QUINAULT INDIAN NATION

Hazard Summary

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The following represents a synopsis of selected data from the various hazard profiles developed for the 2023 update to the Quinault Indian Nation's Hazard Mitigation Plan. This summary is intended to provide only some of the general information, as well as the Impacts and Results of the study completed by the Hazard Mitigation Planning Team. A more detailed analysis and additional information is contained within the actual plan, which is a separately published document.

MAJOR PAST HAZARD EVENTS

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

The table below identifies all Federal Disaster Declarations which have occurred on the QIN since 1957 for which presidential disaster declarations were issued, or in the case of fire, where the fire management was issued. This includes disasters occurring in both Grays Harbor and Jefferson Counties, as identified. A total of 34 federally declared disasters have occurred. In addition, the QIN has also issued its own disaster declarations when situations have justified such actions. Those declarations are referenced within the hazard profiles as the information is available.

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

In addition to the events illustrated in this update, the Nation has been actively collecting weather-related historical event and impact information spanning 40 years as part of an ongoing historical record of the Quinault Indian Reservation – *Land of Trees* (Workman 2016). Reviewers wishing additional information than identified within this document may wish to review that writing as well.

TABLE 1
QUINAULT INDIAN NATION DISASTER HISTORY 1957-2022

Disaster Number	Declaration Date	Incident Type	Title	Incident Begin Date	Incident End Date	QIR Declarations (Grays Harbor)	Queets / Jefferson County Declarations
4650	3/29/2022	Flood	Severe Winter Storms, Snowstorms, Straight-line Winds	12/26/2021	1/15/2022	X	X
4635	1/5/2022	Flood	Flooding and Mudslides	11/13/21	11/15/2021		X

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Disaster Number	Declaration Date	Incident Type	Title	Incident Begin Date	Incident End Date	QIR Declarations (Grays Harbor)	Queets / Jefferson County Declarations
4593	4/8/2021	Severe Winter Storm	Severe Winter Storm, Straight-line Winds, Flooding, Landslides and Mudslides	12/29/2020	1/16/2021	X	X
4539	4/23/2020	Severe Storms	Severe Storms, Flooding, Landslides and Mudslides	1/20/2020	2/10/2020	X	
4481	3/22/2020	Biological / Pandemic	COVID-19 Pandemic	1/20/2020	On-going	X	X
4418	3/4/2019	Severe Winter Storm	Severe Winter Storms, Straight-line Winds, Flooding, Landslides, Mudslides, Tornado	12/10/2018	12/24/2018	X	X
4253	2/2/2016	Flood	Severe Winter Storm, Straight-Line Winds, Flooding, Landslides, Mudslides	12/1/2015	12/14/2015	X	X
4249	1/15/2016	Severe Storms	Severe Storms, Straight-line Winds, Flooding, Landslides and Mudslides	11/12/2015	11/21/2015		X
4242	10/15/2015	Severe Storm(s)	Severe Windstorm	8/29/2015	8/29/2015	X	X
4056	3/5/2012	Severe Storm(s)	Severe Winter Storm, Flooding, Landslides, and Mudslides	1/14/2012	1/23/2012	X	
1825	3/2/2009	Severe Storm(s)	Severe Winter Storm, Record and Near Record Snow	12/12/2008	1/5/2009	X	X
1817	1/30/2009	Flood	Severe Winter Storm, Landslides, Mudslides, and Flooding	1/6/2009	1/16/2009	X	X
1734	12/8/2007	Severe Storm(s)	Severe Storms, Flooding, Landslides, and Mudslides	12/1/2007	12/17/2007	X	X

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Disaster Number	Declaration Date	Incident Type	Title	Incident Begin Date	Incident End Date	QIR Declarations (Grays Harbor)	Queets / Jefferson County Declarations
1682	2/14/2007	Severe Storm(s)	Severe Winter Storm, Landslides, and Mudslides	12/14/2006	12/15/2006	X	
1671	12/12/2006	Severe Storm(s)	Severe Storms, Flooding, Landslides, and Mudslides	11/2/2006	11/11/2006	X	X
1641	5/17/2006	Severe Storm(s)	Severe Storms, Flooding, Tidal Surge, Landslides, and Mudslides	1/27/2006	2/4/2006	X	X
1499	11/7/2003	Severe Storm(s)	Severe Storms and Flooding	10/15/2003	10/23/2003	X	X
1361	3/1/2001	Earthquake	Earthquake	2/28/2001	3/16/2001	X	X
1172	4/2/1997	Flood	Heavy Rains, Snow Melt, Flooding, Land and Mudslides	3/18/1997	3/28/1997	X	X
1159	1/17/1997	Severe Storm(s)	Severe Winter Storms, Land and Mudslides, Flooding	12/26/1996	2/10/1997	X	X
1100	2/9/1996	Flood	High Winds, Severe Storms, Flooding	1/26/1996	2/23/1996	X	X
1079	1/3/1996	Severe Storm(s)	Severe Storms, High Wind, and Flooding	11/7/1995	12/18/1995	X	X
1037	8/2/1994	Fishing Losses	The El Nino (The Salmon Industry)	5/1/1994	10/31/1994	X	X
896	3/8/1991	High Tides	High Tides, Severe Storm	12/20/1990	12/31/1990		X
883	11/26/1990	Flood	Severe Storms, Flooding	11/9/1990	12/20/1990	X	X
852	1/18/1990	Flood	Severe Storms, Flooding	1/6/1990	1/14/1990	X	
757	2/15/1986	Severe Storms	Severe Storms, Flooding	1/16/1986	1/19/1986		X
623	5/21/1980	Volcano	Volcanic Eruption, Mt. St. Helens	5/21/1980	5/21/1980	X	X

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QUINAULT INDIAN NATION DISASTER HISTORY 1957-2022

Disaster Number	Declaration Date	Incident Type	Title	Incident Begin Date	Incident End Date	QIR Declarations (Grays Harbor)	Queets / Jefferson County Declarations
612	12/31/1979	Flood	Storms, High Tides, Mudslides, Flooding	12/31/1979	12/31/1979	X	X
545	12/10/1977	Flood	Severe Storms, Mudslides, Flooding	12/10/1977	12/10/1977	X	X
492	12/13/1975	Flood	Severe Storms and Flooding	12/13/1975	12/13/1975	X	X
322	2/1/1972	Flood	Severe Storms and Flooding	2/1/1972	2/1/1972	X	X
300	2/9/1971	Flood	Heavy Rains, Melting Snow, Flooding	2/9/1971	2/9/1971	X	X
185	12/29/1964	Flood	Heavy Rains and Flooding	12/29/1964	12/29/1964	X	X
EMERGENCY DECLARATIONS							
3227	9/7/2005	Coastal Storm	Hurricane Katrina Evacuation	8/29/2005	10/1/2005	X	X
SIGNIFICANT LOCAL INCIDENTS							
NA	NA	Landslides/ Floods	Heavy Rains and Landslides (Countywide)	1/4/2015	1/5/2015	X	
		Drought	Drought situation	2021			

The most common disasters to occur are severe storms and flooding. Those hazards are further broken down by month, year, recurrence intervals (not based on order of magnitude), probability of occurrence, and FEMA ranking as illustrated in Table 2 (QIR in Grays Harbor County) and Table 3 (QIR in Queets /Jefferson County). These are based on FEMA event typing. For these generalized purposes, recurrence intervals are determined by the number of events divided by the number of years to obtain an average. In some instances, recurrence intervals based on magnitude are contained within the hazard profiles. The recurrence intervals are not based on the order of magnitude (e.g., a 100-year storm), but rather on the fact that the event occurred, no matter what the magnitude. The Percent Probability of Occurrence is calculated by the dividing the number of events by years, and then multiplying that sum by 100 to create the percent probability of an event occurring in any given year.

TABLE 2
STORM DISASTER HISTORY BY MONTH, RECURRENCE, AND PROBABILITY OF OCCURRENCE

Grays Harbor County Portion of Reservation

Hazard Type	Jan	Feb	Mar	Ap	May	June	July	Aug	Sept	Oct	Nov	Dec	Total	Years of Occurrence	FEMA Rank	Recurrence / Years (No Order of Magnitude)	Probability/ (Percent risk that an event may occur)
Flood	2	4	1	2	0	0	0	0	0	0	1	4	**14**	64, 71, 72,75, 77, 79, 90 (x2), 96, 97, 09, 16, 20, 22	1	4.6	21.88
Severe Storm (including Wind)	2	1	3	1	1	0	0	0	0	1	1	2	**12**	96, 97, 03, 06, 07, 09, 12, 15, 19, 21	2	5.3	18.75
TOTAL	**4**	**5**	**4**	**3**	**1**	**0**	**0**	**0**	**0**	**1**	**2**	**6**	**26**				
Based on FEMA designation and dates.																	

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

Queets (Jefferson County) Area of Reservation

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

CHAPTER 1.
DROUGHT

OVERVIEW

Droughts originate from a deficiency of precipitation resulting from an unusual weather pattern. If the weather pattern lasts a short time (a few weeks or a couple of months), the drought is considered short-term. If the weather pattern becomes entrenched and the precipitation deficits last for several months or years, the drought is considered long-term. It is possible for a region to experience a long-term circulation pattern that produces drought, and to have short-term changes in this long-term pattern that result in short-term wet spells. Likewise, it is possible for a long-term wet circulation pattern to be interrupted by short-term weather spells that result in short-term drought.

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

- The water supply for the area is below 75 percent of normal.
- Water uses and users in the area will likely incur undue hardships because of the water shortage.

PREVIOUS OCCURRENCES

While there is no record of data indicating that the Reservation has ever been declared for a Presidential Disaster Declaration involving a drought, the Tribe was declared in 1994 under Disaster Declaration 1037 for an El Nino effect on the salmon industry. As a result of extreme heat conditions occurring in late June and early July 2021, the Business Committee did declare a QIN Disaster under Resolution No. 21-128-99. Most recently occurring during the update of this 2023 plan, historic low water levels closed most fishing in most streams of the Olympic Peninsula.[1] The figure below illustrates impact in October 2022 on the Quinault Riverbed (Nugguam, 2022).

[1] National Park Service. News Release, 2022. Accessed 25 Oct. 2022. Available online at: Emergency Closure of Recreational Fishing in Most Rivers and Streams of Olympic National Park to Begin on October 6 - Olympic National Park (U.S. National Park Service) (nps.gov)

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The Quinault River runs dry in its upper reach in early October

The upper reaches of the Quinault River had no surface flow in the first half of October. There is water flow under the rocky debris and it only appears on the surface just above the Enchanted Valley Chalet, but only as a meager trickle. This is one of the important snow and glacier melt areas to help feed the river in late summer and early fall. There are only two glaciers left on this fork of the Quinault; the White and Lindsey (Hanging) glaciers and they are just remnants of their former selves. The Anderson glacier at the head of the valley perished more than 12 years ago. Nearly all the water in the river was coming from ground water seeping into small side streams. The lowest flow ever recorded at Lake Quinault in early October was 285 cfs (cubic feet per second) in 1968. The flow when this photo was take was 221 cfs at the Lake. The mean flow over the last 108 years in early October is nearly 1,490 cfs and in 1921 the maximum flow was 9,840 cfs. As of October 20th, the river fell below 182 cfs. See the Quests and Quinault river flow charts on page 12. Photo courtesy Larry Workman

IMPACT AND RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from Drought throughout the area is likely. The Tribe has experienced a number of drought incidents, including the 1994 Disaster Declaration #1037 for the El Nino effect on the salmon industry, the 2021 QIN Drought Declaration, and the impacts from the 2022 summer months involving excessive heat, with riverbeds running dry. With the changing environment due to climate change, continued impacts are likely.

In addition, the planning area as a whole (Grays Harbor) has experienced drought conditions, with additional drought incidents occurring in 2015 and 2019. The State experienced one of its driest summers on record for the last 30 years in 2017, with several counties in the state also issuing declarations in April and June 2019. June 2021 saw record-setting temperatures throughout the state, with only a few limited areas not impacted. As indicated, the 2021 incident rose to the level of the QIN declaring a disaster. With anticipated increase in temperatures as a result of climate change continuing, drought situations will only intensify. The higher temperatures anticipated with climate change would increase vulnerability of the population due to excessive heat, while also potentially impacting power supplies at the hydro-dam in the area. The Reservation has somewhat limited resources and does rely on surrounding municipalities for water and power. The timber industry would also be impacted – something on which the QIN rely heavily.

With the new development occurring in areas of the QIR intended to replace some of the existing older structures, the QIN has also planned for new structures which will serve as shelters/ gathering locations or resilience centers. These structures will be utilized as both cooling and warming facilities. Likewise, the new residential structures will be built to higher codes, including better insulation which will help regulate temperatures (both excessive heat and cold) in both residential and governmental structures. Air filtration systems may also be utilized to help reduce the impact of smoke resulting from increased wildfires associated with drought conditions. Construction materials will also be more fire-resistant, helping to reduce impact from fires should they occur as a result of a drought situation.

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

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

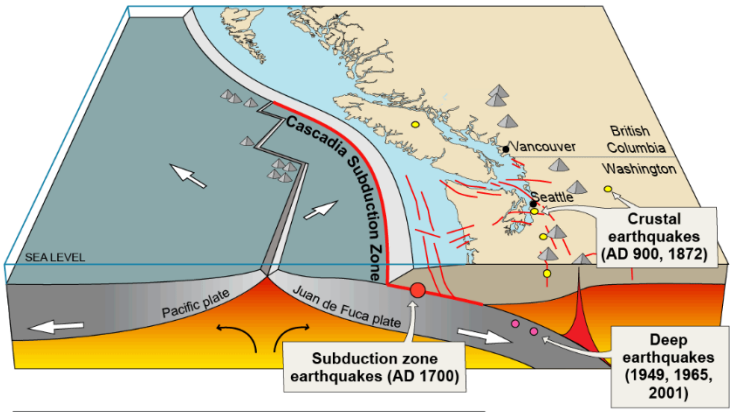
CHAPTER 2.
EARTHQUAKE

OVERVIEW

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

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

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



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

Volcano
Active crustal fault
Active plate boundary fault

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

DEFINITIONS

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

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

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

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

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

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

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

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

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

The Table 2-1 presents a classification of earthquakes according to their magnitude.

