
SITKA HARBOR, BANDORF ISLAND

Risk Report

FEMA Region X – City and Borough of Sitka, Alaska

City and Borough of Sitka

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1. Introduction

This report outlines the risk assessment results and findings for the Federal Emergency Management Agency's (FEMA) Risk Mapping, Assessment, and Planning (Risk MAP) study. All results, databases, and maps used to generate this report are provided in the Risk Assessment Database included with this report. The Risk Report has two goals: inform communities of their risks related to certain natural hazards, and 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 do the following:

- **Update local hazard mitigation plans, shoreline master plans, and community comprehensive plans** – Planners can use risk information when developing or updating hazard mitigation plans, comprehensive plans, future land use maps, and zoning regulations. For example, zoning codes can 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, continuity of government plans, and emergency operations plans 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 (AOMIs).
- **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

2. Risk Assessment

A risk assessment analyzes how hazards affect 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 the City and Borough of Sitka was incorporated into the Hazus model. Other hazards were assessed through a vulnerability assessment. To assess potential community losses, the following information was collected:

- Local assets or resources at risk to the hazard
- Physical features and human activities that contribute to that risk
- Location and severity of the hazard

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

1. 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: Vulnerability Assessment

Additionally, hazard profiles were developed for hazards where spatial data was not readily available:

5. Avalanche: Hazard Profile
6. Wildfire: Hazard Profile

For the basis of this assessment, economic loss is summarized for non-vacant parcels where at least one structure has been identified. Parcels with at least one structure may be referred to throughout this report as "improved parcels" or more generally "buildings". Additionally, total values and economic losses consider the replacement value of the building and its contents. A detailed methodology of the risk assessment is listed in the hazard sections below.

3. City and Borough of Sitka Risk MAP Overview

A flood study project updating riverine flood hazards in select portions of the City and Borough of Sitka is currently ongoing. FEMA's Production and Technical Services provider, the Strategic Alliance for Risk Reduction (STARR); FEMA's Community Engagement and Risk Communication provider, *Resilience Action Partners*; and the Alaska Department of Community and Regional Affairs are contributing to this project.

Project Milestones

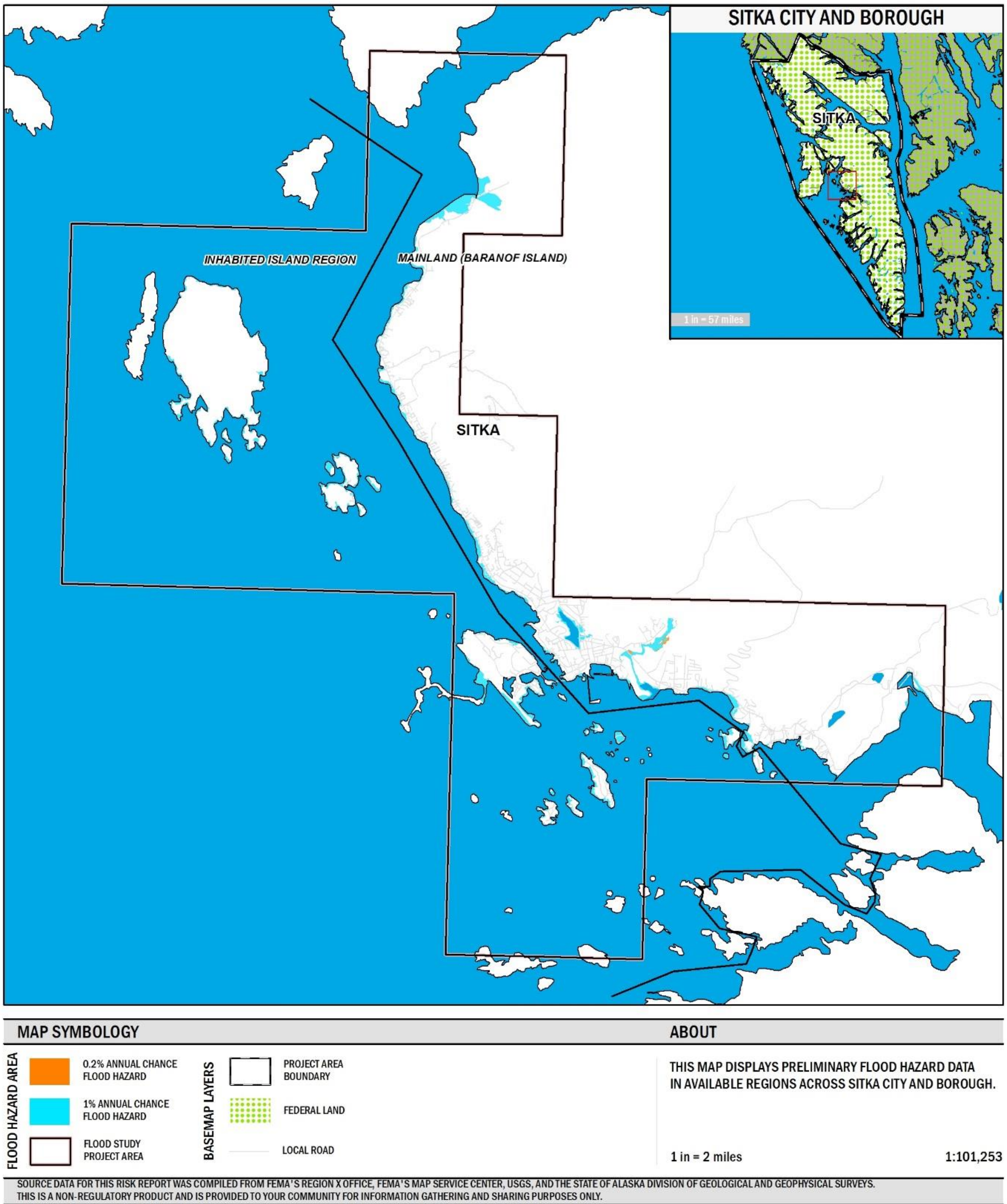
Project milestones are the estimated completion timeframes for key tasks or events that must be accomplished to complete a Risk MAP project phase. They serve as progress indicators and are the basis for planning future Risk MAP meetings. However, all project milestones are subject to change due to changes in scope, delays in data acquisition, and other unforeseen complexities within a study. The project timeline is shown in Table 1.

Table 1: Project Timeline

TASK NAME	CITY AND BOROUGH OF SITKA RISK MAP TIMELINE
RISK MAP DISCOVERY MEETING	AUGUST 5, 2013
FLOOD RISK REVIEW (FRR) MEETING/DRAFT MAPS	FEBRUARY 2, 2016
PRELIMINARY DFIRM/FIS RELEASE	JUNE 30, 2016
CONSULTATION COORDINATION OFFICERS (CCO) WEBINAR	OCTOBER 13, 2016
CCO MEETING AND PUBLIC MEETING/OPEN HOUSE	JANUARY 25, 2017
APPEAL PERIOD START	JANUARY 2017*
APPEAL PERIOD ENDS	APRIL 2017*
DRAFT MULTI-HAZARD RISK REPORT	MID-FEBRUARY 2017*
RISK MAP RESILIENCE WORKSHOP	SPRING/SUMMER 2017*
DELIVERY OF FINAL REPORT AND RISK ASSESSMENT DATABASE	SUMMER 2017*
LETTER OF FINAL DETERMINATION	SUMMER 2017*
MAPS AND FIS BECOME EFFECTIVE	WINTER 2017/2018*

**projected timeline*

PROJECT AREA



Map 1: Project Area and Flood Hazard Areas of Sitka City and Borough

There are three required meetings between FEMA, the State, and the jurisdictions as part of this Risk MAP Project; they are the Flood Risk Review (FRR), Community Coordination Officer (CCO), and Resilience meetings. The input data, methodology, and draft maps will be presented at the FRR meeting. Preliminary results of the Flood Insurance Study are reviewed and discussed with community officials at the CCO meeting. At the request of the City and Borough, meetings for the public will also be held. Finally, Resilience meetings are anticipated to be held in the Spring or Summer of 2017 (City and Borough of Sitka Quarterly Report, 2016). The purpose of Resilience meetings is to continue to build local capacity for implementing the most important mitigation activities within the watershed.

