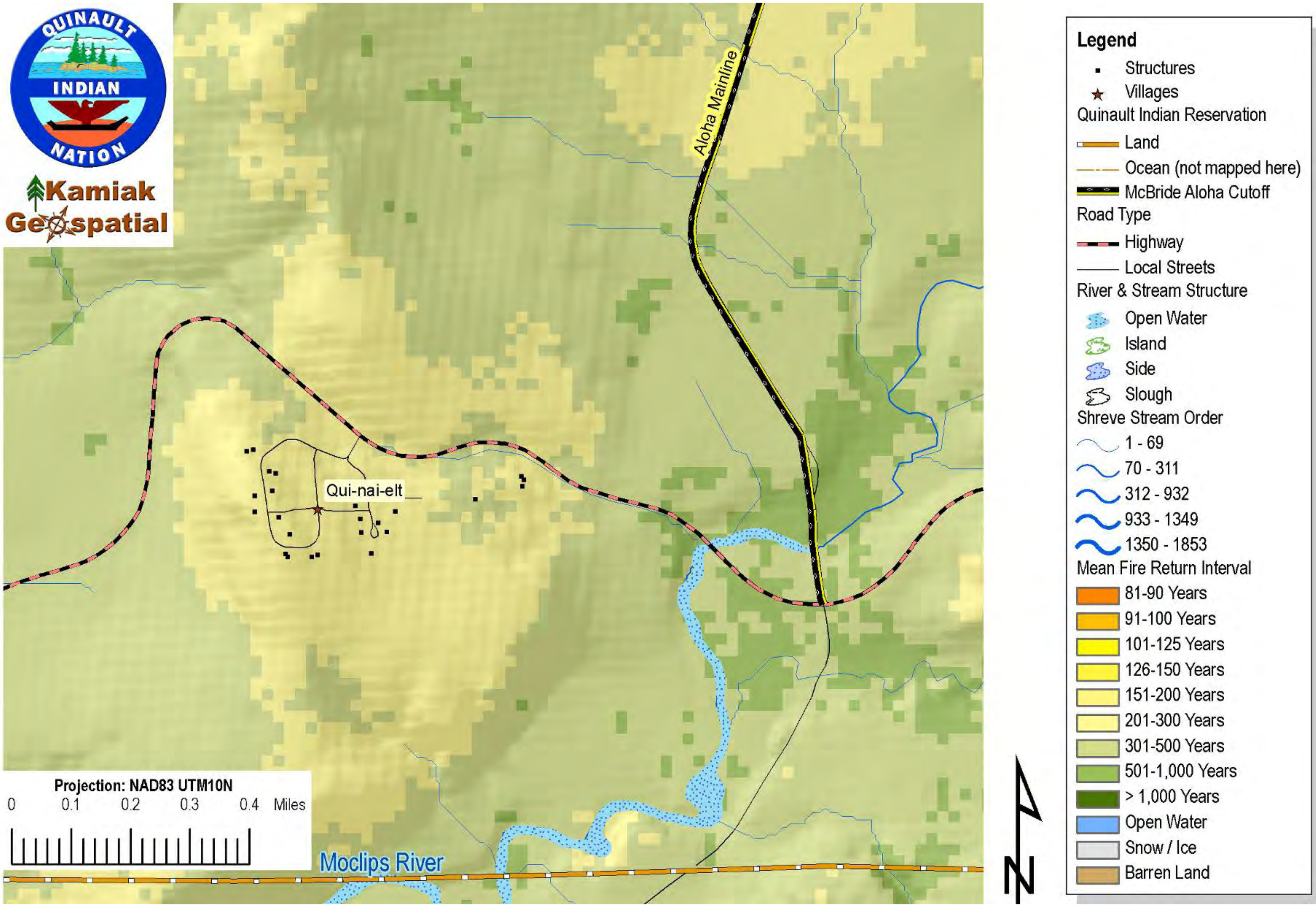
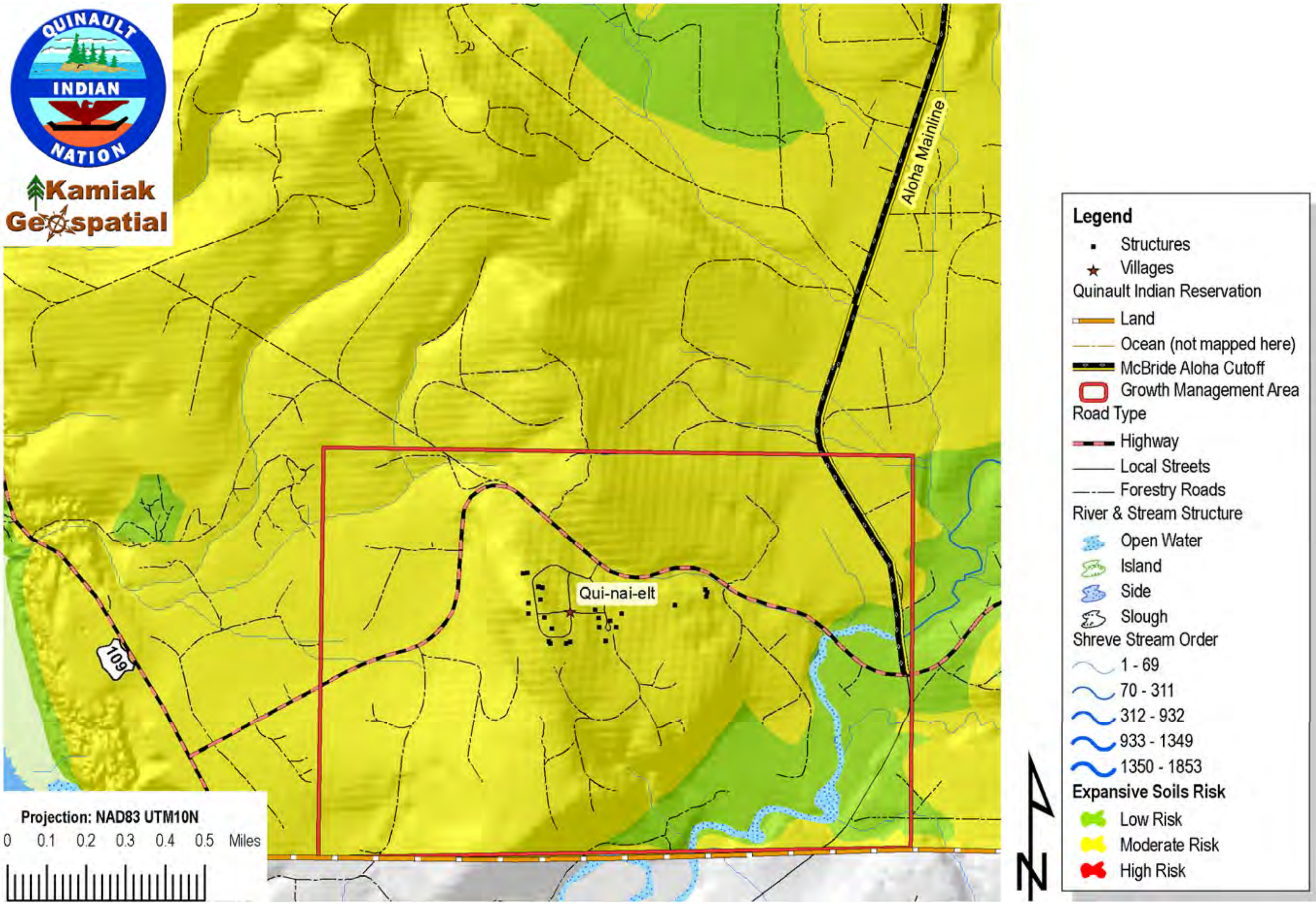


Figure CXV. Expansive Soils and Expansive Clays Assessment of Qui-nai-elt Village.



5.5. Infrastructure Based Risk Exposure

Infrastructure enhancements have been discussed in several locations of this document and many of those complications have identified the current status of SR109 from Moclips to Taholah. This is the first infrastructural component to address in this section. Additional recommendations are made for segments of US101 on the QIN.

5.5.1. SR109 Moclips to Taholah

SR109 traverses several locations where exposure to natural disasters is common. These locations are witnessed by the apparent warnings of "Slide Area" at Swede Hill (4.7.1), standing water over the roadway (Figure CXXI), ditch networks that are quickly overtopped during seasonal rainstorms, bridges that have been washed out by tsunami (Wreck Creek Bridge in 1964), and other risks not witnessed in recent days. These unrealized risks include a CSZ earthquake generated tsunami that can easily compromise SR109 from Moclips to Point Grenville. North of Point Grenville all the way to Taholah, the route is secure from tsunami damage but standing water over the roadway is a common occurrence.

5.5.1.1. McBride/Aloha Mainline Bypass

The attention given to SR109 along the stretch from Moclips to Point Grenville is two-fold. First, the residents of Taholah Ocean Tracts must rely on SR109 to gain access out of the area for daily activities and for emergency services. Second, this route is the only reliable way for street traffic to access Taholah or for Taholah residents to access the rest of the region. If any part of SR109 is compromised, then neither side can access the other over a reliable all-weather road surface.

Consideration has been given to the enhancement of forest roads in the area to circumvent SR109 north of Point Grenville from the McBride road to the Moclips River near the Village of Qui-nai-elt (Figure CXVI). This access begins at McBride Road where it intersects SR109 heading eastward until it intersects the Aloha Mainline. The route then turns southerly along the Aloha Mainline until it intersects with the Moclips / Olympic Highway (Cook Creek Road). The total distance to traverse is 10.9 miles and currently, the road has a gravel base and is impassable by highway passenger vehicles (several steep climbs). These roads have been designed and maintained for logging trucks and 4x4 pickup trucks used by forestry staff.

Expansive soils and expansive clays in along the proposed route rank between moderate and high in the characteristic risks (Figure CXVII). These factors do not eliminate the proposed construction of an emergency route, but they do necessitate additional construction considerations to provide the enhanced access route with longevity and durability.

In order for this route to be used for an emergency vehicle traffic, substantial improvements to the travel surface, ditching, road widening, and even re-routing would be required. Reinforcement of smaller scale logging roads from the McBride Road to the Village of Taholah Ocean Tracts would need to be improved and extended to access the village. Approximately 1.15 miles of road from the McBride Road to the Village of Taholah Ocean Tracts would need to be constructed.

This route traverses several potentially landslide prone areas along the McBride Road that would require attention to the design and construction of the roadbed to ensure road stability for emergency vehicles. Most of this portion of the route is located along the ridgeline where landslides are less probable than if the road were located at the bottom of a valley. Liquefaction risk is very low. Both floods and tsunami would not be expected to negatively impact this access route.

This emergency access route crosses lands held as Quinault Fee, Fee Lands, and BIA Trust Lands.

Figure CXVI. McBride/Aloha Mainline Bypass Proposed Route.

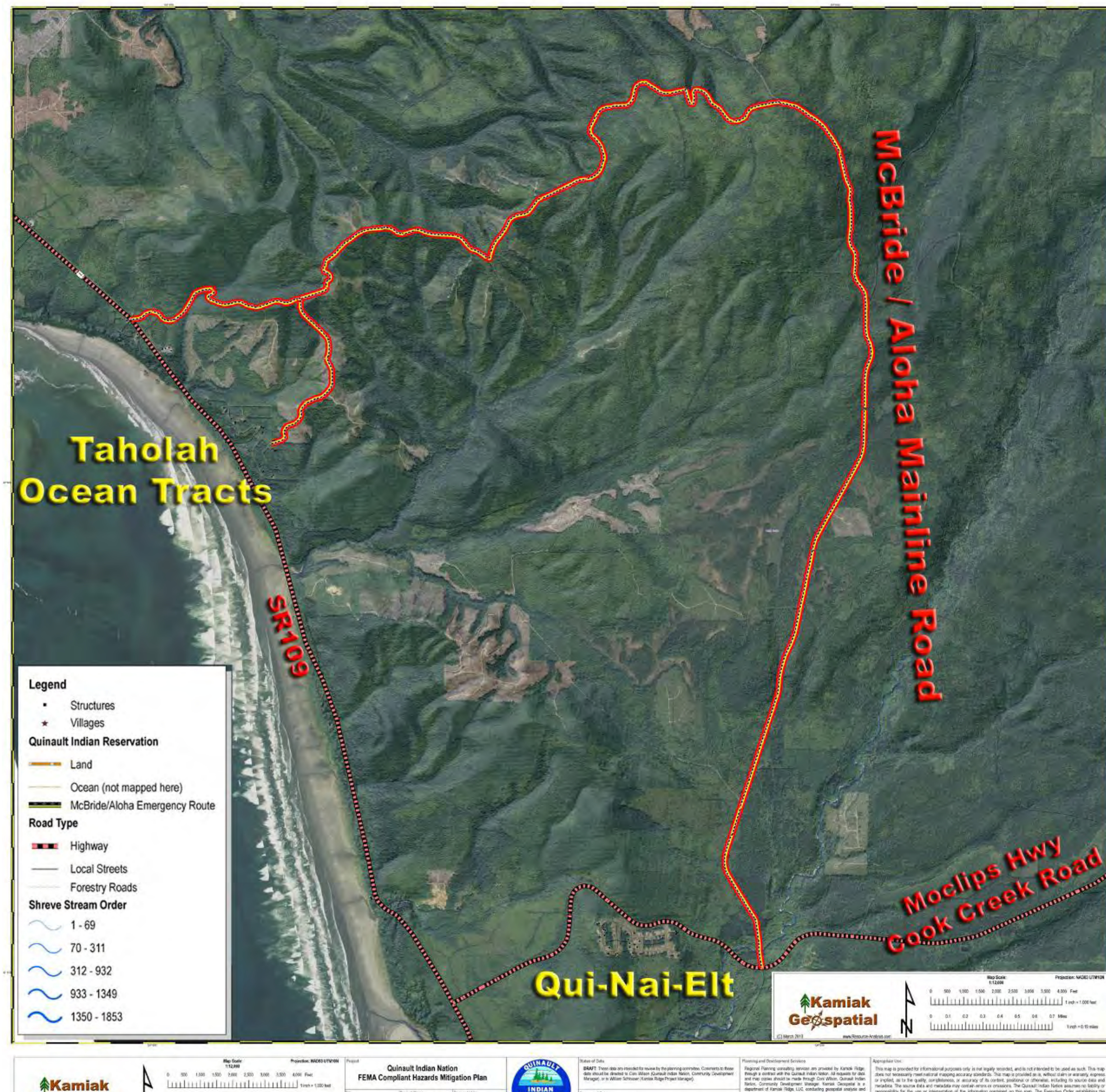
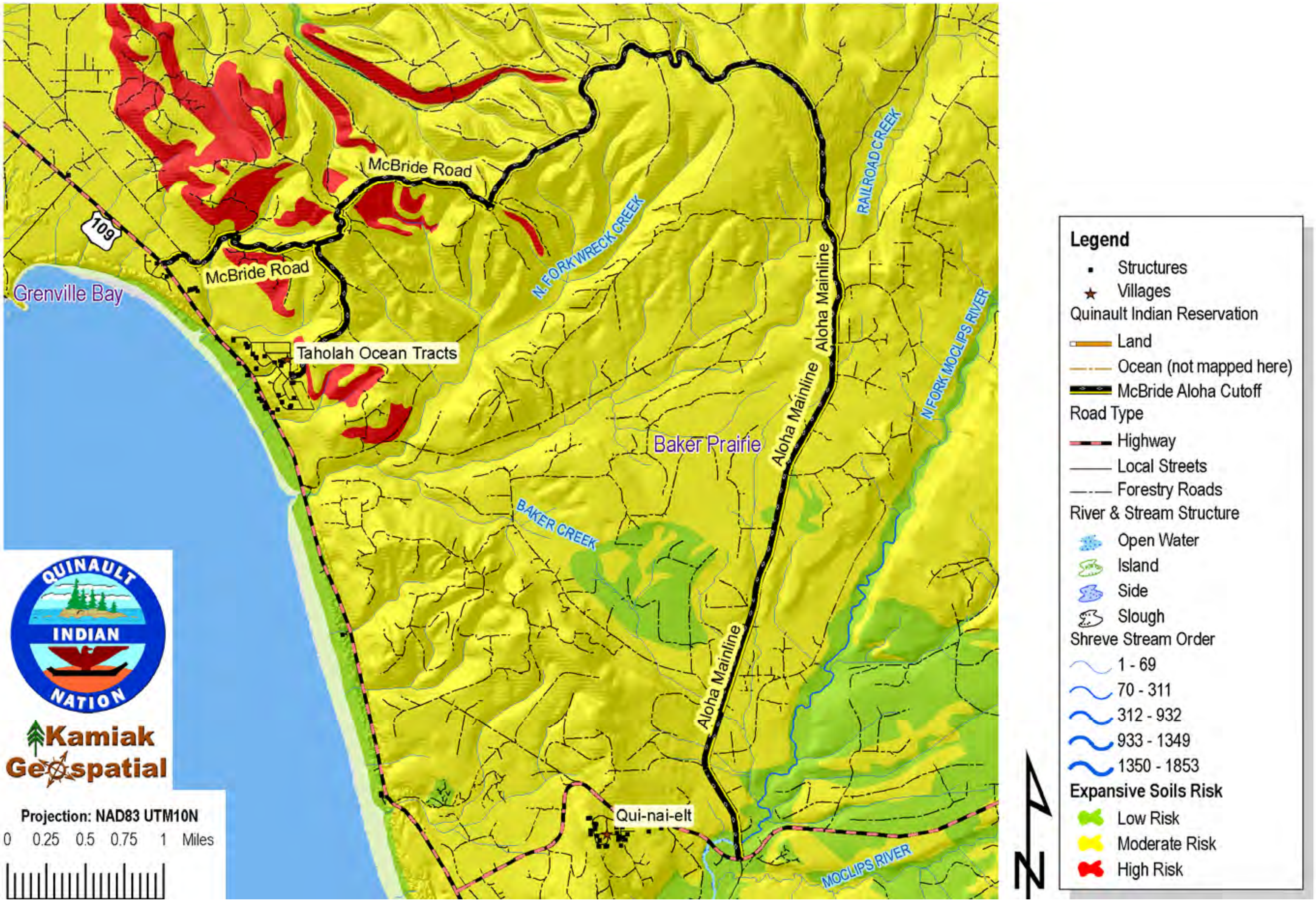


Figure CXVII. McBride/Aloha Mainline Bypass Proposed Route with Expansive Soils and Expansive Clays Assessment.



