Risk Report

For Kitsap County including the Cities of Bremerton, Bainbridge, Port Orchard, Poulsbo, the Port Gamble S'Klallam Indian Reservation, the Suquamish Tribe, and Unincorporated Kitsap County

December 30, 2015

FEMA RiskMAP Increasing Resilience Together
STARR Strategic Alliance for Risk Reduction
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DEPARTMENT OF ECOLOGY State of Washington

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1. Executive Summary

This report discusses risk for Kitsap County and its incorporated cities, including Bainbridge, Bremerton, Port Orchard, and Poulsbo. Two tribal reservations, the Port Gamble S'Klallam Tribe and the Suquamish Tribe, are also included. A Risk Report has two goals: to inform communities of their risk related to natural hazards and to enable communities to act to reduce their risk. State and local officials can use the data provided here to update a variety of local plans, communicate risk, inform the modification of development standards, identify mitigation projects, and ultimately take action to reduce risk.

The report showcases the results of an in-depth risk assessment for flood, earthquake, landslide, and tsunami in Kitsap County. The risk assessment, which analyzes how a hazard affects the built environment, population, and local economy, is used as the basis for developing mitigation strategies and identifying mitigation actions. The risk assessments in this report were completed using the Federal Emergency Management Agency's (FEMA) free risk assessment tool, Hazus, which estimates losses due to a flood and/or earthquake for specific buildings. A complete list of every building in Kitsap County was incorporated into the Hazus model. Other hazards, including landslide and tsunami, were assessed through a vulnerability assessment. Information collected to assess potential community losses include local assets or resources at risk from certain hazards, the physical features and human activities that contribute to that risk, and the location and severity of the hazard. The loss data from Hazus and the exposure analysis highlight areas that would be affected, which provides an opportunity to prioritize mitigation action in these areas.

In Kitsap County, flood losses were modeled at $13.4 million (M). The City of Bainbridge has the largest number of buildings in the Special Flood Hazard Area (SFHA), or 1-percent-annual-chance flood zone, and the highest loss ratio. Not all of the buildings within the SFHA experience damage, as this is affected by the severity of flooding and compliance with current floodplain management regulations. As a result of FEMA's Risk Mapping, Assessment, and Planning (Risk MAP) project for coastal Kitsap County, the community has new Flood Insurance Rate Maps and 1-percent-annual-chance depth grids.

Earthquake building losses were modeled at $3.6 billion (B). Additional damage to infrastructure and building contents was not included in the model. The earthquake assessment in this report was completed for a 7.2-magnitude earthquake on the Seattle Fault, as that event would result in the most damage to Kitsap County. The Cities of Bainbridge and Port Orchard have the highest percentage of buildings in the moderate-high liquefaction zone, but a Seattle Fault event would have a substantial impact on many of the communities.

The landslide area affects over 1,000 buildings with a total building value of $221M. A landslide assessment was completed by comparing the landslide areas with building locations. The largest number of buildings potentially affected by landslides is in the unincorporated areas of the county: 766 buildings, with a total building value of $137M.

The tsunami model indicated that at Bremerton and Port Orchard, the local seismic uplift would generate a 1.5-meter (m) tsunami at the moment of the earthquake, with inundation occurring primarily along the southern shore of Sinclair Inlet and the northern and southern shores of Dyes Inlet. The estimated flow depths are 2m at the shore of Port Orchard, 4m at the northern shore of Dyes Inlet, and 2m at the southern shore of Dyes Inlet.

The results of this assessment, including the loss data from Hazus, the exposure analysis, and design code analysis, can highlight the areas affected by the hazards noted above. These highlights can be used to identify properties for mitigation projects, as well as areas for additional outreach. The highlighted areas of greatest impact, along with potential mitigation actions, are identified in the community sections of this report and should serve as a starting point for identifying and prioritizing actions the community can take to reduce risks.

2. Introduction

This report outlines the risk assessment results and findings for FEMA's Risk MAP study of Kitsap County. All results, databases, and maps used to generate this report are provided in the Risk Assessment Database, which is included with this report. The Risk Report has two goals: to inform communities of their risks related to certain natural hazards and to enable communities to act to reduce their risk. State and local officials can use the summary information provided in this report, in conjunction with the data in the risk database, to accomplish the following:

- **Update local hazard mitigation plans, shoreline master programs, and community comprehensive plans** – Planners can use risk information to develop and/or update hazard mitigation plans, comprehensive plans, future land use maps, and zoning regulations. For example, zoning codes may be changed to provide for more appropriate land uses in high-hazard areas.
- **Update emergency operations and response plans** – Emergency managers can identify low-risk areas for potential evacuation and sheltering. Risk assessment information may show vulnerable areas, facilities, and infrastructure for which planning for continuity of operations plans (COOP), continuity of government (COG) plans, and emergency operations plans (EOP) would be essential.
- **Communicate risk** – Local officials can use the information in this report to communicate with property owners, business owners, and other citizens about risks and areas of mitigation interest.
- **Inform the modification of development standards** – Planners and public works officials can use information in this report to support the adjustment of development standards for certain locations.
- **Identify mitigation projects** – Planners and emergency managers can use this risk assessment to determine specific mitigation projects. For example, a floodplain manager may identify critical facilities that need to be elevated or removed from the floodplain.

The intended audience for this report includes, but is not limited to:

- Local Elected Officials
- Community Planners
- Emergency Managers
- Public Works Officials

3. Risk Analysis

A risk assessment analyzes how a hazard affects the built environment, population, and local economy. In hazard mitigation planning, risk assessments are the basis for mitigation strategies and actions. A risk assessment defines the hazard and enhances the decision-making process. The risk assessments in this report were completed using a free FEMA risk assessment tool, Hazus, which estimates flood and earthquake losses for specific buildings. A complete list of every building in Kitsap County was incorporated into the Hazus model. Other hazards were assessed through a vulnerability assessment, which included determining what properties were at risk in a hazard zone. Some hazards could not be assessed using Geographic Information Systems (GIS). For those, a hazard summary was provided. To assess potential community losses, the following information was collected:

- Local assets or resources at risk from a certain hazard
- The physical features and human activities that contribute to that risk
- Location and severity of the hazard

The report contains the following types of risk analysis to help describe and visualize the risk for a variety of hazards at the jurisdictional levels:

1. Coastal Flood Risk Assessment: Hazus Estimated Loss Information
2. Earthquake Risk Assessment: Hazus Estimated Loss Information
3. Landslide Risk Assessment: Vulnerability Assessment
4. Tsunami Risk Assessment: Hazard Overview

A detailed description of the risk assessment methodology is provided in the appendix to this document.

4. Kitsap County Coastal Project Summary

The Kitsap County Coastal Physical Map Revision project began in November 2010 and is expected to extend through early 2016. FEMA's Production and Technical Services provider, the Strategic Alliance for Risk Reduction (STARR), is working on this project.

Project Milestones

Table 1: Project Milestones

Task Name	Projected Time of Completion*
Engineering Analysis	April 7, 2014
Flood Study Review Meeting	July 9, 2014
Preliminary Map Production	November 18, 2014
Final CCO & Public Meeting	January 27 and May 12-13, 2015
Resilience Meeting	January 2016*
Effective Map Production	Winter 2016*

*Dates are projected and subject to revision.

The input data, methodology, and draft flood map results were presented at the Flood Risk Review (FRR) meeting, which took place on July 9, 2014. The final Community Coordination Officer (CCO) meeting, where the preliminary results of a Flood Insurance Study are reviewed and discussed with community officials, was held on January 27, 2015. Public meetings were held on May 12 and 13, 2015. The Resilience meeting will be held in January 2016. The purpose of the Resilience meeting is to review the risk assessment data and to continue to build local capacity for implementing priority mitigation activities within the watershed.

Project Scope

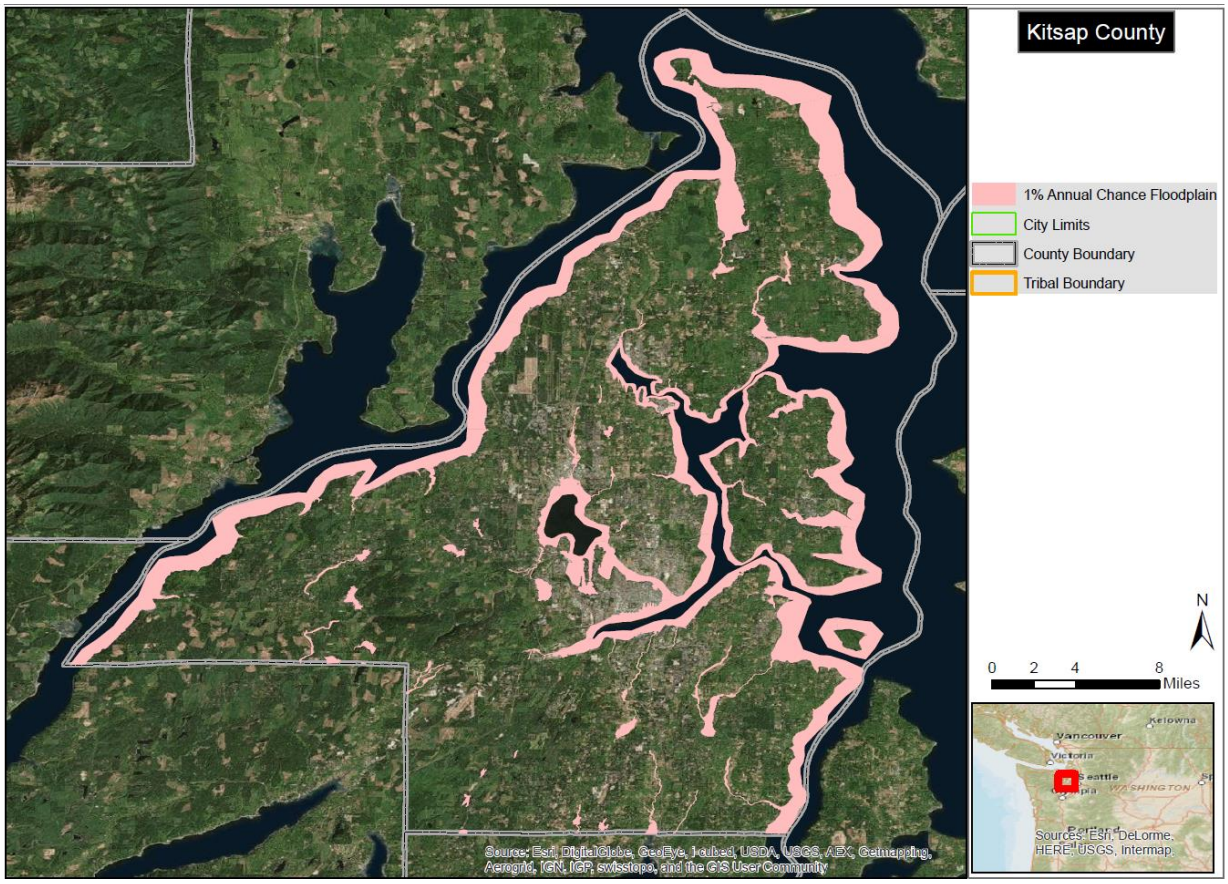
Scope includes the 246.86 miles of coastline in Kitsap County, of which 136.05 miles are being studied using detailed methods and 110.81 miles using approximate methods.

Additional Project Deliverables

The project also includes the delivery of standard Flood Risk Products (Flood Risk Report, Map, and Database) as well as Flood Risk Datasets (Changes Since Last FIRM, Flood Depth and Analyses Grids, and a Flood Risk Assessment). The risk assessment database will be delivered with this report.

Project Location

Map 1: Overview of Project Area

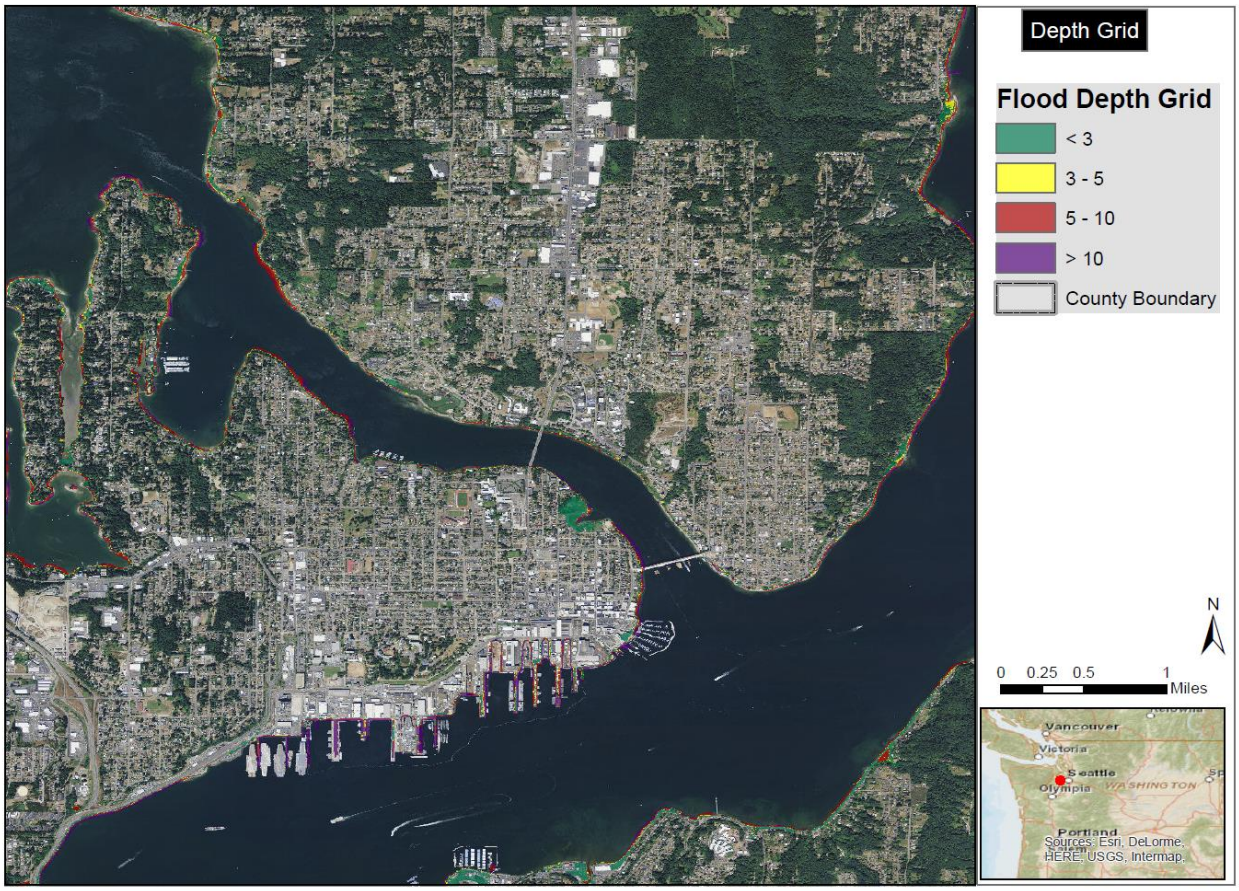


5. Flood Risk Assessment

Flood Hazard Overview

FEMA created new Flood Insurance Rate Maps (FIRMSs) for Kitsap County, which included updated flood modeling for the coastline for Bainbridge, Bremerton, Port Orchard, Poulsbo, Port Gamble S'Klallam Tribe, Suquamish Tribe, and the unincorporated areas of Kitsap County. In addition to new FIRMs, flood risk assessment products were developed and used in this risk report. Depth grids for the 1-percent-annual-chance flood were created for the coastal areas. These depth grids were generated from the coastal flood model and show the level of flooding in feet for each pixel. Depth grids were used in this risk assessment to determine which properties would be affected by flooding. Map 2 shows the 1-percent-annual-chance depth grid for the Bremerton area.