TABLE 2-1
EARTHQUAKE MAGNITUDE CLASSES

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

EFFECT OF SOIL TYPES

Liquefaction is a secondary effect of an earthquake in which soils lose their shear strength and flow or behave as liquid, thereby damaging structures that derive their support from the soil. Liquefaction generally occurs in soft, unconsolidated sedimentary soils. The National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics to identify areas subject to liquefaction. Table 2-2 identifies NEHRP soil classifications and identifies by acre(s) the types of soils on tribal lands. NEHRP Soils B and C typically can sustain ground shaking without much effect, dependent on the earthquake magnitude. Areas that are commonly most affected by ground shaking and susceptible to liquefaction have NEHRP Soils D, E and F. Table 2-3 identifies the number and types of tribal-owned structures within each soil classification. Figure 2-1 illustrates the areas in which the soil classifications are situated (inclusive of all lands within the Reservation boundary, regardless of ownership).

TABLE 2-2 TYPES OF NEHRP SOIL CLASSIFICATIONS ON QIN RESERVATION		
NEHRP Soil Type	**Description**	**QIN Reservation Soils Type (in acres)**
A	Hard Rock	0.00
B	Firm to Hard Rock	16,540.01
C	Dense Soil/Soft Rock	23,156.49
D	Stiff Soil	143,897.90
E	Soft Clays	23,165.36
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 m thick)	0.00

TABLE 2-3 QIN CRITICAL FACILITIES / INFRASTRUCTURE IN NEHRP SOIL CLASSIFICATIONS															
NEHRP Soil Type	**Description**	**Government Function**	**Hazardous Materials**	**Medical / Health Care**	**Protective Services**	**Residential**	**Schools**	**Shelter**	**Commercial**	**Industrial**	**Communications**	**Cultural**	**Natural Resources**	**Water**	**Wastewater**	**Total**
A	Hard Rock	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
B	Firm to Hard Rock	1	0	0	0	0	0	0	0	0	0	0	1	1	0	**3**
C	Dense Soil/Soft Rock	1	0	1	1	0	2	2	1	0	0	0	3	0	0	**11**
D	Stiff Soil	19	1	4	3	1	0	0	4	2	0	2	3	3	3	**45**
E	Soft Clays	11	0	2	9	1	5	2	3	4	2	3	11	3	1	**57**
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 m thick)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**

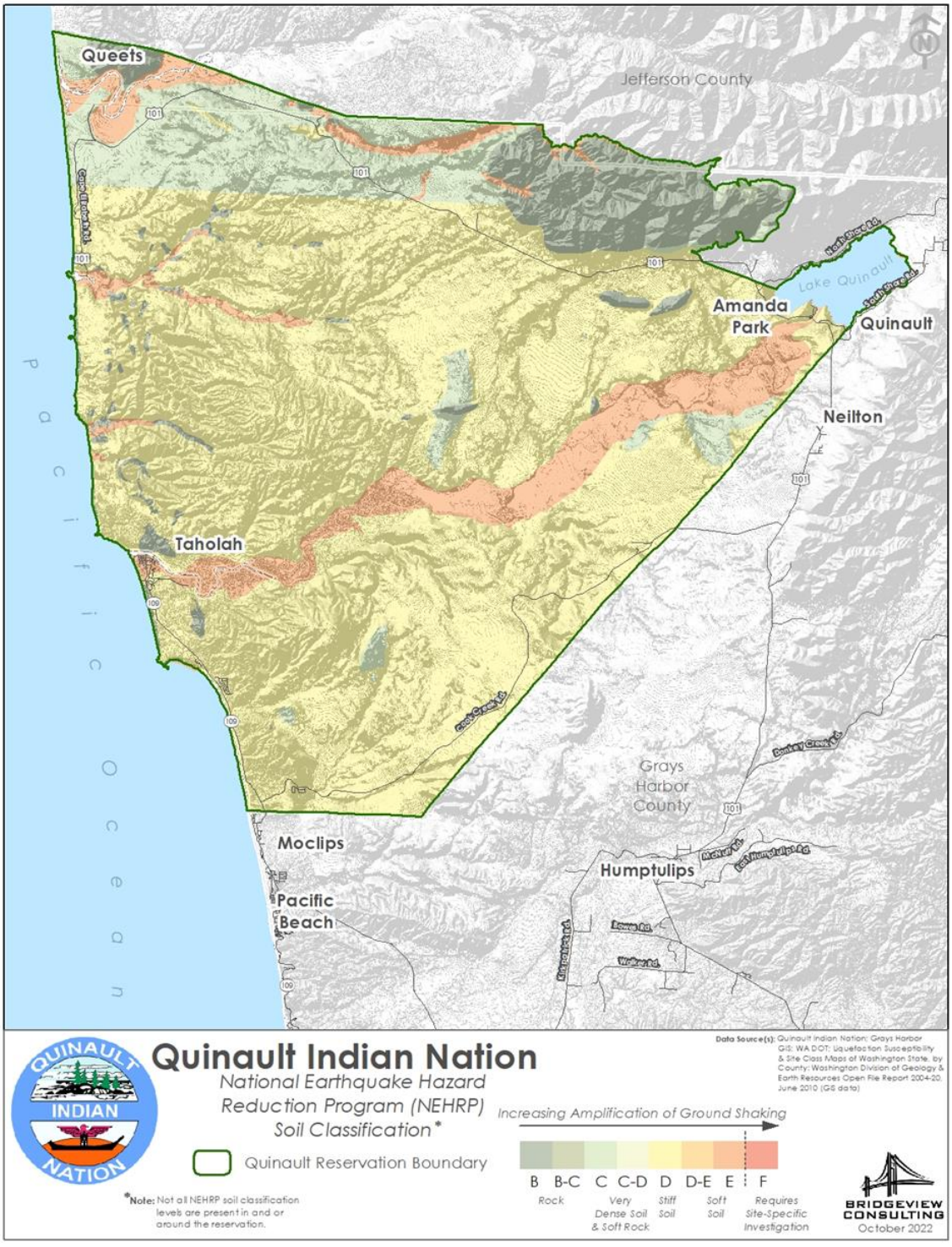


Figure 2-1 NEHRP Soil Classification

Figure 2-2 indicates a number of faults running on or near the QIR. Faults include the Grays Harbor Fault Zone, the Willapa Bay Fault Zone, Saddle Hills Fault Zone, Langley Hill fault, and Canyon Creek fault, which runs on the Grays Harbor and Mason Counties' borders near the Olympic National Forest. Figure 2-3 illustrates liquefiable susceptibility on the QIR based on soil types. Table 2-4 illustrates the number of Tribal structures owned within the various soil types.

Figure 2-2 Faults within the QIR

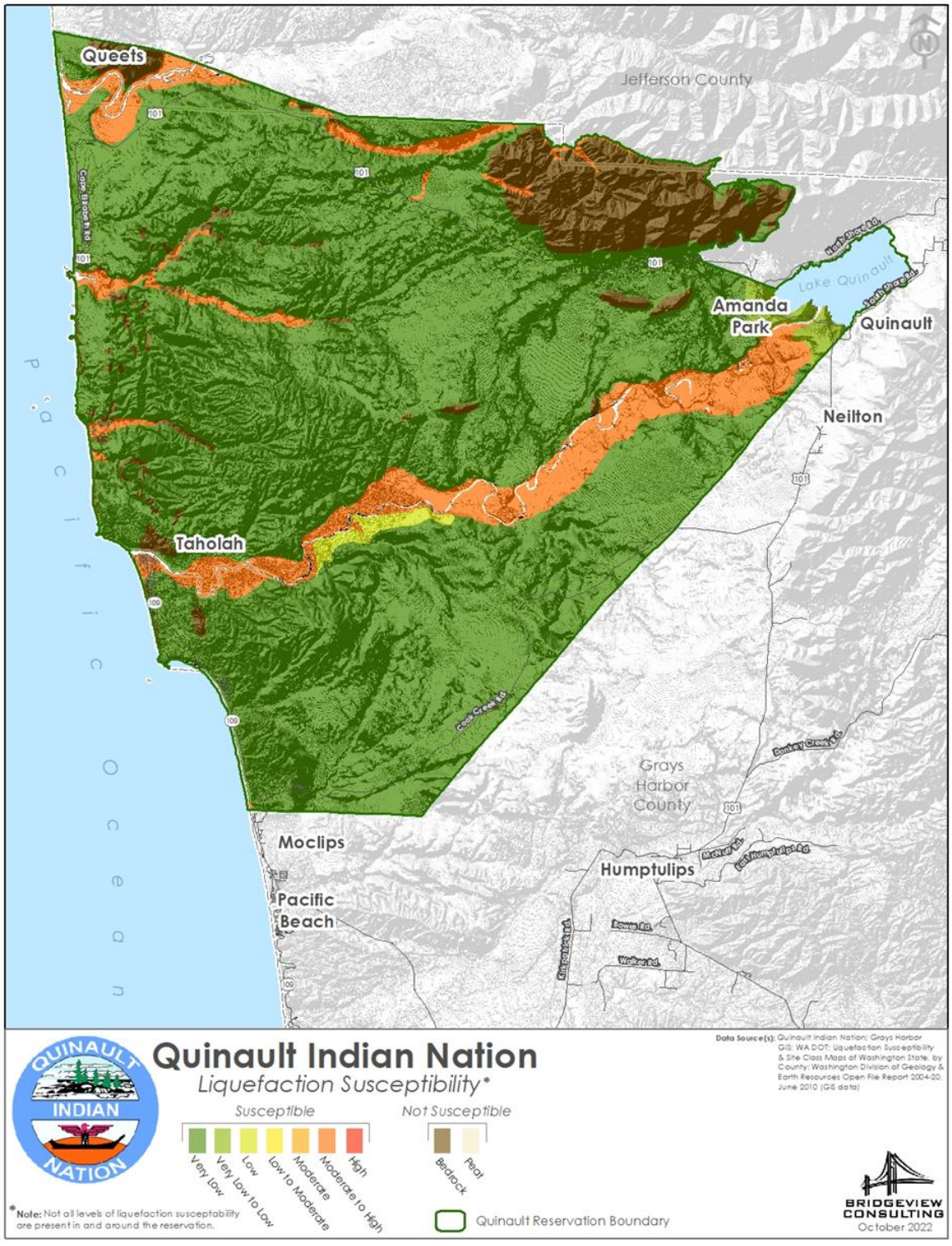


Figure 2-3 Liquefaction Susceptibility

TABLE 2-4
CRITICAL FACILITIES AND INFRASTRUCTURE WITHIN LIQUEFACTION SUSCEPTIBILITY ZONES

Liquefaction Susceptibility Zones	Government Function	Medical/Health	Protective Services	Hazardous Materials	Schools	Shelter	Industrial	Commercial	Communications	Water	Wastewater	Residential	Natural Resources	Cultural	Total
High	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Moderate to High	12	3	13	0	5	2	8	8	2	4	3	1	12	3	**76**
Moderate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Low to Moderate	0	0	0	0	0	0	0	0	0	1	0	0	0	0	**1**
Low	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Very Low to Low	8	1	1	1	0	0	1	0	0	0	1	1	1	0	**15**
Very Low	12	4	2	0	2	2	1	2	0	1	0	0	5	2	**33**
Not Susceptible to Liquefaction															
Bedrock	1	0	0	0	0	0	0	0	0	1	0	0	1	0	**3**
Peat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**

IMPACT AND RESULTS

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

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

- A Cascadia-type earthquake could generate a large amount of damage within the general planning area in which the reservation is situated. Municipalities within the surrounding counties (Jefferson, Grays Harbor, and Mason Counties) have a large number of older structures, particularly in the downtown hub areas. In this respect, the Planning Team considered not only Tribal-owned structures, but also structures which are residences for Tribal citizens; those which provide services to Tribal citizens (e.g., hospitals, medical offices, etc.); or on which Tribal businesses rely (e.g., supply-chain). Collapse or damages to the structures could divert emergency response personnel away from the Reservation or tribal structures.

- Further consideration was given with respect to the distance between the Reservation and the nearest large town, and the response capabilities both by the tribe itself, or through services provided by Grays Harbor or Jefferson Counties, or other local service provider (e.g., fire districts).
- While the Tribe maintains law enforcement and fire response, it is of limited sizes, particularly when considering the potential number of individuals needing assistance or medical care. Given the potential inaccessibility of roadways which have previously been impassible in areas (such as resulted with the Nisqually Earthquake), or impact to the I-5 corridor, the potential for law enforcement response from one area to other areas may be impacted. Such would also be the case for fire response, ambulance transport, or medical services.
- With the potential of a Cascadia event generating a tsunami wave at 43 feet in height at the Taholah School District and 38 feet at the Taholah Community Center, evacuation from the reservation and surrounding beach areas would significantly increase traffic on both major and local roadways. Depending on the area, in some cases, tsunami waves are anticipated to make shore on the QIR, Jefferson, and Grays Harbor Counties within 20 minutes based on WA DNR's analysis (WA DNR, 2022).
- The structural integrity of the Quinault Bridge (as well as other bridges in the area) and major roadways coming from the surrounding counties would undoubtedly be impacted from the earthquake itself, leaving tourists or residents attempting to evacuate isolated in the rural areas, including the reservation and areas immediately around the reservation. With the large number of estimated tourists visiting the area annually, this would, in essence, put roadways at a standstill. Should a Cascadia event occur during a summertime month when a high number of tourists are in the area, resources, and supplies (including medical) throughout the entire region would be significantly taxed in addition to roadway congestion.
- The current Queets Shelter and Tsunami evacuation structure is an uncovered basketball court at the Queets upper village. While this may be adequate as a short-term location for evacuation purposes, if sheltering is needed, an uncovered area would not provide the necessary resources to serve as a true shelter, particularly for longer-term or during inclement weather.
- During a significant event, potential injuries could lead to mass-casualty events throughout the region, wholly taxing capabilities.

Based on the potential impact, the Planning Team determined the CPRI score to be 3.85, with overall vulnerability determined to be a high level.

CHAPTER 3.
FLOOD

OVERVIEW

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

DEFINITIONS

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

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

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

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

Flooding Types

Many floods fall into one of three categories: riverine, coastal, or shallow (which may include urban flooding, areas with gentle slopes and no defined channels with an average depth limited to 3.0 feet or less, or flat areas along river banks which may covered for days after a flood event, etc.). Other types of floods include alluvial fan floods, dam failure floods, ice/debris jam floods, and floods associated with local drainage or high groundwater. On the QIR, the two primary types of flooding to occur include coastal and riverine, although others have also occurred.