5.5.1.2. Point Grenville to Taholah

SR109 traverses an upper plateau of land plagued by storm water accumulations that cannot adequately drain waters under the road (Figure CXXI). These surface waters accumulate, overtop the ditch drainage systems, and create standing water situations that require motorists to take excessive caution. The possible fix for this situation includes elevating the travel surface of SR109 to lift the roadway above the level of flood waters, while installing drainage culverts to cross under the road. These drainage ditches require extension from the “swamps” of the plateau and the road crossing, to the cliff edges leading to the ocean. Simply dropping these surface water drainage systems westerly may not be a suitable solution while mimicking the natural flow direction of these waterways would ensure the support of the existing hydrologic system.

5.5.1.3. Taholah/Quinault River Bridge

The bridge over the Quinault River at Taholah marks the official end of SR109, but the access to the north side of the river at Taholah is important economically, culturally, and recreationally. The bridge is also the main supporting infrastructure for the waterline pipe providing drinking water from the facility north of the river to the village (Figure CXVIII).

The Quinault River carries a substantial large organic debris load on its journey to the ocean. Several recommendations have been offered concerning bridges in this document (Section 4.4.6.3) including debris fins, debris deflectors, debris sweepers. Each of these devices has merit but it seems that the debris sweeper is most suited to the passage of fish, fishermen, and detract minimally from the aesthetic enjoyment of the river.

Figure CXVIII. Water Supply Pipe Supported on the Taholah/Quinault River Bridge.

5.5.2. US101 South of Amanda Park

Segments of US101 just south of the QIR boundary, passes through lands that support old growth timber and are managed by the Olympic National Forest (USFS). This area frequently is flooded during rainstorm events with surface waters over the highway. During high winds, tree tops, branches, and entire tree stems can fall across the roadway blocking traffic. Because this route is the only route for the people of the QIN to access points between the southwest side of the reservation and all other points on the Reservation, the open flow of traffic through this route is needed. However, the land management of these sites is not under the control of the QIN and road cleanup relies on other agencies.

Alternative access routes have been identified that cross QIR lands, but the existing roads along this route traverse portions of the floodplain and often experience the same problems of water--over-the roadway and fallen trees across the road.

5.5.3. US101 Crossing the Queets River

The bridge over the Queets River at Queets is subjected to substantial large organic debris accumulations during normal high flow events. The same condition is seen upstream on the Queets River at the Clearwater Road crossing above the confluence with the Clearwater River. Both of these river crossings mark important infrastructure features for the people of this region both for daily commerce and for use as emergency evacuation routes. If one bridge is compromised, then the other can be used, although the trip from the south side of the Queets US101 bridge to the Clearwater Bridge is less than 6 miles, while the same destination from the north side of a closed US101 bridge to Queets involves gravel roads, steep slopes, and about three times the travel distance.

The Queets River carries a substantial load of large organic debris on its journey to the ocean. Several recommendations have been offered concerning bridges in this document (Section 4.4.6.3) including debris fins, debris deflectors, debris sweepers. Each of these devices has merit but it seems that the debris sweeper is most suited to the passage of fish, fishermen, and will detract minimally from the aesthetic enjoyment of the river.

5.6. Taholah Airstrip

Because the access to the Village of Taholah is necessary to ensure the continuity of operations for the QIN, for emergency medical attention and the provision of emergency supplies in the event that a major disaster (such as a large earthquake or tsunami) compromises either SR109 within the QIR or the access of this route in other critical locations, the construction of an airstrip capable of supporting both helicopter traffic and light aircraft traffic is suggested. The location of the airstrip is proposed for an area south of the “upper village” of Taholah where it is outside of flood zones, tsunami risks, unstable soils (landslide risk), and liquefaction risks. This placement will facilitate ready access to the Roger Saux Health Clinic and the QIN government infrastructure. It is not recommended to create a commercial airport at this location, but to provide a means of emergency access for the Nation and the people of the Village of Taholah.

Table 45. Flood Risk Exposure on QIR by Community Area (**Not FEMA FIRM Determined**).

	Value of Structures					Number of Structures			
Community Area	Structure Value	Not in Flood Impact Area	Annual Flooding	Frequent Flooding	Infrequent Flooding	Not in Flood Impact Area	Annual Flooding	Frequent Flooding	Infrequent Flooding
Amanda Park	$18,045,408	$15,811,346	$-	$2,234,062	$-	129	0	21	0
Cook Creek Hatchery	$7,592,491	$3,108,522	$-	$4,483,969	$-	21	0	7	0
Point Grenville	$864,555	$864,555	$-	$-	$-	13	0	0	0
Queets	$7,809,796	$7,648,473	$-	$161,323	$-	80	0	1	0
Queets / Clearwater	$1,978,706	$1,091,714	$849,672	$37,320	$-	8	9	3	0
Qui-nai-elt Village	$7,508,619	$7,508,619	$-	$-	$-	56	0	0	0
Quinault River	$16,000	$16,000	$-	$-	$-	1	0	0	0
Raft River Wilderness	$390,960	$134,280	$-	$256,680	$-	18	0	2	0
Taholah - Lower Village	$36,338,174	$12,612,555	$-	$1,962,331	$21,763,288	66	0	10	186
Taholah - Upper Village	$23,023,899	$19,842,679	$-	$-	$3,181,220	68	0	0	1
Taholah Ocean Tracts	$1,530,285	$1,530,285	$-	$-	$-	25	0	0	0
US101 Zone	$8,386,947	$8,386,947	$-	$-	$-	21	0	0	0
Totals	$113,485,840	$78,555,975	$849,672	$9,135,685	24,944,508	506	9	44	187

Table 46. Tsunami Risk Exposure on QIR by Community Area (Cascadia Subduction Zone Scenario A).

Community Area	Total Structure Value	Summary Value Table			Summary Count Table		
		Not Within CSZ Scenario A	Within CSZ Scenario A	Percent of Value At-Risk to Event	Not Within CSZ Scenario A	Within CSZ Scenario A	Percent of Value At-Risk to Event
Amanda Park	$18,045,408	$18,045,408	$-	0%	150	0	0%
Cook Creek Hatchery	$7,592,491	$7,592,491	$-	0%	28	0	0%
Point Grenville	$864,555	$854,550	$10,005	1%	10	3	23%
Queets	$7,809,796	$7,578,866	$230,930	3%	79	2	2%
Queets / Clearwater	$1,978,706	$1,978,706	$-	0%	20	0	0%
Qui-nai-elt Village	$7,508,619	$7,508,619	$-	0%	56	0	0%
Quinault River	$16,000	$16,000	$-	0%	1	0	0%
Raft River Wilderness	$390,960	$134,280	$256,680	66%	18	2	10%
Taholah - Lower Village	$36,338,174	$125,000	$36,213,174	100%	2	260	99%
Taholah - Upper Village	$23,023,899	$19,592,679	$3,431,220	15%	67	2	3%
Taholah Ocean Tracts	$1,530,285	$1,231,635	$298,650	20%	20	5	20%
US101 Zone	$8,386,947	$8,386,947	$-	0%	21	0	0%
Totals	$113,485,840	$73,045,181	$40,440,659	36%	472	274	2

Table 47. Liquefaction Risk Exposure on QIR by Community Area.

		Value				Number of Structures				
Community Area	Value	N/A (bedrock)	very low	very low to low	moderate to high	N/A (bedrock)	very low	very low to low	moderate to high	Total Number
Amanda Park	$18,045,408	$-	$-	$18,045,408	$-	0	0	150	0	150
Cook Creek Hatchery	$7,592,491	$-	$7,592,491	$-	$-	0	28	0	0	28
Point Grenville	$864,555	$-	$864,555	$-	$-	0	13	0	0	13
Queets	$7,809,796	$50,000	$4,162,722	$-	$3,597,074	1	34	0	46	81
Queets / Clearwater	$1,978,706	$-	$1,091,714	$-	$886,992	0	8	0	12	20
Qui-nai-elt Village	$7,508,619	$-	$7,508,619	$-	$-	0	56	0	0	56
Quinault River	$16,000	$-	$16,000	$-	$-	0	1	0	0	1
Raft River Wilderness	$390,960	$-	$134,280	$-	$256,680	0	18	0	2	20
Taholah - Lower Village	$36,338,174	$100,000	$25,000	$-	$36,213,174	1	1	0	260	262
Taholah - Upper Village	$23,023,899	$-	$19,274,679	$-	$3,749,220	0	65	0	4	69
Taholah Ocean Tracts	$1,530,285	$-	$1,530,285	$-	$-	0	25	0	0	25
US101 Zone	$8,386,947	$128,000	$8,258,947	$-	$-	1	20	0	0	21
Total	$113,485,840	$278,000	$50,459,292	$18,045,408	44,703,140	3	269	150	324	746

Table 48. Slope Stability Risk Exposure on QIR by Community Area.

Community Area	Total Value	Value				Number of Structures				Total Number
		Very Low Risk	Low Risk	Moderate Risk	High Risk	Very Low Risk	Low Risk	Moderate Risk	High Risk	
Amanda Park	$18,045,408	$337,912	$15,005,434	$2,555,610	$146,452	9	115	22	4	150
Cook Creek Hatchery	$7,592,491	$-	$3,463,230	$161,323	$3,967,938	0	18	1	9	28
Point Grenville	$864,555	$6,670	$483,950	$3,335	$370,600	2	9	1	1	13
Queets	$7,809,796	$139,214	$6,501,187	$640,615	$528,780	2	65	8	6	81
Queets / Clearwater	$1,978,706	$-	$1,961,138	$17,568	$-	0	17	3	0	20
Qui-nai-elt Village	$7,508,619	$-	$5,662,315	$1,846,304	$-	0	42	14	0	56
Quinault River	$16,000	$-	$-	$-	$16,000	0	0	0	1	1
Raft River Wilderness	$390,960	$-	$332,790	$-	$58,170	0	13	0	7	20
Taholah - Lower Village	$36,338,174	$2,100,000	$34,138,174	$-	$100,000	21	240	0	1	262
Taholah - Upper Village	$23,023,899	$-	$21,503,153	$999,423	$521,323	0	59	6	4	69
Taholah Ocean Tracts	$1,530,285	$-	$805,210	$224,760	$500,315	0	16	3	6	25
US101 Zone	$8,386,947	$-	$8,253,947	$5,000	$128,000	0	19	1	1	21
Total	$113,485,840	$2,583,796	$98,110,528	$6,453,938	6,337,578	34	613	59	40	746

Table 49. Mean Fire Return Interval, Structure Value Risk Exposure on QIR by Community Area.

		Structure Value						
Community Area	Total Structure Value	151-200 Years	201-300 Years	301-500 Years	501-1,000 Years	>1,000 Years	Snow/Ice	Barren Land
Amanda Park	$18,045,408	$-	$11,035,911	$4,416,603	$1,683,894	$909,000	$-	$-
Cook Creek Hatchery	$7,592,491	$-	$261,323	$7,008,522	$-	$322,646	$-	$-
Point Grenville	$864,555	$-	$-	$864,555	$-	$-	$-	$-
Queets	$7,809,796	$-	$4,811,924	$2,187,977	$278,428	$208,821	$322,646	$-
Queets / Clearwater	$1,978,706	$-	$400,074	$1,020,350	$24,852	$-	$533,430	$-
Qui-nai-elt Village	$7,508,619	$-	$7,508,619	$-	$-	$-	$-	$-
Quinault River	$16,000	$-	$-	$16,000	$-	$-	$-	$-
Raft River Wilderness	$390,960	$-	$10,365	$380,595	$-	$-	$-	$-
Taholah - Lower Village	$36,338,174	$-	$7,888,626	$21,088,272	$3,461,323	$3,237,161	$662,792	$-
Taholah - Upper Village	$23,023,899	$520,000	$18,705,179	$3,531,220	$-	$267,500	$-	$-
Taholah Ocean Tracts	$1,530,285	$-	$729,555	$740,125	$60,605	$-	$-	$-
US101 Zone	$8,386,947	$-	$-	$6,944,203	$1,314,744	$-	$-	$128,000
Totals	$113,485,840	$520,000	$51,351,576	$48,198,422	6,823,846	4,945,128	1,518,868	128,000

Table 50. Mean Fire Return Interval, Structure Count Risk Exposure on QIR by Community Area.

Community Area	Value	151-200 Years	201-300 Years	301-500 Years	501-1,000 Years	>1,000 Years	Snow/Ice	Barren Land	Total Number
Amanda Park	$18,045,408	-	71	49	27	3	-	-	150
Cook Creek Hatchery	$7,592,491	-	2	24	-	2	-	-	28
Point Grenville	$864,555	-	-	13	-	-	-	-	13
Queets	$7,809,796	-	45	27	4	3	2	-	81
Queets / Clearwater	$1,978,706	-	3	13	3	-	1	-	20
Qui-nai-elt Village	$7,508,619	-	56	-	-	-	-	-	56
Quinault River	$16,000	-	-	1	-	-	-	-	1
Raft River Wilderness	$390,960	-	5	15	-	-	-	-	20
Taholah - Lower Village	$36,338,174	-	25	187	33	12	5	-	262
Taholah - Upper Village	$23,023,899	4	60	3	-	2	-	-	69
Taholah Ocean Tracts	$1,530,285	-	7	16	2	-	-	-	25
US101 Zone	$8,386,947	-	-	17	3	-	-	1	21
Totals	$113,485,840	4	274	365	72	22	8	1	746

Table 51. Replacement Fire Severity, Structure Value Risk Exposure on QIR by Community Area.