Project Scope

The City and Borough of Sitka Risk MAP flood study included updates along the Indian River, Swan Lake, and Sitka Sound. The flood hazards associated with Indian River were redelineated using updated topography. A new approximate flood study was provided for the coastline of Swan Lake. The coastal flood hazards of Sitka Sound were studied in detail from the northwest of Silver Bay to south of Katlian Bay. For additional information, please refer to project scope map in the Appendix (Flood Insurance Study, 2016. P33).

Additional Project Deliverables

The City and Borough of Sitka Risk MAP study includes Flood Risk Datasets (Flood Depth and Analysis Grids), a Multi-Hazard Database, and Risk Report. These Risk MAP datasets will be delivered as part of this report.

4. Flood Risk Assessment

Flood Hazard Overview

The City and Borough of Sitka has experienced five flood insurance claims since 1978. Flooding could result from heavy rainfall, urban stormwater overflow, rapid snowmelt, rising groundwater, chronic debris deposition, ice jamming, flash flooding, fluctuating lake levels, alluvial fan flooding, glacial lake outbursts, subglacial release, coastal storm surges, and tsunamis. Additionally, surface runoff can cause road embankment erosion as seen repeatedly with Blue Lake Road.

Previous occurrences of floods in the City and Borough of Sitka include a hurricane-force storm in 1984 that increased tides and damaged public and private property (City and Borough of Sitka Multi-hazard Mitigation Plan, 2016. P39). In the winter of 2005 a storm of record rainfall resulted in coastal flooding, landslides, and damages (City and Borough of Sitka Multi-hazard Mitigation Plan, 2016. P39).

Flooding can also generate erosion along coastlines and stream banks. Coastal erosion causes the shoreline to retreat and stream bank erosion removes material from the bank of the stream. Both result in a loss of vegetation, fish habitat, and property. Areas of potential coastal flooding include Dove Island, Marina, Sitka Harbor, Harbor Point, Alice & Charcoal Island, Galankin Island, and the Indian River Floodway. The varying sources of local flooding make this hazard a regular occurrence in the region. As of now, the City and Borough of Sitka has a low probability of flooding but the potential is there should an avalanche or landslide occur (City and Borough of Sitka Multi-hazard Mitigation Plan, 2016).

No Presidentially Declared Disasters have occurred within the City and Borough of Sitka, but the following flood occurrences (Table 2) and concerns (Table 3) have impacted and identified the community:

Table 2: Flood Occurrences for Sitka City and Borough

DATE	INCIDENT TYPE	DESCRIPTION
11/26/1984	FLOOD	A STRONG WINDSTORM AND WIND DRIVEN TIDES CAUSED DAMAGE ALONG THE ALASKAN PENINSULA. STATE PROVIDED PUBLIC AND INDIVIDUAL ASSITANCE. A PRESIDENTIAL DISASTER DECLARATION WAS DECLINED.
12/23/2005	FLOOD	A STRONG WINTER STORM, HIGH WINDS, AND RAINFALL OCCURRED ALONG THE ALASKA PENINSULA. COASTAL FLOODING, LANDSLIDES, AND DAMAGE TO LIFE AND PROPERTY OCCURRED. STATE PROVIDED $1.87 MILLION IN ASSISTANCE.

(City and Borough of Sitka Multi-hazard Mitigation Plan, 2010. P39, 52/116)

Table 3: Principal Flood Problems for Sitka City and Borough

FLOODING SOURCE	DESCRIPTION OF FLOOD PROBLEM
INDIAN RIVER	FLOODING AFTER PERIODS OF HEAVY PRECIPITATION.
SITKA SOUND	FLOODING CAN BE EXPECTED AFTER A COMBINATION OF HIGH WINTER TIDES, SOUTHEAST WINDS, AND STORM SURGES.

(Flood Insurance Study, 2016. Table 6)

Studying Flood Hazards with the Risk MAP Program

In 2016, FEMA created a new Flood Insurance Rate Map (FIRM) for the City and Borough of Sitka. New flood modeling was performed for the inland riverine and coastal areas. Areas to be mapped included

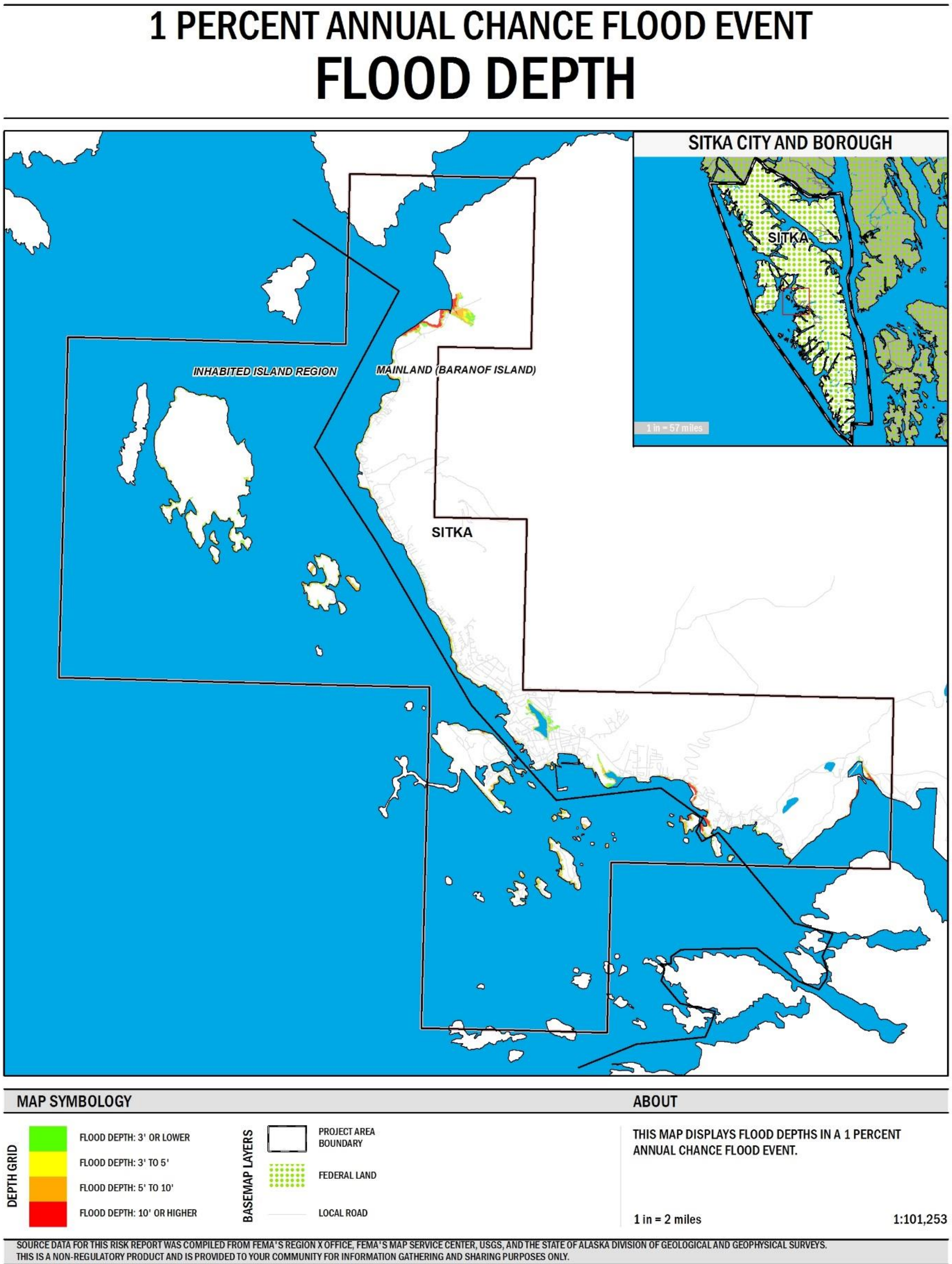
Baranof Island, southern Chichigof Island, Japonski Island, and the coastal areas along these. The City and Borough of Sitka, in all, covers a land area of 2,870 square miles.

In addition to a new FIRM, flood risk assessment products were developed and used to prepare this Risk Report. Depth grids for the 1-percent-annual-chance flood event were created for Swan Lake, Sitka Sound, and Indian River. Depth grids, which display the flood depth in feet, were used in this risk assessment to determine which properties would be affected by flooding (Map 2). Additionally, coastal depth grids for Baranof Island and the surrounding islands of Chichigof and Japonski include depth grids with increases of +1, +2, and +3 feet above Base Flood Elevation (BFE). These grids allow users to review the inundation occurring at 1 foot increases to the 1-percent-annual-chance flood event (Map 3).