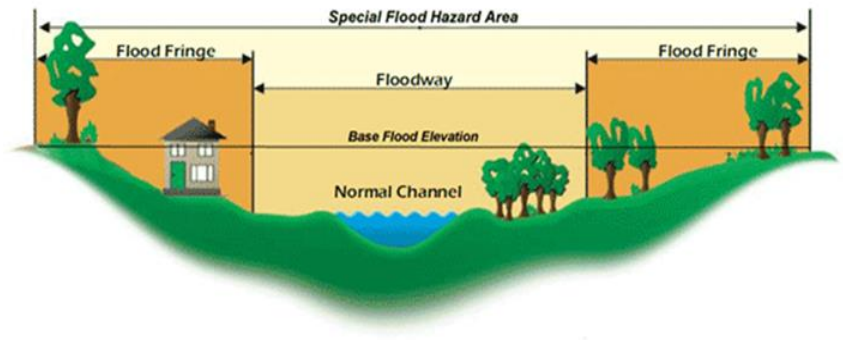


Figure 3-1 Special Flood Hazard Areas Identified

A structure located within a 1 percent (100-year) floodplain has a 26 percent chance of suffering flood damage during the term of a 30-year mortgage. The 100-year flood is a regulatory standard used by federal agencies and most states to administer floodplain management programs. The 1 percent (100-year) annual chance flood is used by the NFIP as the basis for insurance requirements nationwide. FIRMs also depict 500-year flood designations, which is a boundary of the flood that has a 0.2-percent chance of being equaled or exceeded in any given year. It is important to recognize, however, that flood events and flood risk are not limited to the NFIP delineated flood hazard areas. Table 3-1 illustrates the estimated probability of flood events as utilized by the NFIP.

TABLE 3-1 ESTIMATED PROBABILITY OF FLOOD EVENT	
EVENT	**ANNUAL CHANCE OF OCCURRENCE**
10-year flood	10%
25-year flood	4%
50-year flood	2%
100-year flood	1%
500-year flood	0.2%

National Flood Insurance Program Status and Severe Loss/Repetitive Loss Properties

The QIN is a member of the NFIP, Community Number 535535. The Tribe does have regulatory authority within its land use planning which regulates development to IBC standards. The Tribe has FEMA-developed flood maps, which are proprietary in nature. That data has been used to project the floodplain areas in this plan. The Tribe has no previous claim history under the NFIP.[2] The QIN have no current NFIP policies in place as of November 2022.

Extent and Location

Flooding is the most common hazard occurring in the tribal planning area, albeit not always rising to the level of a disaster declaration. Flooding is most often due to riverine or coastal flooding. Coastal flooding is caused by severe storms and storm surge from the ocean.

The severity of flood damage is dependent upon ground elevation, the surrounding topography, peak flow volumes, surface flow velocities, tides, driving winds, and the storm surge impacting the drainage of the various river bodies traveling through the QIR.

Flooding within the Quinault Indian Reservation is typically seen around the populated places of Amanda Park, Queets, Taholah, Taholah Ocean Tracts, and Qui-Nai-Elt as the result of 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. The lower portion of Taholah Village (west of SR 109), portions of Queets Village, and access points on SR 109 are susceptible to coastal flooding. Riverine flooding occurs when a river overtops or stormwater outlets are blocked, preventing runoff from the villages to move away from people, structures, and other assets.

At present, there are ~13,009.25 acres of reservation land in the 100-year flood zone. Data is not available for the 500-year flood zone. The 100-year flood zone encompasses a large portion of land mass of the existing developed area of the Reservation located in the Lower Village area of Taholah. The flood zones do not include the area in the Upper Village area, which is outside of the flood plain.

[2] FEMA Flood Insurance Data and Analytics. Accessed 11 Nov. 2022. Available online at: Flood Insurance Data and Analytics | The National Flood Insurance Program | FloodSmart | NFIPServices.

FEMA Flood Maps

FEMA previously performed a Flood Insurance Study (FIS) for Grays Harbor and Jefferson Counties, and since completion of the last plan, completed some flood mapping for the QIN; however, the QIN has not yet adopted the maps, and the maps are proprietary to the QIN. For purposes of this plan update, the 100-year floodplain generated by FEMA has been utilized in this analysis. No 500-year analysis was completed. The various flood zones associated with the study are illustrated in Figure 3-2. These maps may be updated once the NSD study has been completed.

Figure 3-2 Flood Hazard Areas

Previous Occurrences

Flooding has a long history on the QIR. The month highest in number for declared flood events are February and December (four events each), followed by January, February, and April (two events each), and March and November (one event each).

Historically, beginning the first week of July the Reservation experiences its lowest tides, averaging 6 to 8 feet high. The tides become higher in later months, and by December to January, the Reservation begins to experience its highest tides at 10 to 12 feet. High tides are also often impacted by storm surges, high winds, and periods of driving rain, causing the water levels on the river to rise, flooding the Reservation. Review of existing data does illustrate high tides associated with severe storm events occurring with some frequency during January, December, and March.

Floods on the QIR have damaged governmental structures, roads and bridges, eroded public and private properties, and regularly interrupted transportation. Road and bridge washouts near the Reservation and elsewhere in western Grays Harbor and Jefferson Counties in recent years have isolated portions of the Reservation. Rising waters on the rivers have also necessitated sandbagging and other emergency measures for members of the QIN residing in areas impacted.

The planning area has received 14 flood-related disaster declarations within Grays Harbor County, and nine flood-related disaster declarations within Jefferson County. Because limited data is available for the QIR independent of County data, such was used to populate this data. At present, the dollar value of property damage on the Reservation is unknown. In the future, the Tribe will begin a system for maintaining historical data specific to the Reservation.

Frequency

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

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

Major floods resulting in severe impacts, including evacuation of people from residences in low-lying areas, and the inundation of major access roads, such as SR 109 and U.S. Highway 101, has historically occurred every 4.6 years in the Grays Harbor area, and every 7.5 years in the Jefferson County area. Severe storms that also include flooding occur approximately every 5-6 years. The planning area has sustained 14 (Grays Harbor County) and nine (Jefferson County) declared *Flood* incidents during the period 1953-2022, not inclusive of *Severe Storm/Weather* incidents which also include an element of flood. There are an additional 12 and 11 Severe Storm incidents (respectively) that include some level of flooding.

Table 3-2 identifies the impact to the critical facilities based on the various flood hazard areas identified, or their proximity to the flood zone. For some properties off of the Reservation, the County's FIRM was utilized to identify potential impacts.

TABLE 3-2
IMPACT TO CRITICAL FACILITIES

Critical Facilities in the 100-Year Flood Hazard Area for Queets & Quinault Rivers

Government Function	Medical	Protective Services	Hazardous Materials	Schools	Shelter	Industrial	Commercial	Communications	Water	Wastewater	Residential	Natural Resources	Cultural	**Total**
8	**2**	**8**	**0**	**5**	**2**	**3**	**2**	**2**	**0**	**0**	**1**	**0**	**3**	**36**

Critical Facilities w/n 1,000' of 100-Year Flood Hazard Area for Queets and/or Quinault Rivers

Government Function	Medical	Protective Services	Hazardous Materials	Schools	Shelter	Industrial	Commercial	Communications	Water	Wastewater	Residential	Natural Resources	Cultural	**Total**
10	**5**	**3**	**1**	**2**	**2**	**1**	**2**	**0**	**4**	**1**	**0**	**6**	**1**	**38**

Critical Facilities in the 100-Year Flood Hazard Area for Grays Harbor County, WA DFRIM

Government Function	Medical/Health	Protective Services	Hazardous Materials	Schools	Shelter	Industrial	Commercial	Communications	Water	Wastewater	Residential	Natural Resources	Cultural	**Total**
1	**1**	**3**	**0**	**0**	**0**	**2**	**3**	**0**	**0**	**0**	**0**	**1**	**0**	**11**

Critical Facilities in the 500-Year Flood Hazard Area for Grays Harbor County, WA DFRIM

Government Function	Medical/Health	Protective Services	Hazardous Materials	Schools	Shelter	Industrial	Commercial	Communications	Water	Wastewater	Residential	Natural Resources	Cultural	**Total**
0	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**2**

IMPACT AND RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from Flood throughout the area is highly likely. The area can experience several flood events

annually, albeit not to the level of a disaster declaration. The area has been impacted a total of 23 times (Grays Harbor and Jefferson Counties combined) since 1953 at the level to gain a federal disaster declaration. FEMA has identified the flood hazard as the second most significant hazard to occur (behind severe weather) based on impact.

While structural damage may vary due to flood depths and existing floodplain management regulations, existing structures (particularly in the Taholah area) are impacted on a regular occurrence, particularly if the weather event occurs simultaneously with high tides. The Taholah Mercantile, which supplies both food and gas, could be impacted, limiting supplies while also potentially causing a hazardous materials release from the gas tanks. As a result of impact to governmental structures, public services have previously been interrupted as a result of flood events occurring. Economic impact has also occurred, due to both structural impact and the inability for ingress and egress to businesses, both tribal owned and those owned by individual tribal members.

Roadways both on and off the reservation are also regularly impacted, causing isolation. With individuals traveling through the area, this has the potential to significantly impact the QIN with respect to individuals trapped in the area until floodwaters recede. Emergency response (medical, police and fire) is also impacted as a result of water inundating roadways, making evacuation impossible for extended periods of time.

Flood events could also impact water quality, and water sources, impacting people and the natural resources of the QIR. Flood events also have the potential to negatively impact fish and other wildlife habitats, including the hatcheries. Such impact can be long-lasting as a result of impact on spawning cycles. Of additional consideration are the Nation's restoration projects which have also been impacted by repeated flooding in the area. Flood events can also cause saltwater inundation, contaminating soils while also potentially causing well water intrusion.

Based on the potential impact, the Planning Team determined the CPRI score to be 3.05 with overall vulnerability determined to be a high level.

CHAPTER 4.
LANDSLIDE

GENERAL BACKGROUND

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

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

DEFINITIONS

Landslide—The movement of masses of loosened rock and soil down a hillside or slope. Such failures occur when the strength of the soils forming the slope is exceeded by the pressure, such as weight or saturation, acting upon them.

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

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

All mass movements are caused by a combination of geological and climate conditions, as well as the encroaching influence of urbanization. Vulnerable natural conditions are affected by human residential, agricultural, commercial and industrial development and the infrastructure that supports it.

HAZARD PROFILE

Landslides are caused by one or a combination of the following factors: change in slope of the terrain, increased load on the land, shocks and vibrations, change in water content, groundwater movement, frost action, weathering of rocks, and removing or changing the type of vegetation covering slopes. In general, landslide hazard areas are where the land has characteristics that contribute to the risk of the downhill movement of material.

Extent and Location

The best predictor of where movement of slides and earth flows might occur is the location of past movements. Past landslides can be recognized by their distinctive topographic shapes, which can remain in place for thousands of years. Most landslides recognizable in this fashion range from a few acres to

several square miles. Most show no evidence of recent movement and may not be currently active. A small proportion of them may become active in any given year, with movements concentrated within all or part of the landslide masses or around their edges. For the QIR, landslide history dates back to 1816, with Washington State Department of Natural Resources identifying and plotting well in excess of 230 landslides in the area of the QIR. Such landslides are a recurrent menace to waterways, highways, shorelines, structures, and utility services. SR 109 is the only access route to Taholah, which is the primary point of government services, housing, health care/medications, and food for the QIN.

Figure 4-1 SR 109 Near Moclips/Pacific Beach on QIR - Primary Access for Taholah

Figure 4-2 December 18, 2018 Mudslide at MP 33.5

The recognition of ancient dormant mass movement sites (such as illustrated in Figure 9-6) is important in locating areas susceptible to flows and slides because they can be reactivated by earthquakes or by exceptionally wet weather. Also, because they consist of broken materials and frequently involve disruption of groundwater flow, these dormant sites are vulnerable to construction-triggered sliding. In other cases, such as on the QIR, there are landslides that have been active for many years, and show no signs of stopping, continuing to increase in size.

Table 4-1 identifies the number of acres falling within the various types of landslide hazard areas on the QIR. Figure 4-1 identifies some additional landslide hazard areas in and around the QIR. Based on areas identified in the QIN's 2016 mitigation plan, approximately 7 percent of the total area within the Census track including the Reservation are in a high probability landslide area based on WDNR data (DNR no longer identifies areas of risk in a similar fashion, so this data remains the most current as of this 2023 update).

TABLE 4-1
ACRES OF LANDSLIDE HAZARD AREAS IN QUINAULT INDIAN RESERVATION BOUNDARY

No Slope *(< 15% or < 8.53°)*	**Gentle Slopes** *(15% - 40% or 8.53° - 21.8°)*	**Steep Slopes** *(40% or >21.8°)*	**Unknown Landslide Type**	**Shallow Undifferentiated Landslides**	**Debris Flow**	**Debris Slide & Avalanches**	**Deep-Seated Undifferentiated Landslides**	**88/Corner Landslide Area**
166,190.46	**31,635.86**	**10,216.15**	**0.56**	**23.58**	**47.40**	**15.11**	**163.47**	**242.71**