Community Area	Total Structure Value	Summary of Values			
		0%-25%	26%-50%	51%-75%	76%-100%
Amanda Park	$18,045,408	$-	$1,814,590	$302,870	$15,927,948
Cook Creek Hatchery	$7,592,491	$-	$1,233,969	$3,000,000	$3,358,522
Point Grenville	$864,555	$6,670	$3,335	$-	$854,550
Queets	$7,809,796	$-	$3,866,649	$342,738	$3,600,409
Queets / Clearwater	$1,978,706	$-	$-	$16,568	$1,962,138
Qui-nai-elt Village	$7,508,619	$-	$-	$-	$7,508,619
Quinault River	$16,000	$-	$-	$-	$16,000
Raft River Wilderness	$390,960	$-	$266,680	$-	$124,280
Taholah - Lower Village	$36,338,174	$2,123,958	$19,557,837	$10,438,003	$4,218,376
Taholah - Upper Village	$23,023,899	$-	$267,500	$3,181,220	$19,575,179
Taholah Ocean Tracts	$1,530,285	$49,605	$238,045	$37,170	$1,205,465
US101 Zone	$8,386,947	$-	$5,000	$-	$8,381,947
Totals	$113,485,840	$2,180,233	$27,253,605	$17,318,569	$ 66,733,433

Table 52. Replacement Fire Severity, Structure Count Risk Exposure on QIR by Community Area.

Community Area	Total Structure Value	Summary of Values			
		0%-25%	26%-50%	51%-75%	76%-100%
Amanda Park	$18,045,408	-	14	6	130
Cook Creek Hatchery	$7,592,491	-	9	3	16
Point Grenville	$864,555	2	1	-	10
Queets	$7,809,796	-	32	5	44
Queets / Clearwater	$1,978,706	-	-	2	18
Qui-nai-elt Village	$7,508,619	-	-	-	56
Quinault River	$16,000	-	-	-	1
Raft River Wilderness	$390,960	-	3	-	17
Taholah - Lower Village	$36,338,174	17	119	90	36
Taholah - Upper Village	$23,023,899	-	2	1	66
Taholah Ocean Tracts	$1,530,285	1	3	2	19
US101 Zone	$8,386,947	-	1	-	20
Totals	$113,485,840	20	184	109	433

Figure CXIX. Fire Station in Amanda Park.

Chapter 6. Resources, Capabilities, and Needs Assessment

6.1. QIN Legal and Regulatory Resources Available for Hazard Mitigation Efforts

The Resources, Capabilities, and Needs Summary was a survey given to all managers of Tribal Divisions, emergency services, agencies, and others involved in the administration of hazard mitigation, preparedness, and protection on the QIR. This form was intended to collect information to ascertain the current status of protection responsibilities, current resources available to respond to hazard prevention, mitigation, and response, and to collect current information about resources needed by each respondent's organization to better meet the needs of the citizenry of the QIR.

Table 53. Resources, Capabilities, and Needs QIN Police Department.

Organization Name	Quinault Indian Nation Police Department
Name & Position of Person Preparing this Summary	Public Safety
Address & Telephone	137 Cuitan, Taholah, WA 98587, 360 276 4423
Service Area	Entire Quinault Indian Reservation
Describe your services and organization goals in overview (100 words or less)	We provide police, corrections (jail), emergency dispatching, animal control, and fire on a 24/7 basis
List your currently available technological resources for use in responding to emergencies in your service area (e.g. list of fire protection apparatus, snow plows, search and rescue trucks, etc.)	• We currently have 6 four wheel drive vehicles, about 6 two wheel drive vehicles, and two fire trucks. We are also in the process of upgrading our radio equipment to increase it interoperability ability and range. Should be complete in the next 6 months. We also recently added 5 GPS hand units for this purpose a few weeks ago. We also added a fleet of 7 chain saws this month for weather related emergencies. We will be converting our entire fleet to four wheel drive units as we replace vehicles. • 5 four wheel drive vehicles (50%) and will be converting fleet to 100% over the next few years. The process of upgrading mobile radio communications capabilities in the next several months. Building a portable (suit case) radio / repeater system that can be used with any vehicle that will be compatible with all QIN radios for search and rescue needs. 7 fully ready chain saws. 5 handheld GPS units for search and rescue.
List your currently available human resources for use in responding to emergencies in your service area (e.g. detail staff by position and number, plus volunteers)	I have about 14 paid persons on staff. I do not know how many volunteers.
List your organization's technological needs for responding to hazard emergencies, which are not currently in inventory, in your service area (e.g., fire trucks or water tenders, fire hydrant network, radio communications network, etc.)	• I need one diesel fire truck for Queets, two special diesel 4x4 brush fire units with winches – one for Queets and one for Taholah. The brush units would also be used for search and rescue. I need two hand held FLIR (Forward Looking Infrared) units for search and rescue. I need about 12 SCBA units and extra air bottles for fire and chemical issues. I need at least 2 Air-Purifying Respirator units and a case of Tyvek suits. I would like about 10 sl20 xp rechargeable flashlights. I would like to have about 20 complete sets of bunker gear. • We need to increase our fire/rescue capabilities – both equipment and training. • Search and rescue needs. 7 fully ready chain saws. 5 handheld GPS units for search and rescue

Table 53. Resources, Capabilities, and Needs QIN Police Department.

Organization Name	Quinault Indian Nation Police Department
List your organization's human resource needs for responding to hazard emergencies, which are not currently utilized, in your service area (e.g., additional number of paid staff, more volunteers, training for volunteers and staff, etc.)	I need one fire supervisor and at least two firefighter / paramedics. We need lots of training but I should be able to handle most of that with my regular budget as I have already incorporated it into my public safety plans. I would like to have about another 8 eight employees to fill out my staff.

Table 54. Resources, Capabilities, and Needs Roger Saux Health Center.

Organization Name	Roger Saux Health Center
Name & Position of Person Preparing this Summary	CAPT Robert P. Young, Pharm.D., J.D., M.B.A., FACHE Health & Wellness Director, QIN
Address & Telephone	PO Box 219, Taholah, WA 98587 360-276-4405 x 412
Service Area	Grays Harbor and Jefferson Counties
Describe your services and organization goals in overview (100 words or less)	Health Center – Outpatient Clinic. We provide Medical, Dental and Pharmaceutical Services. Also Radiology, EMS, Family Services, Mental Health Services, and Chemical Dependency Services.
List your currently available technological resources for use in responding to emergencies in your service area (e.g. list of fire protection apparatus, snow plows, search and rescue trucks, etc.)	Ambulances (2) The Clinic can act as Triage Center.
List your currently available human resources for use in responding to emergencies in your service area (e.g. detail staff by position and number, plus volunteers)	Medical Providers (3), Nurses (5), Pharmacist (1), Paramedic (1), EMS (1 plus volunteers), Maintenance/Support (2), Other Staff not listed above (30)
List your organization's technological needs for responding to hazard emergencies, which are not currently in inventory, in your service area (e.g., fire trucks or water tenders, fire hydrant network, radio communications network, etc.)	• Lack adequate supply of portable medical devices, e.g., AEDs, portable respirators; radio communication devices; electrical power generating capacity for the clinic. Supplies for Pandemic Response: Personal protection equipment (PPE), medications to support affected patients (antivirals, supportive medications). Oxygen generation capacity or storage. Oxygen used by respirator devices applied in response to respiratory-centered pandemic infections. • Larger, more reliable energy source, current generator (refurbished 2006 model) is unreliable. If road is blocked, staff cannot get into work and patients cannot get to treatment. For treatment of Pandemic Flu - lack of oxygen and respirators may be a problem.
List your organization's human resource needs for responding to hazard emergencies, which are not currently utilized, in your service area (e.g., additional number of paid staff, more volunteers, training for volunteers and staff, etc.)	Training for current staff, including Incident Command Orientation.

Table 55. Resources, Capabilities, and Needs Quinault Nation Division of Community Services.

Organization Name	Quinault Nation Division of Community Services
Name & Position of Person Preparing this Summary	Richard Wells, Director of Community Services
Address & Telephone	P.O. Box 189, Taholah, WA 98587 360.276.8215 ext. 489
Service Area	Quinault Indian Nation

Table 55. Resources, Capabilities, and Needs Quinault Nation Division of Community Services.

Organization Name	Quinault Nation Division of Community Services
Describe your services and organization goals in overview (100 words or less)	The Division of Community Services provides a variety of basic and essential governmental services for the Reservation communities and the remainder of Quinault Reservation, including: Police, Fire, Animal Control, Community Water, Community Sewer, Solid Waste Management, Land Use Planning, Economic Development Planning, Building & Zoning Code Enforcement, Public Facilities Management, Recreation, Public Roads Maintenance & Construction, Low-Income Food Distribution (Commodities), Low Income Heating and Energy Program (LIHEAP), and Construction Project Management. The goals of the Division include: ensuring the public health and safety, and improving the quality of life for Reservation residents.
List your currently available technological resources for use in responding to emergencies in your service area (e.g. list of fire protection apparatus, snow plows, search and rescue trucks, etc.)	Utilities Department: 2- garbage trucks, small backhoe/loader, utilities trailer, solid waste transfer station, bucket lift truck, generators, trash pumps. Building Maintenance Department: utilities trailer, Recreation Department: 2-15 passenger vans, propane grill. Police/Fire Dept: (reported by others): 2-fire engines, ambulance, generator, dispatch radios, Public Roads Maintenance: low boy truck & trailer, 12 cy dump truck, 5 cy dump truck w/ snow plow & sander attachments, mower/brusher, mini-excavator, tilt deck trailer, backhoe/loader
List your currently available human resources for use in responding to emergencies in your service area (e.g. detail staff by position and number, plus volunteers)	Police Officers- 8, Dispatchers- 7, Volunteer Fire fighters- 3, Building Maintenance- 4, Custodial- 12, Equipment Operators- 2, CDL Truck Drivers- 3 (includes: equipment operators).
List your organization's technological needs for responding to hazard emergencies, which are not currently in inventory, in your service area (e.g., fire trucks or water tenders, fire hydrant network, radio communications network, etc.)	Evacuation Center, large generators, portable showers, portable toilets, evacuation route from Taholah. Ham radios. Better communication tree. Cellular phone tower. Radio Station. For Qui-nai-elt Village: fire suppression apparatus. Roads: Snow plow, sander trucks, de-icing equipment, chain saws, motor graders
List your organization's human resource needs for responding to hazard emergencies, which are not currently utilized, in your service area (e.g., additional number of paid staff, more volunteers, training for volunteers and staff, etc.)	Paid Fire Chief. More volunteer firefighters. More EMTs. Fire fighter training. Emergency center volunteers- cooks, clerical, medical.

Table 56. Resources, Capabilities, and Needs Bureau of Indian Affairs, Taholah Agency.

Organization Name	Bureau of Indian Affairs, Taholah Agency
Name & Position of Person Preparing this Summary	Greg Masten, Superintendent
Address & Telephone	1214 Aalis, Building C, Taholah, WA 98587 360-276-4850
Service Area	Quinault Indian Reservation
Describe your services and organization goals in overview (100 words or less)	Provide Trust Services in Forestry and Realty. The people and Tribes of The Quinault Nation
List your currently available technological resources for use in responding to emergencies in your service area (e.g. list of fire protection apparatus, snow plows, search and rescue trucks, etc.)	5 - 4x4 Pickup Trucks
List your currently available human resources for use in responding to emergencies in your service area (e.g. detail staff by position and number, plus volunteers)	Refer to COOP Plan
List your organization's technological needs for responding to hazard emergencies, which are not currently in inventory, in your service area (e.g., fire trucks or water tenders, fire hydrant network, radio communications network, etc.)	8- Multi Channel Handheld radios. 1-Back-Up Generator

Table 56. Resources, Capabilities, and Needs Bureau of Indian Affairs, Taholah Agency.

Organization Name	Bureau of Indian Affairs, Taholah Agency
List your organization's human resource needs for responding to hazard emergencies, which are not currently utilized, in your service area (e.g., additional number of paid staff, more volunteers, training for volunteers and staff, etc.)	None

Table 57. Resources, Capabilities, and Needs Quinault Indian Nation, Administration.

Organization Name	Quinault Indian Nation, Administration
Name & Position of Person Preparing this Summary	Debbie Martin, Administration Director
Address & Telephone	PO Box 189, Taholah WA, 360-276-8211 x205
Service Area	Quinault Indian Nation
Describe your services and organization goals in overview (100 words or less)	• Day-to-day management of the administration services to the QIN employees and community members such as Personnel, TERO, Communications and TANF
List your currently available technological resources for use in responding to emergencies in your service area (e.g. list of fire protection apparatus, snow plows, search and rescue trucks, etc.)	•
List your currently available human resources for use in responding to emergencies in your service area (e.g. detail staff by position and number, plus volunteers)	Lisa Hall, EMS Rich Bly, RSHC
List your organization's technological needs for responding to hazard emergencies, which are not currently in inventory, in your service area (e.g., fire trucks or water tenders, fire hydrant network, radio communications network, etc.)	I am not familiar with the technological needs in our service area.
List your organization's human resource needs for responding to hazard emergencies, which are not currently utilized, in your service area (e.g., additional number of paid staff, more volunteers, training for volunteers and staff, etc.)	I am not familiar with the human resources needs when responding to a hazard emergency.

Table 58. Resources, Capabilities, and Needs Quinault Division of Natural Resources.

Organization Name	Quinault Indian Nation Division of Natural Resources
Name & Position of Person Preparing this Summary	Dave Bingaman, Director-Division of Natural Resources
Address & Telephone	1214 Aalis Street, Bldg. C PO Box 189 Taholah, WA 98587 360-276-8211, Ext. 374 Fax: 360-276-4682 dbingaman@quinault.org
Service Area	Quinault Indian Reservation
Describe your services and organization goals in overview (100 words or less)	

Table 58. Resources, Capabilities, and Needs Quinault Division of Natural Resources.

Organization Name	Quinault Indian Nation Division of Natural Resources
List your currently available technological resources for use in responding to emergencies in your service area (e.g. list of fire protection apparatus, snow plows, search and rescue trucks, etc.)	• 15-20 vehicles and two fire engines (forestland type). 1 6500 KV Honda generator at Seed Orchard. Radio system with repeater (battery BU 24-36 hrs) covering 99% of QIR. Most vehicles have radio and up to 15 battery operated handhelds. • GPS equipment, GIS layers and hardcopy reservation maps. • Engines, manpower, chainsaws, pumps, helicopter operator. • 19 full time employees, 5 4x4 pick-up trucks • Command, communication, operations • The QIN administration building complex could potentially be used for temporary shelter during some types of natural disaster.
List your currently available human resources for use in responding to emergencies in your service area (e.g. detail staff by position and number, plus volunteers)	• Personnel (volunteers), vehicles with 2 way radios, chain saws and other hand tools.
List your organization's technological needs for responding to hazard emergencies, which are not currently in inventory, in your service area (e.g., fire trucks or water tenders, fire hydrant network, radio communications network, etc.)	• Generator to support Radio System (Repeater). Police and fire also have radio components supporting system i.e.: Police frequency fire and forestry share frequency. Gas pump on generator for power outage in Taholah, Amanda Park & Queets. Generator for seedling storage for tree cooler to un 2 cooling condensers (Cooler often houses hundreds of dollars worth of tree seedlings for reforestation). Generator to for lights and computers at QDNR office, seedling storage and Tsa'alal field station. Weather tower & repeater on "Bear Mountain" may need battery backup. • Electricity to run computers, internet access to gain information and to communicate. Can support SPS and other geospatial asset inventorying. Mapping personnel. • Eight hand-held multi-channel radios. One backup generator. • Cell service for communication. Alternate access to the work site. Backup generator for power. More staff familiar with Incident Command System (ICS). • Command, communication, operations. • The operation of the QDFi requires communications such as radios, telephone and fax. The use of computers is essential to the day-to-day work conducted in the QDFi offices. QDFi staff must be able to travel and access numerous geographic areas both on and off the Quinault Indian Reservation to conduct the required field work. Hatchery staff must be able to access hatchery facilities and receive necessary supplies (e.g. fish feed, diesel/fuel) and equipment maintenance and repair in a timely manner.
List your organization's human resource needs for responding to hazard emergencies, which are not currently utilized, in your service area (e.g., additional number of paid staff, more volunteers, training for volunteers and staff, etc.)	

In addition to the summaries of the departments detailed in this chapter, additional information provided by the Division of Community Services illuminates some of the critical services provided to the communities of the QIR for government services, health and safety, and quality of life. These duties have been categorized in Table 59.

Table 59. Division of Community Services, to protect & promote health, safety, and welfare of the people of the Quinault Nation.