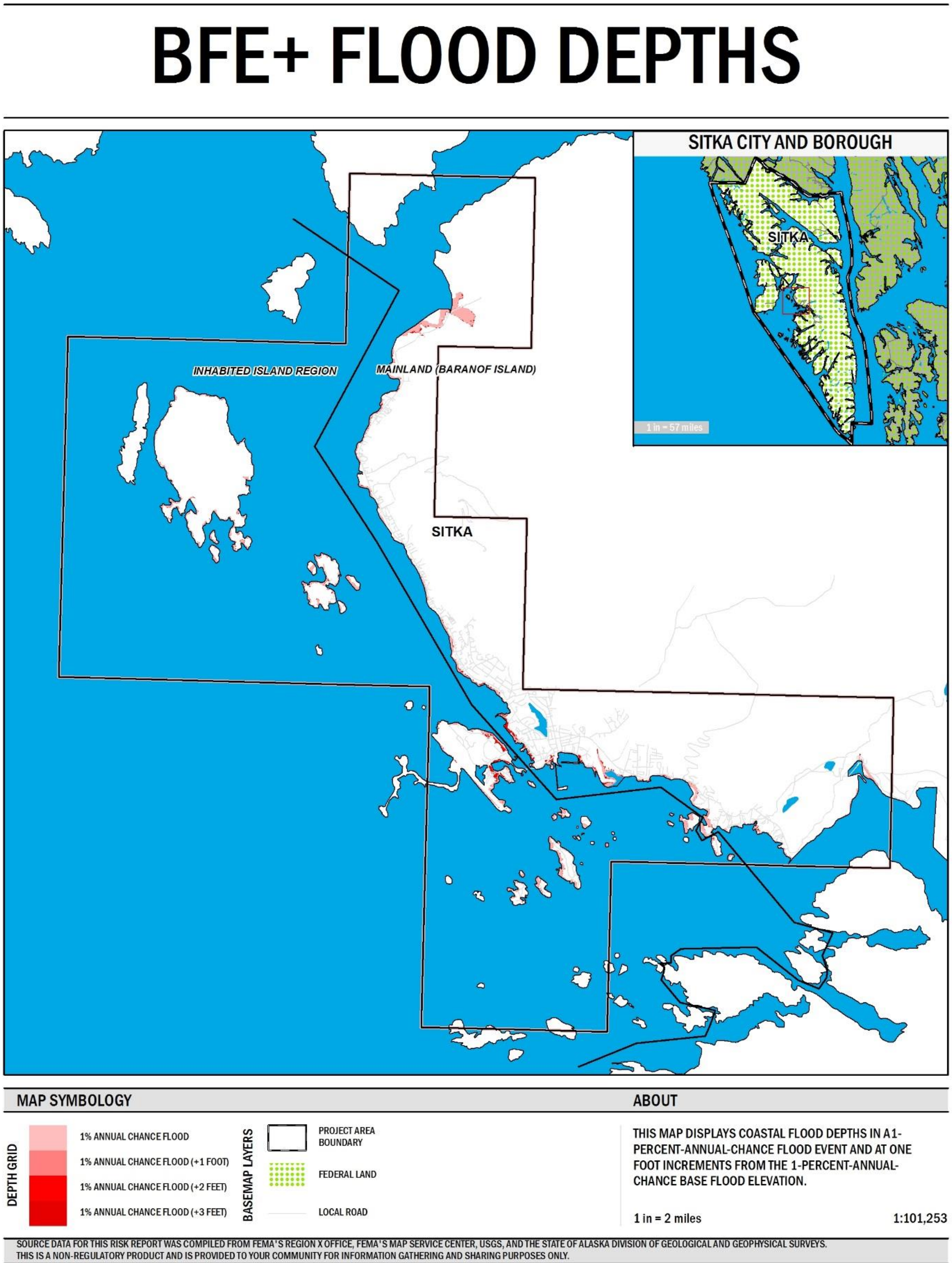
A depth grid can also be used as an outreach tool to show the hazards of flooding. Properties shown to be affected by a flood event would be excellent locations for mitigation projects. Some of these potential mitigation projects are highlighted in the section of this report for each community.

In addition to the depth grids, a water surface elevation grid for Swan Lake's 1-percent-annual-chance event was created. This tool provides a Base Flood Elevation at any location within the Special Flood Hazard Area along the lake. The grid datasets can be used for future land use and comprehensive planning. These products are meant to guide local communities with quick flood elevation determinations.

Map 2: Depth Grid for the City and Borough of Alaska



Map 3: BFE+ Flood Depth Grids for the City and Borough of Sitka



Flood Risk Assessment Overview

This flood risk assessment includes the community shown in Table 4:

Table 4: Community Characteristics in the City and Borough of Sitka

COMMUNITY NAME	TOTAL POPULATION (2015 EST.)	CRS COMMUNITY	FLOOD CLAIMS	REPETITIVE LOSS PROPERTIES	TOTAL POLICIES	TOTAL INSURANCE COVERAGE
SITKA CITY AND BOROUGH	8,863	NO	5	0	81	$23,992,400
MAINLAND (BARANOF ISLAND)	---	---	---	---	---	---
INHABITED ISLANDS	---	---	---	---	---	---

--- (no data available)

Note: Population estimate from US Census. American FactFinder. Insurance data from FEMA Community Information System platform.

The information in Table 4 can be used to highlight areas that are already affected by flooding, including repetitive loss properties and flood claims. In addition, the insurance coverage can be compared to the dollar losses shown in Table 5 to determine if enough coverage exists for a specific event.

The flood risk assessment was completed using Hazus-MH 3.2, FEMA's loss estimation software, with individual parcel data provided by the City and Borough. The DOGAMI Hazus Flood UDF Loss Estimation Script, developed by Oregon's Department of Geology and Mineral Industries, was used to execute the loss estimation. Only properties with buildings (improvements) were incorporated into the analysis; therefore, no impacts to vacant land were assessed. Depth grids derived from the Risk MAP project were also used for this analysis. For this assessment, depth grids were used where available, as shown in **Error! Reference source not found.**. Buildings in areas where depth grids were available were incorporated into Hazus, which provided building, content, and/or inventory loss values.

Buildings outside of the depth grid study extents were analyzed to show whether or not they intersected a SFHA. Structures were further analyzed by the type of hazard area they intersected. Table 5 highlights the building value and loss ratios of parcels within the floodplain, by area. Parcels with buildings intersecting any SFHA are also summarized by area, where the flood hazard data was available.