Map 2: 1-Percent-Annual-Chance Depth Grid (in feet) for the City of Bremerton Area

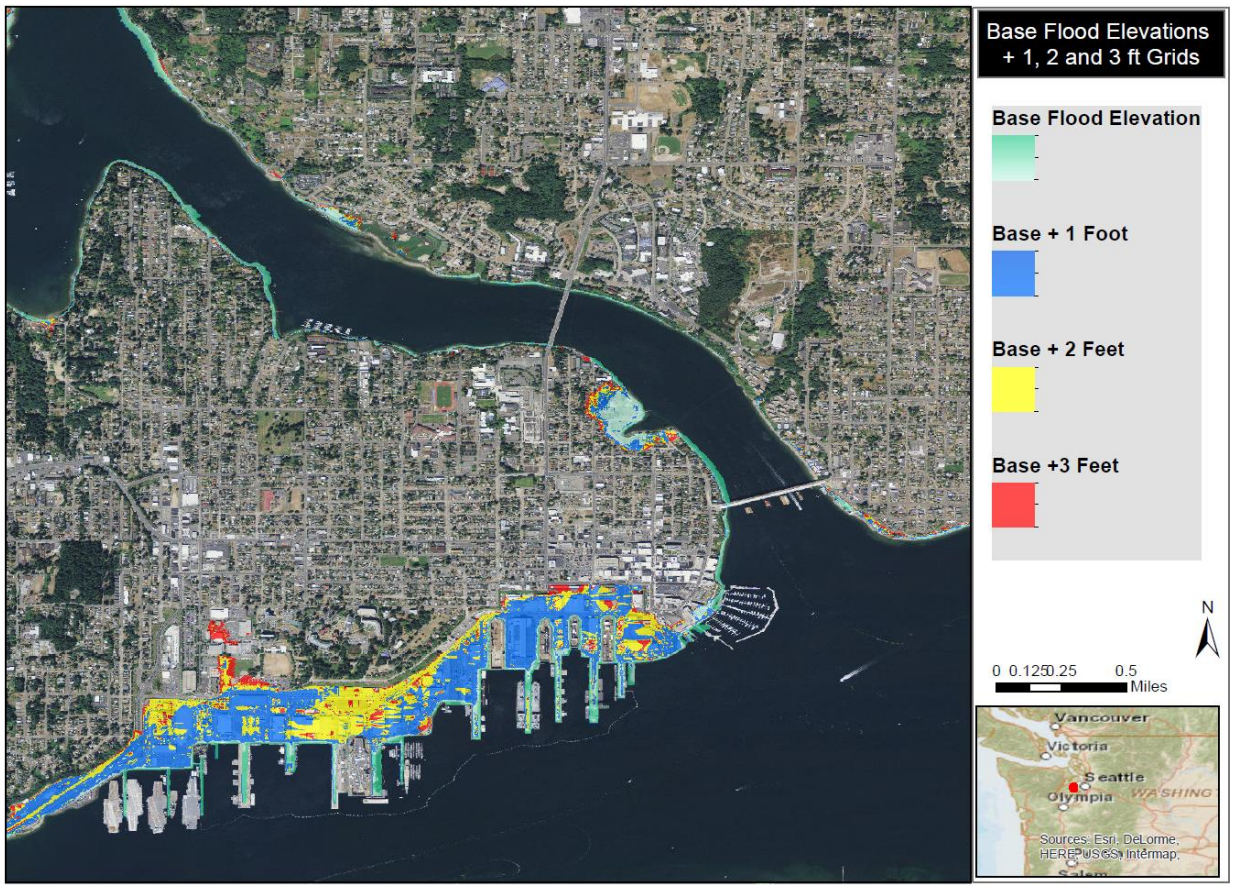


The 1-percent-annual-chancedepth grid can also be used as an outreach tool to illustrate flood hazards. The areas where the flooding depths are high would be excellent locations for mitigation projects. Some of these potential mitigation projects are highlighted in each community section of this report. For riverine floodplains in non-coastal areas, a vulnerability assessment was completed.

In addition to the depth grid, a Base Flood Elevation (BFE)+ grid was created to show the locations where flooding is 1, 2, and 3 feet above the elevation of the 1-percent-annual-chance flood (BFE). This grid can be used to represent flood events greater than the 1-percent-annual-chance flood, including

potential sea level rise. This product is meant to guide local communities about future risk and is not a substitute for detailed sea-level rise modeling. The BFE+ grid for the Bremerton area is shown in Map 3.

Map 3: BFE Plus 1-, 2- and 3-Foot Grids



The BFE+ grid can be used to identify areas affected by increased storm surge, storms greater than the 1-percent-annual-chance event, and areas potentially affected by sea level rise. This dataset can be used for future land use and comprehensive planning.

Flood Risk Assessment Overview

This risk assessment includes the communities shown in Table 2.

Table 2: Community Characteristics

Community Name	Total Population	CRS Community	Flood Claims	Repetitive Loss Properties	Total Policies	Total Insurance Coverage
Bainbridge	23,025	N	6	1	234	$64 Million
Bremerton	37,729	N	5	0	52	$15 Million
Port Gamble S'Klallam Tribe	851	N	0	0	0	$0
Suquamish Tribe	7,434	N	0	0	0	$0
Port Orchard	11,144	N	0	0	25	$6.8 Million
Poulsbo	9,200	N	0	0	49	$8.7 Million
Unincorporated County	170,035	N	58	1	566	$155 Million
Total	**259,418**	**0**	**69**	**2**	**926**	**$318 Million**

The community overview summarizes characteristics at the community level. Data were obtained from FEMA and the U.S. Census and were current as of November 23, 2015.

The information in Table 2 highlights communities that are already affected by flooding, including those with repetitive loss properties and flood claims. In addition, the insurance coverage amount can be compared to the dollar losses shown in Table 3 to determine if enough coverage exists for a specific event.

The flood risk assessment was completed using Kitsap County local parcel/assessors data and the coastal depth grids derived from this Risk MAP project. For this assessment, a coastal flood depth grid was used for the coastal area as shown in Map 2. For the riverine areas, a vulnerability assessment was completed for buildings in SFHAs. Individual parcel data was incorporated into Hazus, which allows losses to be reported at the building/parcel level. Parcel points were moved to the building location for those properties within an SFHA. Please refer to the appendix for detailed methodology on incorporating local data into Hazus. Table 3 highlights the building value and percentage of buildings within the SFHA, by community. In addition, losses for the mapped coastal floodplains are highlighted by community, and a count of buildings within the 1-percent-annual-chance floodplain is included.

Table 3: Special Flood Hazard Area Assessments

Community	Total Estimated Building Value	Percentage of Buildings in the Special Flood Hazard Area	Building Dollar Loss for a 1% Annual Chance Flood Event	Loss Ratio (Dollar Losses/Total Building Value)	Number of Buildings in Zones AE, A	Number of Buildings in Zone VE
Bainbridge	$2.6 Billion	1.5%	$3.6 Million	1.4%	136	8
Bremerton*	$1.7 Billion	<1%	$404,000	<1%	21	0
Port Gamble S'Klallam Tribe**	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Suquamish Tribe	$474 Million	<1%	$175,000	<1%	3	0
Port Orchard	$966 Million	<1%	$579,000	<1%	24	0
Poulsbo	$865 Million	<1%	$3.4 Million	<1%	7	0
Unincorporated County	$9.7 Billion	<1%	$5.2 Million	<1%	164	175
Total	**$16.3 Billion**	**<1%**	**$13.4 Million**	**<1%**	**355**	**183**

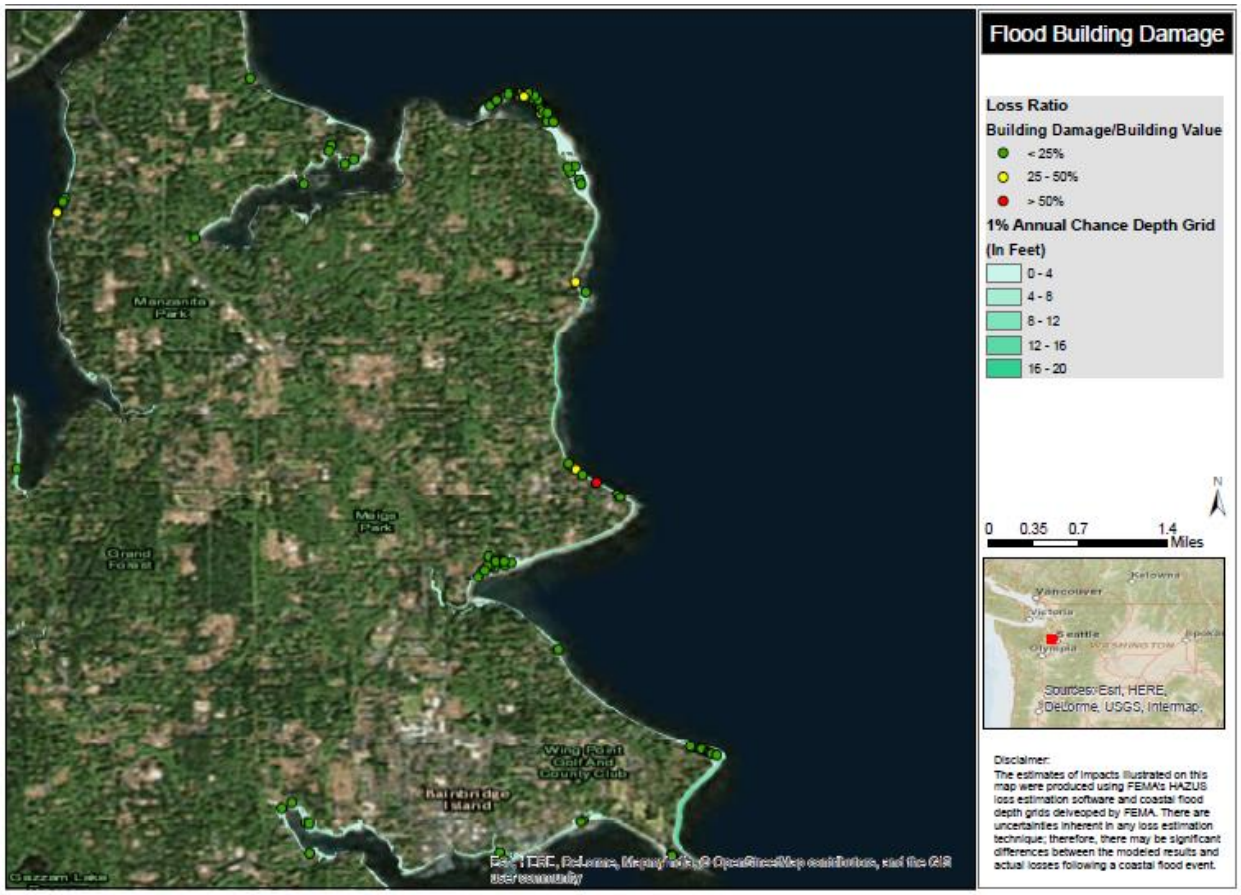
Note: Loss information is included for communities in the coastal floodplain. The table includes both dollar losses and a loss ratio, which is calculated as total losses/total building value. Also included is a count of the buildings in Zone VE, which is the 1-percent-annual-chance coastal flood zone with wave action, and in Zones A and AE, which are riverine or coastal 1-percent-annual-chance floodplains. The loss information for the county is only for coastal SFHAs; the rest of the county's SFHAs are identified as Zones AE or A.
*Information from the military base was not included in the assessment for the City of Bremerton.
**No building data was available from Kitsap County for the Port Gamble S'Klallam Indian Reservation, so the results are listed as unknown.

The City of Bainbridge has the largest number of buildings in the SFHA (1-percent-annual-chance flood zone) and has the highest loss ratio which compares the losses due to flooding to the overall building value within the community. Not all of the buildings within the floodplain experience damage due to level of flooding as well as current floodplain regulations. In addition the number of buildings are highlighted which are located in the 1-percent-annual-chance flood zone. Comparting table 2 to 3 shows that all of the communities have a total of 926 national flood insurance policies and a total of 538 buildings located in the 1-percent-annual-chance flood zone. This could be due to changes from the effective map to the current preliminary map. Regardless there is excellent coverage for the number of properties within the floodplain.