Services by Department	Essential Governmental Service or Mandated by Law (life saving)	Required Support Services or Tribal Priority (maintains health & safety)	Discretionary Services or Non-essential (improves quality of life)
Office of Community Services			
Missions, goals, objectives, and strategies		X	
Department Oversight		X	
Budget Oversight		X	
Personnel Issue Resolution			X
Communication			X
Performance Assessment			X
Community Development			
Land Use Planning		X	
Economic Development Planning		X	
Long-Range Planning		X	
Transportation Planning			X
Building Code Enforcement	X		
Zoning Code Enforcement		X	
Physical Addressing		X	
Demographic Information			X
Utilities			
Clean Water Supply	X		
Wastewater Disposal	X		
Garbage Collection	X		
Recycling		X	
Facilities Management			
Repairs- Gov Buildings		X	
HVAC- Filters		X	
Office Furniture moving			X
Office Equipment Assembly			X
Lighting- replacement		X	
Walkways- snow & ice removal		X	
Install equipment & furniture			X
Office yard maintenance			X
Office cleaning		X	
Window washing			X
Exterior office cleaning			X
Replenish Bathroom paper		X	
Parks & Recreation			
Youth Recreational Activities			X
Youth Centers			X
Activity Trips			X
Recreational Events			X
Ball Field Maintenance			X
Park Maintenance			X
Public Works			
BIA/IRR Roads- mowing		X	
BIA/IRR Roads- culverts		X	
BIA/IRR Roads- pavement repair		X	
BIA/IRR Roads- grading		X	
BIA/IRR Roads- graveling		X	
BIA/IRR Roads- traffic signage	X		
Roads Construction Projects		X	
Capital Improvement Projects		X	
Engineering Services			X

Table 59. Division of Community Services, to protect & promote health, safety, and welfare of the people of the Quinault Nation.

Services by Department	Essential Governmental Service or Mandated by Law (life saving)	Required Support Services or Tribal Priority (maintains health & safety)	Discretionary Services or Non-essential (improves quality of life)
Architectural Services			X
Water System Repairs	X		
Sewer System Repairs	X		
Public Safety			
Police Protection	X		
Fire Protection- Taholah, Queets	X		
Animal Licensing		X	
Dog Kennels		X	
Radio Dispatch		X	
Rat Extermination		X	
Adult Detention	X		
Juvenile Detention	X		
Drug Investigations		X	
Community Assistance			
Food Distribution			X
Low Income Energy Assistance			X

The Division of Community Services provides many hazard mitigation and readiness services to the people of the QIR. The following summary summarizes these services:

- Department/ Program Oversight
  - 7 Departments
  - 37 Budgets
  - Reports- Quarterly, Annual
  - Timesheets
  - Program Performance Evaluation
  - Personnel Evaluation

Department of Community Development (aka: Planning Office)- Coni Wilson, Department Manager

- Land Use Planning
  - Zoning Code Enforcement
  - Transportation Planning
- Economic Development Planning
- Building Code Inspection
- Cultural Affairs Program
  - Museum
- Community Beautification Program
  - Employ up to 20 workers in Taholah & Queets. Generally, all workers are unemployed fishermen.
- Projects:
  - Taala Fund- CDFI (Community Development Financial Institution) assistance
  - HUD Indian Community Development Block Grant (ICDBG)- micro-lending
  - Aggregate Rock Study
  - Hazard Mitigation Planning
  - Transit Grant
- Services:
  - Building Permits
  - Conditional Use Permits

- Variances
- Building Inspection Code Compliance
- Zoning Compliance & Zoning Mapping
- Comprehensive Land Use Plan (Comp Plan)
- Transportation Plan
- Indian Reservation Roads (IRR) Inventory
- Village Mapping & Geographic Information System (GIS)
- Physical Address Assignment
- Homesite Assignment & Leasing applications
- Commercial Leasing applications
- Business Development Assistance
- Staff Support to Planning Commission

- Processes:
  - Land Use Development Permits-
    - Individuals, entities, and programs may obtain application permits from the Community Development Office at 807 5th Avenue in Taholah
    - May request a pre-application consultation meeting
    - Staff review and report
    - Schedule Public Hearing/ Planning Commission, if necessary
    - Business Committee decision, if necessary
  - Complaints- Title 48- Zoning, and Title 50- Building Code
    - Written complaints should be filed with Planning Office
    - Staff will attempt to resolve
    - Complaint will be heard by Planning Commission, if necessary
    - Staff reports back to complainant
  - Building Code Inspections
    - Once developer has obtained a building permit, then they are required to request a building inspection for each stage of the construction (generally before covering any work).
    - Inspector may issue a corrections notice and/or a stop work order, depending upon the nature of any code compliance issues. Specific citation from QIN Building Codes should be used.
    - Electrical Inspections are now being conducted by the Washington State L&I because the QIN does not have a certified electrical inspector.
  - Physical Address System
    - The Planning Staff maintains an accurate and comprehensive database on all buildings and structures on the Reservation. Coordination with QIN Police, EMS, Fire Department, GH 911, GH PUD, CenturyLink, and various delivery services is essential.
    - Whenever a building or structure is constructed or installed, the developer must apply for a physical address assignment from the Planning Office.
    - New addresses should be reported to GH 911 and QIN Police Department
  - Residential Leases
    - Vacant & buildable lots that are owned by the Quinault Nation will be advertised for possible use as a residential homesite. Generally, only enrolled Quinault tribal members are eligible to apply. Federal laws, governing Indian trust lands, allow residential (only) leases to tribal members for a nominal fee. All other leases need to be at the current market rate.
    - Applications for vacant lots and/or re-assignments are submitted to the Planning Commission for recommendation.
    - Planning Commission recommendation for residential lease is submitted to Business Committee for approval.

        - Planning Staff prepares and executes lease.
    - Commercial Leases
        - Commercial leases of QIN-owned trust property must follow the regulations in the 25 CFR (Code of Federal Regulations), and charge a market rate lease.
    - Business Assistance to Tribal Members
        - Contact Economic Development Planner & schedule meeting
        - Individual must be prepared to: write their own business plans, conduct their own market research, provide some of the financing, fill out loan applications. The Economic Development Planner is there to provide assistance and guidance.

Department of Utilities Maintenance- Jim Figg, Utilities Supervisor

- Community Water Systems
    - Taholah Water System
    - Queets Water System
    - Qui-nai-elt Village Water System
    - Tsa'-alal Water System
- Community Sewer Systems
    - Taholah Sewer System & WWTP
    - Queets Sewer System & Lagoons
    - Qui-nai-elt Village Sewer System & WWTP
    - USFS Lake Quinault WWTP (contract to provide service)
- Solid Waste Management
    - Reservation-wide Curbside garbage collection
    - Taholah Transfer Station
    - Recycling (only cardboard at this time)
- Processes:
    - New water, sewer, or garbage collection service
        - Contact QIN Revenue Office & set up an account
        - Revenue will inform Utilities Department of the change in service
        - Homeowners are responsible to maintain their own water and sewer lines, up to the water meter or sewer transmission main.
    - Water Leak in House or Yard
        - Owner's responsibility- call a plumber
    - Home sewer service line plugged up
        - Owner's responsibility- call a plumber
    - Water main leak
        - Call Utilities immediately to report
    - Sewer Main plugged up
        - Call Utilities immediate to report
    - Utilities Payments
        - Mail or deliver to QIN Revenue Office or Queets Admin Office
    - Garbage Collection
        - Homeowner must place garbage cans near sidewalk or close accessible place, before scheduled garbage collection
    - Taholah Transfer Station
        - This transfer station is for QIN Utilities customers only.
        - Separate payments are required for each load- $25 for pickup load, $20 for level load. Payments are to be made to QIN Revenue Office, prior to unloading. Show Utilities worker your receipt.
        - Old Corrugated Cardboard (OCC) boxes can be delivered without charge. These will be recycled.

Department of Building Maintenance- Trevis Jones, Building Maintenance Supervisor

- Services (only available to QIN governmental programs and buildings)
    - Building Repair- 60 buildings
    - Preventative Maintenance
    - Light Replacement
    - HVAC System Maintenance
    - Fire Sprinkler System Maintenance
    - Fire Extinguisher Maintenance
    - Pest Control
    - Move/Assemble Office Furniture
    - Parking Lot Striping
- Processes:
    - Each building should have a person assigned to report building maintenance issues
    - Work Order forms are available at Public Folders/forms
    - Work Orders should be submitted via e-mail, whenever possible.
    - The Building Maintenance Supervisor should report to the program when the work order is completed.
    - HVAC air filters are changed out every four months.

Department of Custodial Services- April Smith-Capoeman, Custodial Services Supervisor

- Services (only available to QIN governmental programs and buildings)
    - Office Cleaning
    - Office Trash Removal
    - Bathroom Paper Products- replacement
    - Window Washing
    - Office Areas External Cleaning and Litter
- Processes:
    - Each custodian is assigned to clean approximately 10,000 square feet of office space each work day- floor cleaning and/or vacuuming, trash removal, bathroom cleaning, bathroom paper product replacement
    - Custodians are instructed to not touch employee's desktops, unless specifically requested.
    - A check list for each building is maintained by the custodian.
    - The Custodial Services Supervisor will inspect each custodian's work on a weekly basis, then instruct and/or train workers on deficient performance.
    - All government office windows will be washed weekly- Fridays
    - Exterior areas, adjacent to government offices will be cleaned weekly.
    - Programs are required to pick up their own program use items and clean their own dishes- (toys, diapers, food, and appliances).
    - Employees eating lunch and community fund-raising activities are required to clean their own dishes, cooking spills, and keep their refrigerators clean.

Department of Parks & Recreation- Ken Stevens, Recreation Supervisor

- Taholah Recreation
- Queets Recreation
- Services:
    - Taholah Recreation Center- games, activities
    - Queets Gym- games, activities
    - Schedule/ transport for outside activities
    - Annual Harvest Festival- October
    - Thanksgiving Event

- Christmas Events- We Care Gift program
    - Basketball tournaments
    - Softball tournaments
    - Community Bazaars
    - Annual Tribal Picnic- activities
    - Standing Tall Youth Conference
- Processes:
    - Recreation Centers- Taholah & Queets
        - Open to all community members (mostly youth), however, this is not a babysitting service. Hours are usually- 11am to 9pm, Tuesday through Saturday
    - Calendars
        - Recreation Supervisor shall develop and post an annual Recreation Calendar of the major recreation events planned for the year.
        - Each Recreation program- Taholah & Queets, will produce an monthly Recreation calendar and post.
    - Outside Recreation Activities- skating, bowling, movies
        - Events will be advertised
        - Participants should sign up at the Recreation Centers. They will be informed if they need to bring money.
        - The number of participants will be limited to the number of adult supervisors available. The programs will only provide one adult supervisor per event.

Department of Public Works- (directly supervised by Divisional Director at this time)

- BIA Road System Maintenance Program
    - 57 miles of BIA-owned roads (generally- Taholah & Queets Streets, and Moclips-Olympic Highway).
    - Services:
        - Asphalt repair
        - Mowing roads shoulders
        - Ditch cleaning
        - Street Cleaning
        - Sidewalk repair & cleaning
        - Grading gravel & earth roads
        - Culvert repair & cleaning
        - Brushing of road right-of-way
- Construction Projects assigned to Community Services (as of 2-5-2010)
    - Taholah WWTP Improvements (close out)
    - ARRA A/C Water Main Replacement
    - Weatherization
    - Queets Senior Center
    - Taholah Senior Center (close out)
    - DOE Energy Efficiency Grant
    - McBride Road-emergency evacuation route
    - CFL Installation

Department of Public Safety- Ron Quilt, Chief of Police

- Law & Order (Police)
- Jail Facility and Dispatch
- Community Fire Protection (Fire Departments- Taholah & Queets)
- Emergency Medical Services
- Animal Control

- Services:
    - Law Enforcement
    - Community Patrols
    - Traffic Patrols
    - Adult Offender Detention
    - Juvenile Detention (contracted to GH County)
    - Dispatching (Police, Fire, EMS, and Resource Protection)
    - Ambulance Service
    - Fire Protection- Taholah
    - Fire Protection- Queets
    - Animal Control
- Processes
    - Reporting a Crime
        - Fill out a Incident Report & turn into QIN Police Station
    - Request for Assistance, Protection- domestic violence, robbery, accident
        - Call Police Station (may also call 911, but it will only be relayed back to QIN Police)
    - Medical Emergency- call for ambulance
        - Call Police Station (may also call 911, but it will only be relayed back to QIN Police)
    - Report a Fire (except woodland wildfire or beach land fire)
        - Call Police Station (may also call 911, but it will only be relayed back to QIN Police)
    - Viscous or Dangerous Dog
        - Fill out a written complaint
        - Animal Control Officer will investigate & take appropriate action
    - Title 18 Violations- Public Nuisances
        - Fill out a written complaint
        - Police Officer will investigate & take appropriate action

Department of Community Assistance- (Divisional Director provides Department oversight)

- USDA Food Distribution Program (commodities)
- Low Income Heating and Energy Assistance Program (LIHEAP)
- Weatherization grants
- Services:
    - Commodities distributed to qualified low-income households
    - Commodities food use demonstrations
    - Emergency Food Vouchers
    - Electric bill payment assistance to qualified low-income households
    - Weatherization repairs and installation
- Processes:
    - Apply for Commodities
        - Fill out application at Commodities Program
        - Provide all necessary documents
        - Pick up food on monthly basis
        - Home deliveries can be requested and scheduled
    - Apply for LIHEAP
        - Program will advertise when funds are available
        - Fill out application forms
        - Provide all necessary documents
        - Program will inform you if you are qualified for the program
        - Presently, there are only 2 rounds of electric bill payments made each year.

    - Apply for Weatherization Assistance
        - Program will advertise when funding is available
        - Must meet specific program requirements (BPA Weatherization requires that the house be heated with electric heat).
        - Presently, all houses have been selected for current round of funding.

Outliers- other services that we occasionally provide, but are not specifically assigned or funded or we are specifically restricted because of funding requirements (Indirect, grants, 638 contracts).

- Spring Clean Up
    - Big garbage day (weeks)- last year we spent $21,000 on garbage disposal
    - Community Services employees help with Clean Up, no other Division or Department is required by QIN to help. This takes about a week of employees time- mostly Building Maintenance & Custodial Services
    - Each year we need to rent a backhoe to assist with the garbage clean up.
- Cemetery
    - Maintenance
    - Grave digging
    - Head stones
    - Grave Mapping
- Community Center- Taholah
    - Scheduling
    - Equipment maintenance & re-purchasing
        - Tables
        - Chairs
        - PA System
        - Kitchen appliances and cleaning
- Street Lights
    - Request for installation
    - Repairs- call in to PUD
- Forest Road Maintenance
    - This is generally handled by the Natural Resources Division, but we get called & expected to perform maintenance.
- Boat Ramp & River Access Maintenance

Figure CXX. New Queets Fire Truck, Reproduced from the November 2009 Nugguam.

A New Fire Truck for Queets Village

Interview by Pies Underwood

It's Christmas time for Queets and the present is worth more to people's lives than money could ever buy. The meaning of a fire truck - is the idea that it could save lives. So, October 15th marked the date for a fire truck to arrive all the way from New Mexico. The fire truck cost $155,000 and that's not too shabby when comparing it to the trucks you may find from Hoquiam which are around $500,000 price range.

The fire truck will be specifically for the Queets community. Up to now, they had no way of putting out a fire if one was to catch. This is good news and helps insure the people of the Queets village safety in a time of the potential fire hazard.

Most fire trucks are red as this is the traditional fire truck color, but it is not required. Many cities and agencies have experimented with other colors like yellow, white and lime green. I've seen trucks painted blue, black and even orange. The general idea behind the color is to stand out so that the truck gets noticed and people move out of the way. Most people would rather see a red fire truck.

Harry Butler, who will drive the new fire truck, shows off the interior to Gloria Francis.

Facts about the New Fire Truck

- 1000 gallon water tank and a 1250 gallon per minute pump
- Cummins ISC Diesel engine with 330 horsepower and 1000 foot pounds of torque
- Freightliner M2 chassis with an Emergency One aluminum fire body built in Ocala, FL
- This truck is a new stock unit and they are routinely shipped to various dealerships throughout the US. The truck was first shipped to the dealer in Albuquerque, NM and then to Midvale, OH before making the trip to Washington.
- There are a number of things on the truck to make sure it lasts a long time. The body is built completely of aluminum, all of the plumbing is stainless steel, the water tank is plastic and the light is all LED that lasts longer than conventional bulbs and have no moving parts to wear out. The truck has an automatic transmission, power steering and anti-lock brakes.