Table 5: SFHA Assessments in the City and Borough of Sitka

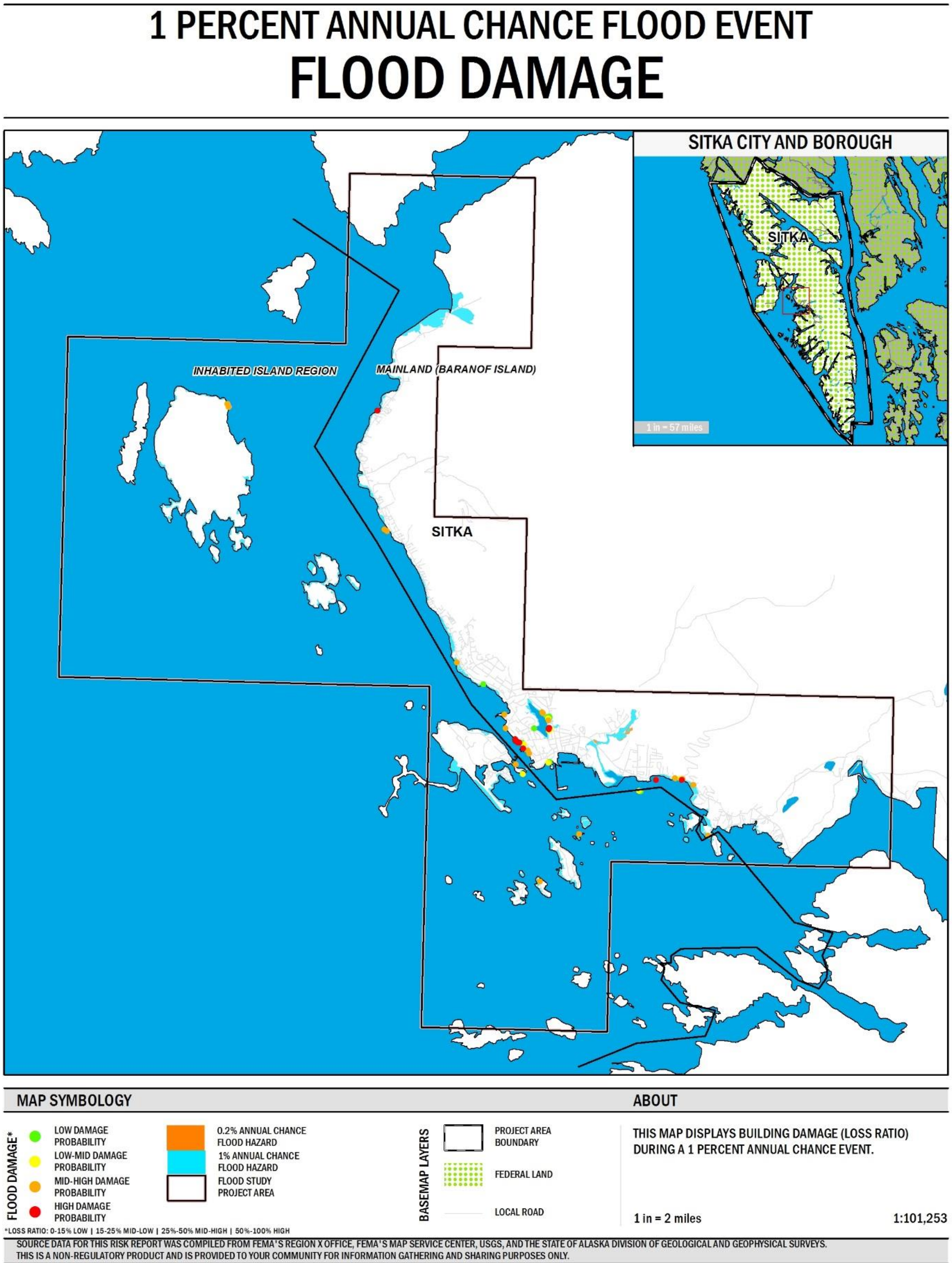
COMMUNITY NAME	BUILDINGS IN SPECIAL FLOOD HAZARD AREA	BUILDINGS IN ZONE A, AE	BUILDINGS IN ZONE VE	BUILDINGS IN HAZUS FLOOD ANALYSIS	BUILDING DOLLAR LOSS FOR A 1%-ANNUAL-CHANCE FLOOD EVENT	LOSS RATIO (DOLLAR LOSSES / TOTAL BUILDING VALUE)
SITKA CITY AND BOROUGH	119	73	46	49	$13,285,000	1.24%
MAINLAND (BARANOF ISLAND)	91	65	26	36	$9,953,000	0.99%
INHABITED ISLANDS	28	8	20	13	$3,332,000	4.87%

Note: Dollar losses are reported, as well as a loss ratio, which is calculated as the total building losses/total building value. The loss values are for building and contents only; additional damages to infrastructure are not captured in this table.

Sitka has 119 structures identified in a SFHA. Slightly below two-thirds of these structures are located within Zone A or AE while the remaining third reside in a coastal Zone VE SFHA. Flood depth grids, required to run a Hazus flood assessment, are only available for Swan Lake and Sitka Sound. Loss estimates can only be generated for approximately 40-percent of inundated structures. From the available data, an estimated $13.3 million is at risk to a 1-percent-annual-chance flood event. While losses are expected to be only 1-percent of the total building and content value of structures, the total community dollar loss would be expected to be much greater than $13.3 million; accounting for structures where site specific assessments are not available. When comparing buildings at risk to flooding and enacted insurance policies, there is room to target additional outreach. There are 81 policies in effect (as seen in Table 4) compared to 119 structures at risk to a flood event.

While a 1-percent-annual-chance event will result in significant losses, a tsunami event would most likely generate much more in losses. Please refer to Section 8 on Tsunamis to review the potential impact.

Map 4: Building Damage Percentage (Loss Ratio) in the City and Borough of Sitka for a 1% Flood Event



5. Earthquake Risk Assessment

Earthquake Hazard Overview

The City and Borough of Sitka is subject to numerous earthquake events of varying magnitudes. The region faces significant risk from earthquakes as Sitka resides between the Queen Charlotte-Fairweather fault and the Denali fault. The Queen Charlotte and Fairweather faults are the boundary of the meeting point of the North American and Pacific plates. Since 1900, three out of the ten largest earthquakes in the world have occurred within Alaska (City and Borough of Sitka Multi-Hazard Mitigation Plan, 2010).

Historic earthquakes in this area include a 2013 magnitude (M) 7.2-7.5 event on the Fairweather fault, a 1927 7.1M event in northern Chichagof Island, a 1949 8.1M event along the Queen Charlotte fault, a 1958 7.9M event on Fairweather fault near Lituya Bay, and a 1972 7.4M event near Sitka. It is estimated that, in this area, there are earthquakes of 7.0M or greater every year and earthquakes of 8.0M or greater every 14 years.

Additional factors resulting from earthquake events are liquefaction of soils, landslides, and tsunamis. Liquefaction occurs when sandy and silty soils with high water content act like a liquid resulting in ground failure. Ground failure can be a factor of landslides creating the potential for damages. Tsunamis result in increased wave action due to immense energy from earthquake events.

ShakeMaps

Maps depicting the shaking intensity and ground motion produced by 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 U.S. Geological Survey (USGS). ShakeMaps can be used for response, land use, and emergency planning purposes. ShakeMap scenarios in the vicinity of Sitka area are limited and currently do not exist for the Fairweather and Denali faults. One far reaching event, the 1964 Great Alaska Earthquake scenario, provides a glimpse at the potential earthquake hazards to Sitka. While shaking is expected to be minimal (Map 5), results from this assessment will assist with statewide planning efforts for emergency response.

Earthquake Risk Assessment Overview

For this study, individual building data from the City and Borough was incorporated into Hazus to allow losses to be reported at the parcel level. Only properties with buildings (improvements) were incorporated into the analysis; therefore, no impacts to vacant land were assessed. Assessments were simulated using two different building code assumptions: one scenario using the default Hazus building code parameters (referred to as the Default Scenario) while the other scenario utilized statewide building code adoption history (referred to as the Building Code Effectiveness Grading Schedule or BCEGS Scenario). Please refer to the building code section for a detailed methodology on incorporating local data into Hazus. The building loss from the earthquake assessments are summarized below in Table 6 and displayed in Maps 6 and 7.

Table 6: Hazus Earthquake Results for the M9.2 Earthquake in the City and Borough of Sitka

COMMUNITY NAME	TOTAL ESTIMATED VALUE (BUILDINGS AND CONTENTS)	TOTAL NUMBER OF BUILDINGS	M9.2 SCENARIO TOTAL LOSS (DEFAULT)	M9.2 SCENARIO LOSS RATIO (DEFAULT)	M9.2 SCENARIO TOTAL LOSS (BCEGS)	M9.2 SCENARIO LOSS RATIO (BCEGS)
Sitka City and Borough	$1,073,742,842	2,733	$3,076	0.0003%	$5,561	0.0005%
MAINLAND (BARANOF ISLAND)	$1,005,390,025	2,555	$2,912	0.0003%	$5,274	0.0005%
INHABITED ISLANDS	$68,352,817	178	$163	0.0002%	$287	0.0004%

Note: This table shows the total estimated parcel value by community. The total estimated value of improved parcels are only parcels with buildings. The total estimated value of parcels is the total building and content value on that parcel. Content value was estimated based on a percentage of the building value, as defined in the Hazus model. Dollar losses are also reported as a loss ratio, which is calculated by the total losses (including building and contents loss)/total building and contents value. Estimated loss values are for the M9.2 scenario.

The M9.2 scenario of the Great Alaska Earthquake proved to have minimal damages and the shaking alone does not pose a large threat to the City and Borough of Sitka. Though minimal, the BCEGS scenario shows a marginally higher total loss. This increase of loss is likely due to the stricter building code assumptions. Future assessments on the direct impact of earthquakes (and the shaking associated with them) should be focused on nearby faults like the Queen-Charlotte/Fairweather Fault. Due to the greater intensity and close proximity of the fault, loss values are expected to be much greater. The M9.2 Great Alaska Earthquake still poses considerable risk in regards to tsunami. Please refer to the tsunami assessment located in Section 8 of the Risk Report for additional information.