The buildings located within the VE zone are highlighted specifically since they are subject to 3 feet or more of wave inundation and are considered a high hazard area due to the velocity impacts The risk assessment only takes depth of water into account when calculating damages, therefore the properties that are within the VE zone should use the loss information as a minimum since velocity impacts are not accounted for.

The community results shown above give an idea of where the largest flooding concerns are. This risk assessment includes information for every building in each community, so you can easily determine which buildings in your community have the highest flood risk. Map 4 shows the building losses for a 1-percent-annual-chance event for a portion of Bainbridge Island. Buildings shown in red and yellow have a potential to be damaged during a 1-percent-annual-chance flood event based on the depth of flooding at their location as well as the height of the building.

Map 4: Building Damage Percentage (Loss Ratio) In and Near the Town of Bremerton



Note: The loss ratio is calculated by the total building loss divided by the total building value. This percentage easily highlights those buildings which will have the most building damage in the community.

The loss data from Hazus and the exposure analysis can highlight those areas affected by flooding and identify properties for mitigation projects as well as additional outreach in the area. The areas at greatest risk and those suited for potential mitigation actions will be shown in the community sections of this report. All results, databases, and maps are provided in the Risk Assessment Database which is included with this report.

6. Earthquake Risk Assessment

Earthquake Hazard Overview

An earthquake is the motion or trembling of the ground produced by sudden displacement of rock, usually within the upper 10-20 miles of the Earth's crust. Earthquakes result from crustal strain, volcanism, landslides, or the collapse of underground caverns. Kitsap County is vulnerable to earthquakes due to its location in the Puget Sound region, which features numerous seismogenic geologic faults. Since 1962, earthquakes have had the greatest impact of any hazard on the county in terms of monetary costs and disruptions to daily life. The Nisqually earthquake of 2001 was the most recent earthquake event that caused significant damage to Kitsap County and the Puget Sound region. This 6.8 magnitude earthquake struck the Puget Sound region on February 24, 2001, and caused minor

to moderate damage to the properties of over 750 Kitsap County residents (Kitsap County Department of Emergency Management, 2012). According to the U.S. Geological Survey (USGS) Earthquake Hazards Program, preliminary damage estimates from this incident amounted to $1 billion to $4 billion dollars throughout the region (USGS, 2012).

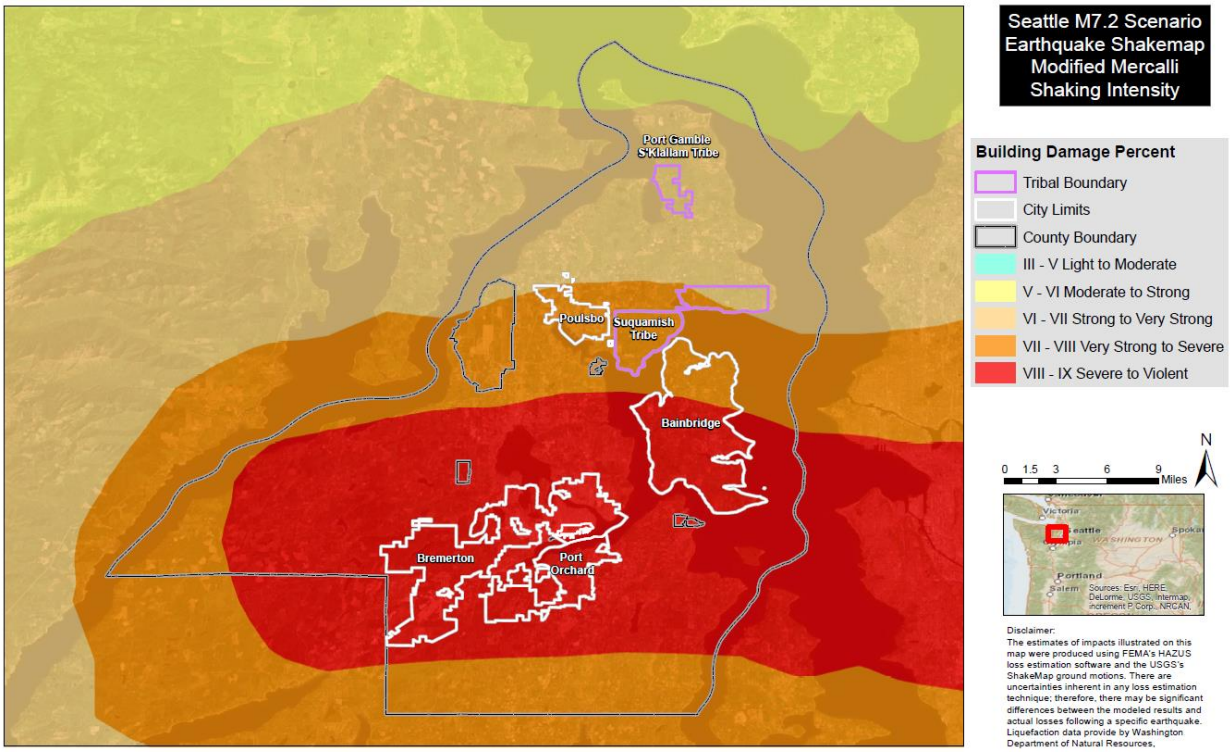
Kitsap County is vulnerable to subduction as well as to fracture faults. The County lies within Seismic Risk Zone 3, which requires buildings to be designed to withstand major earthquakes measuring 7.5 in magnitude. It is anticipated, however, that earthquakes caused from subduction plate stress in the region could reach a magnitude greater than 8.0. The Seattle fault is recognized as a significant seismic hazard; evidence has indicated that it was the cause of a major 7.0 magnitude earthquake approximately 1,100 years ago (Haugerud, 2009). The potential effects of a comparable 7.2 magnitude earthquake were modeled for the Seattle Fault zone by the Washington State Department of Natural Resources (WADNR). The scenario predicts that thousands of injuries and fatalities would occur throughout the region, and thousands of buildings would collapse or be in imminent danger of collapse. There would also be a significant number of building losses, with damage totaling $3.6 billion in Kitsap County (WADNR, 2012-2013).

The effects of a major earthquake in Kitsap County would be catastrophic. Hundreds of residents could be injured or killed, and a multitude of others would be left homeless. Depending on the time of day and time of year, a catastrophic earthquake could cause hundreds of injuries and deaths and millions of dollars in critical infrastructure and private property damage (WADNR, 2012-2013). A severe earthquake could level or severely damage older buildings, especially those constructed of non-reinforced masonry. Newer structures, which were built under recent building codes, would probably sustain less damage, but would remain vulnerable to the soil conditions of the building site. A severe earthquake would also cause major damage to County and City utilities.

ShakeMaps

Maps depicting shaking intensity and ground motion following an earthquake, called ShakeMaps, can be produced in near-real time for events or created for specific scenarios by regional seismic network operators in cooperation with the USGS. These ShakeMaps can be used for response, land use, and emergency planning purposes. For this analysis, a ShakeMap was used for the modeled Seattle Fault 7.2 magnitude event. Map 5 shows the shaking intensity for this scenario. The central and eastern portions of Kitsap County, including Bainbridge Island, Port Orchard, and Bremerton, are located in the severe (instrumental intensity VIII) to extreme (instrumental intensity X+) shake zones.

Map 5: Shaking Intensity for a 7.2 Seattle Fault Earthquake



Earthquake Risk Assessment Overview

The earthquake risk assessment in this report was based on a 7.2 magnitude earthquake on the Seattle fault. Additional earthquakes have been modeled that may affect other areas in the County, including the Tacoma fault, Canyon River fault, and the Cascadia subduction zone fault; however, the Seattle fault was chosen for this analysis because it could potentially cause the most damage to Kitsap County.

The earthquake risk assessment was completed using local parcel data from the County, the USGS ShakeMap listed above, and liquefaction data from WADNR. For this study, individual building/parcel data from the county was incorporated into Hazus to report losses at the building level. Please refer to the appendix for the detailed methodology on incorporating local data into Hazus. The results are summarized below in Table 4.

Table 4: Hazus Earthquake Results for a Seattle M 7.2 Earthquake

Community	Total Estimated Building Value	Total Number of Buildings	Number of Buildings in the Moderate-High Liquefaction Zone	Percentage of Buildings in the Moderate-High Liquefaction Zone	Building Dollar Loss for a Seattle 7.2 Event	Loss Ratio (Dollar Losses/Total Building Value)
Bainbridge	$2.6 Billion	9,094	384	4%	$538 Million	21%
Bremerton*	$1.7 Billion	10,899	116	1%	$760 Million	45%
Port Gamble S'Klallam Tribe**	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Suquamish Tribe	$474 Million	3,093	97	3%	$29.8 Million	6.3%
Port Orchard	$966 Million	4,076	258	6%	$377 Million	39%
Poulsbo	$865 Million	3,160	50	2%	$67.5 Million	7.8%
Unincorporated County	$9.7 Billion	57,801	1,921	3%	$1.8 Billion	18%
Total	**$16.3 Billion**	**88,123**	**2,826**	**3%**	**$3.6 Billion**	**18%**

Note: The above table shows the total estimated building value by community, total number of buildings by community, total number of buildings within the moderated to high liquefaction zone, and percentage of buildings within the moderate to high liquefaction zone. In addition buildings losses are reported for a Seattle Fault 7.2 magnitude event as well as a loss ratio. A loss ratio is calculated by dividing the dollar loss by the total building value. The loss values are for building losses only; additional damages to infrastructure and building contents are not captured in this table. *Information from the military base was not included in the assessment for the City of Bremerton. **No building data was available for the Port Gamble S'Klallam Indian Reservation from Kitsap County, so the results are shown as unknown.

All communities in Kitsap County would be affected if a Seattle Fault event were to occur. The Cities of Bainbridge Island and Port Orchard have the largest percentage of buildings located in the moderate-high liquefaction zone, while unincorporated areas of the county have the highest total number of buildings located in these zones. The total building dollar loss in Kitsap County for an earthquake of this magnitude is estimated at $3.6 billion. Additional damage to infrastructure and building contents were not included in this analysis, and therefore these estimated losses should be considered a minimum.

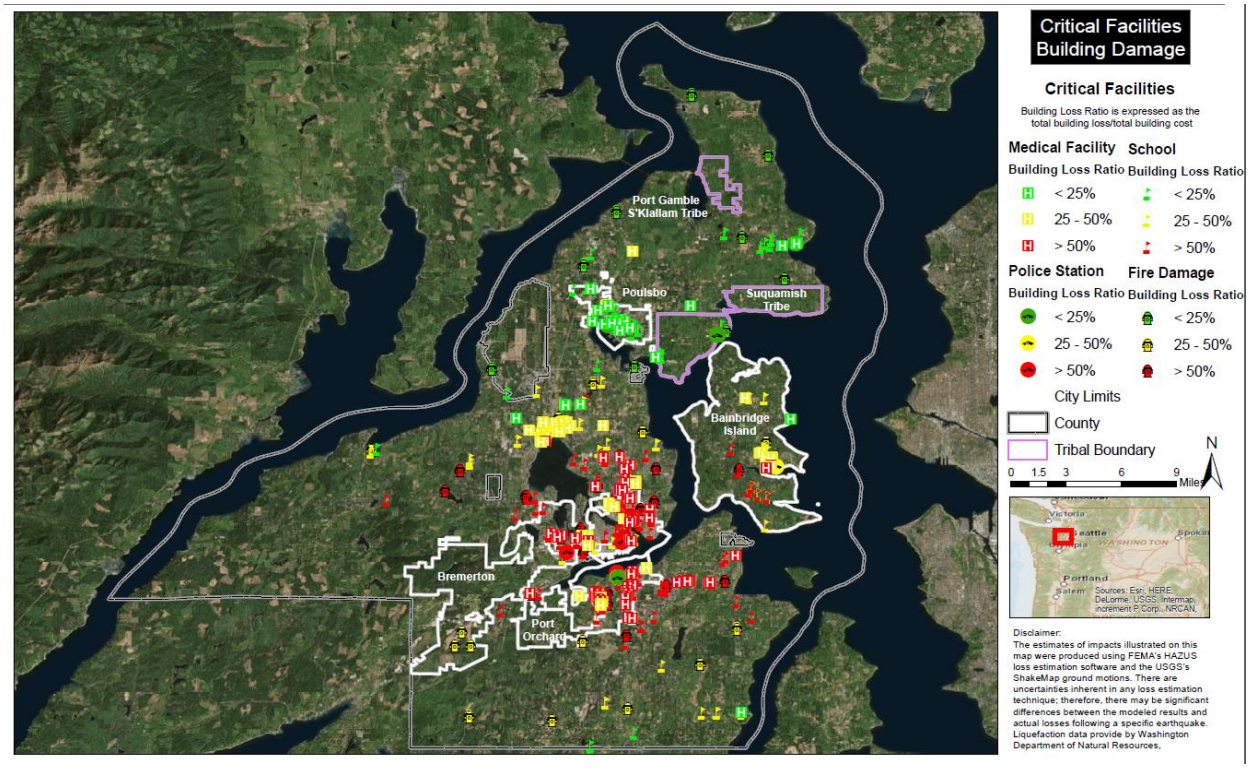
The building loss ratio is shown below on Map 6 for the entire County. Bainbridge Island, Bremerton, Port Orchard, and Poulsbo all contain a substantial number of buildings that would experience building loss ratios of greater than 25 percent during an earthquake event of this magnitude. As shown in Table 4, the City of Bremerton had the highest average building loss ratio (45 percent), followed by Port Orchard (39 percent) and Bainbridge Island (21 percent).

Map 6: Building Damage Percentage (Loss Ratio) for the Study Area

Note: The loss ratio is calculated by the total building loss divided by the total building value. This ratio easily highlights those buildings that will have the most building damage in the community. Only the building damage is shown above; other infrastructure damage was not included in this map. Damage below 1% loss ratio is not shown.

In addition to the building analysis, essential facilities (schools, fire, police, and medical facilities) were analyzed. Essential facilities were analyzed to determine if they would experience damage from the earthquake event. Anything labeled greater than 50 percent would be considered damaged. As shown in Map 7, for the entire study area, 155 schools buildings of 292 are expected to have a greater than 50 percent chance of being damaged; 93 medical facilities out of 184 are expected to have a greater than 50 percent chance of being damaged; and 19 fire stations out of 48 are expected to have a greater than 50 percent chance of being damaged. Transportation damage is not shown in the report. This data was analyzed for the risk assessment and will be provided to the communities to facilitate further planning.