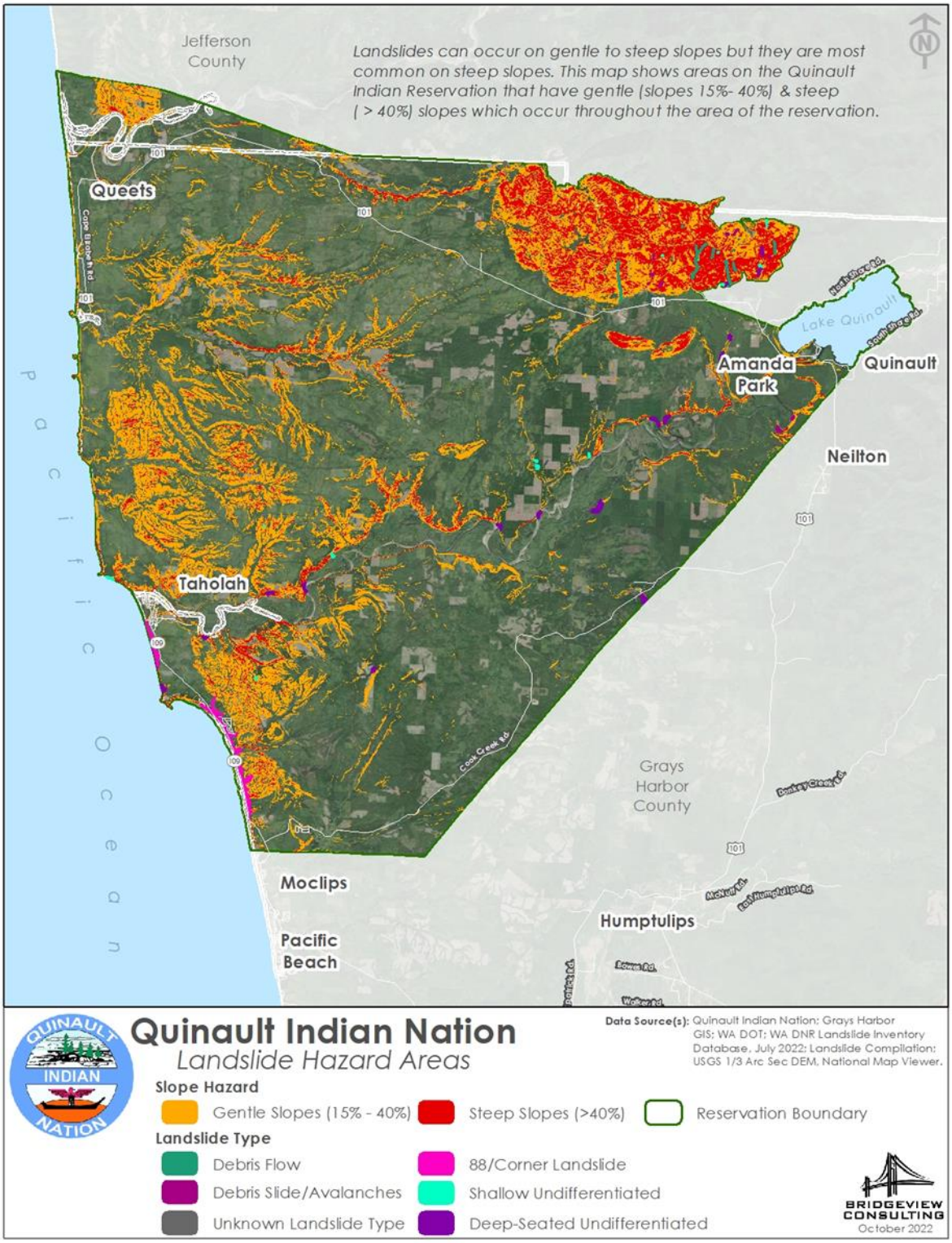


Figure 4-3 Landslide Hazard Areas

Of current concern, in 2021, the QIN observed changes in an old landslide commonly referred to as the "88-Corner Landslide". Due to observed changes, the QIN hired Saturna Watershed Sciences to conduct a study and analysis of the slide and surrounding area.[3] Figure 4-4 identifies some of the areas of concern.

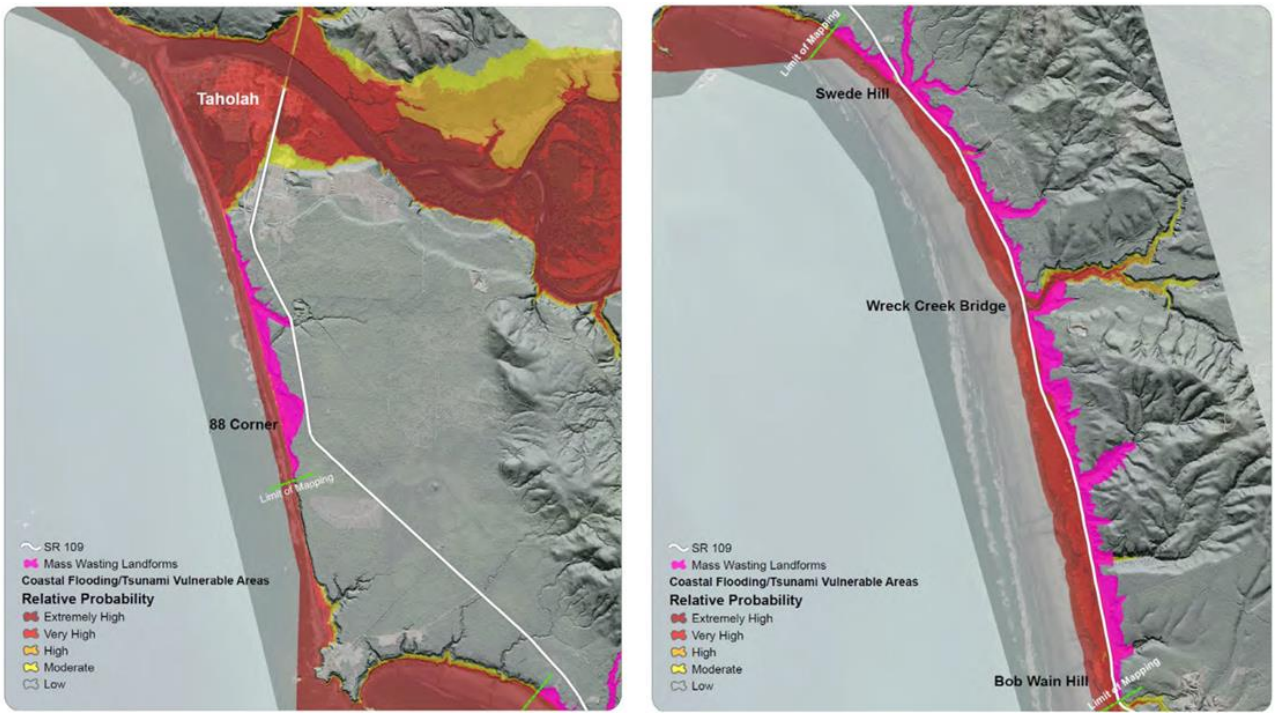


Figure 4-4 88Corner Landslide (illustrations developed by Saturna)

Previous Occurrences

The QIN has experienced landslides on a fairly regular basis, with the first recorded slide occurring in February 1816. Since then, WDNR has recorded well in excess of 230 slides. The most recent slide (November 2022) is the active 88-Corner Landslide, which has been an on-going issue for many years.

The 88-Corner Landslide did rise to the level of a Declaration of Emergency by the QIN and remains an ongoing event. The Tribe currently is working in conjunction with WDOT on an emergency bypass route, and developing long-term plans to re-route SR 109 to ensure access to the Village as future landslide events occur in the area, as well as for use for Tsunami evacuation purposes.

Figure 4-5 88Corner Landslide

[3] A large amount of data is available from the QIN should reviewers wish more detailed information on the slide.

Frequency

Landslides are often triggered by other natural hazards such as earthquakes, heavy rain, floods or wildfires, so landslide frequency is often related to the frequency of these other hazards. Within the planning area, landslides typically occur during and after major storms, so the potential for landslides largely coincides with the potential for sequential severe storms that saturate steep, vulnerable soils. Frequency for flood and severe storm for Grays Harbor and Jefferson Counties are 4.6 and 5.3 years, and 7.5 and 6.18 years, respectively.

Based on data from FEMA's National Risk Index, the QIR (for Census tract 53027940000 – the Grays Harbor portion of the Reservation) has a relatively low risk based on tribal owned lands.[4] From review of the data, it is unclear if the analysis includes the state highway system, or just incidents occurring on the Reservation for which the Tribe has sustained landslide impact, as there are no events on record.[5]

IMPACT AND RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from a landslide throughout the area is highly likely, as there is an on-going slide as of this update. Beyond the 88-Corner Landslide, the planning area as a whole has experienced some level of landslides annually since completion of the last plan. These slides have impacted ingress and egress to the Reservation, causing isolation – particularly in the Taholah area. While no tribal-owned structures have been destroyed as a result of the slides, some areas, such as Santiago Hill on the east side of SR109, as well as multiple houses on the coastal bluff, are within landslide prone areas. In addition to the structures, there is also the impact to roadways, and the fiber optic cables, power, and water (in some areas) that could be impacted as a result of the washout of the roadways.

The coastal bluff areas along the mouths of the rivers also have identifiable landslide risk. While some of the area is more limited to impact as a result of the geological construction, that is not true of all coastal bluff areas. Landslides can also change the course of the waterway. In addition, climate change will only further exacerbate continued erosion due to increased storm surge, particularly when occurring simultaneous with high tides, which is something which the QIN experiences several times annually.

While there are large areas on the Reservation where no landslide risk is identified, landslides can occur on fairly low slopes, and areas with no slopes can be impacted by slides at a distance. Construction in critical areas, which include geologically sensitive areas such as landslide areas, is regulated by the QIN on the Reservation. Beyond the structural impact, there is the potential impact of slides to the fisheries industry and the hatcheries releasing the salmon. The Planning Team also considered the significance of impact to those cultural resources exposed to the hazard. Secondary impact includes potential isolation and commodity shortages, which also has the potential to impact the entire region.

Based on the potential impact, the Planning Team determined the CPRI score to be 3.6, with overall vulnerability determined to be a high level.

[4] FEMA National Risk Index. (2022). Accessed 19 Dec 2022. Available online at: Map | National Risk Index (fema.gov)

[5] FEMA National Risk Index. (2022). Accessed 19 Dec 2022. Available online at: Community Report - Census tract 53027940000, Grays Harbor County, Washington | National Risk Index (fema.gov)

CHAPTER 5.
SEVERE WEATHER

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

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

DEFINITIONS

Freezing Rain—The result of rain occurring when the temperature is below the freezing point. The rain freezes on impact, resulting in a layer of glaze ice up to an inch thick. In a severe ice storm, an evergreen tree 60 feet high and 30 feet wide can be burdened with up to six tons of ice, creating a threat to power and telephone lines and transportation routes.

Hail Storm—Any thunderstorm which produces hail that reaches the ground is known as a hailstorm. Hail has a diameter of 0.20 inches or more. Hail is composed of transparent ice or alternating layers of transparent and translucent ice at least 0.04 inches thick. Although the diameter of hail is varied, in the United States, the average observation of damaging hail is between 1 inch and golf ball-sized 1.75 inches. Stones larger than 0.75 inches are usually large enough to cause damage.

Thunderstorm—A storm featuring heavy rains, strong winds, thunder and lightning, typically about 15 miles in diameter and lasting about 30 minutes. Hail and tornadoes are also dangers associated with thunderstorms. Lightning is a serious threat to human life. Heavy rains over a small area in a short time can lead to flash flooding.

Tornado— Most tornadoes have wind speeds less than 110 miles per hour are about 250 feet across, and travel a few miles before dissipating. The most extreme tornadoes can attain wind speeds of more than 300 miles per hour, stretch more than two miles across, and stay on the ground for dozens of miles They are measured using the Enhanced Fujita Scale, ranging from EF0 to EF5.

Windstorm—A storm featuring violent winds. Southwesterly winds are associated with strong storms moving onto the coast from the Pacific Ocean. Southern winds parallel to the coastal mountains are the strongest and most destructive winds. Windstorms tend to damage ridgelines that face into the winds.

Winter Storm—A storm having significant snowfall, ice, and/or freezing rain; the quantity of precipitation varies by elevation.

Atmospheric Phenomenon

Atmospheric rivers (Figure 5-1) are relatively long, narrow regions in the atmosphere – like rivers in the sky – that transport most of the water vapor outside of the tropics. These columns of vapor move with the weather, carrying an amount of water vapor roughly equivalent to the average flow of water at the mouth of the Mississippi River. When the atmospheric rivers make landfall, they often release this water vapor in the form of rain or snow. Those that contain the largest amounts of water vapor, and the strongest winds can create extreme rainfall and floods, often by stalling over watersheds vulnerable to flooding. These events can disrupt travel, induce mudslides, and cause catastrophic damage to life and property. A well-known example is the “Pineapple Express,” a strong atmospheric river that is capable of

bringing moisture from the tropics near Hawaii over to the U.S. West Coast. [6] What follow are a series of graphics which help identify and define the various potential impacts from severe weather incidents.