If you have any more questions, please call Roy Laneville - United Fire Service - 425-710-9190 - office.

Figure CXXI. One of the infrastructure failures on the QIR in need of mitigation measures. This one is along SR 109 between Moclips and Taholah and is the only access route in and out of the QIR's largest population center: this picture was taken after a moderate rainfall system hit the area.

Chapter 7. Proposed Mitigation Measures

7.1. Summary of the Mitigation Measures Approach

This Tribal Hazards Mitigation Plan's implementation will reflect the unique challenges of the Quinault Indian Nation, and each village within the reservation. In response to these challenges, it is the desire of the Quinault Indian Nation, associated agency and organization to continue the implementation of existing programs that have already provided a level of safety and preparedness in the protection of people, structures, infrastructure, the economy, and traditional way of life of the Quinault Indian Nation.

A series of potential mitigation measures have been developed in this section of the Tribal Hazards Mitigation Plan. These activities are listed in Table 63 - Table 66. While each of these activities has been presented as a stand-alone project, in reality these projects must be implemented in a holistic approach to hazard mitigation in order to achieve increased protection.

Much of the funding for QIN projects identified in this project will rely substantially on funding from outside sources. The QIN has the resources to provide in-kind services of professional staff and administrative staff in the development and implementation of hazard mitigation projects. The acquisition of materials and equipment to implement many of the projects will rely on grant funding and cooperation with partners.

7.2. Potential Funding Opportunities

General long-range fiscal planning is needed to carry out the activities recommended in this plan. Financial considerations include tribal, federal, state, and private granting entities, directed local in-kind services, local funding, and local funding assistance from Tribal and State resources. Funding mechanisms are combined to maximize project financing and project diversity.

7.2.1. Traditional Funding Agency Approach

Traditional funding agencies (e.g., Rural Development, Department of Commerce, and USACE) are focused on particular infrastructure issues that address regulatory compliance or public safety. Regulated systems typically funded are water and sewer because of the Clean Water Act, National Pollution Discharge Elimination System (NPDES), Safe Drinking Water Act, and other federal and state laws. These two systems are common to all communities and are a focus of lawmakers and regulators. Finally, these systems are necessary for development, job creation, and other high priority uses for grant and loan monies made available by the federal government.

7.2.2. Non-Traditional Funding Opportunities

Private funding from foundations and corporations is very competitive, and their processes are different from federal government funding. Because they are not accountable to voters, they fund according to their own specific set of priorities. The most common recipients of this type of funding are non-profit organizations. These non-profit organizations typically carry forward the goals of these non-traditional funding sources and can be an important implementation mechanism for rural communities such as are found on the QIR. This funding source will typically contribute $5,000 to $100,000 towards a project. This source should be viewed as a supplement to the major funding agencies or as a funding source for smaller projects.

7.2.2.1. Federal, State, and Local Funding Options

Federal, State, Tribal and local funding sources are available to Indian Villages and utility districts located on the QIR. In general, funding options can be broken down into several categories, including grant and loan programs. The following list provides potential sources of funding and contains outlines for availability and eligibility requirements for the various funding options.

7.2.2.1.1. Grant Programs

- Community Development Block Grant Program (Washington Department of Commerce)
- Economic Development Administration (U.S. Department of Commerce)
- Rural Development Program, US Department of Agriculture (formerly Farmers Home Administration)
- Surface Transportation Program (STP) Local Rural, Washington Department of Transportation
- Surface Transportation Program (STP) Local Urban, Washington Department of Transportation
- Surface Transportation Program Enhancement, Washington Department of Transportation

7.2.2.1.2. Loan Programs

- Drinking Water State Revolving Fund Loan
- Wastewater Revolving Fund Loan

7.2.2.1.3. Local Resources

- Pay-As-You-Go
- Reserve Fund Financing
- General Obligation Bonds
- Revenue Bonds
- Local Improvement District
- Business Improvement District
- Impact Fees

7.2.2.2. Leveraging Funds

There are several methods to make grant dollars stretch so that the QIN can get the "biggest bang for the buck." The concept of leveraging means that you use more than one source of money to supplement a project.

7.2.2.2.1. Percentage and/or In-Kind Match

The Percentage and/or In-Kind Match method requires a set percentage (such as 25%) in local cash or in-kind resources from an entity to support a project. Without this amount of local financial contribution the grant application may not receive sufficient scoring points used to calculate grant awards, or may not be qualified to receive the intended grant award.

7.2.2.2.2. In-Kind Match

A second method, In-Kind Match, means that the agency or community will make a non-cash contribution toward the project. Non-cash contributions can be in the form of goods, services, facilities, space, personnel, materials, and equipment calculated at fair market value.

7.2.2.2.3. Dollar-for-Dollar Leverage Match

A third method, Dollar-for-Dollar Match, means that an entity, like the QIN, can leverage grant funds from one funding source with grant funds from a second funding source. For instance, the QIN may be able to leverage state grant funds with federal dollars. Verification is necessary before implementation to confirm that a grantor agency will allow this arrangement. Some grantor agencies use a so-called leveraging ratio to measure money an entity has from other sources that could be matched to the project grant. Generally, the more money an entity can bring in from other sources the better the chance of being funded.

7.2.3. Project Funding Opportunities Identified by FEMA

FEMA Region X has provided valuable references for potential funding of projects identified in this planning effort. These are summarized in Table 60 and are available to the QIN and associated cooperators.

Table 60. Federal Financial Resources for Hazard Mitigation.

Subtype	Administrator	Purpose	Amount/Availability
Hazard Mitigation Grant Program (HMGP)	Federal Emergency Management Agency (FEMA)	Support pre- and post-disaster mitigation plans and projects.	Available to communities after a Presidentially declared disaster has occurred within the state. Grant award based on specific projects as they are identified.
Pre-Disaster Mitigation (PDM) grant program	FEMA	Support pre-disaster mitigation plans and projects.	Available on an annual basis, nationally competitive grant. Grant award based on specific projects as they are identified (no more than $3M federal share for projects).
Flood Mitigation Assistance (FMA) grant program	FEMA	Mitigate repetitively flooded structures and infrastructure.	Available on an annual basis, distributed to communities within state by the state emergency management grants specialists. Grant award based on specific projects as they are identified.
Assistance to Firefighters Grant (AFG) Program	FEMA/USFA (U.S. Fire Administration)	Provide equipment, protective gear, emergency vehicles, training, and other resources needed to protect the public and emergency personnel from fire and related hazards.	Available to fire departments and nonaffiliated emergency medical services. Grant award based on specific projects as they are identified.
Homeland Security Preparedness Technical Assistance Program (HSPTAP)	FEMA/DHS	Build and sustain preparedness technical assistance activities in support of the four homeland security mission areas (prevention, protection, response, recovery) and homeland security program management.	Technical assistance services developed and delivered to state and local homeland security personnel. Grant award based on specific projects as they are identified.
Community Block Grant Program Entitlement Communities Grants	U.S. Department of Housing and Urban Development	Acquisition of real property, relocation and demolition, rehabilitation of residential and non-residential structures, construction of public facilities and improvements, such as water and sewer facilities, streets, neighborhood centers, and the conversion of school buildings for eligible purposes.	Available to entitled cities. Grant award based on specific projects as they are identified.

Table 60. Federal Financial Resources for Hazard Mitigation.

Subtype	Administrator	Purpose	Amount/Availability
Community Action for a Renewed Environment (CARE)	U.S. Environmental Protection Agency (EPA)	Through financial and technical assistance, offers an innovative way for a community to organize and take action to reduce toxic pollution (i.e., storm water) in its local environment. Through CARE, a community creates a partnership that implements solutions to reduce releases of toxic pollutants and minimize people's exposure to them.	Competitive grant program. Grant award based on specific projects as they are identified.
Clean Water State Revolving Fund (CWSRF)	EPA	The CWSRF is a loan program that provides low-cost financing to eligible entities within state and tribal lands for water quality projects, including all types of non-point source, watershed protection or restoration, estuary management projects, and more traditional municipal wastewater treatment projects.	CWSRF programs provided more than $5 billion annually to fund water quality protection projects for wastewater treatment, non-point source pollution control, and watershed and estuary management.
Public Health Emergency Preparedness (PHEP) Cooperative Agreement.	Department of Health and Human Services' (HHS) Centers for Disease Control and Prevention	Funds are intended to upgrade state and local public health jurisdictions' preparedness and response to bioterrorism, outbreaks of infectious diseases, and other public health threats and emergencies.	Competitive grant program. Grant award based on specific projects as they are identified.

7.3. Tribal Mitigation Strategies

Mitigation strategies detailed within this Tribal Hazards Mitigation Plan have been developed through an integrated approach of (1) findings determined through this series of analyses, (2) recommendations from Planning Committee members, and (3) suggestions and ideas presented by the public during the Residential Survey, public meetings, and open discussions between the planning team members and the public.

Critical to the implementation of this Tribal Hazards Mitigation Plan will be the identification of, and implementation of, an integrated schedule of treatments within the QIR targeted at achieving an elimination of the lives lost and reduction in structures damaged or destroyed, infrastructure compromised, reduction to the economy of the QIN, and unique ecosystems damaged. Since there are many management agencies and hundreds of residents living on the QIR, it is reasonable to expect that differing schedules of adoption will be made and varying degrees of compliance will be observed across all properties.

The QIN, and the villages of the QIR, encourage the philosophy of instilling disaster resistance in normal day-to-day operations. By implementing plan activities through existing programs and resources, the cost of mitigation is often a small portion of the overall cost of a project's design or program.

The state and federal land management agencies operating in and near the QIR, specifically the Washington DNR, BIA, and USFS are participants in this planning process and have contributed to its development. Where available, their schedules of land treatments have been considered in light of the QIN (esp. QDNR) management projections in this planning process to better facilitate a correlation between their identified planning efforts and the efforts of government organizations.

All risk assessments were made based on the conditions existing during 2009 and 2010; thus, the recommendations in this section have been made in light of the understanding of those conditions. However, the components of risk and the preparedness of the Nation's resources are not static. It will be necessary to fine-tune this plan's recommendations annually to adjust for changes in the components of risk, population density changes, infrastructure modifications, and other factors.

7.3.1. Prioritization of Mitigation Activities

Prioritization of projects will occur at the QIN and private levels with cooperation and collaboration with the adjacent Counties, the State of Washington, and the adjacent Federal Land Management Agencies such as the USFS. Differing prioritization processes will occur; however, the QIN will adopt and lead in the implementation of the overall prioritization process, as indicated through the adoption of this plan.

The prioritization process includes a special emphasis on cost-benefit analysis review. The process will reflect that a key component in funding decisions is a determination that the project will provide an equivalent, or more, in benefits over the life of the project when compared with the costs. Projects will be administered by QIN to meet these goals.

Tribal Council and the representatives of all cooperating agencies will evaluate opportunities and establish their own unique priorities to accomplish mitigation activities where existing funds and resources are available and there is community interest in implementing these mitigation measures. If no federal funding is used in these situations, the prioritization process may be less formal. Often, the types of projects that the Nation can afford to do on its own are in relation to improved codes and standards, department planning and preparedness, and education. These types of projects may not meet the traditional project model, selection criteria, and benefit-cost model. The Nation will consider all pre-disaster mitigation proposals brought before the Tribal Council by department heads, village representatives, fire districts, local civic groups, and private citizens.

When federal or state funding is available for hazard mitigation, there are usually requirements that establish a rigorous benefit-cost analysis as a guiding criterion in establishing project priorities. The QIN will follow the basic federal grant program criteria that will drive the identification, selection, and funding of the most competitive and worthy mitigation projects. FEMA's three primary grant programs (the post-disaster Hazard Mitigation Grant Program, and the pre-disaster Flood Mitigation Assistance and Pre-Disaster Mitigation grant programs) that offer federal mitigation funding to state, Tribal, and local governments, all include the benefit-cost and repetitive loss selection criteria.

The QIN is committed to compliance with all applicable Federal statutes and regulations in effect with respect to the periods for which it receives grant funding from Federal agencies, in compliance with 44 CFR 13.11(c). The QIN will amend this plan whenever necessary to reflect changes in Tribal or Federal laws and statutes as required in 44 CFR 13.11(d).

The prioritization of projects will occur annually and be facilitated by the QIN to include the Tribal Council, Fire District Chiefs, agency representatives (USFS, State Lands, etc.), and representatives of adjacent Counties (Grays Harbor County and Jefferson County). Prioritization will be based on the selection of projects that create a balanced approach to pre-disaster mitigation by recognizing the hierarchy of treating (highest first):

- People and Structures
- Infrastructure
- Local and Regional Economy
- Traditional Way of Life

- Ecosystems

The resources at risk within each populated place on the QIR and the Villages detailed in this document will serve to establish a consistent and uniform basis for the “benefit” portion of the cost-benefit ratio analysis for all projects.

7.3.2. STAPLEE Matrix for Initial Ranking of Mitigation Measures

The STAPLEE matrix has been proposed as an approach to use when creating unbiased evaluations of potential mitigation measures. These seven criteria are determined subjectively and independently from each other. For these purposes each project has been rated on a scale of zero (low benefit) to ten (high benefit). The cumulative scores can range from zero to seventy. The score of seventy would be considered a highly desirable project while a very low scoring project would be considered a very undesirable project (Table 61).

Table 61. Evaluation Criteria (STAPLEE) for Mitigation Actions.

Evaluation Category	Discussion “It is important to consider…”	Considerations
Social	The public support for the overall mitigation strategy and specific mitigation actions.	Community acceptance, or Adverse effect on the population
Technical	If the mitigation action is technically feasible and if it is the whole or partial solution.	Technical feasibility Long-term solutions Secondary impacts
Administrative	If the community has the personnel and administrative capabilities necessary to implement the action or whether outside help will be necessary.	Staffing Funding allocation Maintenance/operations
Political	What the community and its members feel about issues related to the environment, economic development, safety, and emergency management.	Political support Local champion Public support
Legal	Whether the community has the legal authority to implement the action, or whether the community must pass new regulations.	Tribal, local, state, and/or federal authority Potential legal challenge
Economic	If the action can be funded with current or future internal and external sources, if the costs seem reasonable for the size of the project, and if enough information is available to complete a FEMA Benefit-Cost Analysis.	Benefit/cost of action Contributes to other economic goals Outside funding required FEMA Benefit-Cost Analysis
Environmental	The impact on the environment because of public desire for a sustainable and environmentally healthy community.	Effect on local flora and fauna Consistent with community environmental goals Consistent with local, state, and federal laws

All of these have been ranked on scale (subjective) from 0 to 10. The sum of the total will create the Mitigation Action’s overall score, with the highest ranked scores achieving the highest ranked mitigation measures. If any one score is below 3, the mitigation measure will be determined to be “unfeasible”, removing it from further consideration.

7.3.3. Proposed Mitigation Measures

Potential mitigation measures are presented in Table 63 - Table 66. These measures include a Project Number. Project numbers contain a series of letters and numbers separated by dashes. For instance, TAH-1006 is one example of a project identifier used in Table 62, representing a project in Taholah (TAH), in the “1000” series (Policy Related Activities), and unique project number “006”. The definition of these codes is listed in Table 62. All projects identified in this plan will be led by the governing body of the QIN. The location identifiers used here are to identify the major focus of specific projects, those identified only with “QIN-” are projects having impact on multiple communities or the entire QIR.

Table 62. Unique project codes for potential mitigation measures.