Map 7: Critical Facility Building Damage



Note: Damage for essential facilities is shown. A loss ratio is calculated as building loss/building total value. Loss ratio is shown as >50%, between 25-50%, and less than 25%. Buildings with a loss ratio of >50% will be severely damaged and most likely not be functional after a Seattle Fault 7.2M earthquake.

The loss data from Hazus and the design level analysis can highlight the buildings and areas impacted by earthquakes and can be used to identify properties for mitigation projects, as well as areas for additional outreach. Highlighted areas of greatest impacts and potential mitigation actions are shown in the community sections of this report (Section 9).

An analysis was also completed to identify how many buildings were built to a specific building code. Homes built prior to 1975 are considered pre-code since there was no requirement state-wide to include seismic provisions in the building code. Those built after 1975 are considered moderate code- - at that time all Washington jurisdictions were then required to adhere to provisions of the most recently adopted version of the Uniform Building Code (UBC) (Noson et. al.,1988). Local building codes may be slightly different than the dates shown below, but the information can be used a general planning tool until more information on the local code can be acquired. The 1988 UBC and later adoptions of the UBC and IBC provisions statewide may have been integrated into local building codes on slightly different than the dates shown below, but the information can be used a general planning tool until more information on the local code can be acquired.

High loss ratios in earthquake events are typically attributed to the number of pre-code structures in each community. Because of their age and pre-code status, these buildings will not perform as well in an earthquake. Bremerton has the highest number of pre-code buildings with 80 percent. By quantities, the County with 17,278 buildings have the largest number of pre-code facilities.

Table 5: Pre-Code versus Moderate Code Buildings in Kitsap County

Community	Number of Pre-Code Buildings (before 1975)	Percent Pre-Code Buildings	Number of Moderate Code Buildings (after 1975)	Percent of Moderate Code Buildings
Bainbridge Island	3,082	34%	6,012	66%
Bremerton	8,698	80%	2,201	20%
Port Orchard	1,415	35%	2,661	65%
Poulsbo	725	23%	2,435	77%
Suquamish Tribe	780	25%	2,313	75%
Port Gamble S'Klallam Tribe	Unknown	Unknown	Unknown	Unknown
Unincorporated County	17,278	30%	40,523	70%
Total	**31,978**	**36%**	**56,145**	**64%**

Note: Pre-code buildings are those that are built prior to 1975. Moderate code are those built after 1975. These dates were chosen based on when the seismic provisions were incorporated into the building code statewide which was 1975. Please note that the analysis in Hazus used the following dates: Pre-code are any buildings prior to 1941. Moderate Code were any buildings after 1941, which is the default Hazus methodology. Please refer to the appendix for additional information.

Liquefaction susceptibility describes the likelihood of saturated sediments to liquefy during an earthquake, resulting in permanent ground deformations. When liquefaction occurs, the ability of soil to support buildings and infrastructure is diminished. Map 8 below shows the liquefaction susceptibility for the study area. A liquefaction susceptibility rating of none indicates that the ground consists of bedrock, while a high susceptibility rating occurs in areas with loose soil. This map shows that a large percentage of buildings in Kitsap County are located in a highly susceptible area, particularly those near coastal areas and river corridors.

Map 8: Liquefaction Susceptibility in Kitsap County

Note: Moderate to high liquefaction susceptibility can lead to greater damage to buildings in an earthquake.

The loss data from Hazus, the design code analysis, and liquefaction data can highlight those buildings/areas affected by earthquakes and can be used to identify properties for mitigation projects, as well as additional outreach opportunities. The areas of greatest impacts and potential mitigation actions will be shown in the community sections of this report.

7. Landslide Hazard Overview

Landslide Hazard Overview

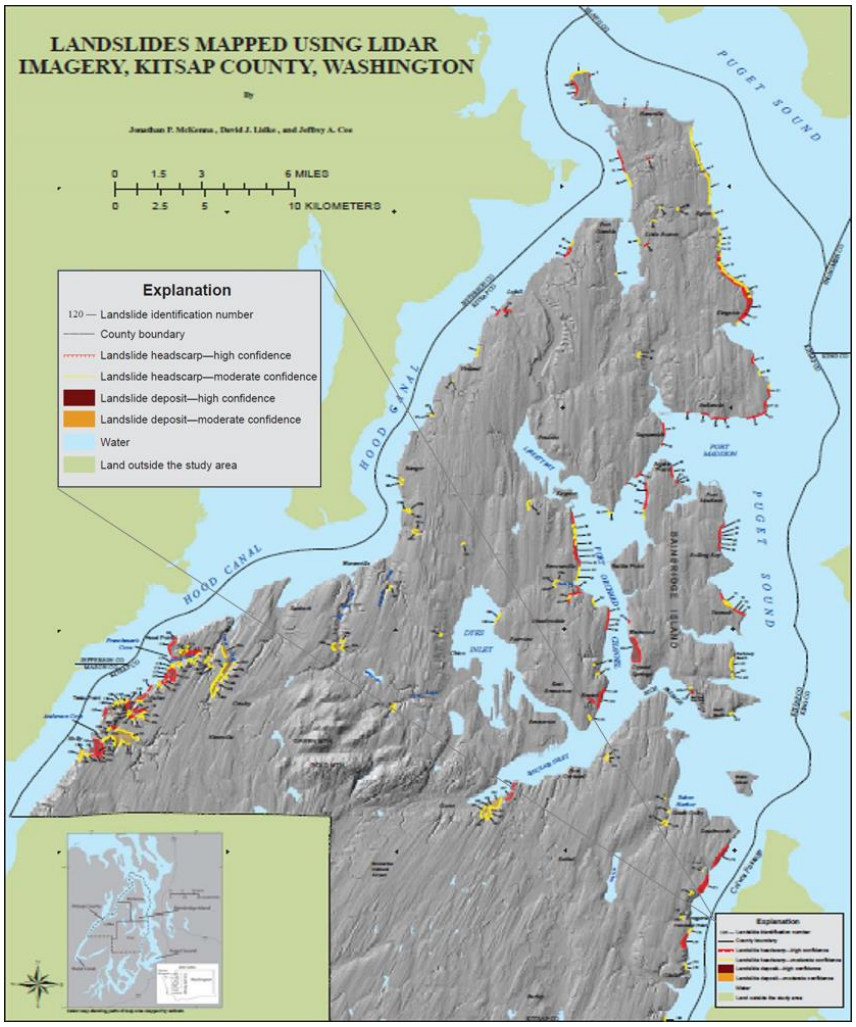
Kitsap County is subject to landslides and soil erosion due to wind, water, and flooding at all times of the year. Landslides can cause deaths, significant damage to properties and infrastructure, and in some cases, losses of the use of land for many years due to the extensive cost of restoration. Earthquakes also have the potential to trigger landslides. The 2001 Nisqually earthquake caused approximately $34.3 million in damage due to earthquake-induced landslides throughout the region (Highland, 2001). Landslide occurrences in Kitsap County have been concentrated along its coastal bluffs as well as within river valleys near the coastline.

Several landslides have affected Kitsap County over the last 20 years, causing deaths, injury, damage to properties, and loss of land use. The following accounts were documented by McKenna and others (2008). Several landslides were triggered by storms throughout the winter of 1996-1997. One of these storm events caused a landslide in the Rolling Bay area of Bainbridge Island, which forced a house off its foundation and down a hill into Puget Sound. Several other landslides severely damage homes, roads,

and utilities along the bluffs of Bainbridge Island. One of these events resulted in the death of a family of four and destroyed millions of dollars of both public and private property. This deadly landslide demonstrates the unpredictability and destructiveness of landslides in Kitsap County. The scar of the slide was nearly 15 meters wide and 15 to 20 meters high. While assessing the damage from this incident, the USGS also observed numerous other scars from many previous landslides that occurred on the steep bluffs of Bainbridge Island.

Landslide events often occur within the boundaries of pre-existing deep-seated landslide deposits. Since landslide occurrences can be difficult to identify in densely forested terrain in Kitsap County, McKenna and others (2008) used Light Detection and Ranging (LIDAR) imagery to identify and map landslides in the County. Derivatives of the LIDAR data, such as topographic-contour lines, slope, and hill-shaded relief maps, were used to estimate where landslides occurred. A total of 231 landslides were identified in this study, all of which were assigned a confidence interval of high or moderate to indicate how certain the USGS was that the event occurred. According to this study, landslides represented 0.8 percent of the land area of Kitsap County. As shown in Map 9, landslide events in Kitsap County were concentrated to the coastal areas on Puget Sound, Port Orchard Channel, Hood Canal, and Colvos Passage. The largest cluster of landslide deposits appeared near Holly and Hoods Point along Hood Canal, as well as near Kingston in the northeastern part of Kitsap County along Puget Sound.

Map 9: Shallow Landslide Susceptibility Zones – Kitsap County



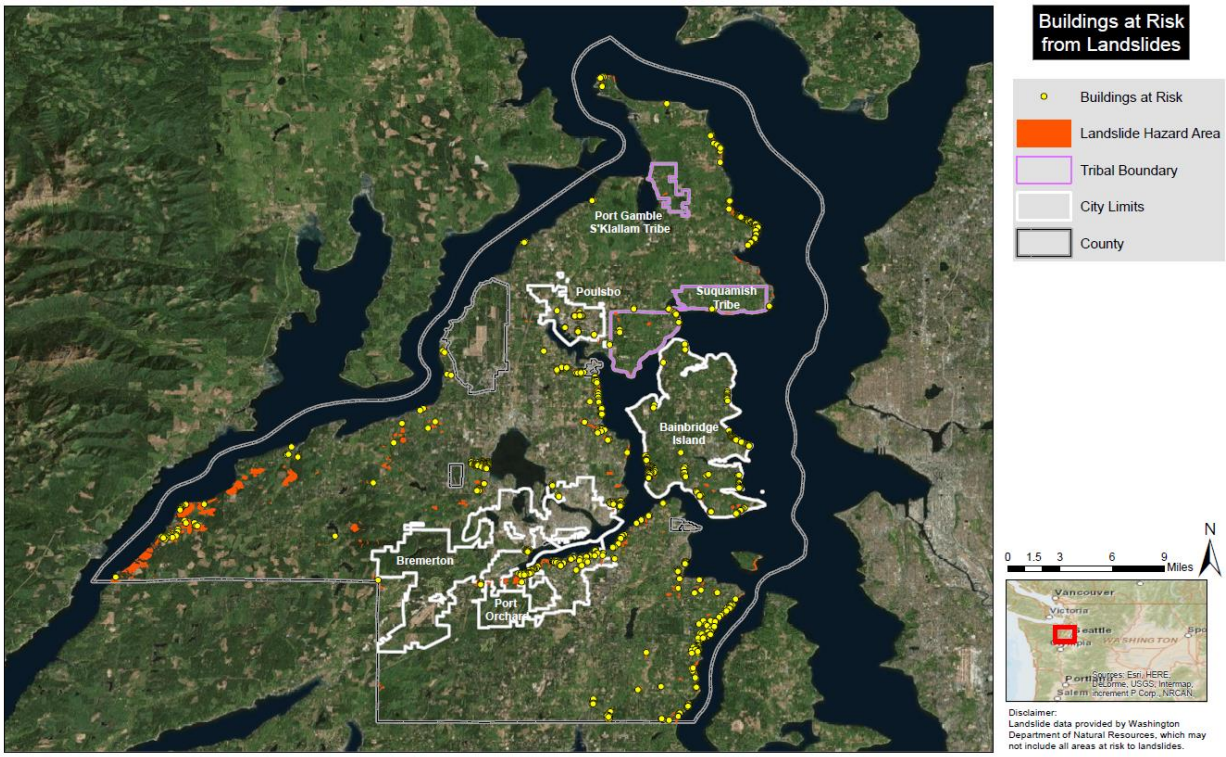
Landslide Risk Assessment Overview

A landslide risk assessment was completed by comparing the landslide areas with the locations of buildings throughout Kitsap County. The analysis is summarized by city in Table 6. Over 1,000 buildings are located in the defined landslide zone, which have a total estimated value of approximately $211 million. The majority of these buildings are located in unincorporated areas; these 766 buildings have an estimated value of $137 million and comprise nearly 72 percent of all buildings that are susceptible to landslides in the county. As shown in Map 10, these buildings are concentrated in the northeastern part of the county along Puget Sound, in the southwestern section of the county along Hood Canal, and in the southeastern portion of the county along Colvos Passage. Bainbridge Island also contains a significant number of buildings that are exposed to the effects of landslides, and Port Orchard contains 66 buildings near the Sinclair Inlet that are in the landslide zone.

Table 5: Building Exposure to Landslides

City	Buildings within Landslide Zone	Building Value with Landslide Zone
Bainbridge Island	177	$55 Million
Port Orchard	66	$8.1 Million
Poulsbo	40	$9.8 Million
Unincorporated County	766	$137 Million
Suquamish Tribe	21	$1.9 Million
Port Gamble S'Klallam Tribe	Unknown	Unknown
Total	**1,070**	**$211 Million**

Map 10: Shallow Landslide Susceptibility Zones and Building Impacts



The landslide inventory assessment can be used to identify properties for mitigation projects as well as for additional outreach opportunities in the area. The community sections of this report will highlight areas of greatest impacts and potential mitigation actions. All results, databases, and maps are provided in the Risk Assessment Database, which is included with this report.