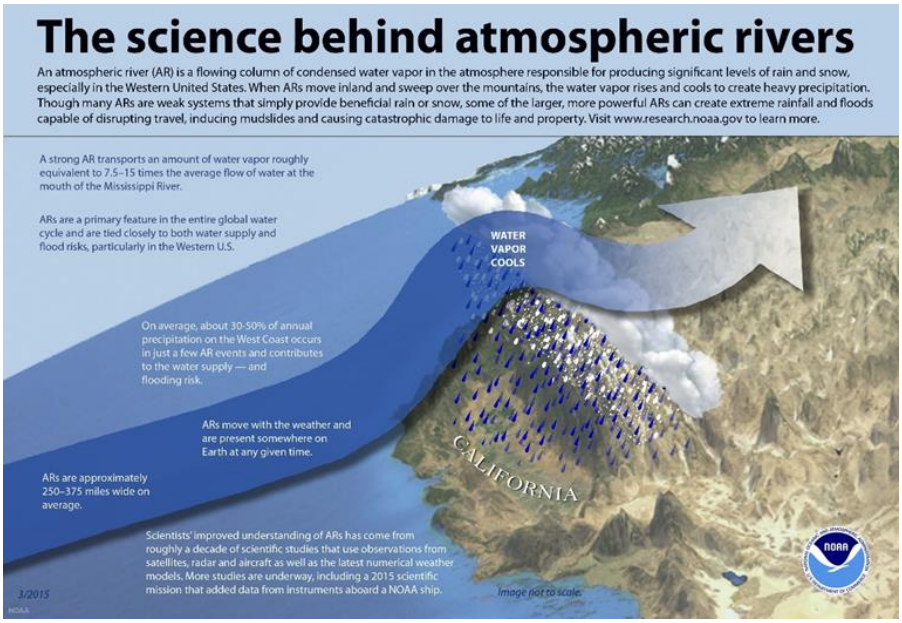


Figure 5-1 Atmospheric Rivers

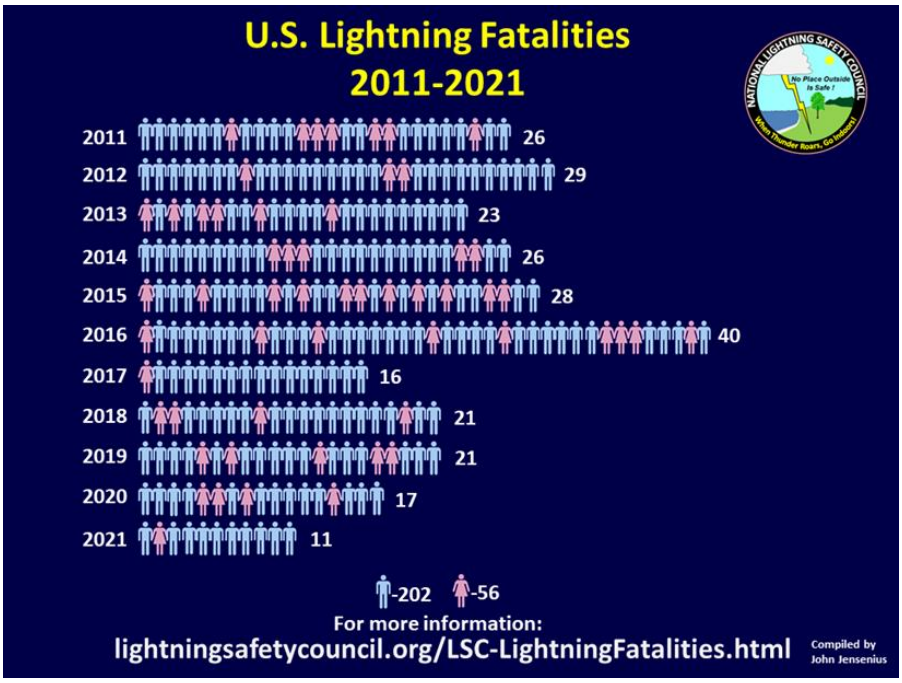


Figure 5-2 Nationwide Lightning Fatalities

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

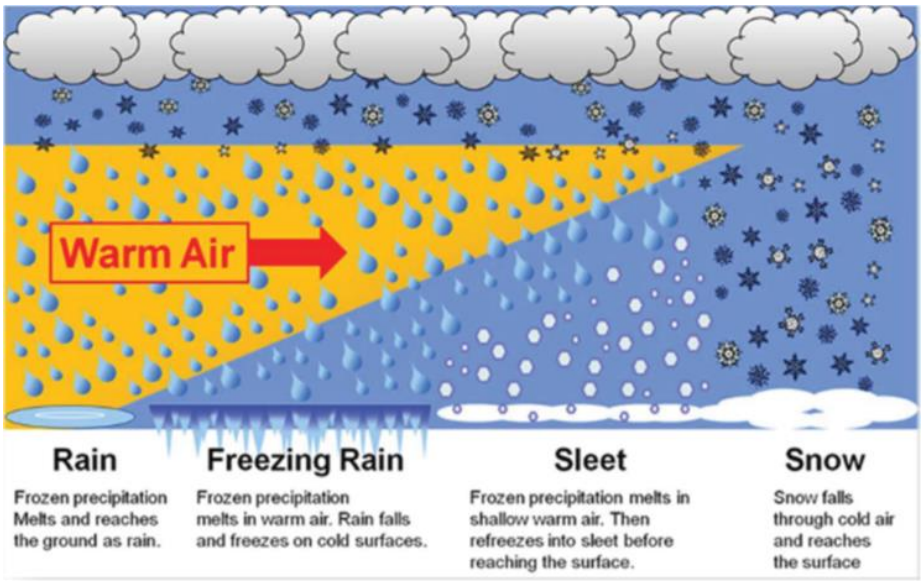


Figure 5-3 Variations of Precipitation

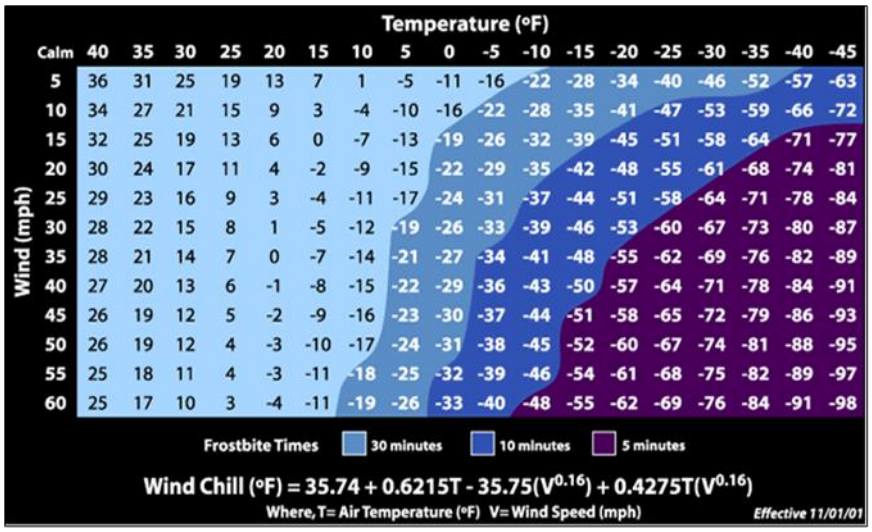


Figure 5-4 Wind Chill Factors

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

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

Figure 5-5 Heat Impact

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

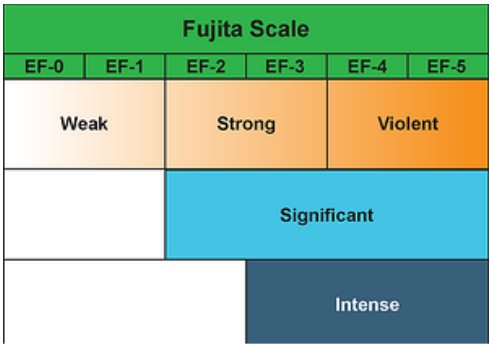


Figure 5-6 Tornado Scale

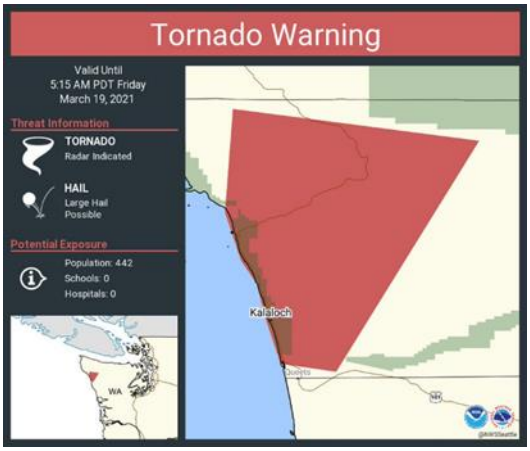


Figure 5-7 March 19, 2022 Tornado Warning on QIR

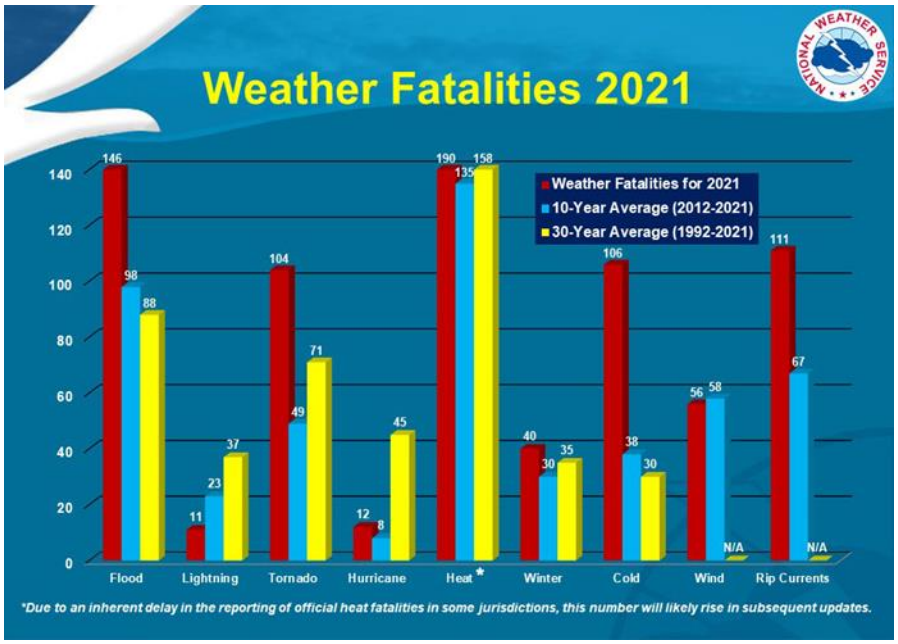


Figure 5-8 Annual Weather Fatalities by Type

Extent and Location

The entire planning area is susceptible to the impacts of severe weather. Severe weather events customarily occur during the months of October to May, although they have occurred year-round. When reviewing NOAA and FEMA data, the months of January (two events), March (three events), and December (two events) have the highest severe weather occurrences. The area has been impacted by significant strong winds at least annually, heavy rains, snow (although limited), and have experienced thunder or lightning storms. Tornado warnings have been issued, but no direct (significant) impact has been experienced. Based on FEMA ranking, severe storms is the number two typed-hazard to impact the QIR for the Grays Harbor portion of the Reservation, and the hazard rated number one in the Jefferson

County/Queets portion of the Reservation. Due to the size and elevation of the reservation, some areas are more significantly impacted than others.

Previous Occurrences

Types of severe weather occurring on the QIR can vary but impact the tribe at least once annually. The most common types of severe storms experienced can include thunderstorms, hailstorms, heavy precipitation, straight line winds, and damaging downburst winds. Less frequent severe weather phenomena include ocean squalls (Figure 5-9), tornadoes, heavy snowstorms, and ice storms.

Figure 5-9 Squall Moving onto Quinault Indian Reservation (Workman, 2009)

Since 1953, 12 severe weather events (including FEMA's severe winter, severe wind, and severe storm-typing) have been declared in Grays Harbor County, with 11 declared events occurring in Jefferson County.

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

Figure 5-10 KIRO 7 Weather Map March 19, 2021

The most recent tornado event to have occurred in the area occurred on March 19, 2021, when tornado warnings were issued for much of the Olympic Peninsula (see Figure 5-10). The event included large hail and significant thunderstorms.

Winds in general are a regular occurrence on the QIR, and have impacted every home, business, power line, and shoreline, with all areas of the Reservation. In addition to the structures and infrastructure of the QIR that have been impacted by high winds, the losses to standing timber volume have been substantial. Across the QIR, forest management activities have covered timberlands adjacent to the major access routes where power lines are located. The result has been a power delivery infrastructure that is

currently at reduced risk. These are positive activities that should be conducted when the management of the forestlands can help to protect the investment in the power supply system and not adversely affect homes and businesses on the Quinault Indian Reservation.

Frequency

The severe weather events are often related to high winds and associated other winter storm-type events such as heavy rains and landslides, and occasionally snow. Severe storms are the first-most declared event for the planning area in the Queets/Jefferson County area, and the second-most declared event for the remaining portion of the Reservation within Grays Harbor. The QIN experiences some form of a severe storm annually, although in most cases, such events do not always rise to the level of a declared disaster. While snow events do occur, they customarily are not significant, nor last for extended periods of time. For declared-level events, the Tribe experiences a significant severe storm every 5.3 years, with a probability of occurrence of 18.75 percent per year that such a significant event will occur for the Grays Harbor portion of the QIR, and every 6.18 years, with a probability of occurrence of 16.18 percent per year that such a significant event will occur for the Queets/Jefferson County portion of the QIR.

IMPACT AND RESULTS

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

The entire area experiences some severe storm or weather event annually, with 11 events occurring within Grays Harbor County, and 12 events occurring within Jefferson County since 1953. FEMA has identified Severe Storm/Weather as the number one hazard impacting the area within Jefferson County, and the number two event within Grays Harbor County.

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

Wind is a very significant factor, which can cause power outages, as well as impacting transportation for both citizens and goods/supply chain. While the local PUD/utilities maintain excellent records for low incidents of long-term power outages, the possibility does exist. Historically, severe weather events that occur are of a relatively short duration, with more localized impacts, and thankfully, power outages have not been for extended periods of time, but shorter in duration and is something to which Tribal Members have become accustomed to deal with when it occurs. However, it does impact the ability to carry out normal functions, including governmental operations. There are also health-related issues if power outages last beyond a day. While the Tribe does not experience extremely cold or hot temperatures with any great frequency, it does occur. There are some portable generators, and fixed generators in enough buildings that could be utilized for cooling or heating facilities. There is also concern of a power outage impacting the hatcheries, which rely on power to maintain fish tanks, etc. The new community structure in the Taholah Village has been identified as the QIN's shelter/resilience center to ensure citizens (both tribal and non-tribal) are provided care and resources as available.

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

CHAPTER 6.
TSUNAMI

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

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

DEFINITIONS

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

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

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

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

GENERAL BACKGROUND

Physical Characteristics of Tsunamis

All waves, including tsunamis, are defined by the following characteristics:

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

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

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

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

The Washington Department of Natural Resources (WDNR) has mapped the tsunami risk zone along Washington's coastline, identifying the various depths shown on Figure 6-1 (WDNR, 2022). These results are based on a M9.0 Cascadia Subduction Zone Earthquake. Due to the size of the map(s), details are difficult to read and are for illustrative purposes only. Reviewers wishing direct access and additional available data may wish to check WDNR's website directly. The data is available at Tsunamis | WA – DNR The anticipated depth data on the QIR is illustrated in Figure 6-2.