Community Codes	Series Codes
QIN: Quinault Indian Nation Leadership	1000: Policy Related Activities
TAH: Village of Taholah	2000: Activities to Reduce Loss Potential
AMP: Village of Amanda Park	3000: Resource and Capabilities Enhancements
QUT: Village of Queets	4000: Activities to Change the Characteristics of Risk
QNE: Village of Qui-nai-elt	
TOT: Village of Taholah Ocean Tracts	

The Series Codes (1000-4000) include projects generally listed by their potential to accomplish certain hazard mitigation goals. The first, Policy Related Activities (1000), are projects that specifically target the plans, policies, and programs conducted through existing Tribal programs. These efforts can preclude future developments from placing resources at risk to hazards currently identified (through Planning and Zoning). In this way, the Tribal Council can focus on correcting current problems without allowing the same risk exposure conditions to be repeated in the future. The QIN can also ensure that currently ongoing beneficial practices, such as participation in astute forest management practices, are continued into the foreseeable future. The update to existing policies, plans, and programs of the QIN, as expressed in 2.9 (QIN Legal and Regulatory Resources Related to Hazard Mitigation Efforts), will be the focus of the aforementioned Policy Related Activities (1000 Series projects) and be the responsibility of the QIN Tribal Council to adopt. Formally, this process requires existing planning documents to be updated with analyses contained in this planning document, and then each specific regulatory guidance should be presented to Tribal Council, debated, and potentially adopted through formal resolution of adoption that integrates the guidance of hazard preparedness. It is critical to recognize that although specific policy related recommendations are formally presented in this Quinault Indian Reservation, Tribal Hazards Mitigation Plan, that the formulation, specific wording, and implementation time horizon are at the discretion of the members of the QIN Tribal Council. The members of this governing body are committed to the safety and prosperity of the residents and visitors to the QIR, and it is expected they will implement measures consistent with these goals.

The second category, Activities to Reduce Loss Potential (2000 Series projects), includes activities generally targeted at changing a structure's risk or infrastructure component's risk profile. This may include elevating homes currently located within a flood zone above the height of flood waters, or replacing roofing on homes showing vulnerability to wind damage. These activities are targeted to change the risks of improvements placed in harm's way. The implementation of these activities can only be implemented through the integrated efforts of the QIN Tribal Council providing the guidance to Divisions to implement and the financial resources (either through direct QIN budget funding or through grant applications) with the staff and human resources to implement the recommendations.

The third category, Resource and Capability Enhancements (3000 Series projects), contains efforts to expand the ability of the QIN's departments to respond to emergencies from natural hazards. For instance, one of the repeated themes in this risk assessment has been the need for increased communications between departmental administration, police, fire protection, Tribal Fisheries, regional, state, and federal agencies. These types of improvements generally apply equally to all hazard types and can impact the effectiveness of disaster response. Improving radio communications, power supply to run these communications, and increased cellular phone coverage may be applicable projects for the QIR in this category. The implementation of these activities can only be implemented through the integrated efforts of the QIN Tribal Council providing the guidance to Divisions to implement and the financial resources (either through direct QIN budget funding or through grant applications) with the staff and human resources to implement the recommendations.

Finally, the forth category, Activities to Change the Characteristics of Risk (4000 Series projects), represents activities targeted at modifying the characteristics of the hazard. In the case of flooding, a levee is an example of a mitigation measure targeting the change of a risk component based on the vector of the hazard. Another example is improving storm water handling as it moves through a community to alleviate potential structure or infrastructure damages from flood-type impacts. Elevating a road access and improving culvert sizing and location are examples to change the characteristics of risk exposure. The implementation of these activities can only be implemented through the integrated efforts of the QIN Tribal Council providing the guidance to Divisions to implement and the financial resources (either through direct QIN budget funding or through grant applications) with the staff and human resources to implement the recommendations.

Each table includes a project type, identifying the hazard most directly affected by the proposed activity. Some of the mitigation measures include multiple hazards, and others state they are applicable to “All Hazards”. The listing order for these potential mitigation measures is random. The STAPLEE score is determined for each project in Table 63 – Table 66 based on the discussion items listed in Table 61 and are presented in Table 67 – Table 70 .

Table 63. Potential Mitigation Activities for Policy Related Activities (1000 series).

Project Number	Project Description	Type of Project	Responsible Organization	STAPLEE Score	Implementation Time Frame
QIN-1001	Quinault Indian Nation to consider entry into the National Flood Insurance Program. Include training and certification of a Quinault Planning Department staff member as a Nationally Certified Floodplain Administrator (fill the role of QIN Floodplain Administrator).	Flood	QIN, Planning Department	68	Immediate
QIN-1002	Quinault Indian Nation to work with agencies to provide training in the usage of P-25 compliant communications equipment.	All Hazards	QIN, USFS, Washington DNR	70	Immediate
QIN-1003	Update the QIR Wildland-Urban Interface Wildfire Mitigation Plan and Forest Management Plan.	Wildfire, Landslides	QIN, USFS, Washington DNR	69	Long-term
QIN-1004	Obtain equipment and provide training to facilitate better communications between disaster response agencies on the Reservation.	All Hazards	QIN, USFS, Washington DNR	70	Intermediate
QIN-1005	Implement an Enhanced 911 Program on the QIR and complete the saturation of 911 telephone service in the entire Reservation .	All Hazards	QIN	67	Immediate
QIN-1006	QIN Planning Department to identify QIN Tribal Floodplain Administrator who will complete requirements for training to certify through the Building Code Effectiveness Grading Schedule (BCEGS), which assesses the building codes in effect and how the communities enforce building codes, with special emphasis on mitigation of losses from natural hazards. The Tribal Floodplain Administrator will then work with the Tribal Council to implement these findings through current programs on the QIR.	All Hazards (especially Flood, Windstorm, and Earthquake damage)	QIN Floodplain Administrator	70	Immediate
QIN-1007	QIN Floodplain Administrator will complete requirements for training to begin advancement of National Incident Management System (NIMS) training.	All Hazards (especially Flood and Wildfire)	QIN Floodplain Administrator	70	Immediate
QIN-1008	QIN Floodplain Administrator will complete requirements for training to complete training course E-273- Managing Floodplain Development, through the NFIP.	Flood	QIN Floodplain Administrator	70	Immediate
QIN-1009	QIN Floodplain Administrator will complete requirements for training to complete training course E-278- NFIP, Community Rating System.	Flood	QIN Floodplain Administrator	70	Immediate
QIN-1010	QIN Floodplain Administrator will complete requirements for training to complete training and certification as a Federally Certified Floodplain Administrator by FEMA.	Flood	QIN Floodplain Administrator	70	Immediate

Table 63. Potential Mitigation Activities for Policy Related Activities (1000 series).

Project Number	Project Description	Type of Project	Responsible Organization	STAPLEE Score	Implementation Time Frame
QIN-1011	QIN will take an active participant role in the identification and mapping of **Flood Insurance Rate Maps developed by FEMA**. This participation will be indicated by the development and sharing of pertinent locally collected information that influences the identification of the floodplain on QIR. Further, this activity level will be indicated by the enforcement of the DFIRM map zones for planning and zoning ordinances in each Village. This is dependent on the implementation of project QIN-1001.	Flood	QIN and all Villages	70	Immediate
QIN-1012	Create the development of a QIR **comprehensive disaster database** of all hazards in terms of the hazard event, location, beginning date, ending date, and impact of the event on people, structures, infrastructure, and the economy of the Reservation. Include the cost of rehabilitating the site to pre-disaster conditions, and any mitigation measures implemented to prevent future disaster losses, and location dependant information (for mapping).	All Hazards	QIN Emergency Management	70	Immediate
QIN-1013	Develop and deliver an information sharing **public relations program** for residents and businesses of the QIR to disseminate detailed information about hazards, and to highlight ongoing management of hazard mitigation programs, information on risks, and regional responses to implementing programs and policies to reduce losses from natural disasters.	All Hazards	QIN Emergency Manager	70	Long-Term
QIN-1014	Participate in, and continue registration in the **StormReady** & **TsunamiReady** Community Programs.	Severe Weather, Tsunami	QIN	70	Short-term
TAH-1015	Participate in, and become officially registered in the **StormReady** Community Program.	Severe Weather	Village of Taholah	70	Short-term
AMP-1016	Participate in, and become officially registered in the **StormReady** Community Program.	Severe Weather	Village of Amanda Park	70	Short-term
QUT-1017	Participate in, and become officially registered in the **StormReady** Community Program.	Severe Weather	Village of Queets	70	Short-term
QIN-1018	Provide information about, and clearly identify with signs for area residents, the locations of **Emergency Shelters and Emergency Plans** in each Village.	All Hazards	QIN, all villages	70	Short-term

Table 63. Potential Mitigation Activities for Policy Related Activities (1000 series).

Project Number	Project Description	Type of Project	Responsible Organization	STAPLEE Score	Implementation Time Frame
QIN-1019	Develop **Minor Home Repair Program** and obtain grant funding support to award low-interest deferred loans for emergency preparedness repairs to low income resident homeowners on the QIR.	All Hazards	QIN	68	Mid-term
QIN-1020	Develop a **flood response plan** to identify the activation of the EOC, emergency responses, human safety and health, and warning systems in advance of approaching flood hazards.	Flood	QIN, QIN Floodplain Administrator	70	Immediate
QIN-1021	Review the current road/stream crossing inventory being developed by the QDNR and develop a **road/stream crossing implementation plan** to correct the floodplain function impediments.	Flood	QIN (esp. QDNR)	70	Immediate
QIN-1022	Begin the **Shoreline Management Plan** development for the QIR and use the recommendations in the plan to solidify the management of the floodplains within the exterior boundaries of the QIR.	Flood	QIN	70	Immediate
QIN-1023	Enact **Floodplain Ordinance** for the QIR to restrict the building of structures and infrastructure within the QIR to include new construction and substantial value structure remodeling.	Flood	QIN, esp. Building Inspector and QIN Floodplain Administrator	70	Immediate
QIN-1024	Initiate the service of incorporating **high wind warnings** to the operation of the EOC. Work with residents to identify high wind hazard components of buildings and vegetation surrounding homes and power lines.	Severe Weather	QIN	70	Immediate
QIN-1025	QIN Business Council to **consider the entry into the FEMA sponsored NFIP program** and work with FEMA to map the floodplains of the QIR.	Flood	QIN	70	Short-term
QIN-1026	Initiate **training in the Incident Command System** (ICS) for all employees that may be used during emergency situations.	All	QIN	70	Short-term
QIN-1027	QIN to develop, adopt, and implement a **flood response plan**.	Flood	QIN, QIN Floodplain Administrator	70	Immediate
QIN-1028	Initiate the **update of the QIR Tribal Hazards Mitigation Plan** starting 3 years from the effective date of this plan to guarantee the resources for personnel, funding, and integration with other QIN objectives leading to an updated Tribal Hazards Mitigation Plan within 5 years	All	QIN	70	Long-term

Table 63. Potential Mitigation Activities for Policy Related Activities (1000 series).

Project Number	Project Description	Type of Project	Responsible Organization	STAPLEE Score	Implementation Time Frame
QIN-1029	Integrate a **geotechnical site review** into the Planning and Zoning ordinance of the QIN for all new site subdivisions, new building sites within identified high risk areas, and remodeling activities of existing structures with a value equal to or greater than 50% of the total structure value before remodeling, to check for **expansive soils and expansive clays** and implement program to deal with the challenges faced.	Expansive Soils & Clays	QIN, building inspector	70	Immediate
QIN-1030	**Enact updates to Planning and Zoning** policies, curtail new structure developments in hazard prone areas as identified in this plan for each of the moderate to high risk areas. Use recommended structure protection strategies as appropriate.	All	QIN, Planning and Zoning Plan Update	70	Immediate

Table 64. Potential Mitigation Activities to Reduce Loss Potential (2000 series).

Project Number	Project Description	Type of Project	Responsible Organization	STAPLEE Score	Implementation Time Frame
QIN-2001	Develop **evacuation sites** and improve defensible space for evacuation along Reservation roads.	All	QIN	67	Immediate
TAH-2002	Seek project funding, and identify needed **roofing improvements**, especially for low income families, related to severe weather events such as high winds. Implement corrective actions within the **Village of Taholah**.	Severe Weather	Village of Taholah with QIN	64	Mid-term
AMP-2003	Seek project funding, and identify needed **roofing improvements**, especially for low income families, related to severe weather events such as high winds. Implement corrective actions within the **Village of Amanda Park**.	Severe Weather	Village of Amanda Park with QIN	64	Mid-term
QUT-2004	Seek project funding, and identify needed **roofing improvements**, especially for low income families, related to severe weather events such as high winds. Implement corrective actions within the **Village of Queets**.	Severe Weather	Village of Queets with QIN	64	Mid-term
QIN-2005	Seek project funding, and identify needed **roofing improvements**, especially for low income families, related to severe weather events such as high winds. Implement corrective actions within other **populated places on the QIR**.	Severe Weather	QIN	64	Mid-term

Table 64. Potential Mitigation Activities to Reduce Loss Potential (2000 series).					
Project Number	Project Description	Type of Project	Responsible Organization	STAPLEE Score	Implementation Time Frame
QIN-2006	Structural Landslide Protection of private structures and public structures: identification of public assistance money, design and implementation of structural enhancements and access stabilization within the QIR.	Landslide	QIN	64	Short-term
QIN-2007	Acquire Red Zone Software and implement the suite of services provided by that system to assess, map, and identify structures within the QIR that are in need of WUI treatments to prevent wildfire damages. As results are developed from the Red Zone Program implement them with project QIN-4008 to mitigate wildfire fuels around WUI structures.	Wildfire	QIN, QDNR, BIA, Washington DNR	64	Short-term
AMP-2008	Conduct home defensibility actions against wind damage and wildfire damage for the homes within Amanda Park and Tsa'alal.	Winds, Wildfire	QIN	65	Short-term
QUT-2009	Conduct home defensibility actions against wind damage and wildfire damage for the homes within Queets.	Winds, Wildfire	QIN	65	Short-term
TAH-2010	Conduct home defensibility actions against wind damage and wildfire damage for the homes within Taholah.	Winds, Wildfire	QIN	65	Short-term
TOT-2011	Conduct home defensibility actions against wind damage and wildfire damage for the homes within Taholah Ocean Tracts, Point Grenville, and Qui-nai-elt.	Winds, Wildfire	QIN	65	Short-term
AMP-2012	Identify masonry chimneys in need of reinforcement from earthquake damage, seeking funding to implement the program for homes in Amanda Park & Tsa'alal.	Earthquake	QIN	68	Short-term
QUT-2013	Identify masonry chimneys in need of reinforcement from earthquake damage, seeking funding to implement the program for homes in Queets.	Earthquake	QIN	68	Short-term
TAH-2014	Identify masonry chimneys in need of reinforcement from earthquake damage, seeking funding to implement the program for homes in Taholah.	Earthquake	QIN	68	Short-term
TOT-2015	Identify masonry chimneys in need of reinforcement from earthquake damage, seeking funding to implement the program for homes in Taholah Ocean Tracts, and Point Grenville.	Earthquake	QIN	68	Short-term

Table 64. Potential Mitigation Activities to Reduce Loss Potential (2000 series).

Project Number	Project Description	Type of Project	Responsible Organization	STAPLEE Score	Implementation Time Frame
QIN-2016	**Complete a QIR geotechnical review of building sites where expansive soils or expansive clays** may be contributing to structural damages, develop potential mitigation measures for each affected structure, and implement an improvement program to protect these structures.	Expansive soils & Clays	QIN	65	Short-term

Table 65. Potential Mitigation Activities to Enhance Resources and Capabilities (3000 series).

Project Number	Project Description	Type of Project	Responsible Organization	STAPLEE Score	Implementation Time Frame
QIN-3001	**Improve roads for ingress and egress**. Assess road segments, and develop action plan for corrections especially in terms of beaver dam flooding, wind damages causing trees to fall across the roads, and road substrate failure.	All Hazards	QIN with Washington Department of Transportation	70	Intermediate
QIN-3002	**Assess all stream/road crossings** on the QIR and create database of location, crossing type, flow characteristics, and needed changes to improve storm water and flood water handling. Implement recommendations to improve road use.	Flood	QIN	67	Short-term
QIN-3003	Purchase and install **back-up generators** for evacuation site use during emergencies.	All Hazards	QIN	68	Short-term
QIN-3004	Enter into the **StormReady Program** and facilitate the placement of a NOAA weather radio tower (or two) on the Reservation. Work with NOAA to implement program.	All Hazards	QIN, NOAA	69	Immediate
QIN-3005	Purchase radios, repeaters and associated equipment to make all departments on the Reservation **P-25 compliant.**	All Hazards	QIN, Washington DNR, USFS	69	Immediate
QIN-3006	**Develop** an all-jurisdiction / all-agency **communication plan.**	All Hazards	QIN, USFS, Washington DNR, BIA.	70	Short-term
QIN-3007	**Radio System Coverage Enhancement.** Enhance radio communications throughout QIR by locating **radio repeaters** in strategic locations to allow coverage in several remote areas accessed by emergency responders.	All Hazards	QIN, USFS, BIA, Washington DNR	69	Mid-term
QIN-3008	**Fire Department Training Opportunities:** develop custom training programs for firefighting on the QIR and implement training for all fire department staff and volunteers on the QIR.	All Hazards	QIN and all Fire Districts	70	Short-term

Table 65. Potential Mitigation Activities to Enhance Resources and Capabilities (3000 series).