Essential Facilities

By utilizing local assessor data, essential facilities can be promoted for risk awareness and analyzed for potential mitigation opportunities. Sitka City and Borough does not have any building values associated with its schools, emergency response, and health care facilities. As a result, a simple vulnerability assessment providing a matrix of available hazards and whether or not the facility may intersect the hazard is provided below in Table 7.

Table 7: Essential Facility Vulnerability Assessment in the City and Borough of Sitka

ESSENTIAL FACILITY	ADDRESS	CATEGORY	EARTHQUAKE RISK	FLOOD RISK	LANDSLIDE RISK	TSUNAMI RISK
BARANOF ELEMENTARY SCHOOL	305 BARANOF STREET	EDUCATIONAL	YES	MINIMAL	UNIDENTIFIED	UNIDENTIFIED
BLATCHLEY MIDDLE SCHOOL	601 HALIBUT POINT ROAD	EDUCATIONAL	YES	MINIMAL	UNIDENTIFIED	UNIDENTIFIED
KEET GOOSHI HEEN ELEMENTARY SCHOOL	307 KASHEVAROFF STREET	EDUCATIONAL	YES	MINIMAL	UNIDENTIFIED	UNIDENTIFIED
SITKA HIGH SCHOOL	1000 LAKE STREET	EDUCATIONAL	YES	MINIMAL	UNIDENTIFIED	UNIDENTIFIED
SITKA SCHOOL DISTRICT OFFICE	300 KOSTROMETINOFF STREET	EDUCATIONAL	YES	MINIMAL	UNIDENTIFIED	UNIDENTIFIED
UNIVERSITY OF ALASKA SOUTHEAST	1332 SEWARD AVENUE	EDUCATIONAL	YES	MINIMAL	UNIDENTIFIED	IDENTIFIED
SITKA FIRE DEPARTMENT	209 LAKE STREET	FIRE	YES	MINIMAL	UNIDENTIFIED	UNIDENTIFIED
CITY AND BOROUGH OF SITKA	100 LINCOLN STREET	GOVERNMENTAL	YES	MINIMAL	UNIDENTIFIED	UNIDENTIFIED

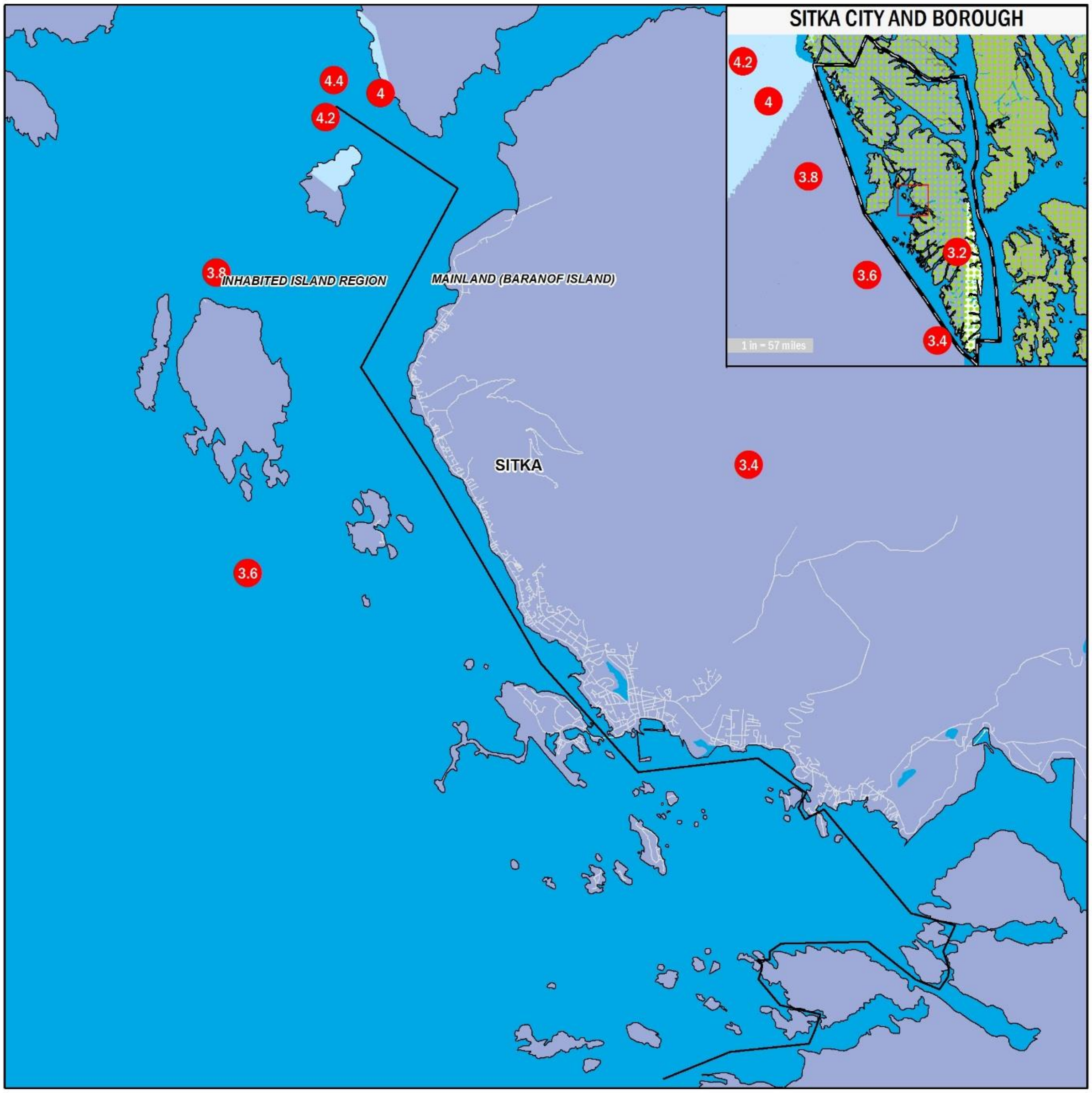
ESSENTIAL FACILITY	ADDRESS	CATEGORY	EARTHQUAKE RISK	FLOOD RISK	LANDSLIDE RISK	TSUNAMI RISK
KETTLESON MEMORIAL LIBRARY	320 HARBOR DRIVE	GOVERNMENTAL	YES	MINIMAL	UNIDENTIFIED	IDENTIFIED
SITKA POST OFFICE	1207 SAWMILL CREEK ROAD	GOVERNMENTAL	YES	MINIMAL	UNIDENTIFIED	UNIDENTIFIED
SITKA POST OFFICE	338 LINCOLN STREET	GOVERNMENTAL	YES	MINIMAL	UNIDENTIFIED	IDENTIFIED
SEARHC/MT. EDGECUMBE HOSPITAL	222 TONGASS DRIVE	HEALTH	YES	MINIMAL	UNIDENTIFIED	UNIDENTIFIED
SITKA COMMUNITY HOSPITAL	209 MOLLER AVENUE	HEALTH	YES	MINIMAL	UNIDENTIFIED	UNIDENTIFIED
SITKA POLICE DEPARTMENT	304 LAKE STREET	POLICE	YES	MINIMAL	UNIDENTIFIED	UNIDENTIFIED

Note: Essential Facility locations are approximate. Earthquake risk is prevalent from the Queen Charlotte and Fairweather Fault. No 0.2 or 1-percent-annual-chance flood hazard areas were identified for the above facilities. No structures intersect the South Kramer Landslide Assessment area. Tsunami area identified using the maximum credible scenario.

Future assessments are needed to determine the resilience of Sitka's essential facilities. Under the M9.2 Great Alaska Earthquake, it is assumed that shaking will not cause considerable damage to the facilities. However a tsunami generated from that event could pose a high risk to the University of Alaska located on Japonski Island, Kettleson Memorial Library, and the Sitka Post Office off of Lincoln Street. A future earthquake assessment using a scenario of a large earthquake along the Queen Charlotte and Fairweather Faults will provide a better assessment of the local risk to earthquakes. Additionally, landslides assessments, which at present time are only available for the South Kramer area, should be conducted in other areas of the community where necessary.