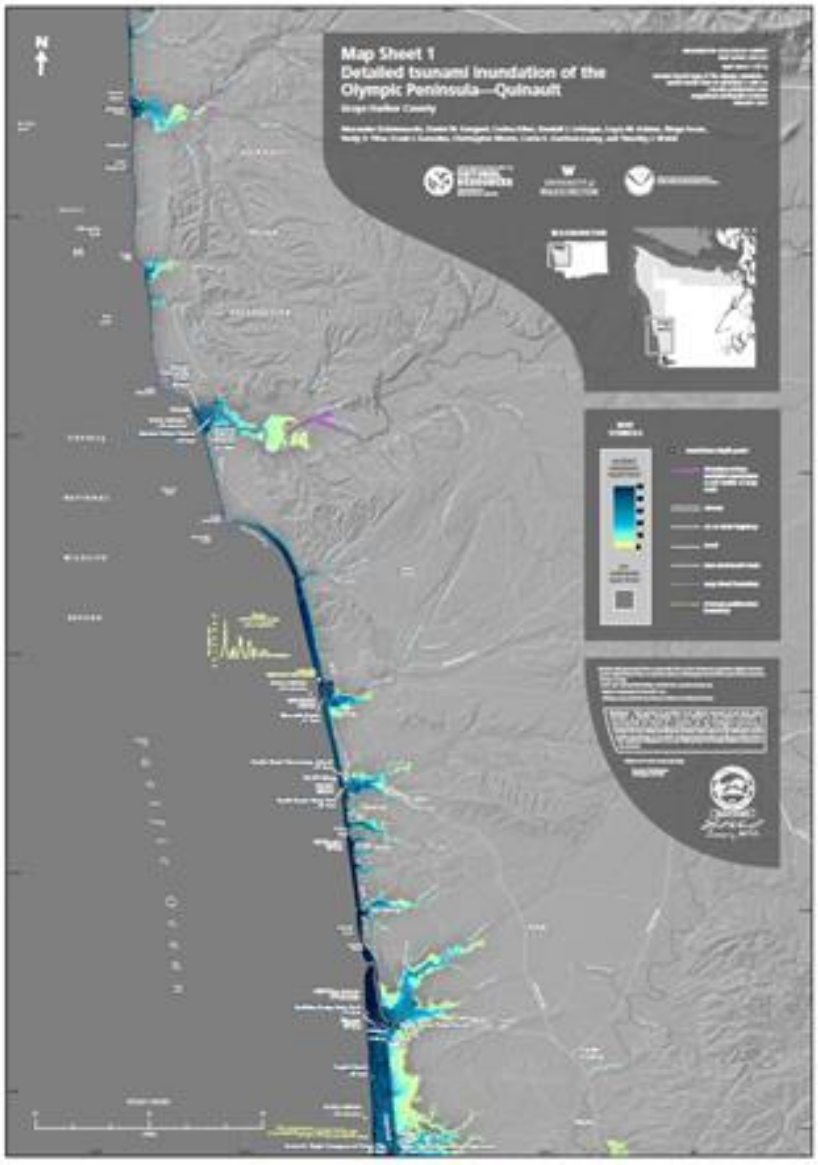


Figure 6-1 Tsunami Risk Zone and Depth

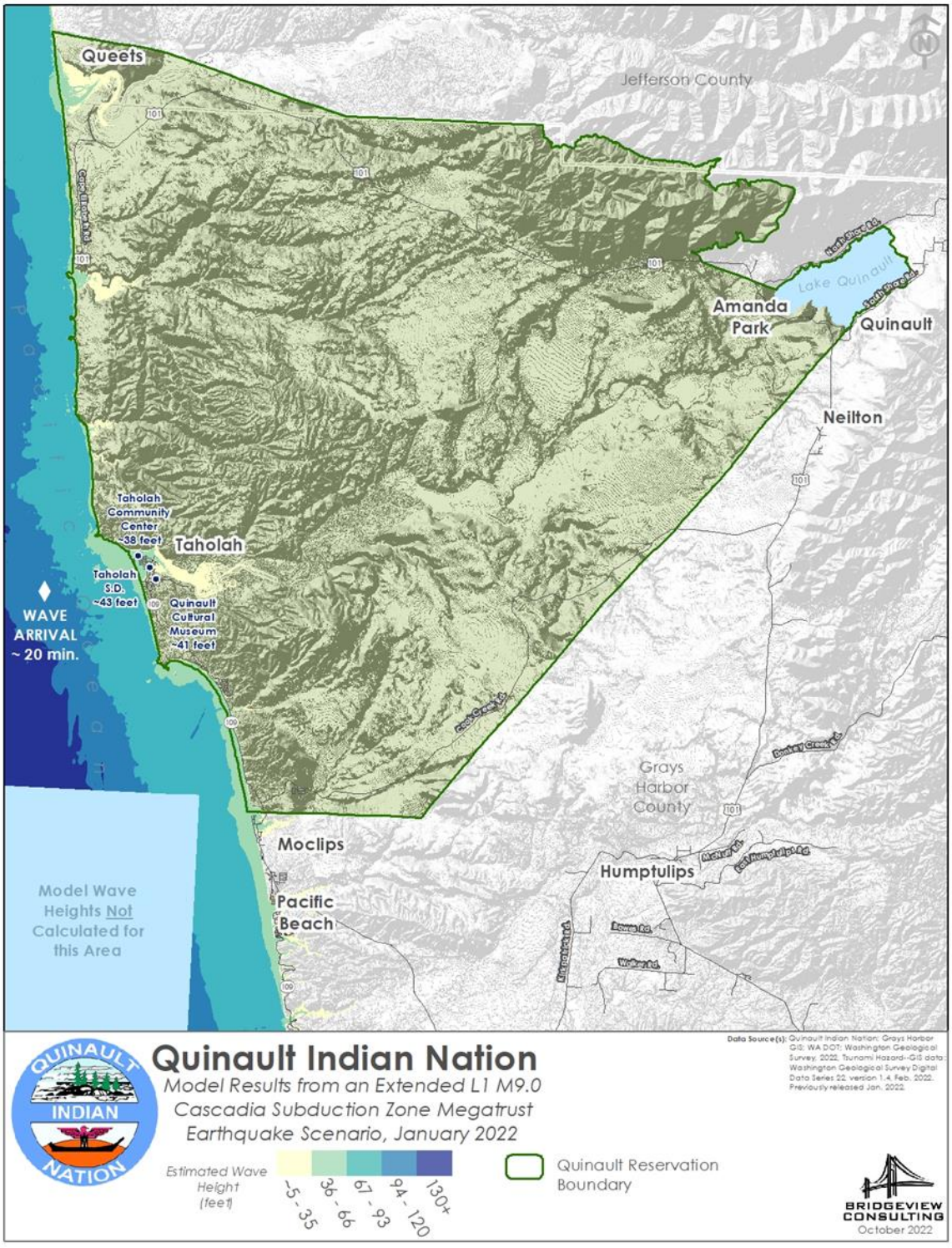


Figure 6-2 Modeled Wave Height and Arrival Time

Arrival Time and Inundation

The arrival time and duration of flooding are key factors to be considered in evacuation strategies. For locations on the outer coast, the first wave crest is generally predicted to arrive between 25 and 40 minutes after the earthquake (Gica, 2014). Review of Washington State Department of Natural Resource (2022) data indicate an estimated arrival time of 20 minutes for the QIR.[7] However, significant flooding can occur before the first crest arrives because a Cascadia Subduction Zone earthquake is expected to lower the ground surface along the coast, with some models predicting a 4-8 meters subsidence (Figure 6-3).

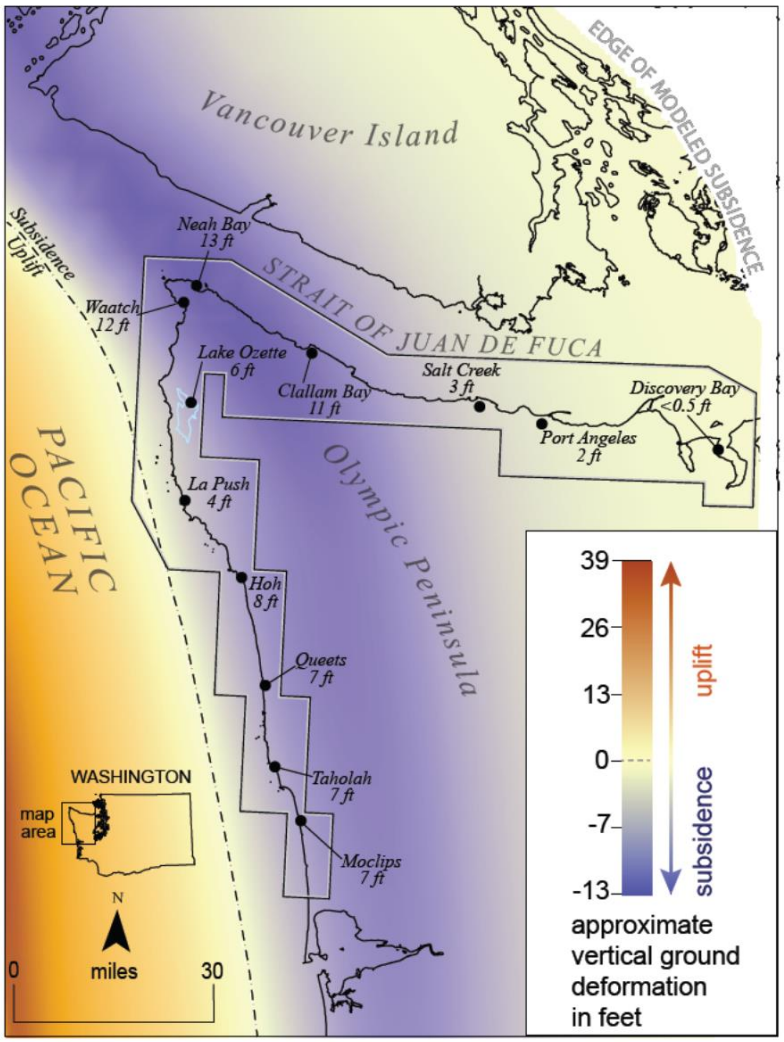


Figure 6-3 Subsidence Resulting from Cascadia Event

Flooding of areas less than six (6) feet above tide stage is expected a short time after the initial earthquake. This will effectively render evacuation times short not only for people on the beach, but also along coastal roadways, including major highways traversing the coastline. In the event of a tsunami, all tributaries and creeks connected to the coast would be intermittently flooded. The modeled study area may not encompass the entirety of all drainage basins, and the extent of flooding from the next tsunami could continue along these river channels and creeks.

Based on the 2022 study, locations along the Pacific Ocean within the study area should expect the first offshore wave arrival within 20 minutes following the beginning of the earthquake shaking. Communities that could expect inundation of 40-60 ft or more include Queets and Taholah on the Quinault Indian Reservation, Moclips, Pacific Beach, Iron Springs, Copalis Beach, Ocean City, and the Hoh Indian Reservation (north of the QIN).[8] The M9 Earthquake scenario also causes significant flooding up rivers and along the tributaries and floodplains of the Quillayute, Dickey, Hoh, Queets, Quinault, Moclips, and Copalis Rivers on the Pacific coast. Based on the study, the Taholah School District, located on the QIR, can anticipate inundation depth of 43 feet, with arrival time within 25 minutes, and an onshore speed of 9+

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

[8] ibid

knots (see figures below). Table 6-1 identifies the potential critical facilities impacted in the Tsunami Inundation Zones based on WDNR's scenario events.