8. Tsunami Risk Assessment

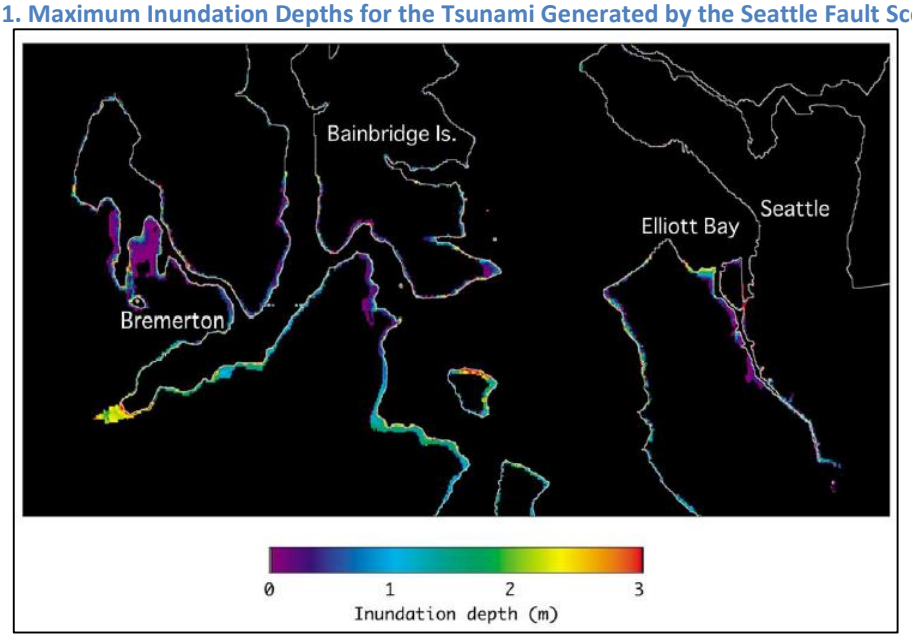
Tsunami Hazard Overview

Tsunamis are generated when geologic events, such as earthquakes, landslides, submarine landslides, or volcanic activity, cause large, rapid movements in the sea floor that displace the water column above. In Puget Sound, tsunamis can be caused by local landslides from surrounding bluffs. The displacement of water creates a series of high-energy waves that radiate outward like pond ripples. Offshore tsunamis can strike adjacent shorelines in minutes and cross the ocean at speeds as great as 600 miles per hour to strike distant shores.

Kitsap County is at risk from tsunamis of both local and distant origin. These destructive waves are most commonly caused by submarine earthquakes. Our current technology gives us adequate warning for tsunamis produced by distant quakes; however, an earthquake on the Seattle fault would have near immediate impacts.

It is believed that the magnitude 7.0 earthquake that occurred on the Seattle fault 1,100 years ago caused a tsunami. As discussed in the Earthquake Risk Assessment section, the Seattle fault is active and capable of generating a large earthquake with a magnitude greater than 7.0. Koshimura and Mofjeld (2005) modeled the potential effects of a tsunami caused by a 7.0 magnitude earthquake at major ports and harbors in Puget Sound as well as at several communities in Kitsap County, such as Bremerton and Port Orchard. The model indicated that at Bremerton and Port Orchard, the local seismic uplift would generate a 1.5m tsunami at the moment of the earthquake, with inundation occurring primarily along the southern shore of Sinclair Inlet and the northern and southern shore of Dyes Inlet. The estimated flow depths range between 2m at the shore of Port Orchard, 4m at the northern shore if Dyes Inlet, and 2m at the southern shore of Dyes Inlet. The results of this model are shown in Map 11. A tsunami in these developed areas would affect homes, schools, businesses, ports, harbors, shipyards, marinas, transportation infrastructure, utilities, and coastal ecosystems (Crawford and others, 2001).

Map 11. Maximum Inundation Depths for the Tsunami Generated by the Seattle Fault Scenario



Note: Maximum Inundation Depths (meters) relative to the local land elevation

The tsunami GIS data was not available for an individual building assessment. Using the depth information from the study could inform future mitigation projects and indicate areas to focus on for tsunami outreach opportunities and evacuation routes.

9. Areas of Mitigation Interest (AOMI) and Recommended Mitigation Strategies

This section of the Risk Report takes risk findings from Hazus models and other hazard overlays and focuses on specific areas where mitigation efforts should occur. These areas are called "Areas of Mitigation Interest" (AOMI) and were developed through conversations with the community during the Risk MAP process, as well as through analysis of various datasets for flood, earthquake, tsunami, and landslide hazards. The AOMI targets areas where potential damage, economic loss, and casualties could occur from a hazard event; FEMA has provided strategies for mitigation in these specific areas. These mitigation strategies provide advice on ways to reduce risk, thereby reducing potential damages, economic loss, and casualties during hazard events. The mitigation strategies suggest potential projects for hazard mitigation, encourage local collaboration, and communicate how various mitigation activities can successfully reduce risk.

The AOMI section of this report is broken down by individual community to create a more specific discussion of mitigation strategies for each jurisdiction.

Unincorporated Kitsap County: Areas of Mitigation Interest and Recommended Mitigation Strategies

Based on the Hazus risk assessment, an overall hazard assessment was completed for the County that includes the buildings most at risk from multiple hazards. The table below highlights some of the buildings in the unincorporated Kitsap County affected by flooding, tsunami, earthquake, and landslide risks.

Table 6: Kitsap County Areas of Mitigation Interest

Community Building Name	Address	Building Value	Loss Value	Loss Ratio	Hazard Type
Multiple Single Family Homes	NE Twin Spits Rd.	$2.0M (15 Homes)	$790K	40%	Flood
Sunnyslope Elementary School	4183 Sunnyslope Rd. SW, Port Orchard	$2.6M	$1.3M	50%	Earthquake
Apartment Complex	1623 W. Admiralty Heights Ln.	$8.1M (9 Units)			Landslide
Tracyton Community Library	351 NW Tracy Ave.	$85K	$53k	64%	Earthquake
South Kitsap Fire and Rescue	1974 Fircrest Dr. SE	$994K	$651K	65%	Earthquake

Hazard Mitigation Plan Analysis

The Kitsap County Hazard Mitigation Plan, effective April 30, 2014, to April 30, 2019, identifies the following Hazard Mitigation Projects that can be aided by the information in this Risk Report.

Table 7: Kitsap County Hazard Mitigation Plan Analysis

Hazard	Projects	Additional information from Risk Report
Flood	Identify high-risk areas on Geographic Information System (GIS). Update local storm water system plans and improve storm water facilities in high-risk areas.	Use Risk Report and Risk Database to identify high-risk areas on public roads and inform storm water facility management.
Flood	Identify locations where flooding has occurred on a repeated basis and conduct a cost-benefit analysis to determine if a flood buyout option would be cost effective.	Use Risk Report and Risk Database to analyze repetitive loss properties and inform the benefit cost analysis.
Earthquake/ Landslide	Identify and study ground motion, landslide, and primary liquefaction community-wide. Include new data from most recent earthquake studies.	Use Risk Report and Risk Database that identify most current ground motion assessments.
Tsunami	Create a “Kitsap County Shore Zone Inventory” including a building footprint for all lands within 1 km of the shoreline.	Use Risk Report and Risk Database to identify structures at risk of tsunami.
Multi-hazard	Identify areas of geographical/geological influence affecting identified critical area hazards.	Use Risk Report and Risk Database to identify critical area risks.

Recommended Mitigation Strategy

Based on the assessment above, the following mitigation strategies are recommended.

Table 8: Kitsap County Recommended Mitigation Strategies

Problem Statement	Recommended Strategy
Kitsap County’s building dollar losses are $7.1B representing a 46% loss ratio (dollar losses/total	• Develop priority list for essential facility earthquake retrofit.

building value) for a Seattle Fault 7.2 earthquake. Essential facilities and infrastructure are of particular concern and are likely to lose function immediately after an event.	
Unincorporated Kitsap County has 30% of its structures built before modern building code. This could result in significant damage during an earthquake.	• Develop priority list for essential facility earthquake retrofit. • Develop an outreach strategy or mitigation program for homeowners or businesses to retrofit older buildings.
Kitsap County has 766 buildings within the landslide zone representing $137M in value.	• Provide outreach to homeowners regarding the landslide risk. • Consider limiting additional development in landslide hazard zones. • Move or harden essential facilities and infrastructure in landslide hazard zones. • Develop a buyout program for homes in landslide areas.
Gorst is a transportation choke-point that becomes impassable with any minor or major impact, including high-winds, floods, and car accidents.	• Develop alternative transit plan and incorporate into the County's Hazard Mitigation Plan and/or Emergency Thoroughfare Plan.

While Federal funding for the above projects is limited, FEMA recommends incorporating these projects into the Natural Hazards Mitigation Plan should disaster funds become available. Additional funding may be available through the community's Capital Improvement Planning (CIP) process, bond authority, or other local, state, or private funding source. More information on how to mitigate for natural hazards can be found in the FEMA Local Mitigation Planning Handbook (http://www.fema.gov/media-library/assets/documents/31598?id=7209). Additional information on integrating the Hazard Mitigation Plan with the Local Planning Process can be found here (http://www.fema.gov/media-library/assets/documents/19261?id=4267)

City of Bremerton: Areas of Mitigation Interest and Recommended Mitigation Strategies

Based on the Hazus risk assessment an overall hazard assessment was completed for the County that includes the buildings most affected by multiple hazards. The table below highlights some of the buildings that are affected in the City of Bremerton by earthquake.

Table 9: City of Bremerton Areas of Mitigation Interest

Community Building Name	Address	Building Value	Loss Value	Loss Ratio	Hazard Type
Bremerton Post Office	602 Pacific Ave. Bremerton	$316K	$302K	96%	Earthquake
Kitsap Regional Library	612 5th St. Bremerton	$756K	$724K	96%	Earthquake
Bremerton High School (Multiple buildings)	1313 Ohio Ave. Bremerton	$9.1M	$5.6M	61%	Earthquake
Fire Station #2 Bremerton	5005 Kitsap Way	$438K	$269K	61%	Earthquake

Hazard Mitigation Plan Analysis

The City of Bremerton Hazard Mitigation and Preparedness Plan, effective April 30, 2014, to April 30, 2019, identifies the following Hazard Mitigation Projects that can be aided by the information in this Risk Report.

Table 10: City of Bremerton Hazard Mitigation Plan Analysis

Hazard	Project	Additional information from Risk Report
Multi-hazard	Improve citizen preparedness programs to include mitigating residential structures.	Use information from the Risk Assessment and Risk Database to identify structures most at risk.
Flood	Develop and implement projects to improve control of runoff and flooding.	Use information from the Risk Assessment and Risk Database to identify structures in the floodplain and/or at risk of flood.

Recommended Mitigation Strategy

Based on the assessment above, the following mitigation strategies are recommended.

Table 11: City of Bremerton Recommended Mitigation Strategies

Problem Statement	Recommended Strategy
Bremerton has 312 buildings in the SFHA, representing $8.2M in loss after a 1-percent-annual-chance flood.	• Develop an outreach strategy to help homeowners, realtors, and insurance agents understand the value of flood insurance.
80% of Bremerton's structures were built before modern building codes, increasing the risk of significant damage during an earthquake.	• Develop priority list for essential facility earthquake retrofit. • Develop an outreach strategy or mitigation program for homeowners or businesses to retrofit older buildings.
Both fire stations in Bremerton are brick, are not retrofitted, and show significant damage in earthquake HAZUS models.	• Apply for open HMGP grants for an initial design estimate and structural retrofit of one or both fire stations.

While Federal funding for the above projects is limited, FEMA recommends incorporating these projects into the Natural Hazards Mitigation Plan should disaster funds become available. Additional funding may be available through the community's Capital Improvement Planning (CIP) process, bond authority, or other local, state, or private funding source. More information on how to mitigate for natural hazards can be found in the FEMA Local Mitigation Planning Handbook (http://www.fema.gov/media-library/assets/documents/31598?id=7209). Additional information on integrating the Hazard Mitigation Plan with the Local Planning Process can be found here (http://www.fema.gov/media-library/assets/documents/19261?id=4267)

City of Bainbridge: Areas of Mitigation Interest and Recommended Mitigation Strategies

Based on the Hazus risk assessment, an overall hazard assessment was completed for the County that includes the buildings most affected by multiple hazards. The table below highlights some of the buildings that are affected in the City of Bainbridge by flooding, tsunami, earthquake, and landslide.

Table 12: City of Bainbridge Areas of Mitigation Interest

Community Building Name	Address	Building Value	Loss Value	Loss Ratio	Hazard Type
Single Family Home	10680 NE Gertie Johnson Road	$501	$247k	49%	Flood
Hyla Middle School	7861 NE Bucklin Hill Road	$290k	$266k	91%	Earthquake
Bainbridge Island Fire Department Station #22	7934 NE Bucklin Hill Road	$377k	$202	53%	Earthquake
Single Family Home	5151 Crystal Springs Dr. NE	$501K	$366K	73%	Earthquake, Landslide
Shopping Center/Mixed Retail	4569 Lynwood Center Rd. NE	$2.39M	$2.29M	96%	Earthquake

Hazard Mitigation Plan Analysis

The City of Bainbridge Hazard Mitigation Plan, effective April 30, 2014, to April 30, 2019, identifies the following Hazard Mitigation Projects that can be aided by the information in this Risk Report.

Table 13: City of Bainbridge Hazard Mitigation Plan Analysis

Hazard	Project	Additional information from Risk Report
Tsunami	Study tsunamis and improve mapping of tsunami risk on Bainbridge Island.	Use Risk Report and Risk Database to identify structures most at risk.
Earthquake	Develop a program to identify at-risk seismic assessment of structures in need of retrofitting.	Use Risk Database to identify structures in need of retrofit.
Landslide	Identify slide-prone areas and study specific mitigation steps to reduce existing risk and prevent increased risks.	Use Risk Report and Risk Database to inform identified of slide-prone areas.

Recommended Mitigation Strategy

Based on the assessment above, the following mitigation strategies are recommended.

Table 14: City of Bainbridge Recommended Mitigation Strategies

Problem Statement	Recommended Strategy
Bainbridge has 11% of its buildings located in the moderate-high liquefaction zone with 3,082 of them built before modern building codes, increasing the risk of significant damage to an earthquake.	• Develop priority list for essential facility earthquake retrofit. • Develop an outreach strategy or mitigation program for homeowners or businesses to retrofit older buildings.
Bainbridge has 177 buildings within the landslide zone representing $55M in value.	• Provide outreach to homeowners regarding the landslide risk. • Consider limiting additional development in landslide hazard zones. • Move or harden essential facilities and infrastructure in landslide hazard zones.