Map 5: USGS ShakeMap of M9.2 Great Alaska Earthquake Scenario

SHAKEMAP: M9.2 SCENARIO



MAP SYMBOLOGY

EXPECTED INTENSITY

II - III	WEAK	VI	STRONG	IX	VIOLENT
IV	LIGHT	VII	VERY STRONG	X+	EXTREME
V	MODERATE	VIII	SEVERE		

5.1 MODIFIED MERCALLI INTENSITY VALUE

BASEMAP LAYERS

- PROJECT AREA BOUNDARY
- FEDERAL LAND
- LOCAL ROAD

ABOUT

THIS MAP DISPLAYS INSTRUMENTAL INTENSITY DURING A MAGNITUDE 9.2 GREAT ALASKA EARTHQUAKE SCENARIO.

1 in = 2 miles 1:101,253

SOURCE DATA FOR THIS RISK REPORT WAS COMPILED FROM FEMA'S REGION X OFFICE, FEMA'S MAP SERVICE CENTER, USGS, AND THE STATE OF ALASKA DIVISION OF GEOLOGICAL AND GEOPHYSICAL SURVEYS.
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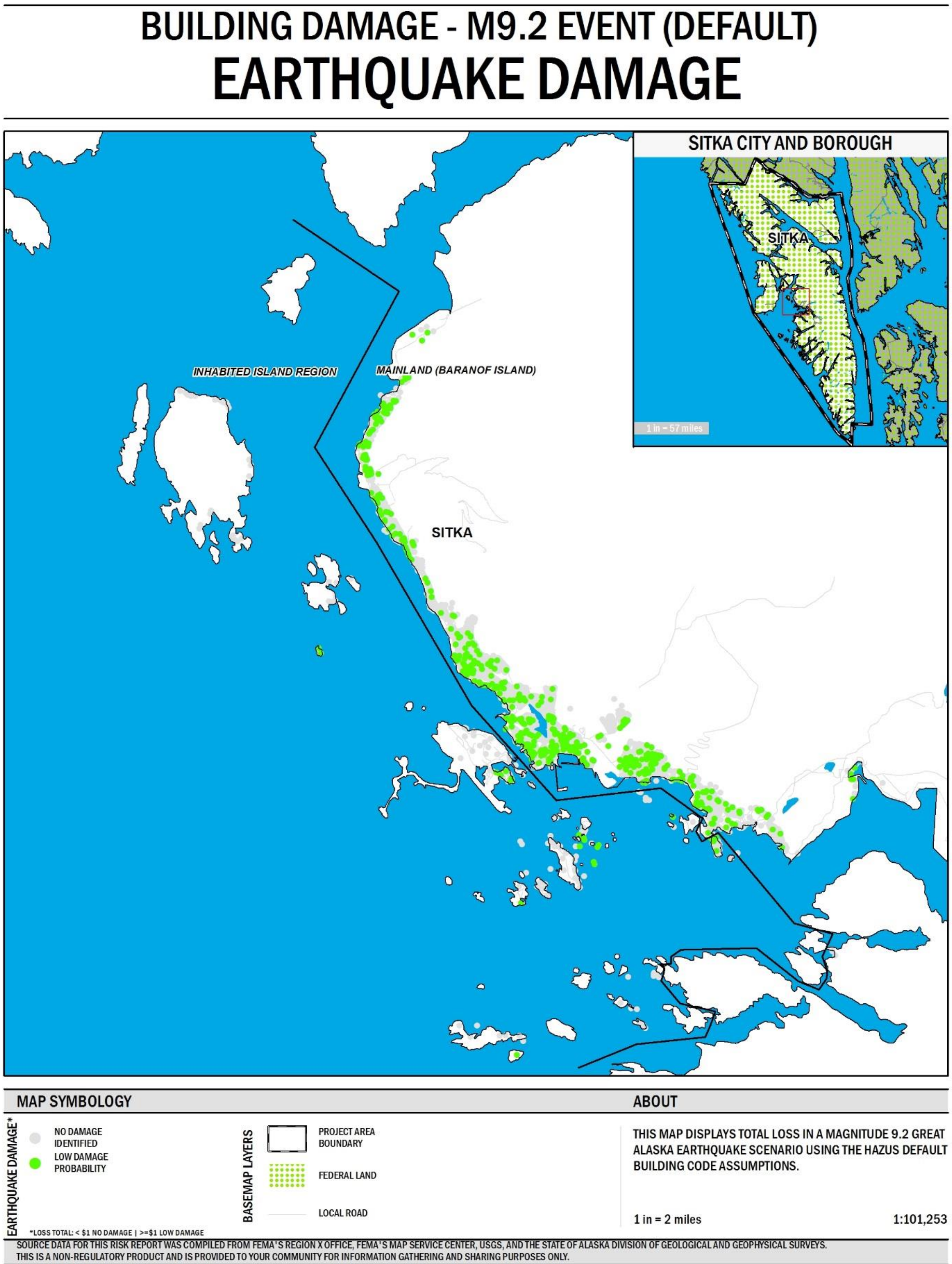
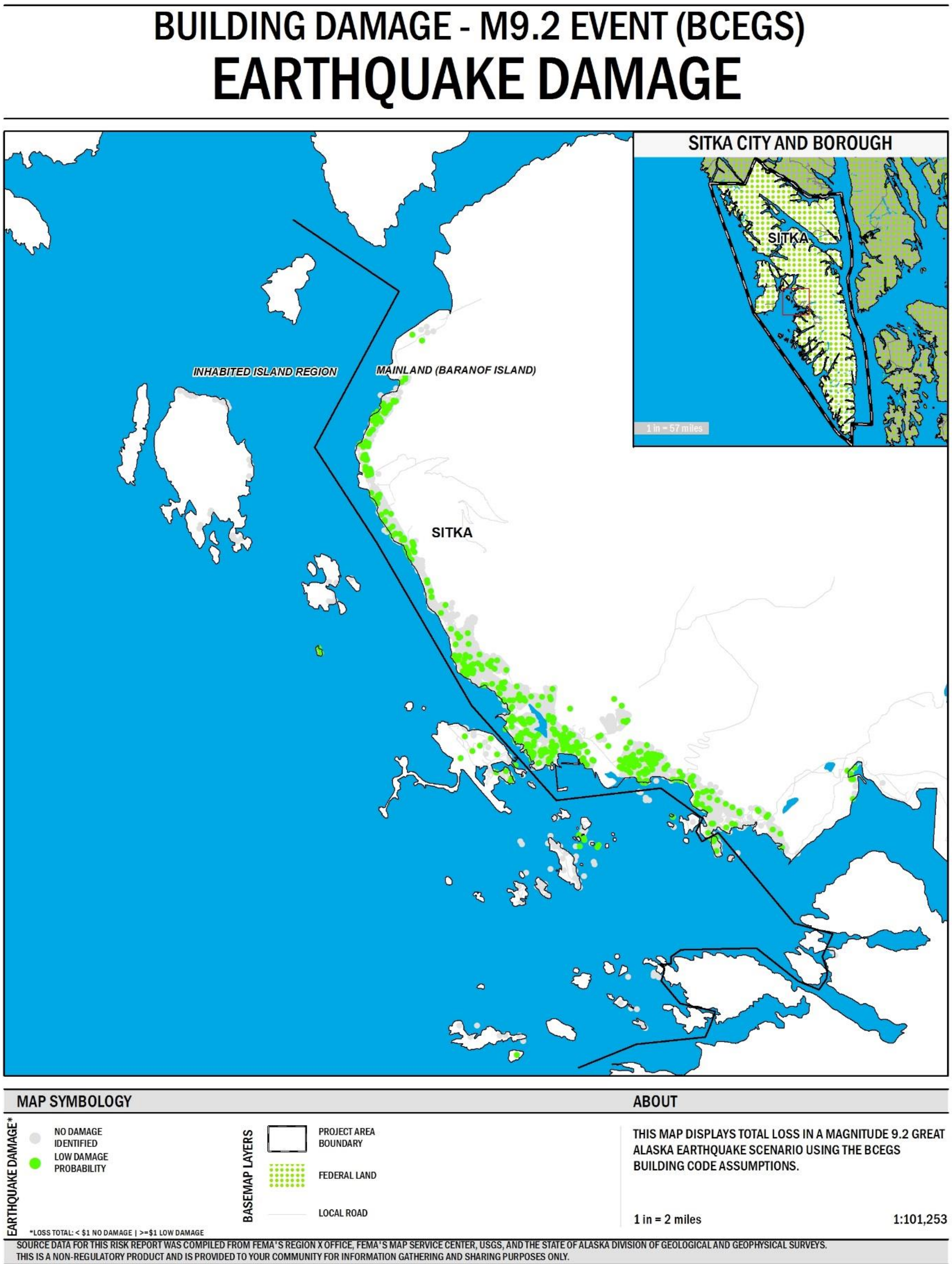
Map 6: Building Damage Percentage (Loss Ratio) in the City and Borough of Sitka for a M9.2 Great Alaska Earthquake (Default Scenario)*