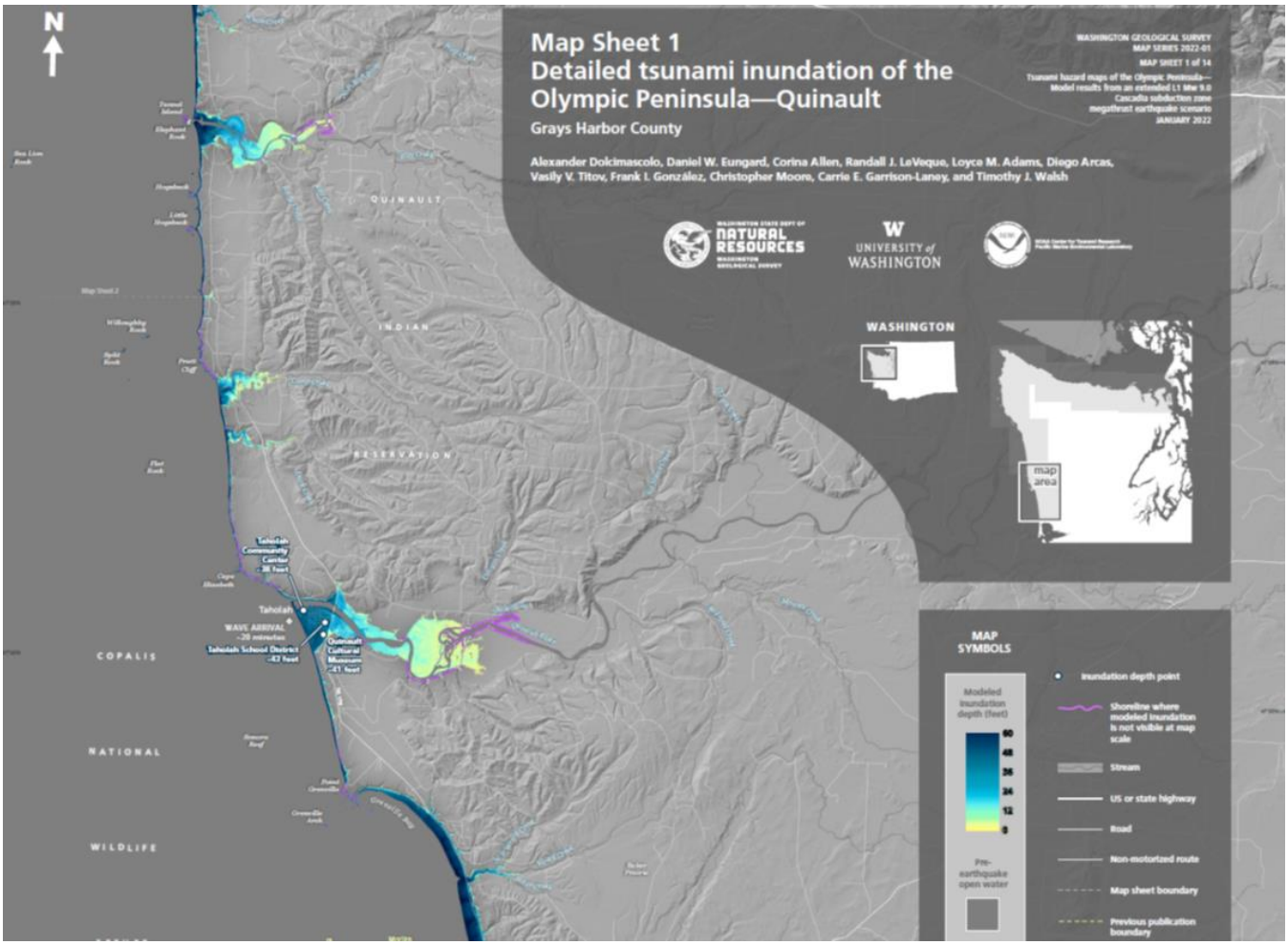


Figure 6-4 Tsunami Inundation - Quinault

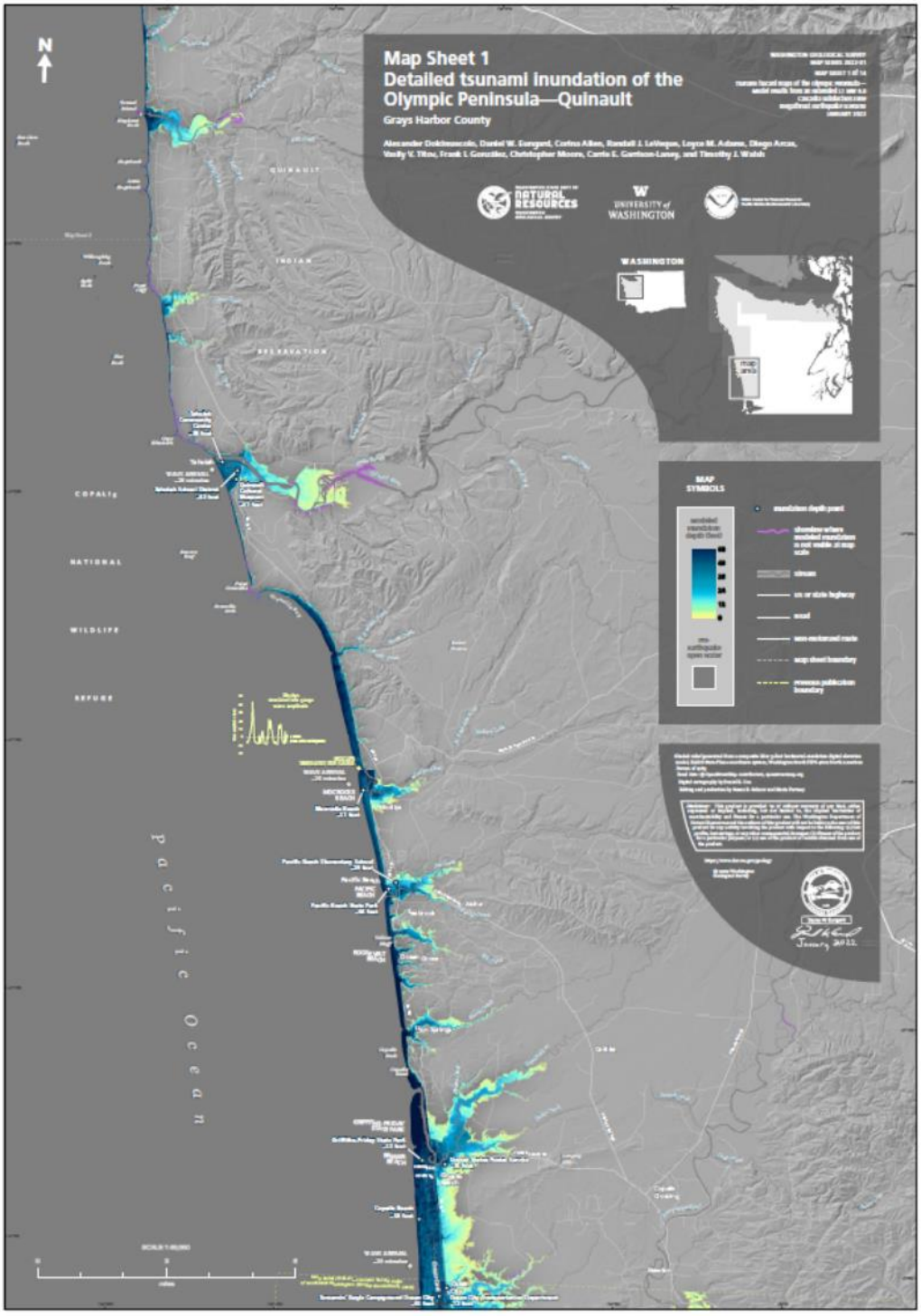


Figure 6-5 Tsunami Inundation Olympic Peninsula

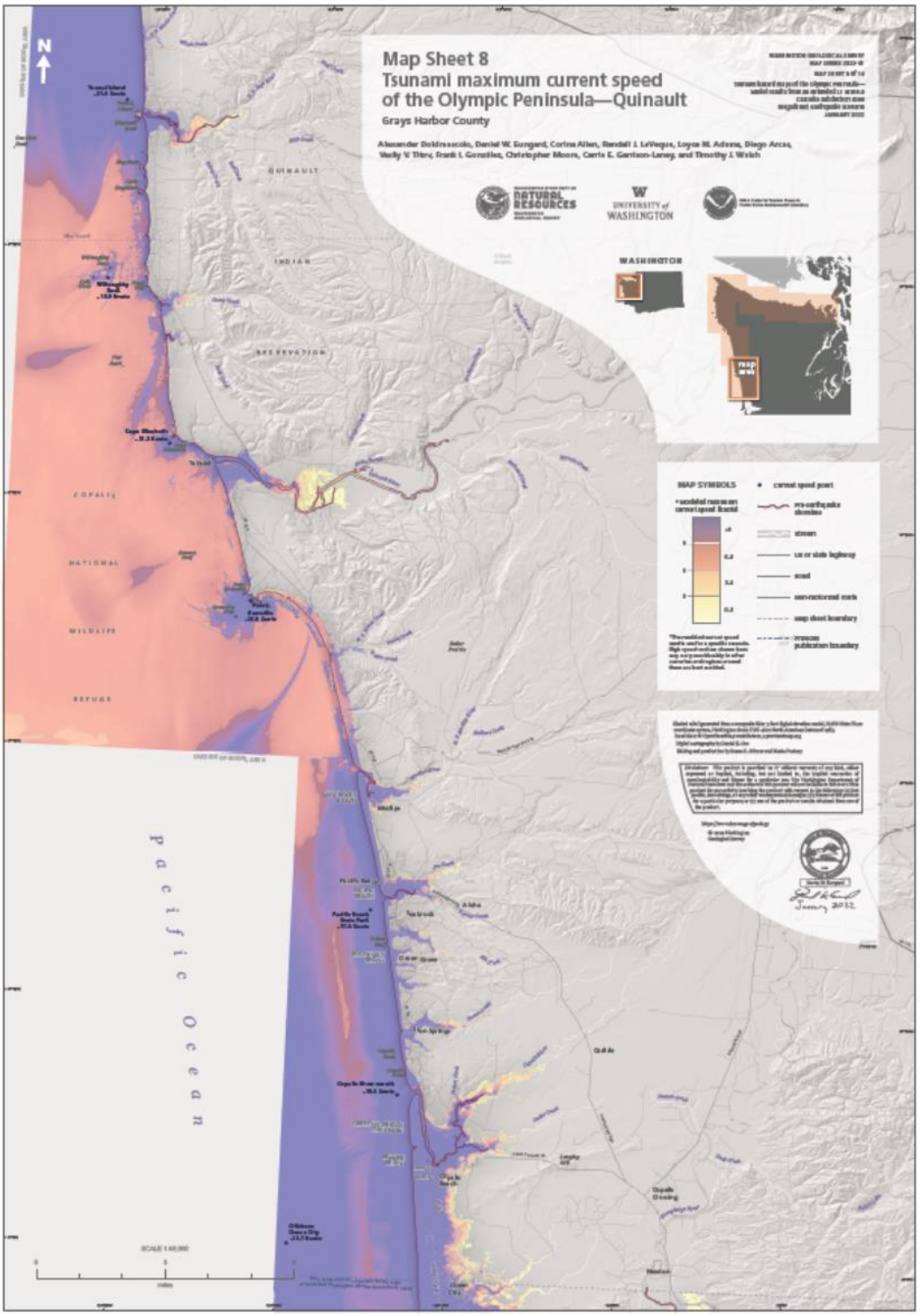


Figure 6-6 Tsunami Wave Speed - Olympic Peninsula

TABLE 6-1
IMPACT TO CRITICAL FACILITIES

Critical Facilities the Tsunami Hazard Area Scenario L1-Extended Hazard Area (modeled after simulated M9.0 earthquake along Cascadia Subduction Zone using Splay Fault Model)

Government Function	Medical	Protective Services	Hazardous Materials	Schools	Shelter	Industrial	Commercial	Communications	Water	Wastewater	Residential	Natural Resources	Cultural	**Total**
4	**1**	**2**	**0**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**0**	**15**

Critical Facilities within the Tsunami Hazard Area - Scenario 1A (Modeled after a simulated 9.1 magnitude earthquake, based on the ~A.D. 1700 event along the Cascadia subduction zone) AND Scenario L1-Extended Hazard Area (modeled after simulated M9.0 earthquake along Cascadia Subduction Zone using Splay Fault Model)

Government Function	Medical	Protective Services	Hazardous Materials	Schools	Shelter	Industrial	Commercial	Communications	Water	Wastewater	Residential	Natural Resources	Cultural	**Total**
12	**3**	**12**	**0**	**5**	**2**	**7**	**8**	**2**	**1**	**3**	**1**	**3**	**3**	**62**

Critical Facilities within the Tsunami Hazard Area - Scenario 1A (Modeled after a simulated 9.1 magnitude earthquake, based on the ~A.D. 1700 event along the Cascadia subduction zone) AND Scenario L1-Extended Hazard Area (modeled after simulated M9.0 earthquake along Cascadia Subduction Zone using Splay Fault Model) AND Scenario 1A with Asperity (Modeled after a simulated 9.1 magnitude earthquake, based on the ~A.D. 1700 event along the Cascadia subduction zone. Simulation adds an extra 20ft of uplift as compared to Scenario 1A)

Government Function	Medical/Health	Protective Services	Hazardous Materials	Schools	Shelter	Industrial	Commercial	Communications	Water	Wastewater	Residential	Natural Resources	Cultural	**Total**
0	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**

IMPACT AND RESULTS

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from Tsunami throughout the area is highly likely, with catastrophic impact in some areas of the existing reservation, including loss of life, injuries, and structure impact.

Wave height is estimated to be ~43 feet in Taholah. The entire Reservation will be impacted to some degree, including roadways and the possibility for evacuation. For existing structures, the age of the

building stock (and previous impact from other hazard events) have left many structures weakened. While the area has experienced tsunami impact historically, those incidents have occurred infrequently, with minimal (if any) damage on the QIR. However, due to the fact that we are well over-due for a Cascadia-type earthquake event, which undoubtedly will generate a significant tsunami within the entire region from Canada to California, the probability of occurrence is high.

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

Guests to the Reservation may not be familiar with the area, and while signage is in place for tsunami evacuation, travel time is limited to 20 minutes before the first waves are anticipated. Relocation to the Upper Taholah Village and Queets areas, when completed, are the only certain efforts to help reduce the impact on tribal citizens and guests on the QIR.

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

CHAPTER 7.
WILDFIRE

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

People start most wildfires; major causes include arson, recreational fires that get out of control, smoker carelessness, debris burning, and children playing with fire. Wildfires started by lightning burn more state-protected acreage than any other cause, an average of 10,866 acres annually; human caused fires burn an average of 4,404 state-protected acres each year. Fires during the early and late shoulders of the fire season usually are associated with human-caused fires; fires during the peak period of July, August and early September often are related to thunderstorms and lightning strikes.

The QIN does engage in pile burning on the QIR, which is perhaps one of the biggest forest fire dangers occurring annually. In addition, the QIN has practiced cultural burning on prairies (bog wetlands), with the Moses Prairie burning roughly 5-10 years ago.

The most common cause of fire on the QIR occurs during the Chief Taholah Days. The QIN and its members have numerous fireworks stands, as well as large fireworks shows during Chief Taholah Days, which occurs in conjunction with the 4th of July. As a result, fireworks are the predominant cause of fires (forest and structure), on the QIR. Based on US Forest Service analysis, Figure 7-1 illustrates the potential fire danger on the QIR. It should be noted this data changes regularly, particularly with climate change occurring.

Fire Causes

According to Washington State Department of Natural Resources (DNR), review of the 2021 fire season reports:[9]

- A total 674,249 acres burned statewide;
- 88% (1,640 total) of Washington wildfires were human-caused;

DEFINITIONS

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

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

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

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

[9] Washington Forest Protection Association. 2021 Wildfire Season Summary. at 2021 wildfire season summary – Washington Forest Protection Association (wfpa.org)

- 12% (232 total) of Washington wildfires were caused by lightning;
- 44 Washington fires met the large fire criteria- described as fires larger than 1,000 acres in the western United States; and
- Burning a total 107,118 acres, the Schneider Spring fire was the state's largest wildfire for 2021.

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

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

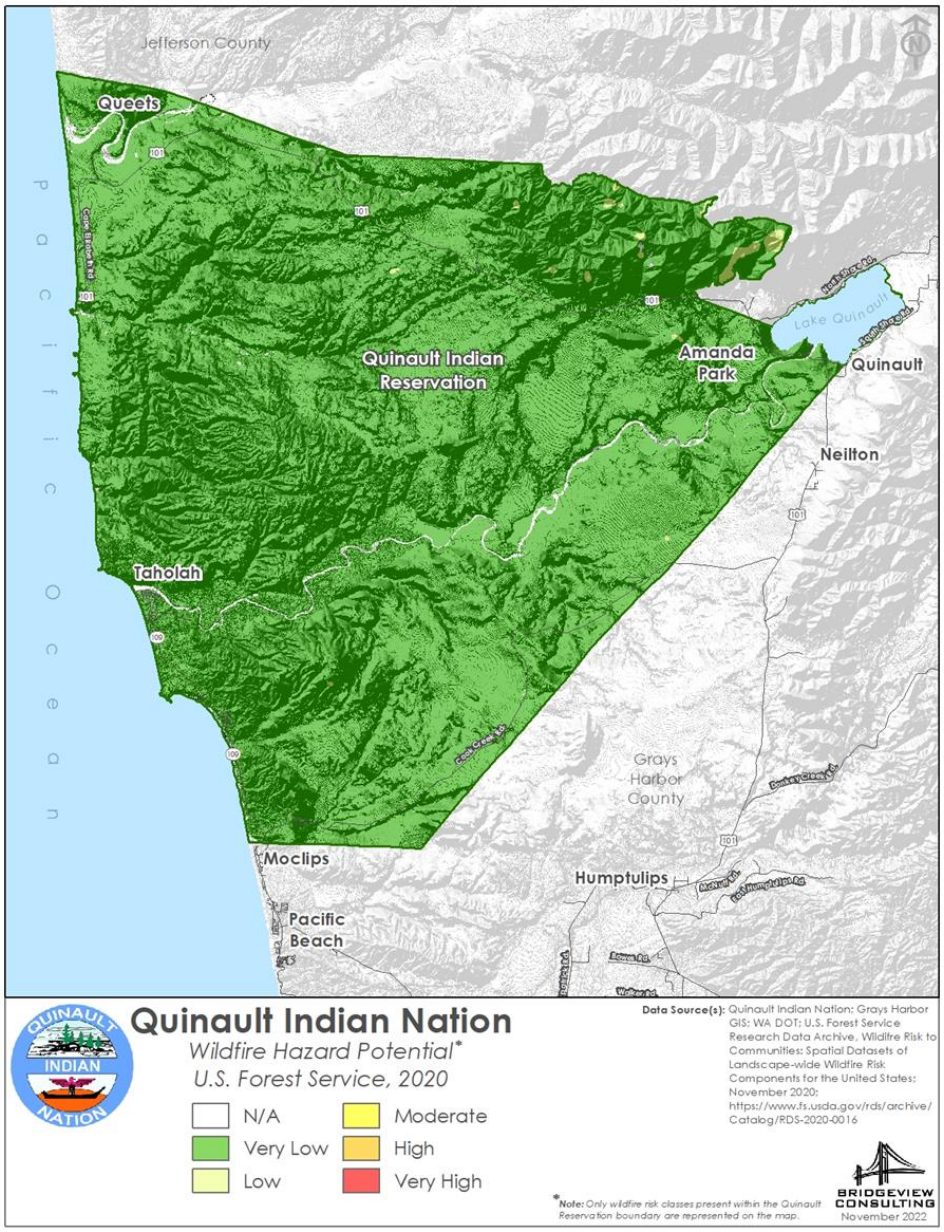


Figure 7-1 Wildfire Potential

Large wildfires have historically been infrequent in the coastal regions of the Pacific Northwest. Table 7-1 identify some of the fires occurring on the QIR during 2015-2022. While fires have occurred in the planning area, due to firefighting efforts, many have been contained with limited impact on acreage burned. The majority lands owned by the Quinault Indian Nation fall within Fire Regime V, with a 200+ year frequency. Small portions fall within Fire Regime Group III.