	• Develop a buyout program for homes in landslide areas.
Bainbridge would like to increase public education around all-hazard risk and develop a landslide hazard inventory map.	• Identify and publicize concerns regarding hazards. • Increase community involvement. • Develop a comprehensive program with public buy-in. • Conduct a landslide assessment/pilot project to improve landslide hazard inventory. • Develop a landslide hazard map.

While Federal funding for the above projects is limited, FEMA recommends incorporating these projects into the Natural Hazards Mitigation Plan should disaster funds become available. Additional funding may be available through the community's Capital Improvement Planning (CIP) process, bond authority, or other local, state, or private funding source. More information on how to mitigate for natural hazards can be found in the FEMA Local Mitigation Planning Handbook (http://www.fema.gov/media-library/assets/documents/31598?id=7209). Additional information on integrating the Hazard Mitigation Plan with the Local Planning Process can be found here (http://www.fema.gov/media-library/assets/documents/19261?id=4267)

City of Poulsbo: Areas of Mitigation Interest and Recommended Mitigation Strategies

Based on the Hazus risk assessment, an overall hazard assessment was completed for the County that includes the buildings most affected by multiple hazards. The table below highlights some of the buildings that are affected in the City of Poulsbo by flooding, earthquake, and landslide.

Table 15: City of Poulsbo Areas of Mitigation Interest

Community Building Name	Address	Building Value	Loss Value	Loss Ratio	Hazard Type
Commercial Office Buildings	17791 Fjord Dr. NE	$1.2M	$473K	38%	Flood
Commercial – General Retail	18969 Front St. NE	$126K	$63K	50%	Earthquake
Multiple Single Family Homes	West side of 11th Ave. NE	$2.6M (12 Homes)			Landslide
Multiple Single Family Homes	Rosebud Pl. NE	$2.1M (9 Homes)			Landslide

Hazard Mitigation Plan Analysis

The City of Poulsbo Hazard Mitigation Plan, effective April 30, 2014, to April 30, 2019, identifies the following Hazard Mitigation Projects that can be aided by the information in this Risk Report.

Table 16: City of Poulsbo Hazard Mitigation Plan Analysis

Hazard	Project	Additional information from Risk Report
Earthquake	Pursue seismic upgrades to equipment, infrastructure, and critical facilities.	Use information in the Risk Report and Risk Database to identify and prioritize structures at risk.
Multi-hazard	Improve citizen preparedness programs to include mitigating residential structures.	Use information from the Risk Assessment and Risk Database to identify structures most at risk.
Flood	Develop and implement projects to improve control of runoff and flooding.	Use information from the Risk Assessment and Risk Database to identify structures in the floodplain and/or at risk of flood.

Recommended Mitigation Strategy

Based on the assessment above, the following mitigation strategies are recommended.

Table 17: City of Poulsbo Recommended Mitigation Strategies

Problem Statement	Recommended Strategy
Poulsbo has 35 buildings in the SFHA, representing $740,000 in loss after a 1-percent-annual-chance flood.	• Develop an outreach strategy to help homeowners, realtors, and insurance agents understand the value of flood insurance.
Poulsbo has 40 buildings within the landslide zone representing $9.8M in value.	• Provide outreach to homeowners regarding the landslide risk. • Consider limiting additional development in landslide hazard zones. • Move or harden essential facilities and infrastructure in landslide hazard zones. • Develop a buyout program for homes in landslide areas.

While Federal funding for the above projects is limited, FEMA recommends incorporating these projects into the Natural Hazards Mitigation Plan should disaster funds become available. Additional funding may be available through the community's Capital Improvement Planning (CIP) process, bond authority, or other local, state, or private funding source. More information on how to mitigate for natural hazards can be found in the FEMA Local Mitigation Planning Handbook (http://www.fema.gov/media-library/assets/documents/31598?id=7209). Additional information on integrating the Hazard Mitigation Plan with the Local Planning Process can be found here (http://www.fema.gov/media-library/assets/documents/19261?id=4267)

City of Port Orchard: Areas of Mitigation Interest and Recommended Mitigation Strategies

Based on the Hazus risk assessment, an overall hazard assessment was completed for the County that includes the buildings most affected by multiple hazards. The table below highlights some of the buildings which are affected in the City of Port Orchard by flooding, tsunami, earthquake, and landslide.

Table 18: City of Port Orchard Areas of Mitigation Interest

Community Building Name	Address	Building Value	Loss Value	Loss Ratio	Hazard Type
General Retail	205 Bethel Ave.	$76k	$50k	66%	Earthquake, Landslide
Cedar Heights Junior High School	336 Lippert Dr. W.	$2.9M	$1.6M	56%	Earthquake
Kitsap County Government Building	507 Austin Ave.	$5.0M	$2.9M	57%	Earthquake
Single Family Home	1699 Bay St.	$61K	$26K	42%	Flood
Multiple Single Family Homes	SW Bay St.	$676K			Landslide

Hazard Mitigation Plan Analysis

The City of Port Orchard Hazard Mitigation Plan, effective April 30, 2014, to April 30, 2019, identifies the following Hazard Mitigation Projects that can be aided by the information in this Risk Report.

Table 19: City of Port Orchard Hazard Mitigation Plan Analysis

Hazard	Project	Additional information from Risk Report
Earthquake	Pursue seismic upgrades to equipment, infrastructure, and critical facilities.	Use information in the Risk Report and Risk Database to identify and prioritize structures at risk.
Flood/Severe Storm	Evaluate water and sewer utilities within 50 feet of shoreline to mitigate high tide, winter storm and flood events.	Use information in the Risk Report and Risk Database to identify and prioritize structures at risk.
Multi-hazard	Improve citizen preparedness programs to include mitigating residential structures.	Use information from the Risk Assessment and Risk Database to identify structures most at risk.
Flood	Develop and implement projects to improve control of runoff and flooding.	Use information from the Risk Assessment and Risk Database to identify structures in the floodplain and/or at risk of flood.

Recommended Mitigation Strategy

Based on the assessment above, the following mitigation strategies are recommended.

Table 20: City of Port Orchard Recommended Mitigation Strategies

Problem Statement	Recommended Strategy
Port Orchard has 6% of its buildings located in the moderate-high liquefaction zone, with 725 of them built before modern building codes, increasing the risk of significant damage to an earthquake.	• Develop priority list for essential facility earthquake retrofit. • Develop an outreach strategy or mitigation program for homeowners or businesses to retrofit older buildings.
Port Orchard's EOC is located in a high-tide, liquefaction zone and will be rendered unusable during a significant earthquake.	• Retrofit existing public works building (aka "the Shop.") • Identify and implement a plan to relocate the EOC.
Port Orchard lacks GIS capabilities to sync GIS data to inform funding awareness and justification for seismic upgrades.	• Hire a GIS person at Port Orchard Public Works and Utilities. • Synthesize GIS data to inform funding awareness. • Integrate the information into the Kitsap County Hazard Mitigation Plan.

While Federal funding for the above projects is limited, FEMA recommends incorporating these projects into the Natural Hazards Mitigation Plan should disaster funds become available. Additional funding may be available through the community's Capital Improvement Planning (CIP) process, bond authority, or other local, state, or private funding source. More information on how to mitigate for natural hazards can be found in the FEMA Local Mitigation Planning Handbook (http://www.fema.gov/media-

library/assets/documents/31598?id=7209). Additional information on integrating the Hazard Mitigation Plan with the Local Planning Process can be found here (http://www.fema.gov/media-library/assets/documents/19261?id=4267)

Port Gamble S'Klallam Tribe: Areas of Mitigation Interest and Recommended Mitigation Strategies

A risk assessment was not completed for the Port Gamble S'Klallam Tribe since parcel/assessors was not available through Kitsap County.

Hazard Mitigation Plan Analysis

The Port Gamble S'Klallam Hazard Mitigation Plan, effective November 2, 2015, through November 1, 2020, identifies the following Hazard Mitigation Projects that can be aided by the information in this Risk Report.

Table 21: Port Gamble S'Klallam Mitigation Plan Analysis

Hazard	Project	Additional information from Risk Report
Landslide	Relocate existing structures on Port Gamble Bay and Hood Canal bluffs that are threatened by potential landslides or high rates of erosion.	Use information in the Risk Report and Risk Database to identify and prioritize structures at risk of landslide.
Earthquake	Seismic retrofit of tribal buildings and infrastructure, including a reservation-wide back-up generator program.	Use information in the Risk Report and Risk Database to identify and prioritize structures at risk of earthquake.
Multi-hazard	Identify hazard prone areas, map each of them, prepare a text description and include in the Tribe's Master Plan.	Use information from the Risk Assessment and Risk Database to identify and describe hazard prone areas.

Recommended Mitigation Strategy

Based on the assessment above, the following mitigation strategies are recommended.

Table 22: Port Gamble S'Klallam Recommended Mitigation Strategies

Problem Statement	Recommended Strategy
Port Gamble S'Klallam Tribe has $13.6M of estimated losses for structures and infrastructures due to an earthquake (according to the Port Gamble S'Klallam Hazard Mitigation Plan).	• Develop priority list for essential facility earthquake retrofit. • Develop an outreach strategy or mitigation program for homeowners or businesses to retrofit older buildings.

While Federal funding for the above projects is limited, FEMA recommends incorporating these projects into the Natural Hazards Mitigation Plan should disaster funds become available. Additional funding may be available through the community's Capital Improvement Planning (CIP) process, bond authority, or other local, state, or private funding source. More information on how to mitigate for natural hazards

can be found in the FEMA Local Mitigation Planning Handbook (http://www.fema.gov/media-library/assets/documents/31598?id=7209). Additional information on integrating the Hazard Mitigation Plan with the Local Planning Process can be found here (http://www.fema.gov/media-library/assets/documents/19261?id=4267)

Suquamish Tribe: Areas of Mitigation Interest and Recommended Mitigation Strategies

Based on the Hazus risk assessment, an overall hazard assessment was completed for the County that includes the buildings most affected by multiple hazards. The table below highlights some of the buildings that are affected in the Port Madison Reservation by earthquake and landslide. Please note the results for the Suquamish Tribe were taken from Kitsap County parcel/assessors information. The assessment may not include building information for tribally owned land.

Table 23: Suquamish Tribe Areas of Mitigation Interest

Community Building Name	Address	Building Value	Loss Value	Loss Ratio	Hazard Type
Commercial – Restaurant/Small Shop	Saltair Dr. NE	$698K	$375K	53%	Earthquake
Multiple Single Family Homes	NE Pebble Beach Dr.	$753K			Landslide
Multiple Single Family Homes	NE Shore Dr.	$393K			Landslide

Hazard Mitigation Plan Analysis

The Suquamish Tribe does not have a hazard mitigation plan; completing one is highly recommended.

Recommended Mitigation Strategy

Based on the assessment above, the following mitigation strategies are recommended.

Table 24: Suquamish Tribe Recommended Mitigation Strategies

Problem Statement	Recommended Strategy
The Suquamish Tribe has 3% of its buildings located in the moderate-high liquefaction zone, increasing the risk of significant damage to an earthquake.	• Develop priority list for essential facility earthquake retrofit. • Develop an outreach strategy or mitigation program for homeowners or businesses to retrofit older buildings.
The Suquamish Tribe would like to communicate risk to tribal and community members.	• Develop templates for communication with tribal members.

While Federal funding for the above projects is limited, FEMA recommends incorporating these projects into the Natural Hazards Mitigation Plan should disaster funds become available. Additional funding may be available through the community's Capital Improvement Planning (CIP) process, bond authority, or

other local, state, or private funding source. More information on how to mitigate for natural hazards can be found in the FEMA Local Mitigation Planning Handbook (http://www.fema.gov/media-library/assets/documents/31598?id=7209). Additional information on integrating the Hazard Mitigation Plan with the Local Planning Process can be found here (http://www.fema.gov/media-library/assets/documents/19261?id=4267)

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11. Appendices

Hazus Methodology

For the risk assessment, local GIS data from Kitsap County were used for this assessment. The data were downloaded from here: http://www.kitsapgov.com/gis/metadata/. Using parcel and assessor's information from the County, Hazus user defined facilities (UDF) were created for every parcel within the county. This analysis used parcel and building information to determine the correct location of buildings. The analysis only incorporated parcels that had buildings on them, which was identified by having a cost or building square footage. The UDF database was then used in Hazus for both the earthquake and flood analysis and was also used for the vulnerability assessment for tsunami and landslide. This methodology below identifies the assumptions, feature class overview, and the steps required to develop the Hazus UDF database.

The following assumptions were made for the UDF dataset:

- Parcel data is inconsistent. For example, water parcels (extensions of land parcels) are attributed with the same parcel data and unique identifier.
- Structure Footprints provided by Kitsap County are the best available data to assist in determining spatial integrity of Parcel Footprints.
- When a structure footprint intersects two or more parcels, the parcel that will be selected is the one where the structure footprint centroid rests.
- Parcel centroids resting outside of census tract boundaries are moved within the nearest census tract.
- Parcels are attributed with the following Unique ID Field: RP_ACCT_ID.
- For field populating, gray is target field entry; white is source behind entry.

AGR1

Farm Implement Building; Farm Sun Shade Shelter; Farm Utility Shelter; Farm Utility Storage Shed; Greenhouse Lath Shade House; Greenhouse Shade Shelter

The following datasets were used to develop the UDF database. These datasets are mentioned in the procedure section below.