Project Number	Project Description	Type of Project	Responsible Organization	STAPLEE Score	Implementation Time Frame
QIN-3009	QIN to sponsor and host **training opportunities** for all cooperators on the Reservation in coordination with American Red Cross to conduct **volunteer and first-responder training**.	All	QIN	70	Short-term
QIN-3010	**Update the Taholah Law Enforcement Office Command Center** for improved communications, internet connectivity, and facilitating emergency responder coordination.	All	QIN	68	Short-term
TAH-3011	**Deploy emergency generators** to the **Village of Taholah** for use when the power grid fails, so that the Village can provide potable water to residents and water for firefighting activities.	All	Village of Taholah, QIN	69	Immediate
AMP-3012	**Deploy emergency generators** to the **Village of Amanda Park** for use when the power grid fails, so that the Village can provide potable water to residents and water for firefighting activities.	All	Village of Amanda Park, QIN	69	Short-term
QUT-3013	**Deploy emergency generators** to the **Village of Queets** for use when the power grid fails, so that the Village can provide potable water to residents and water for firefighting activities.	All	Village of Queets, QIN	68	Short-term
QUT-3014	Acquire **diesel fire truck** for Queets and special diesel 4x4 brush fire unit with winches for the Village of Queets.	Wildfire	Village of Queets, QIN Police	65	Short-term
TAH-3015	Acquire special **diesel 4x4 brush fire unit** with winches for the **Village of Taholah**.	Wildfire	Village of Taholah, QIN Police	65	Short-term
QIN-3016	Purchase and deploy 12 **SCBA units and extra air bottles** for fire and chemical issues.	All	QIN Police	67	Short-term
QIN-3017	Obtain 2 **Air-Purifying Respirator** units and a case of **Tyvek suits** used in HazMat substances and environments.	All	QIN Police	67	Short-term
QIN-3018	Purchase and deploy miscellaneous **equipment for police and fire** to outfit personnel while responding to natural disaster events on the QIR.	All	QIN Police	68	Short-term
QIN-3019	**Enhance fire/rescue capabilities** – both equipment and training	All	QIN Police	70	Short-term
QIN-3020	**Search and rescue** needs: 7 fully ready chain saws, and 5 handheld GPS units for search and rescue.	All	QIN Police	70	Short-term

Table 65. Potential Mitigation Activities to Enhance Resources and Capabilities (3000 series).

Project Number	Project Description	Type of Project	Responsible Organization	STAPLEE Score	Implementation Time Frame
QIN-3021	**Staff increase**: one fire supervisor and at least two firefighter / paramedics. All will need training. Need another eight employees to fill out staffing.	All	QIN Police	66	Short-term
QIN-3022	Supply enhancement of **portable medical devices**, e.g., AEDs, portable respirators; radio communication devices; electrical power generating capacity for the clinic. Supplies for Pandemic Response: Personal protection equipment (PPE), medications to support affected patients (antivirals, supportive medications). Oxygen generation capacity or storage. Oxygen used by respirator devices applied in response to respiratory-centered pandemic infections.	All	QIN, Roger Saux Health Center	69	Immediate
QIN-3023	Require larger, more **reliable energy source**, current generator (refurbished 2006 model) is unreliable (for the Roger Saux Health Center in Taholah).	All	QIN, Roger Saux Health Center	69	Immediate
QIN-3024	**Training** for all emergency response staff in the **Incident Command System** – all levels; 100, 200, 300, 400	All	QIN – All Emergency Response Depts.	70	Immediate
QIN-3025	Develop and implement plans for the establishment of an **Evacuation Center**, large generators, portable showers, portable toilets.	ALL	QIN	65	Short-term
QIN-3026	Acquire and train operators in the use of **Ham radios** in all villages and populated places where emergency responses may be needed. Conduct as part of a larger **communication tree** for Nation activities and coordination during disasters.	All	QIN	70	Immediate
QIN-3027	Identify high quality **communication tower locations for cellular communications**, negotiate land leases (when needed) and work with commercial Cellular phone providers to install and activate services.	All	QIN	70	Short-term
QIN-3028	Acquire **Radio Station** equipment, license its use, and begin using as a public service station for residents and visitors to the QIR that can be activated during emergency situations.	All	QIN	65	Mid-term
QNE-3029	Build **fire station to serve Qui-nai-elt** and equip it is fire suppression apparatus and provide training for fire fighters and emergency responders.	All	QIN	68	Mid-term
QIN-3030	Acquire and deploy snow plow, sander trucks, de-icing equipment, chain saws, motor graders for **road maintenance and use.**	All	QIN	60	Mid-term
QIN-3031	Secure funding for and hire a paid **fire chief.** Recruit more volunteer firefighters and provide them training. **Recruit more EMTs. Emergency center volunteers- cooks, clerical, medical.**	All	QIN	60	Mid-term
QIN-3032	Purchase and Deploy 8- **Multi Channel Handheld radios, and 1-Back-Up Generator** for use by **BIA Taholah Agency.**	All	QIN	60	Immediate

Table 65. Potential Mitigation Activities to Enhance Resources and Capabilities (3000 series).

Project Number	Project Description	Type of Project	Responsible Organization	STAPLEE Score	Implementation Time Frame
QIN-3033	Purchase and install generator to support Radio System (Repeater). Police and fire also have radio components supporting system i.e.: Police frequency fire and forestry share frequency.	All	QIN, QDNR	60	Immediate
TAH-3034	Install gas pump on generator in case of power outage in Taholah, Amanda Park & Queets.	All	QIN, QDNR	60	Immediate
QIN-3035	Install sufficient sized generator for seedling storage cold storage to run 2 cooling condensers (Cooler often houses thousands of dollars worth of tree seedlings for reforestation).	All	QIN, QDNR	60	Immediate
QIN-3036	Install generator to for lights and computers at QDNR office.	All	QIN, QDNR	60	Immediate
QIN-3037	Purchase and install weather tower & repeater on "Bear Mountain" as well as battery backup.	All	QIN, QDNR	60	Immediate
QIN-3038	Purchase eight hand-held multi-channel radios for QDNR emergency uses.	All	QIN, QDNR	60	Immediate
QIN-3039	Install sufficient sized generators for operating the fish hatcheries and have enough fuel available to operate the system for 7 days.	All	QIN, QDNR	60	Immediate
QIN-3040	Locate site and build a licensed airstrip at Taholah upper-Village to accommodate light aircraft and helicopter access to be used for emergency response purposes including medical evacuation and continuity of government actions, as well as food, and medical supply delivery during disasters that prevent the use of roads.	All	QIN	59	Short-term
QIN-3041	Seek to improve the disaster cleanup of US101 south of Amanda Park from surface water, flood water, and tree fall (from high winds) to insure the open access to the Reservation.	Flood, Wind	QIN, in cooperation with USFS, WA DNR, WA DOT, and Grays Harbor County	60	Immediate
QIN-3042	Improve the surface water accumulation situation over SR109 between Moclips and Taholah to elevate the road surface, improve ditching and water transport to locations where the water can effectively drain out of the area.	Flood	QIN, in cooperation with WA DOT	63	Immediate
QIN-3043	Acquire and deploy wildfire apparatus in Queets to be housed at the Queets Fire Station.	Wildfire	QIN	69	Short-term
QIN-2044	Develop alternative access from SR109 near Point Grenville to Qui-nai-elt village along the McBride / Aloha Mainline Bypass proposed route terminating along the Moclips Highway.	Flood, Tsunami, Earthquake	QIN	65	Short-term

Table 66. Potential Mitigation Activities to Change Characteristics of Risk (4000 series).

Project Number	Project Description	Type of Project	Responsible Organization	STAPLEE Score	Implementation Time Frame
TAH-4001	Improve **storm water drainage** on the south sides of the Quinault River within the Village of Taholah to avoid destructive surface water damage.	Flood	Village of Taholah, QIN	67	Short-term
QIN-4002	Work with the Washington Department of Transportation to make **substantial improvements to SR109 at Swede Hill** where a long history of landslides has compromised ingress and egress.	Landslides	QIN, WA DOT	67	Immediate
QIN-4003	Establish a site location for a **NOAA Weather Radio Tower Repeater** in collaboration between **QIN and the National Weather Service** for participation in the **StormReady & TsunamiReady Program**.	All Hazards	QIN, National Weather Service	68	Immediate
QIN-4004	Identify and construct **alternative evacuation routes** across the QIR to replace compromised routes due to bridge loss, and access constraints consistent with evacuation and emergency needs.	All Hazards	QIN with the WA DOT	68	Short-term
QUT-4005	Create an **improved debris handling mechanism** of the US101 bridge crossing over the **Queets River** where heavy debris accumulates during high water events.	Flood	Village of Queets, QIN, WA DOT	63	Mid-term
TAH-4006	Increase the **height and width of the floodwall along the Quinault River at Taholah** to prevent combination events (e.g., flood, high tide, storm surges, and minor tsunami events) from breaching the floodwall into the village.	Flood, Severe Weather, Tsunami	QIN	62	Short-term
TAH-4007	Install a functional **one-way floodgate** to connect the Village of Taholah with the Ocean to facilitate **storm water drainage** out of the village.	Flood	QIN	57	Mid-term
QIN-4008	**Implement** the activities of the **Red Zone Software** project in QIN-2007 to mitigate homes and infrastructure within the WUI on the QIR.	Wildfire	QIN, QDNR, BIA, Washington DNR	64	Mid-term
TAH-4009	Create an **improved debris handling mechanism** of the SR109 bridge crossing over the **Quinault River** where heavy debris accumulates during high water events.	Flood	QIN with the WA DOT	63	Mid-term
QUT-4010	**Rebuild the gravel access road** along the Queets River from US101 past the **Queets Rose Bowl** (wastewater treatment facility), to elevate the road at-least 3 feet above the base flood elevation.	Flood	QIN	68	Immediate
QUT-4011	**Relocate the Queets Rose Bowl**, to a site outside of flood risks and erosion potential where it can serve the Village of Queets. Size the facility for the anticipated growth of the area anticipated through 2020.	Flood	QIN, Indian Health Services	65	Long-term

Table 66. Potential Mitigation Activities to Change Characteristics of Risk (4000 series).

Project Number	Project Description	Type of Project	Responsible Organization	STAPLEE Score	Implementation Time Frame
QIN-4012	Evaluate and implement stream/road crossings on the QIR currently being developed by the QDNR.	Flood	QDNR	70	Short-term

7.3.4. Proposed Mitigation Measures STAPLEE Scores

STAPLEE Scores have been subjectively determined for each project proposed in Table 63 – Table 66 and are presented numerically in Table 67 – Table 70.

Table 67. STAPLEE Scores for 1000 Series Potential Mitigation Measures.

Project	Social	Technical	Administrative	Political	Legal	Economic	Environmental	Total Score
QIN-1001	10	10	9	9	10	10	10	68
QIN-1002	10	10	10	10	10	10	10	70
QIN-1003	10	10	9	10	10	10	10	69
QIN-1004	10	10	10	10	10	10	10	70
QIN-1005	10	9	9	10	10	9	10	67
QIN-1006	9	9	9	9	10	10	10	66
QIN-1007	10	9	9	9	10	10	10	67
QIN-1008	10	10	10	9	10	10	10	69
QIN-1009	10	10	10	9	10	10	10	69
QIN-1010	9	10	9	9	10	10	10	67
QIN-1011	10	10	10	10	10	10	10	70
QIN-1012	10	10	10	10	10	10	10	70
QIN-1013	10	10	10	10	10	10	10	70
QIN-1014	10	10	10	10	10	10	10	70
TAH-1015	10	10	10	10	10	10	10	70
AMP-1016	10	10	10	10	10	10	10	70
QUT-1017	10	10	10	10	10	10	10	70
QIN-1018	10	10	9	10	10	10	10	70
QIN-1019	10	10	9	10	10	9	10	68
QIN-1020	10	10	10	10	10	10	10	70
QIN-1021	10	10	10	10	10	10	10	70
QIN-1022	10	10	10	10	10	10	10	70
QIN-1023	10	10	10	10	10	10	10	70
QIN-1024	10	10	10	10	10	10	10	70
QIN-1025	10	10	10	10	10	10	10	70
QIN-1026	10	10	10	10	10	10	10	70
QIN-1027	10	10	10	10	10	10	10	70
QIN-1028	10	10	10	10	10	10	10	70
QIN-1029	10	10	10	10	10	10	10	70
QIN-1030	10	10	10	10	10	10	10	70

Table 68. STAPLEE Scores for 2000 Series Potential Mitigation Measures.

Project	Social	Technical	Administrative	Political	Legal	Economic	Environmental	Total Score
QIN-2001	10	10	10	10	9	9	9	67
TAH-2002	10	9	9	8	9	7	9	64
AMP-2003	10	8	9	8	9	6	10	64
QUT-2004	10	8	9	10	10	6	10	64
QIN-2005	10	9	9	9	9	7	10	64
QIN-2006	10	9	9	9	9	7	10	64
QIN-2007	10	9	9	10	10	8	8	64
AMP-2008	10	9	9	9	9	9	10	65
QUT-2009	10	9	9	9	9	9	10	65
TAH-2010	10	9	9	9	9	9	10	65

Table 68. STAPLEE Scores for 2000 Series Potential Mitigation Measures.

Project	Social	Technical	Administrative	Political	Legal	Economic	Environmental	Total Score
TOT-2011	10	9	9	9	9	9	10	65
AMP-2012	10	9	9	10	10	10	10	68
QUT-2013	10	9	9	10	10	10	10	68
TAH-2014	10	9	9	10	10	10	10	68
TOT-2015	10	9	9	10	10	10	10	68
QIN-2016	10	8	9	10	10	8	10	65

Table 69. STAPLEE Scores for 3000 Series Potential Mitigation Measures.

Project	Social	Technical	Administrative	Political	Legal	Economic	Environmental	Total Score
QIN-3001	10	10	10	10	10	6	10	70
QIN-3002	10	10	10	10	10	10	8	67
QIN-3003	10	10	10	10	10	8	10	68
QIN-3004	10	10	10	10	10	10	10	69
QIN-3005	10	9	9	10	10	9	10	69
QIN-3006	9	10	10	9	10	8	10	70
QIN-3007	10	10	10	10	10	9	10	69
QIN-3008	10	10	10	10	10	10	10	70
QIN-3009	10	10	10	10	10	10	10	70
QIN-3010	10	10	9	9	10	10	10	68
TAH-3011	10	10	10	10	10	9	10	69
AMP-3012	10	9	10	10	10	10	10	69
QUT-3013	10	10	9	10	10	9	10	68
QUT-3014	10	10	10	10	10	5	10	65
TAH-3015	10	10	10	10	10	5	10	65
QIN-3016	10	10	10	10	10	7	10	67
QIN-3017	10	10	10	10	10	7	10	67
QIN-3018	10	10	10	10	10	8	10	68
QIN-3019	10	10	10	10	10	10	10	70
QIN-3020	10	10	10	10	10	10	10	70
QIN-3021	10	10	10	10	10	6	10	66
QIN-3022	10	10	10	10	10	9	10	69
QIN-3023	10	10	10	10	10	9	10	69
QIN-3024	10	10	10	10	10	10	10	70
QIN-3025	10	10	10	10	10	5	10	65
QIN-3026	10	10	10	10	10	10	10	70
QIN-3027	10	10	10	10	10	10	10	70
QIN-3028	10	10	5	10	10	10	10	65
QNE-3029	10	10	10	10	10	8	10	68
QIN-3030	10	10	8	10	10	6	6	60
QIN-3031	10	10	8	10	10	6	6	60
QIN-3032	10	10	8	10	10	6	6	60
QIN-3033	10	10	8	10	10	6	6	60
TAH-3034	10	10	8	10	10	6	6	60
QIN-3035	10	10	8	10	10	6	6	60
QIN-3036	10	10	8	10	10	6	6	60
QIN-3037	10	10	8	10	10	6	6	60

Table 69. STAPLEE Scores for 3000 Series Potential Mitigation Measures.