Mean Fire Return Interval (MFRI) layer quantifies the average period between fires under the presumed historical fire regime. MFRI is intended to describe one component of historical fire regime characteristics. LANDFIRE's MFRI for acres within the Reservation boundary and off-reservation owned lands are identified in Table 7-2 and illustrated on Figure 7-2.

TABLE 7-1.
RECORD OF FIRE IN OR NEAR THE PLANNING AREA 2015-PRESENT

Name of Event	Acres Burned	Date
Paradise Fire (started by lightning strike on Queets River in Olympic National Park	Unknown	May 2015
South Shore Fire (Upper Quinault River on State-owned land ~4 miles from Reservation)	2.5 Acres (Slash and Forested land)	July 2016
Bob Wayne #2	1 acre	September 2018
Wolf Den	1 acre	March 2019
Car Wash	119 Acres	March 2019
Bob Wayne	21 Acres	September 2020

TABLE 7-2
MEAN FIRE RETURN INTERVAL BY ACRES

Jurisdiction	6-10 Years	71-80 Years	201-300 Years	301-500 Years	501-1000 Years	>1,000	Water	Snow/Ice	Barren	Indeterminate Fire Regime Characteristics
Quinault Indian Reservation	0.00	60.79	10.26	8,577	178,954	138.38	6,339.89	6.83	489.88	13,456.66

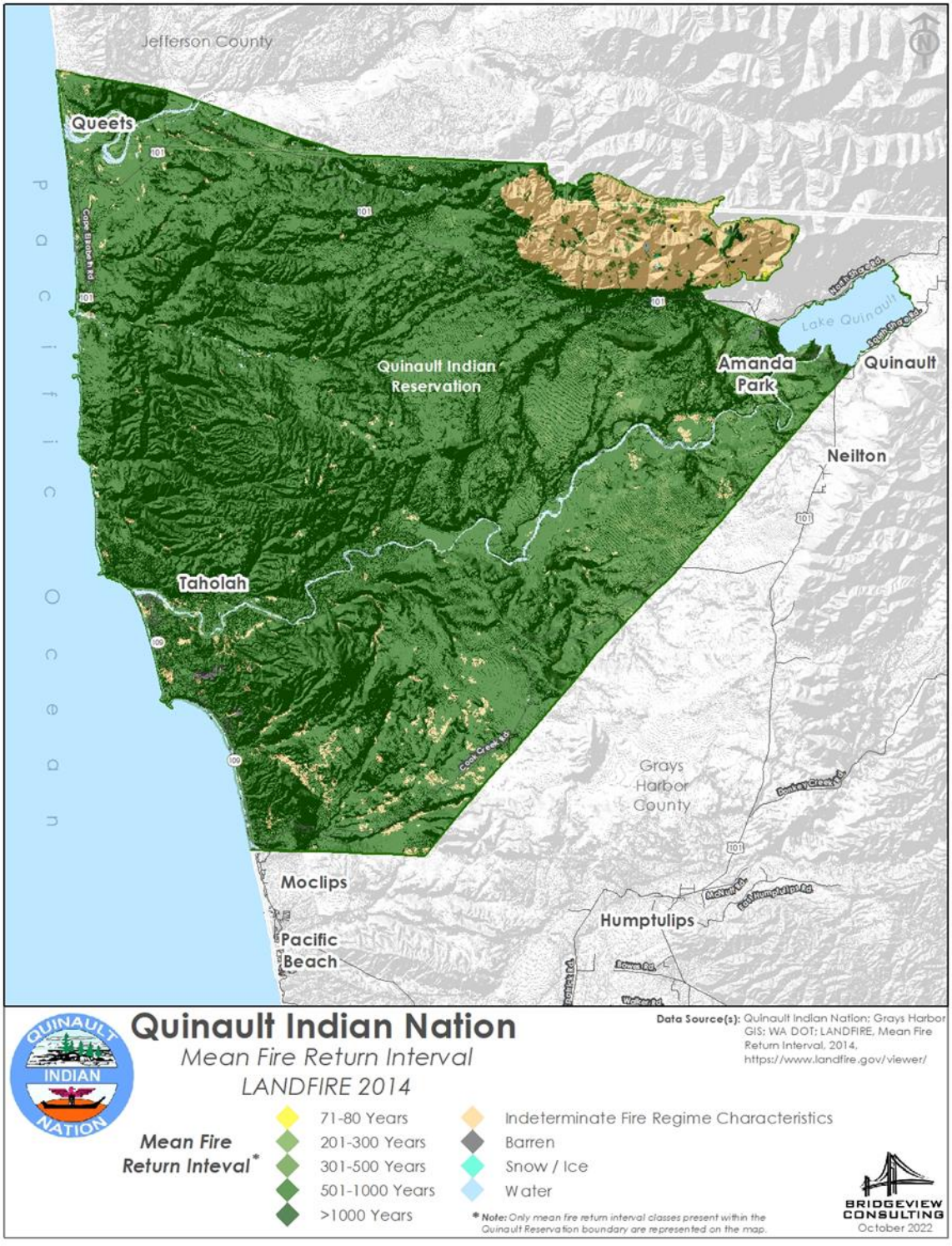


Figure 7-2 Mean Fire Return Interval

IMPACT AND RESULTS

Due to its close proximity to densely wooded areas, fire danger is of significant concern to the QIN, although historical fire damage has been low. With the increase in popularity of tourists to the Olympic National Park, there is an increase in concern for fire danger.

Based on review and analysis of the data, the Planning Team has determined that the probability for impact from Wildfire throughout the area is likely, but the impact is more limited with respect to geographic extent. While the reservation itself has never experienced a significant wildfire within its boundary, the general planning area experiences some level of wildfire almost annually, but the acreage burned has, thankfully, been more limited in nature due in large part to response activities. The tribe has never lost a structure due to wildfire, but the condition of many of the structures on the reservation is of concern should a fire occur.

For purposes of ranking, it is determined that potential impact to Tribal population due to fire is medium to high. This is due to the forested lands and timber industry on which the Nation heavily relies, albeit forest management practices have been very successful for the QIN.

There is the potential for isolation should a significant wildfire occur in certain areas, as well as the potential impact from smoke and the elderly population of citizens living on the Reservation. As the tribe continues to build and develop into its new areas, it will take fire danger into consideration utilizing best practice construction standards and materials, to include landscaping and by establishing barriers around the proximity of the new facilities. This may also include air filtration systems in the new residences, once completed, to assist with smoke issues for the elderly. As growth continues, the QIN also feels that it may be prudent to look at establishing additional tribal fire departments in different locations throughout the Reservation.

Construction into the wildfire hazard areas undoubtedly will continue to expand, thereby increasing the risk of fires. This is particularly true since there are non-tribal properties located within the Reservation boundary, for which the QIN have limited ability to maintain or control. For new construction by the QIN, implementation of mitigation strategies which help reduce wildfire risk, such as landscaping regulations, type of construction material, and mandatory sprinkler systems, could potentially help reduce the number of structures at risk. Based on the potential impact, the Planning Team determined the CPRI score to be 2.4, with overall vulnerability determined to be a medium level.

CHAPTER 8.
HAZARD RANKING

The risk ranking process conducted by Planning Team members assessed the probability of each hazard's occurrence, as well as its likely impact on the people, property, and economy of the planning area. Also of significant concern to the Tribe is the impact of these hazards on the environment, which factor was also taken into consideration during this plan update.

For some hazards, estimates of risk were generated with data from Hazus, using methodologies promoted by FEMA. For other hazards, citizens, and Planning Team members (who have an extensive historic perspective and knowledge base concerning the impact of hazards on the Tribe) provided invaluable information during this process. That information had a significant impact on the risk ranking process.

In ranking the hazards, the Planning Team completed a Calculated Priority Risk Index worksheet for each hazard (Figure 8-1). The Index examines the various criteria for each hazard (probability, magnitude/severity, geographic extent and location, warning time, and duration) (discussed in detail in Chapter 5 of the Hazard Mitigation Plan), defines a risk index for each criterion according at four levels (1-4), and then applies a weighting factor.

The result is a score that has been used to rank the hazards for the Tribe. Table 8-1 presents the results of the Calculated Priority Risk Index (CPRI) scoring for the hazards of concern. Once the hazard ranking was completed, the Planning Team also assigned an ordinal scale to identify the level of significance based on the CPRI score and rank, assigning a low-to-high rating of concern or significance. Those ratings are categorized into the following levels, with Table 8-2 presenting the overall results:

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

CPRI Category	Degree of Risk: Impact/ Level ID	Degree of Risk: Description	Degree of Risk: Impact Factor	Assigned Weighting Factor
Probability	Unlikely	• Rare with no documented history of occurrences or events. • Annual probability of less than 1% (~100 years or more).	1	40%
	Possible	• Infrequent occurrences; at least one documented or anecdotal historic event. • Annual probability that is between 1% and 10% (~10 years or more).	2	
	Likely	• Frequent occurrences with at least two or more documented historic events. • Annual probability that is between 10% and 90% (~10 years or less).	3	
	Highly Likely	• Common events with a well-documented history of occurrence. • Annual probability of occurring. (1% chance or 100% Annually).	4	
Magnitude/ Severity	Negligible	• People – Injuries and illnesses are treatable with first aid; minimal hospital impact; no deaths. Negligible impact to quality of life. • Property – Less than 5% of critical facilities and infrastructure impacted and only for a short duration (less than 24-36 hours such as for a snow event); no loss of facilities, with only very minor damage/clean-up. • Economy – Negligible economic impact. • Continuity of government operating at 90% of normal operations with only slight modifications due to diversion of normal work for short-term response activity. Disruption lasts no more than 24-36 hours. • Special Purpose Districts: No Functional Downtime.	1	25%
	Limited	• People – Injuries or illness predominantly minor in nature and do not result in permanent disability; some increased calls for service at hospitals; no deaths; 14% or less of the population impacted. Moderate impact to quality of life. • Property – Slight property damage -greater than 5% and less than 25% of critical and non-critical facilities and infrastructure. • Economy – Impact associated with loss property tax base limited; impact results primarily from lost revenue/tax base from businesses shut down during duration of event and short-term cleanup; increased calls for emergency services result in increased wages. • Continuity of government impacted slightly; 80% of normal operations; most essential services being provided. Disruption lasts >36 hours, but <1 week. • Special Purpose Districts: Functional downtime 179 days or less.	2	
	Critical	• People – Injuries or illness results in some permanent disability or significant injury; hospital calls for service increased significantly; no deaths. 25% to 49% of the population impacted. • Property – Moderate property damages (greater than 25% and less than 50% of critical and non-critical facilities and infrastructure). • Economy - Moderate impact as a result of critical and non-critical facilities and infrastructure impact, loss of revenue associated with tax base, lost income. • Continuity of government ~50% operational capacity; limited delivery of essential services. Services interrupted for more than 1 week, but <1 month. • Special Purpose Districts: Functional downtime 180-364 days.	3	
	Catastrophic	• People - Injuries or illnesses result in permanent disability and death to a significant amount of the population exposed to a hazard. >50% of the population impacted. • Property – Severe property damage >50% of critical facilities and non-critical facilities and infrastructure impacted. • Economy – Significant impact - loss of buildings /content, inventory, lost revenue, lost income. • Continuity of government significantly impacted; limited services provided (life safety and mandated measures only). Services disrupted for > than 1 month. • Special Purpose Districts: Functional Downtime 365 days or more.	4	
Geographic Extent and Location	Limited	Less than 10% of area impacted.	1	20%
	Moderate	10%-24% of area impacted.	2	
	Significant	25%-49% of area impacted.	3	
	Extensive	50% or more of area impacted.	4	
Warning Time / Speed of Onset	<6 hours	Self-explanatory.	4	10%
	6 to 12 hours	Self-explanatory.	3	
	12 to 24 hours	Self-explanatory.	2	
	> 24 hours	Self-explanatory.	1	
Duration	< 6 hours	Self-explanatory.	1	5%
	< 24 hours	Self-explanatory.	2	
	<1 week	Self-explanatory.	3	
	>1 week	Self-explanatory.	4	

Figure 8-1 CPRI Defined

TABLE 8-1
CALCULATED PRIORITY RANKING SCORES

Hazard	Probability	Magnitude and/or Severity	Geographic Extent and Location	Warning Time	Duration	Calculated Priority Risk Index Score
Drought	3	2	2	1	4	2.35
Earthquake	4	4	4	4	1	3.85
Flood	4	3	3	1	2	3.05
Landslide	4	3	3	4	4	3.60
Severe Weather	4	3	4	2	4	3.35
Tsunami	3	4	4	4	2	3.5
Wildfire	2	2	2	4	4	2.4

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

TABLE 8-2
HAZARD RANKING

Hazard in Ranked Order	CPRI Score	Level of Concern and Significance
Earthquake	3.85	High
Tsunami	3.5	High
Landslide	3.6	High
Flood	3.35	High
Severe Weather	3.05	High
Wildfire	2.4	Medium
Drought	2.35	Medium