Type	Source	Description	Feature/Table Name
Feature Class	RX RSC	Earthquake UDF Building Stock	parcels_final
Table	RX RSC	Flooding UDF Building Stock	UDF_FL_Kitsap
Feature Class	US Census (TIGER)	Census Blocks	x_Census_Block
Feature Class	US Census (TIGER)	Census Tracts	x_Census_Tract
Table	DFIRM (Preliminary)	Community Information Table	y_L_COMM_INFO
Feature Class	DFIRM (Preliminary)	Flood Hazard Areas	y_S_FLD_HAZ_AR
Feature Class	DFIRM (Preliminary)	Political Boundaries	y_S_POL_AR
Table	Kitsap County	Full Address	z_addrunits
Table	Kitsap County	Building Stock Information	z_building
Table	Kitsap County	Building Stock Information	z_CAMAPUBLIC_REAL_IMPROV
Table	Kitsap County	Building Stock Information	z_dwellings

Table	Kitsap County	Building, Land, and Assessed Values	z_flatats
Table	Kitsap County	Basic Parcel Information	z_main
Feature Class	Kitsap County	Parcel Footprints	z_parcels
Feature Class	Kitsap County	Parcel Centroids	z_parcels_pt
Table	Kitsap County	Full Address	z_Property_Addresses
Feature Class	Kitsap County	Structure Footprints	z_footprints
Feature Class	Kitsap County	Structure Centroids	z_structures_pt

The following procedure was completed for the development of the UDF database for the earthquake analysis. The procedure details each GIS step and process needed to create the UDF database.

1. Convert structure footprints to structure centroids
    a. Operation: Feature to Point
    b. Output: z_structures_pt
    c. Feature Count: 164,728 structure points
2. Select parcels with structures
    a. Operation: Select by Location
    b. Target Layer: z_parcels
    c. Source Layer: z_structures_pt
    d. Spatial Selection Method: intersect the source layer feature
    e. Selected Feature Count: 87,156 of 130,050 parcels with structures (67.0%)
3. Export selected parcels with structures
    a. Operation: Export Data
    b. Export: Selected Features
    c. Output: temp1
    d. Feature Count: 87,156 parcels with structures
    *Of Note: 348 of 87,156 Parcels have a RP_ACCT_ID of 0. These parcels may be general waterbodies, right-of-ways, or other non-relevant properties. This error is due to some structure footprints overlapping into these properties and the centroid plotting there accordingly. Based on a quick review, it appears accessory buildings are encroaching, not the main structure on the lot. The main structure and its corresponding parcel would still be accounted for.
4. Link Data in building table with temp1 parcel output
    a. Operation: Attribute Join
    b. Target Layer: temp1
    c. Source Table: building
    d. Join Field: RP_ACCT_ID
    e. Join Count: 82,977 of 87,156 parcels with structures have corresponding building data (95.2%)
5. Export selected parcels with building stock information
    a. Operation: Export Data
    b. Export: Selected Features
    c. Output: temp2
    d. Feature Count: 82,977 parcels with structures and building stock information
6. Add Latitude and Longitude Fields
    a. Target Layer: temp2
    b. Operation: Add Field
    c. Name: Latitude; Longitude
    d. Type: Double
7. Add UDF_Name Unique Identifier

a. Target Layer: temp2
b. Operation: Add Field
c. Name: UDF_Name
d. Type: String

8. Calculate Latitude and Longitudes of Parcels
    a. Target Layer: temp2
    b. Operation: Calculate Geometry
    c. Property: Y Coordinate of Centroid (Latitude); X Coordinate of Centroid (Longitude)
    d. Units: Decimal Degrees
9. Calculate UDF_Name of Parcels
    a. Target Layer: temp2
    b. Operation: Field Calculator
    c. Equation: "UDF"&[OBJECTID]
10. Load Features into Parcels (Final)
    a. Source Layer: temp2
    b. Target Layer: parcels_final*
    c. Fields Loaded: RP_ACCT_ID; IMPROV_TYP; USE_DESC; SumOfTotal_SqFT; UD_YRBLT; UD_STORIES; Latitude; Longitude; UDF_Name
       *parcels_final schema was acquired from a prior effort in the area – check with FEMA Region X for official template
11. Populating Field: CountOfRP_ACCT_ID
    a. Operation: Summarize
    b. Source Field: RP_ACCT_ID
    c. Output: temp_RP_ACCT_I_Count
    d. Operation: Join
    e. Target Layer: parcels_final
    f. Source Table: temp_RP_ACCT_I_Count
    g. Join Field: RP_ACCT_ID
    h. Operation: Field Calculator
    i. Source Field: CountOfRP_ACCT_ID
    j. Formula: parcels_final.CountofRP_ACCT_ID = temp_RP_ACCT_I_Count.CountofRP_ACCT_ID
    k. Operation: Remove Join
12. Populating Field: UD_OCC
    a. Source Field: USE_DESC; IMPROV_TYP
    b. Target Field: UD_OCC

       AGR1

       Farm Implement Building; Farm Sun Shade Shelter; Farm Utility Shelter; Farm Utility Storage Shed; Greenhouse Lath Shade House; Greenhouse Shade Shelter

       COM1

       Auto Showroom; Bookstore – Schools; Car Wash Auto; Car Wash Canopy; Car Wash Drive-Thru; Car Wash Self-Serve; Community Shopping Center; Complete Auto Dealership; Convenience Market; Country Club; Day Care Facility; Department Store; Discount; Drugstore; General Retail; Market; Mixed Retail with Office Units; Mixed Retail with Residential; Neighborhood Shopping Center; Regional Shopping Center; Small Shop; Supermarket; Warehouse Discount Store

       *COM1 used when no use description was available and the improvisational type was deemed "Commercial"

       COM2

       Armory; Barn; Cold Storage Facility; Cold Storage, Farm; Distribution Warehouse; Equipment Shed; Equipment – Shop – Building; Field Houses; General Commercial; Golf Cart Storage Building; Hangar; Heavy Utility Storage; Lean-To; Light Utility Storage; Light Warehouse; Loft Warehouse; Lumber Storage Building, Vertical; Lumber Storage Building, Horizontal; Material Shelter; Material Storage Shed; Mini Warehouse; Passenger Terminal; Storage Garage; Storage Warehouse; T-Hangar; Utility/Storage; Warehouse Showroom Store

       *COM2 used when no description was available and the improvisational type was deemed "Other"

       COM3

       Auto Service; Laundromat; Mini-Lube Garage; Mortuary; Service Garage; Service Station with Bays

       COM4

Office; Relocatable Office; Restroom Building; Shell, Office Building

COM5

Bank

COM6

Hospital

COM7

Dental Clinic; Kennel Animal Care; Medical Office; Veterinary Hospital

COM8

Auditorium; Bowling Alley; Casino; Clubhouse; Community Center; Convention Center; Dining/Lounge; Fast Food Restaurant; Fast Food Restaurant MSBB; Fitness Center; Food Booth, Prefabricated; Fraternal Building; Health Club; Indoor Tennis Club; Lodge; Museum; Restaurant; Skating Rink; Snack Bar; Tavern/Bar; Visitor Center

COM9

Cinema Theater; Theater-Live

COM10

Commercial Garage; Parking Garage; Parking Level

EDU1

Elementary School – Entire; High School – Entire; Junior High School – Entire; Multipurpose Building K-12; Physical Education Building K-12; Relocatable Classroom;

EDU2

Arts & Crafts Building College; Classrooms – College; Commons/Student Center; Gymnasium – College; Multipurpose Building-College; School Administration; School Classrooms; School Dining Facility; School Gymnasium; School Shower Rooms; Technical Trades Building-College; Vocational School

GOV1

Government Building; Library or Museum; Post Office; Post Office, Branch

GOV2

Fire Station Staffed; Fire Station Volunteer

IND1

Heavy Manufacturing

IND2

Industrial Flex Mall Building; Light Manufacturing; Research/Development

IND3

Barn, Hog; Barn, Sheep; Laboratory; Milkhouse

IND6

Industrial Office; Shed Office Structure

REL1

Church; Church with Sunday School; Fellowship Hall; Rectory

RES1

5; Condo – Tenant; Single Family; Townhouse – Owner

*RES1 used when no description was available and the improvisational type was deemed “Dwelling”

RES3A

Duplex

RES3B

Multi-family; Multiple Res-Low Rise, Shell; Multiple Res Senior-Low Rise; Triplex

RES3C

4-6 family

RES3D

Apartments

RES3E

Apartments, High Rise, Shell

RES4

Bed & Breakfast Inn; Guest Cottage; Hotel/Motel Service; Hotel/Motel Unit; Motel Room, 1 Sty-Single Row; Motel Room, 2 Sty-Single Row; Motel, Extended Stay

RES5

Fraternity House; Jail; Rooming House; School Dormitory

RES6

Convalescent Hospital; Group Care Facility; Senior Care Facility

13. Populating Field: UD_CONTENTS

a. Source Field: UD_OCC
b. Target Field: UD_CONTENTS

Contents Value % - 50

COM10, RES1, RES3A, RES3B, RES3C, RES3C, RES3D, RES3E, RES4, RES5, RES6

Contents Value % - 100

AGR1, COM1, COM2, COM3, COM4, COM5, COM8, COM9, EDU1, GOV1, IND6, REL1

Contents Value % - 150

COM6, COM7, EDU2, GOV2, IND1, IND2, IND3

14. Populating Field: UD_BLDGTYPE
    a. Source Field: UD_OCC
    b. Target Field: UD_BLDGTYPE

CONCRETE

COM1, COM2, COM3, COM4, COM5, COM6, COM7, COM8, COM9, COM10, EDU1, EDU2, GOV1, GOV2, REL1

STEEL

IND1, IND2, IND3, IND6

WOOD

RES1, RES3A, RES3B, RES3C, RES3C, RES3D, RES3E, RES4, RES5, RES6

15. Populating Field: UD_EQBLDGTYPE
    a. Source Field: UD_BLDGTYPE; SumOfTotal_SqFt
    b. Target Field: UD_EQBLDGTYPE

C1L

CONCRETE

S1L

STEEL

W1

WOOD and Square Feet is less than or equal to 5000

W2

WOOD and Square Feet is greater than 5000

16. Populating Field: UD_AREA
    a. Source Field: SumOfTotal_SqFt
    b. Target Field: UD_AREA
17. Populating Field: UD_FOUNDTYPE
    a. Source Field: FOUNDAT (from Kitsap County Table – z_CAMAPUBLIC_REAL_IMPROV)
    b. Target Field: UD_FOUNDTYPE

4 (Basement)

½ Basement; ½ Basement, ¼ Crawlspace; ½ Basement, ¼ Crawlspace, Lower Level; ½ Basement, Lower Level; ¼ Basement; ¼ Basement, Lower Level; ¾ Basement; ¾ Basement, ¼ Crawlspace; ¾ Basement, Lower Level; Full Basement; Full Basement, Lower Level

5 (Crawlspace)

½ Crawlspace; ½ Crawlspace, Lower Level; ¼ Basement, ½ Crawlspace; ¼ Basement, ½ Crawlspace, Lower Level; ¼ Basement, ¾ Crawlspace; ¼ Basement, ¾ Crawlspace, Lower Level; ¼ Crawlspace; ¼ Crawlspace, Lower Level; ¾ Crawlspace; ¾ Crawlspace, Lower Level; Full Crawlspace; Full Crawlspace, Lower Level

7 (Slab)

½ Basement, ½ Crawlspace; ½ Basement, ½ Crawlspace, Lower Level; ¼ Basement, ¼ Crawlspace; ¼ Basement, ¼ Crawlspace, Lower Level; Lower Level

*7 (SLAB) value used for null, no, and unknown values

*z_CAMAPUBLIC_REAL_IMPROV does not have a Unique ID Field. Multiple structures on the same lot may share the same RP_ACCT_ID value but have unique foundation types. Attribute Join used to link table.

18. Populating UD_EQFOUNDTYPE
    a. Source Field: FOUNDAT (from Kitsap County Table – z_CAMAPUBLIC_REAL_IMPROV)
    b. Target Field: UD_EQFOUNDTYPE

5 (Basement)

½ Basement; ½ Basement, ¼ Crawlspace; ½ Basement, ¼ Crawlspace, Lower Level; ½ Basement, Lower Level; ¼ Basement; ¼ Basement, Lower Level; ¾ Basement; ¾ Basement, ¼ Crawlspace; ¾ Basement, Lower Level; Full Basement; Full Basement, Lower Level

2 (Crawlspace)

½ Crawlspace; ½ Crawlspace, Lower Level; ¼ Basement, ½ Crawlspace; ¼ Basement, ½ Crawlspace, Lower Level; ¼ Basement, ¾ Crawlspace; ¼ Basement, ¾ Crawlspace, Lower Level; ¼ Crawlspace; ¼ Crawlspace, Lower Level; ¾ Crawlspace; ¾ Crawlspace, Lower Level; Full Crawlspace; Full Crawlspace, Lower Level

1 (Slab)

½ Basement, ½ Crawlspace; ½ Basement, ½ Crawlspace, Lower Level; ¼ Basement, ¼ Crawlspace; ¼ Basement, ¼ Crawlspace, Lower Level; Lower Level

*1 (SLAB) value used for null, no, and unknown values

*z_CAMAPUBLIC_REAL_IMPROV does not have a Unique ID Field. Multiple structures on the same lot may share the same RP_ACCT_ID value but have unique foundation types. Attribute Join used to link table.