Project	Social	Technical	Administrative	Political	Legal	Economic	Environmental	Total Score
QIN-3038	10	10	8	10	10	6	6	60
QIN-3039	10	10	8	10	10	6	6	60
QIN-3040	9	10	8	10	10	6	6	59
QIN-3041	10	10	8	10	10	6	6	60
QIN-3042	9	9	8	9	9	9	10	63
QIN-3043	10	10	10	10	10	9	10	69
QIN-3044	10	10	10	10	8	7	10	65

Table 70. STAPLEE Scores for 4000 Series Potential Mitigation Measures.

Project	Social	Technical	Administrative	Political	Legal	Economic	Environmental	Total Score
TAH-4001	10	9	10	9	10	9	10	67
QIN-4002	10	9	10	9	10	9	10	67
QIN-4003	10	10	10	9	9	10	10	68
QIN-4004	10	10	10	10	10	8	10	68
QUT-4005	9	9	8	9	9	9	10	63
TAH-4006	10	9	9	10	9	7	8	62
TAH-4007	10	7	8	10	9	6	7	57
QIN-4008	10	10	9	10	10	7	8	64
TAH-4009	10	9	9	10	10	7	8	63
QIN-4010	10	10	9	10	9	10	10	68
QIN-4011	10	9	9	10	9	8	10	65
QIN-4012	10	10	10	10	10	10	10	70

7.4. Monitoring and Maintenance Program

This Progress Report is to be completed annually on the review of the Quinault Indian Reservation Tribal Hazards Mitigation Plan by the QIN, specifically by the Division of Health and Wellness, Environmental Health Specialist (the QIN Emergency Manager) in cooperation with the QIN Division of Community Service, Department of Planning (Community & Economic Development). Representatives from the QIN Planning Department will cooperate with the Environmental Health and Wellness Department to complete these forms annually in preparation for the annual review by QIN Tribal Council. Once completed, the progress report and the and the annual review questionnaire for each Division will be summarized in an annual notebook. This notebook of status reports will form the basis for a summary presentation with the QIN Tribal Council, open to the QIR public, discussing the status and pending action items related to hazard mitigation and preparedness on the QIR.

These annual summaries will form the basis for updating the plan within a five year cycle. The Division of Health and Wellness, Environmental Health Specialist (the QIN Emergency Manager) in cooperation with the QIN Division of Community Service, Department of Planning (Community & Economic Development) will be responsible for coordinating these efforts on a continual basis, for coordinating the annual reviews, and preparing the QIR for the five year update process of the Tribal Hazards Mitigation Plan. Each project's manager will be responsible for completing these project evaluations as projects are implemented, with the assistance of the QIN Planning Department and the QIN Emergency Manager.

The monitoring of the impacts of the Quinault Indian Reservation Tribal Hazards Mitigation Plan will be completed formally on an annual basis, but ongoing evaluations of project impacts will be a critical measure of success for improvements and amplifications of the positive benefits of the hazard mitigation ethic expressed in this plan. Monitoring of the positive impacts of the Quinault Indian Reservation Tribal Hazards Mitigation Plan should be completed at critical event junctures, no less than annually. These critical event junctures include 1) when projects are launched to implement mitigation measures, 2) after disaster events happen within the QIR or on adjacent lands to determine how specific mitigation measures did positively impact the negative influences of disaster events, or could have benefited the QIR if implemented, 3) when new developments are proposed for structures or infrastructure and pre-disaster mitigation planning can be implemented to reduce future development losses, and 4) as new scientific data becomes available to cast new understandings about natural disasters on the QIR leading to increased understanding of risk exposure. This monitoring of the Quinault Indian Reservation Tribal Hazards Mitigation Plan will serve to manage disaster preparedness as an ongoing effort, not a static 5-year blue-print that cannot be modified. It should be continually updated and improved so that when the 5-year life of this document expires, and it is updated for another 5-year cycle, the growth of the hazard mitigation plan can continue to benefit the residents and visitors to the QIR.

Tribal Hazards Mitigation Plan Progress Report (Annual & Periodic)			
Progress Report Period From (date):		**To (date):**	
Plan Title:	**Quinault Indian Reservation Tribal Hazards Mitigation Plan**		
Description of Plan:	**Hazard Preparedness & Disaster Mitigation**		
Implementing Agency:	**Quinault Indian Nation**		
Contact Name:			
Contact E-mail and Number:			
Summary of Progress of Tribal Hazards Mitigation Plan for this Reporting Period			
1. Did any hazard / disaster events occur during this report period? If so, list events.			
2. Did anyone from the public comment on the plan during this reporting period? If so, list the comments.			
3. Were any mitigation projects identified in the Hazard Mitigation Plan implemented during this reporting period?			
4. What obstacles, problems, or delays did any current or ongoing mitigation projects encounter, if any? How were the problems resolved?			

PLAN MAINTENANCE

Annual Review Questionnaire				
Project Title	**Questions**	**Yes**	**No**	**Comments**
PLANNING PROCESS	Are there internal or external organizations and agencies that have been invaluable to the planning process or to mitigation action?			
	Are there procedures (e.g., meeting announcements, plan updates) that can be done differently or more efficiently?			
	Has the Planning Team undertaken any public outreach activities regarding the THMP or a mitigation project?			
HAZARD ANALYSIS	Has a natural and/or human-caused disaster occurred in this reporting period?			
	Are there natural and/or human-caused hazards that have not been addressed in this THMP and should be?			
	Are additional maps or new hazard studies available? If so, what are they and what have they revealed?			
VULNERABILITY ANALYSIS	Do any new critical facilities or infrastructure need to be added to the asset lists?			
	Have there been changes in development trends that could create additional risks?			
CAPABILITY ASSESSMENT	Are there different or additional resources (financial, technical, and human) now available for mitigation planning?			
MITIGATION STRATEGY	Should new mitigation actions be added to the Implementation Strategy/Plan?			
	Are the mitigation actions listed in a community's Implementation Strategy/Plan appropriate for available resources?			

PLAN MAINTENANCE

Individual Mitigation Project Progress Report			
Progress Report Period From (date):		**To (date):**	
Project Title and Project ID:			
Description of Project:			
Implementing Agency or Department:			
Contact Name:			
Contact E-mail and Number:			
Grant/Finance Administrator:			
Total Project Cost:			
Anticipated Cost Overrun/Under run:			
Date of Project Approval:			
Project Start Date:			
Anticipated Completion Date:			
Summary of Project Progress for this Reporting Period			
1. What was accomplished during this reporting period?			
2. What obstacles, problems, or delays did the project encounter, if any? How were the problems resolved?			

7.5. Continued Public Involvement Program

The QIN is dedicated to involving the public directly in review and updates of the Tribal Hazards Mitigation Plan. The QIN Emergency Manager is responsible for the annual review and update of the plan as advised in the “Recommendations” section of this document.

The QIN Emergency Manager will take the responsibility for meeting with each Tribal Division and cooperating Agency and organization at least annually to discuss ongoing projects, needs, and changes in status of hazard preparedness. These annual meetings will be summarized in written form, then presented and discussed along with the summary to the Tribal Council. These meetings will result in an action plan to deal with the status of preparedness and mitigation measures.

The QIR public will have the opportunity to provide feedback about the Tribal Hazards Mitigation Plan annually at a meeting of the Tribal Council, coinciding approximately with the anniversary of the adoption of this plan. Copies of the Plan will be catalogued and kept at the QIN Planning

Department. The existence and location of these copies will be publicized. Instructions on how to obtain copies of the plan will be made available on the QIN Internet website and annually in a Nugguam (newsletter) article.

In addition, copies of the plan and any proposed changes will be posted on the QIN website. This website will also contain an e-mail address and phone number to which people can direct their comments and concerns.

A public meeting will also be held as part of each annual evaluation or when deemed necessary by the QIN Emergency Manager. The meetings will provide the public a forum for expressing concerns, opinions, or ideas about the implementation of the Tribal Hazards Mitigation Plan. The QIN Emergency Manager will be responsible for using Tribal resources to publicize the annual public meetings and maintain public involvement through the webpage and the Nugguam.

Figure CXXII. Quinault fisherman tends nets along the Quinault River in September 2009 as tradition and a significant part of the QIR's economy.

Chapter 8. Information Citations

8.1. Acronyms and Abbreviations Used

Table 71. List of Acronyms and Abbreviations used in this report.

ALDS	Automated Lightning Detection System
BIA	Bureau of Indian Affairs
CBRA	Coastal Barrier Resources Act
CBRS	John H. Chafee Coastal Barrier Resources System
CEDS	Comprehensive Economic Development Strategy
CERT	Community Emergency Response Team
CFR	Code of Federal Regulations
COOP	Continuity of Operations Plan
CSZ	Cascadia Subduction Zone
DOE	Department of Ecology (Washington)
DNR	Washington Department of Natural Resources
EAF	Essential Activities and Functions
EMI	Emergency Management Institute
EMT	Emergency Medical Technician
EOP	Emergency Operations Plan
EPA	U.S. Environmental Protection Agency
FARR	Federal Air Rules for Reservations
FEMA	Federal Emergency Management Agency
FIP	Federal Implementation Plan
FIRM	Federal Insurance Rate Map
FMP	Forest Management Plan
FRCC	Fire Regime Condition Class
FTP	File Transfer Protocol
FWS	U.S. Fish and Wildlife Service
GIS	Geographic Information Systems
GPS	Global Positioning System
HazMat	Hazardous Materials
HFR	Historic Fire Regime
HIVA	Hazard Identification and Vulnerability Assessment
HMGP	Hazard Mitigation Grant Program
IBC	International Building Code
ICBO	International Conference of Building Officials
ICS	Incident Command System
IRR	Indian Reservation Road (System)
LAFD	Los Angeles Fire Department
LANDFIRE	(Landscape Fire and Resource Management Planning Tools Project
LIHEAP	Low Income Heating and Energy Program
LIHTC	Low Income Housing Tax Credit
MRLC	Multi-Resolution Land Consortium
NFIP	National Flood Insurance Program
NIMS	National Incident Management System
NLCD	National Land Cover Database
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRCS	USDA Natural Resources Conservation Service
OIA	Office of Indian Affairs (precursor to the present day Bureau of Indian Affairs)
PDF	Portable Document Format (Adobe Acrobat Reader file)

Table 71. List of Acronyms and Abbreviations used in this report.

PDM	Pre-Disaster Mitigation Program
PDO	Pacific Decadal Oscillation
PNV	Potential Natural Vegetation Type
QDFi	Quinault Division of Fisheries
QDNR	Quinault Division of Natural Resources
QHA	Quinault Housing Authority
QIN	Quinault Indian Nation
QIR	Quinault Indian Reservation
QLTE	Quinault Land and Timber Enterprise
QRDA	Quinault Resources Development Administration
QRDP	Quinault Resources Development Project
RFLP	Repetitive flood loss properties
SFHA	Special Flood Hazard Area
SHMO	State Hazard Mitigation Officer
SR	State Route (usually followed by the SR number)
STATSGO	NRCS State Soils Geographic Database
THMP	Tribal Hazards Mitigation Plan
UBC	Uniform Building Code
US	United States (often in reference to a US Highway, followed by the road number)
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USDI	U.S. Department of Interior
USFS	USDA Forest Service
USGS	U.S. Geological Survey
WDEQ	Washington Department of Environmental Quality
WDWR	Washington Department of Water Resources
WRCC	Western Regional Climate Center
WUI	Wildland-Urban Interface

8.2. Glossary of Technical Terms Used

All definitions are cited from www.en.Wikipedia.org.

Cases

Accrete: Accretion is a process by which material is added to a tectonic plate or a landmass. This material may be sediment, volcanic arcs, seamounts or other igneous features. There are two types of geologic accretion. The first kind of accretion, plate accretion, involves the addition of material to a tectonic plate. When two tectonic plates collide, one of the plates may slide under the other, a process known as subduction. The plate which is being subducted (the plate going under), is floating on the asthenosphere and is pushed up and against the other plate. Sediment on the ocean floor will often be scraped by the subducting plate. This scraping causes the sediment to come off the subducted plate and form a mass of material called the accretionary wedge, which attaches itself to the subducting plate (the top plate). Volcanic island arcs or seamounts may collide with the continent, and as they are of relatively light material (i.e. low density) they will often not be subducted, but are thrust into the side of the continent, thereby adding to it. 113

Amplitude: The amplitude is the height of the wave. 199

Anabranche: An anabranch is a section of a river or stream that diverts from the main channel or stem of the watercourse and rejoins the main stem downstream. Local anabranches can be the result of small islands in the watercourse. In larger anabranches, the flow can diverge for a distance of several miles before rejoining the main channel. 159

Anthropogenic Influences: Anthropogenic (from the Greek meaning manmade) effects, processes or materials are those that are derived from human activities, as opposed to those occurring in biophysical environments without human influence. 231

Avulse: In sedimentary geology and fluvial geomorphology, avulsion is the rapid abandonment of a river channel and the formation of a new river channel. Avulsions occur as a result of channel slopes that are much lower than the slope that the river could travel if it took a new course. 159

Bathymetry: Bathymetry is the study of underwater depth of lake or ocean floors. The name comes from Greek βαθυς, deep, and μετρον, measure. Bathymetric (or hydrographic) charts are typically produced to support safety of surface or sub-surface navigation, and usually show seafloor relief or terrain as contour lines (called depth contours or isobaths) and selected depths (soundings), and typically also provide surface navigational information. Bathymetric maps (a more general term where navigational safety is not a concern) may also use a Digital Terrain Model and artificial illumination techniques to illustrate the depths being portrayed. 124

Burned Slopes: hillsides that have been de-vegetated during wildfire events leaving exposed sites, rocks, and potentially, hydrophobic soils (those soil conditions that cause water to collect on the soil surface rather than infiltrate into the ground). Wildfires generally cause soils to be hydrophobic temporarily, which increases water repellency, surface runoff and erosion in post-burn sites. 164

Debris Flow: A debris flow is a fast moving, liquified landslide of unconsolidated, saturated debris that looks like flowing concrete. It is differentiated from a mudflow in terms of the viscosity and textural properties of the flow. 205

Deluge: A deluge is a large downpour of rain, or a flood. 196

Earthflow: An earthflow (earth flow) is a downslope viscous flow of fine grained materials that have been saturated with water, and moves under the pull of gravity. They are an intermediate type of mass wasting that is between downhill creep and mudflow. The types of materials that are susceptible to earthflows are clay, fine sand and silt, and fine-grained pyroclastic material. 205

Impermeable Surface: A surface that cannot be penetrated by any element. Generally, this is in reference to a hardpan sub-surface layer that does not allow water to penetrate it. All water movement is along the plane of the layer. It can also refer to surface developments like roadbeds or developments (concrete pad, roofing, etc.). 155

Megafauna: In terrestrial zoology, megafauna (Ancient Greek megas "large" + New Latin fauna "animal") are "giant", "very large" or "large" animals. Their original and most common definition is 100 lb, often rounded in the metric system to 40 or 45 kg. This thus includes many species not popularly thought of as overly large, such as white-tailed deer and red kangaroo, as well as humans. 110

Mesoscale Convective System: A mesoscale convective system (MCS) is a complex of thunderstorms that becomes organized on a scale larger than the individual thunderstorms but smaller than extratropical cyclones, and normally persists for several hours or more. A mesoscale convective system's overall cloud and precipitation pattern may be round or linear in shape, and include weather systems such as tropical cyclones, squall lines, lake-effect snow events, polar lows, and Mesoscale Convective Complexes (MCCs), and generally form

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Workman, L.J. 2010. Photography taken by Larry Workman on the QIR and provided for use in this planning effort. Reproduced with permission. Photography of Qui-nai-elt Village was published in the Nugguam, March 2010.

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