**damage does not factor collateral effects like landslides, land subsidence, liquefaction, fire, flooding, or tsunami*

Map 7: Building Damage Percentage (Loss Ratio) in the City and Borough of Sitka for a M9.2 Great Alaska Earthquake (BCEGS Scenario)*



**damage does not factor collateral effects like landslides, land subsidence, liquefaction, fire, flooding, or tsunami*

Transportation and Utility Assessment

Hazus also provides an analysis on transportation and utility systems. Transportation systems include highways, railways, light rail, buses, ports, ferries, and airports. Utility systems include potable water, wastewater, natural gas, crude and refined oil, electric power, and communications. The transportation and utility information was taken from the original Hazus database. No local updates were applied, so the number of facilities could vary greatly from what actually exists. Table 8 provides an overview of potential damage to transportation systems in the event of a M9.2 earthquake, summarized at the Borough level. **Error! Reference source not found.** provide an overview of the utility systems in the event of a M9.2 earthquake.

Table 8: Transportation System Impacts for a M9.2 Great Alaska Earthquake in the City and Borough of Sitka

TRANSPORTATION SYSTEM	COMPONENT	LOCATIONS / SEGMENTS	MODERATE DAMAGE OR GREATER	FUNCTIONALITY		INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
				After Day 1	After Day 7			
Highway	Segments	--	0	--	--	--	--	--
	Bridges	36	0	36	36	187,830,000	170,000	0.09
	Tunnels	--	0	--	--	--	--	--
Railway	Segments	--	0	--	--	--	--	--
	Bridges	--	0	--	--	--	--	--
	Facilities	3	0	3	3	8,040,000	30,000	0.41
Light Rail	Segments	--	0	--	--	--	--	--
	Facilities	--	0	--	--	--	--	--
	Facilities	--	0	--	--	--	--	--
Bus	Facilities	--	0	--	--	--	--	--
Ferry	Facilities	1	0	1	1	1,340,000	10,000	0.75
Port	Facilities	18	0	18	18	48,270,000	470,000	0.97
Airport	Runways	1	0	1	1	38,320,000	0	--
	Facilities	1	0	1	1	6,700,000	70,000	1.04
TOTAL		**60**	**0**	**60**	**60**	**290,400,000**	**700,000**	**0.24**

Table 9: Utility System Impacts for a M9.2 Great Alaska Earthquake in the City and Borough of Sitka

UTILITY SYSTEM	COMPONENT	FACILITIES / SEGMENTS (KM)	MODERATE DAMAGE OR GREATER	FUNCTIONALITY		INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
				After Day 1	After Day 7			
Potable Water	Facilities	--	--	--	--	7,000,000	0	--
	Pipelines	348	0	--	--	--	--	--
Waste Water	Facilities	1	0	1	1	81,900,000	0	--
	Pipelines	209	0	--	--	4,200,000	0	--
Oil Systems	Facilities	--	--	--	--	--	--	--
	Pipelines	--	--	--	--	--	--	--

UTILITY SYSTEM	COMPONENT	FACILITIES / SEGMENTS (KM)	MODERATE DAMAGE OR GREATER	FUNCTIONALITY		INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
				After Day 1	After Day 7			
Natural Gas	Facilities	--	--	--	--	--	--	--
	Pipelines	139	0	--	--	2,800,000	0	--
Electric Power	Facilities	--	--	--	--	--	--	--
Communication	Facilities	4	0	4	4	500,000	0	--
TOTAL		**4/696**	**0**	**5**	**5**	**96,400,000**	**0**	**--**

The utility system loss estimation capabilities require a great deal of user input and modification to model the inventory, which was beyond the scope of this report.

Minimal economic losses for transportation systems are projected for the M9.2 Great Alaska Earthquake scenario. The greatest risk from the earthquake is posed to the port and airport facilities (whose loss values don't account for impacts from tsunami). Port and airport facilities have estimated loss ratios at 1-percent with an estimated $540 thousand in economic loss. Collectively, transportation systems are estimated to lose $700 thousand, which represents a loss ratio of 0.42-percent.

Utility systems are not posed to have any immediate adverse impact caused by the shaking from a M9.2 Great Alaska Earthquake. Functionality remains at 100-percent and no identified economic loss occurs as a result of the earthquake.

Building Code Analysis

The loss data from Hazus and the design code analysis can highlight the buildings and areas potentially affected by earthquakes and can be used to identify properties for mitigation projects and areas for additional outreach. Highlighted areas of greatest impacts and potential mitigation actions are shown in the community sections of this report (Section 12).

For this earthquake assessment, the following two building code scenarios were developed:

Default Scenario

Hazus identifies key changes in earthquake building codes, based on year. The NEHRP United States Seismic Zone Map from the 1997 Edition of the Universal Building Code identifies the Sitka City and Borough in Zone 3. Utilizing the HAZUS-MH guidelines based on seismic zone, the following designations were assumed:

1. Structures (except those with a wood frame and under 5,000 square feet) and structures built prior to 1941 are considered pre-code.

2. For all other buildings, moderate-code is designated if:
    a. Structures with a wood frame and under 5,000 square feet (or)
    b. Any buildings constructed 1941 or after.

The dates for local building codes may be slightly different than the dates shown below, but the information can be used as a general planning tool until more information on the local building code can be acquired. These assumptions are based off of HAZUS-HM guidelines.

BCEGS Scenario

Alaska statewide adoption of building codes did not occur until September 2005 (for commercial buildings) and have yet to be adopted for residential structures. Local enforcement of building codes may vary by jurisdiction. For this Risk Assessment effort the following designations were assumed:

1. Structures (except those with a wood frame and under 5,000 square feet) and structures built prior to 2004 are considered pre-code.
2. Structures with a wood frame and under 5,000 square feet are considered moderate code.
3. Buildings built in 2004 or after are considered high code.

Table 10: Building Codes for Structures in Sitka City and Borough (Default Scenario)

COMMUNITY NAME	TOTAL NUMBER OF BUILDINGS	TOTAL PRE-CODE BUILDINGS	PERCENT PRE-CODE BUILDINGS	TOTAL MODERATE-CODE BUILDINGS	PERCENT MODERATE-CODE BUILDINGS
SITKA CITY AND BOROUGH	2,733	27	1.0%	2,706	99.0%
MAINLAND (BARANOF ISLAND)	2,555	27	1.1%	2,528	98.9%
INHABITED ISLANDS	178	0	0.0%	178	100.0%

Table 11: Building Codes for Structures in Sitka City and Borough (BCEGS Scenario)

COMMUNITY NAME	TOTAL NUMBER OF BUILDINGS	TOTAL PRE-CODE BUILDINGS	PERCENT PRE-CODE BUILDINGS	TOTAL MODERATE CODE BUILDINGS	PERCENT MODERATE CODE BUILDINGS	TOTAL HIGH-CODE BUILDINGS	PERCENT HIGH-CODE BUILDINGS
SITKA CITY AND BOROUGH	2,733	242	8.9%	2,145	78.5%	346	12.7%
MAINLAND (BARANOF ISLAND)	2,555	233	9.1%	2,012	78.7%	310	12.1%
INHABITED ISLANDS	178	9	5.1%	133	74.7%	36	20.2%

High loss ratios in earthquake events are typically attributed to the number of pre-code structures. Because of their age and pre-code status, these buildings would not perform as well in an earthquake event. Contrarily, high-code buildings will fare much better in the event of an earthquake. Here, two scenarios are compared to show the percentages of buildings within each code.