19. Populating Field: UD_PARCELID
    a. Source Field: PARCELID (from Kitsap County Table – z_main)
    b. Target Field: UD_PARCELID
20. Populating Field: UD_COST
    a. Source Field: BLDG_VALUE (from Kitsap County Table – z_flatats)
    b. Target Field: UD_COST
    c. Field Calculator: UD_COST = BLDG_VALUE / CountOfRP_ACCT_ID

    *Cost data is aggregated at the parcel level in the z_flatats table. Value is divided equally among all structures.
21. Populating Fields: UD_BLDGDAMGE; UD_CONTDAMGE; UD_INVDAMGE
    a. Source Fields: UD_OCC; default table provided below
    b. Target Fields: UD_BLDGDAMGE; UD_CONTDAMGE; UD_INVDAMGE

UD_OCC	UD_BLDGDAMGE	UD_CONTDAMGE	UD_INVDAMGE
AGR1	616	616	116
COM1	217	217	1
COM10	543	357	
COM2	341	195	46
COM3	375	240	
COM4	431	280	
COM5	467	304	
COM6	474	309	
COM7	475	312	
COM8	493	322	
COM9	532	352	
EDU1	643	480	
EDU2	643	480	
GOV1	631	472	
GOV2	640	477	
IND1	545	358	70
IND2	559	384	81
IND3	575	408	93
IND4	586	433	106
IND5	591	442	111
IND6	592	443	112
REL1	624	467	
RES1	105	21	
RES2	189	74	
RES3A	204	81	
RES3B	204	81	
RES3C	204	81	
RES3D	204	81	

UD_OCC	UD_BLDGDAMGE	UD_CONTDAMGE	UD_INVDAMGE
RES3E	204	81	
RES3F	204	81	
RES4	209	85	
RES5	214	88	
RES6	215	89	

22. Populating Field: BLDG_VALUE
    a. Source Field: BLDG_VALUE (from Kitsap County Table - flatats)
    b. Target Field: BLDG_VALUE
    *Cost data is aggregated at the parcel level in the flatats table. Value is divided equally among all structures.
23. Populating Field: LAND_VALUE
    a. Source Field: LAND_VALUE (from Kitsap County Table - flatats)
    b. Target Field: LAND_VALUE
    *Cost data is aggregated at the parcel level in the flatats table. Value is divided equally among all structures.
24. Populating Field: ASSD_VALUE
    a. Source Field: ASSD_VALUE (from Kitsap County Table - flatats)
    b. Target Field: ASSD_VALUE
    *Cost data is aggregated at the parcel level in the flatats table. Value is divided equally among all structures.
25. Populating Field: AE_VE_ZONE
    a. Source Field: FLD_ZONE (from DFIRM Feature - y_S_FLD_HAZ_AR)
    b. Target Field: AE_VE_ZONE

FLOOD HAZARD AREA	AE_VE_ZONE
V (including Zone V, VE)	2
A (including Zone A, AE, AH, AO)	1
X (including Zone X, X (shaded))	0

    * Priority goes to V Zones, then A Zones, and then X Zones
26. Populating Field: UD_Cont_Cos
    a. Source Field: UD_OCC; UD_COST
    b. Target Field: UD_Cont_Cos

    UD_Cont_Cos = 0.5*(UD_COST) if UD_OCC:
    COM10, RES1, RES3A, RES3B, RES3C, RES3C, RES3D, RES3E, RES4, RES5, RES6
    UD_Cont_Cos = 1.0*(UD_COST) if UD_OCC:
    AGR1, COM1, COM2, COM3, COM4, COM5, COM8, COM9, EDU1, GOV1, IND6, REL1
    UD_Cont_Cos = 1.5*(UD_COST) if UD_OCC:
    COM6, COM7, EDU2, GOV2, IND1, IND2, IND3
27. Populating Field: Design_Qtl
    a. Source Field: UD_EQBLDGTYPE; UD_YRBLT
    b. Target Field: Design_Qtl

    PC
    If UD_YRBLT is before 1941 and UD_EQBLDGTYPE is not equal to W1
    MC
    If UD_YRBLT is 1941 or after; If UD_YRBLT is before 1941 and UD_EQBLDGTYPE is equal to W1
28. Populating Field: Tract
    a. Source Field: parcels_final; (from x_Census_Tract Feature – GEOID)
    b. Target Field: Tract
    c. Operation: Feature to Point (parcels_final)
    d. Output: z_parcels_pt
    e. Spatial Join: Points to Polygons; Each point will be given all the attributes of the polygon that it falls inside
    f. Output: temp_z_parcels_pt_census_tract
    g. Operation: Attribute Join
    h. Target Layer: parcels_final
    i. Source Table: temp_z_parcels_pt_census_tract

j. Join Field: UDF_Name
k. Operation: Field Calculator
l. Equation: parcels_final.tract = temp_z_parcels_pt_census_tract.GEOID
m. Operation: Remove Join
*If point does not intersect tract, the point will be edited and moved to the nearest census tract and given the attributes of that census tract. The Latitude and Longitude fields will also be recalculated.

The following procedure was completed for the development of the UDF database for the flood analysis. The procedure details each GIS step and process needed to create the UDF database.

1. Select parcels that intersect a Special Flood Hazard Area
   a. Source Layer: parcels_final
   b. Operation: Select by Attributes
   c. Equation: AE_VE_ZONE IN (1, 2)
2. Export selected parcels intersecting a Special Flood Hazard Area
   a. Source Layer: parcels_final
   b. Operation: Export Table
   c. Export: Selected Features
   d. Output: temp_fld
3. Load Features into UDF_FL_Kitsap table
   a. Source Table: temp_fld
   b. Target Table: UDF_FL_Kitsap*
   c. Fields Loaded: Name; Address; City; State; Zip; Occupancy; BldgType; Cost; Area; NumStories; FoundationType; ContentCost; BldgDamageFnld; ContDamageFnld; InDamageFnld; Latitude; Longitude; CensusTract; FloodZone; YearBuilt
   *UDF_FL_Kitsap schema was acquired from template – check with FEMA Region X for official template.
   **County was populated as "Kitsap"; Comment was populated as "A Zone" for Flood Zone value of 1; Comment was populated as "V Zone" for Flood Zone value of 2
4. Populating Field: FirstFloorHt
   a. Source Fields: AE_VE_ZONE; CID (S_POL_AR); IN_FRM_DAT (L_COMM_INFO)
   b. Target Field: FirstFloorHt
   c. Process: Centroid of an SFHA Parcel is spatially joined with the Political Boundary (Feature: S_POL_AR). CID (Field: CID) from S_POL_AR is joined with CID (Field: COM_NFO_ID) from L_COMM_INFO table. Initial FIRM Date (Field: IN_FRM_DAT) is used to determine Pre-FIRM / Post-FIRM designations.

A Zones (Including A, AE, and Coastal AE)

4 – Basement - Pre-FIRM: 4' | Post-FIRM: 4'
5 – Crawlspace - Pre-FIRM: 3' | Post-FIRM: 4'
7 – Slab - Pre-FIRM: 1' | Post-FIRM: 1'

V Zones (Including VE)

4 – Basement - Pre-FIRM: 4' | Post-FIRM: 4'
5 – Crawlspace - Pre-FIRM: 3' | Post-FIRM: 4'
7 – Slab - Pre-FIRM: 1' | Post-FIRM: 1'

Initial FIRM Dates

Community	Initial FIRM Year
Kitsap County, Unincorporated Areas of (530092)	1980
Bremerton, City of (530093)	1979
Port Orchard, City of (530094)	1979
Poulsbo, City of (530241)	1979
Bainbridge Island, City of (530307)	1986

*Parcel centroids residing within in the Port Gamble S'Klallam Tribe and Suquamish Tribe were given Pre-FIRM status for First Floor Height designation.

29. Populating Field: CensusBlock
   a. Source Field: z_parcels_pt; (from x_Census_Block Feature – GEOID)
   b. Target Field: CensusBlock

c. Spatial Join: Using z_parcels_pt, Points to Polygons; Each point will be given all the attributes of the polygon that it falls inside
d. Output: temp_z_parcels_pt_census_block
e. Operation: Attribute Join
f. Target Table: UDF_FL_Kitsap
g. Source Table: temp_z_parcels_pt_census_block
h. Join Field: UDF_Name
i. Operation: Field Calculator
j. Equation: UDF_FL_Kitsap.CensusBlock = temp_z_parcels_pt_census_block.GEOID
k. Operation: Remove Join
*If point does not intersect block, the point will be edited and moved to the nearest census block and given the attributes of that census block. The Latitude and Longitude fields will also be recalculated.

Some additional edits were required for the UDF datasets, which are identified below.

26 properties had a 0 year built; this was changed to 1975 since many looked to be modern buildings. 7,572 buildings have 0 for the number of stories; these were all changed to one story. The content cost was calculated for those that had 0 as well.

466 properties had no cost. A $/square footage was calculated per occupancy and applied to determine the cost. The $/square footage table is shown below.

Occupancy	**Total Square Footage**	**Total Cost**	**$/SqFt**
AGR1	70,802	9,922,328.21	140.1419
COM1	8,841,348	738,692,143.28	83.54972
COM10	970,878	14,033,969.17	14.45493
COM2	6,846,682	367,043,955.48	53.60903
COM3	902,623	54,966,450.62	60.89635
COM4	3,953,624	396,569,753.04	100.3054
COM5	453,448	54,677,391.00	120.5814
COM6	402,956	128,515,520.00	318.9319
COM7	1,287,113	172,073,921.17	133.6898
COM8	2,224,725	221,494,031.72	99.56018
COM9	210,865	17,983,506.90	85.28446
EDU1	2,248,605	246,903,231.43	109.8028
EDU2	4,082,428	261,040,831.53	63.94254

Occupancy	Total Square Footage	Total Cost	$/SqFt
GOV1	396,634	36,022,158.83	90.81964
GOV2	262,301	28,428,234.54	108.3802
IND1	8,924	261,602.50	29.31449
IND2	711,128	41,748,234.59	58.70706
IND3	21,518	1,302,755.40	60.54259
IND6	10,930	1,340,983.33	122.6883
REL1	2,024,756	143,498,942.86	70.87222
RES1	188,187,757	12,505,004,285.65	66.44962
RES3A	3,415,475	154,378,253.42	45.19964
RES3B	329,834	14,541,165.56	44.08631
RES3C	1,342,954	30,624,457.45	22.8038
RES3D	10,410,026	507,589,356.59	48.75966
RES3E	27,408	350,580.71	12.79118
RES4	804,880	56,442,858.38	70.12581
RES5	349,584	21,322,026.15	60.99257
RES6	1,316,372	104,860,550.50	79.65875

The completed UDF dataset for earthquake and flood were used in the Hazus analysis for earthquake and flood and was also used for the tsunami and landslide vulnerability assessment. The datasets used in the analysis are in the risk database. The GIS layers in the risk database are described below.

Notes: The following codes were used in the UDF database and Hazus earthquake analysis. Pre-code is any buildings built prior to 1941. Moderate code is any building built post 1941. These values are the Hazus defaults. The dates differ for the building code analysis since additional research was done to understand the building codes in Washington. An additional Hazus analysis will have to be completed to incorporate updated pre-code for structures prior to 1975 and moderate code for structures after 1975 which will result in higher damages for those buildings that are between 1941 and 1975.

Risk Database - GIS layers

Many of these layers have been symbolized and is available in a map package called Risk_Asses_Results.mpk. Below are the list of datasets available in the Risk Assessment Database.

Layer			Description
Grouping	Component	Feature Name	
Earthquake Hazard	Instrumental Intensity	mmi.shp	Shaking of the ground due to an earthquake.
	Earthquake Losses	EQ_Results.gdb	Structures with building loss due to earthquake. The feature class for every building with damage is called UDF_Loss_Final. Other datasets include essential facility and transportation damage.
Flood Hazard	Flood Losses	UDF_Losses	Structures with building loss due to flood. The feature class is located in the Flood_Losses.gdb.
	Hazard Area	S_FLD_HAZ_AR	Identified Special Flood Hazard Areas and other corresponding zones of known or unknown flood risk. Located within the DFIRM_DB folder. Also includes additional DFIRM information such as base flood elevation, cross sections, etc.
	Coastal Depth Grid	Coastal_depth01pct	Flooding depth in feet during a 1% annual chance flood event (coastal only).Included in the database titled 53035C_Kitsap_WA_FSR_Rasters.gdb.
	Coastal Depth Grid (Plus 1 Ft)	Coastal_depth01pct_plus1	Flood inundation during a 1% annual chance flood and at one foot increments from the 1% annual chance base flood elevation (coastal only).
	Coastal Depth Grid (Plus 2 Ft)	Coastal_depth01pct_plus2	
	Coastal Depth Grid (Plus 3 Ft)	Coastal_depth01pct_plus3	
Landslide Hazard	Hazard Area	Landslide_final	Landslide hazard area.
Liquefaction Hazard	Hazard Area	Liquefaction.mdb	Liquefaction hazard area.
Political Boundaries	Jurisdictional Boundaries	Cities.shp, County.shp, Tribal.shp	Political Boundaries taken from effective or preliminary flood studies.
UDF	Raw Data	UDF_Input.mdb	User Designed Facilities are attributed with basic information including cost, contents cost, design quality, area, building type, year built, location, etc. For certain hazards (earthquake and flood), loss estimates and loss ratio are provided. For other hazards, a simple intersect between the hazard layer and UDF point was used. The two input tables are called Parcel_EQ_pt and UDF_FL_Kitsap.

Acronyms and Definitions

AOMI Area of Mitigation Interest
BFE Base Flood Elevation
CCO Community Coordination Officer
CIP Capital Improvement Plan
COG Continuity of Government
COOP Continuity of Operations Plans
CDMS Comprehensive Data Management System
DGER Division of Geology and Earth Resources
EF Essential Facility
EOP Emergency Operations Plans
FIRM Flood Insurance Rate Map
FRR Flood Risk Review
GBS General Building Stock
LiDAR Light Detection and Ranging
LOMA Letters of Map Amendment
NEHRP National Earthquake Hazards Reduction Program
SFHA Special Flood Hazard Area
STARR Strategic Alliance for Risk Reduction
UDF User Defined Facility
USGS U.S. Geological Survey
WADNR Washington State Department of Natural Resources

Additional Resources

Hazus-MH Earthquake Model

Technical Manual: http://www.fema.gov/media-library-data/20130726-1820-25045-6286/hzmh2_1_eq_tm.pdf

User Manual: http://www.fema.gov/media-library-data/20130726-1820-25045-1179/hzmhs2_1_eq_um.pdf
Comprehensive Data Management System:

Data Dictionary: http://www.fema.gov/media-library-data/20130726-1749-25045-0320/cdms_data_dict.pdf

Hazus-MH Flood Model
Technical Manual: http://www.fema.gov/media-library-data/20130726-1820-25045-8292/hzmh2_1_fl_tm.pdf

User Manual: http://www.fema.gov/media-library-data/20130726-1820-25045-8814/hzmh2_1_fl_um.pdf

USGS Shakemap Scenarios:
http://earthquake.usgs.gov/earthquakes/shakemap/global/shake/Casc9.0_expanded_se/

WA Geological Information Portal: https://fortress.wa.gov/dnr/geology/ or
http://www.dnr.wa.gov/ResearchScience/Topics/GeosciencesData/Pages/geology_portal.asp