DEFAULT SCENARIO

The default scenario references the 1997 United States Seismic Zone Map, using predetermined codes for Zone 3, Sitka's respective zone. The City and Borough of Sitka contains a total of 2,733 buildings, of which 27 buildings are determined to be pre-code. Moderate code buildings are determined to be built between 1941 and present day, or before 1941, built with a wood frame, and under 5,000 square feet. The City and Borough of Sitka contains 2,706 moderate-code buildings. Moderate-code buildings are considered to have some basic building standards to protect the integrity of structures and may limit losses in the event of an earthquake. Pre-code buildings, which make up 1.0-percent of the City and Borough of Sitka were built prior to assumed local building code adoption. While 99.0-percent of structures are of moderate-code, adopting earthquake specific codes may improve the structural integrity of buildings and would reduce potential losses from an earthquake event.

BCEGS SCENARIO

The BCEGS scenario includes high-code buildings which, as defined by this scenario, are buildings built after 2004. Pre-code structures were built prior to 2004 or are residential without a wood frame. Under this scenario, 242 buildings are determined to be pre-code, 2,145 buildings are determined to be moderate-code, and the remaining 346 buildings hold a high-code rating. A total of 8.9-percent of buildings are pre-code and are assumed to be more susceptible to earthquake damage than moderate or high code buildings. High code buildings account for 12.7-percent of total buildings in the City and Borough of Sitka. A majority of structures (78.5-percent) fall in the moderate-code category and may contain some basic design standards to reduce the impact of an earthquake event.

6. Landslide Risk Assessment

Landslide Hazard Overview

Landslides occur throughout the U.S and can be caused by a variety of factors including earthquakes, storms, volcanic eruptions, fire and by human modification of land. Landslides can occur quickly, especially during wet winter months. Landslides usually occur in steep areas, but not exclusively. Occurrence can happen at ground failure of river bluffs, cut-and-fill failures associated with road and building excavations, collapse of mine-waste piles, and slope failures associated with open-pit mines and quarries. Underwater landslides usually involve areas of low relief and slope gradients in lakes and reservoirs or in offshore marine settings.

The City and Borough of Sitka is vulnerable to landslides primarily in areas with high ground failure susceptibility. Sitka and surrounding areas consist of mountainous forest lands from the adjacent Tongass National Forest and coastline of the Pacific Ocean. Baranof Island, of which much of the population is located on, is the most mountainous island in the Alexander Archipelago. Outdoor recreation including hiking, backpacking, and skiing are popular in this area adding potential risks to landslide events.

A landslide in 2015 was responsible for the death of three individuals. This landslide began along the western side of Harbor Mountain and came to rest near the southern end of Kramer Road (Shannon & Wilson, 2016). The terrain in this area enabled landslide susceptibility. Harbor Mountain reaches slopes of greater than 100 percent (45°) with a steady 70 percent slope down the mountainside. Once the slope meets Kramer Road, the slope is only about 14 percent (Shannon & Wilson, 2016). The Kramer landslide was determined to be a natural event caused by multiple conditions increasing the likelihood of an event. A future risk analysis was completed to determine the potential future risks of Kramer Avenue. Modeling concluded that, as long as the protective berms were left in place, the flow would end in the same location of Kramer Avenue should another event occur. However, if the berms were to be removed, the flow could continue roughly 400 feet southwest of Kramer Avenue.

Other common landslide prone areas are located along Halibut Point Road and Blue Lake Road as well as near Redoubt Lake, where a landslide destroyed a Forest Service Cabin (City and Borough of Sitka Multi-hazard Mitigation Plan, 2010).

Landslide Risk Assessment

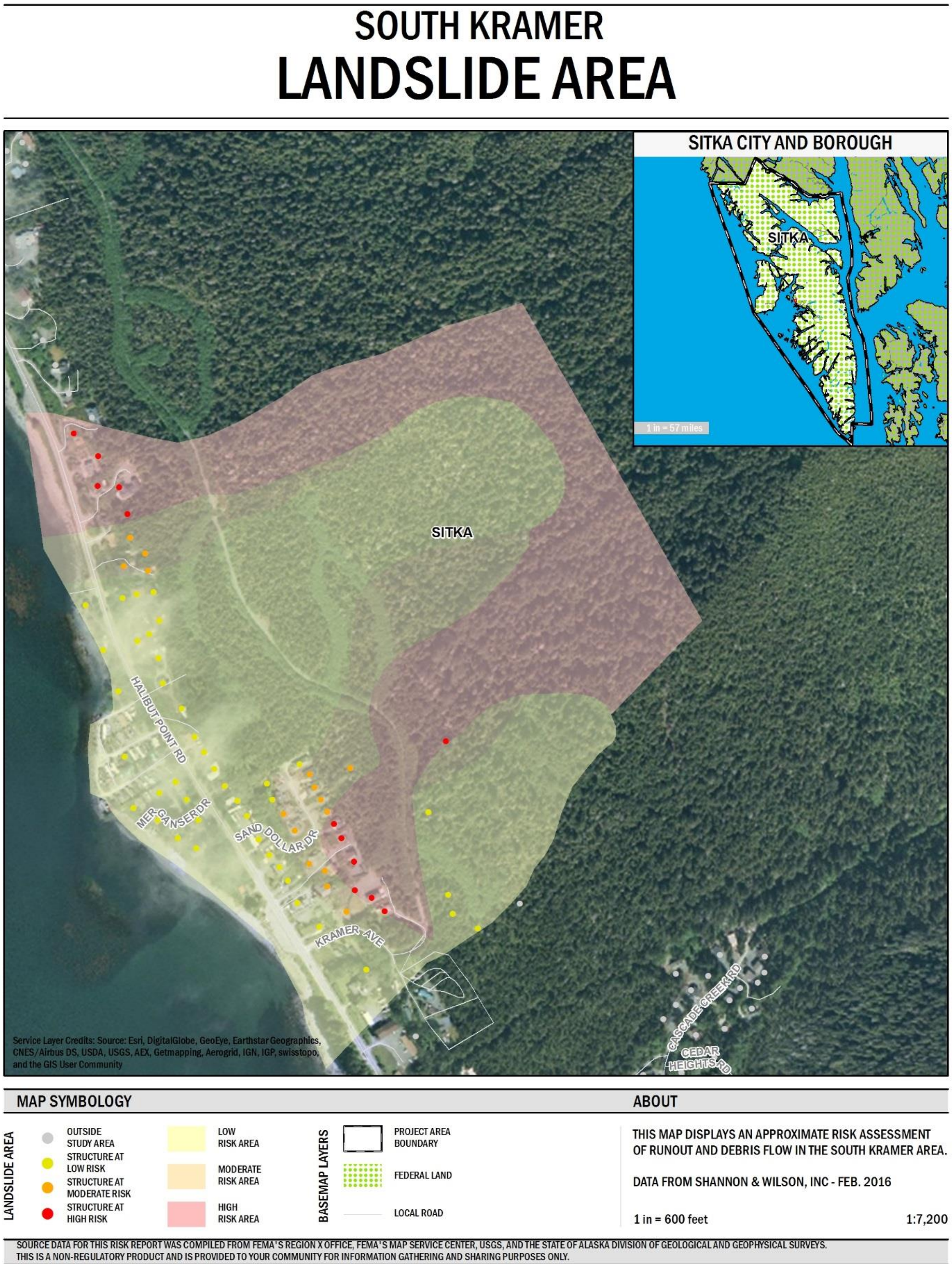
The South Kramer Landslide Report published in February 2016 provided a risk map assessing localized risk to debris flow. Risk categories range from low to high identifying potential exposure to future runout and debris flow in the Kramer area. As part of this risk assessment, the map was digitized and captured spatially (Map 8) to identify buildings at risk and to what extent.

COMMUNITY NAME	BUILDING VALUE IN LANDSLIDE ZONE	NUMBER OF BUILDINGS IN LANDSLIDE AREA	BUILDING VALUE IN HIGH RISK AREA	NUMBER OF BUILDINGS IN HIGH RISK AREA	BUILDING VALUE IN MODERATE RISK AREA	NUMBER OF BUILDINGS IN MODERATE RISK AREA
SITKA CITY AND BOROUGH	$27,140,185	68	$4,982,708	12	$7,102,609	15

Note: Per the South Kramer Landslide Report, the boundaries are considered approximate and should be utilized as a basis of planning and identifying potential mitigation activities and not as an accurate prediction of future runout distance or direction.

The City and Borough of Sitka contains 68 buildings within the South Kramer Landslide Hazard Area totaling just over $27 million. Of the 68 structures, 12 are determined to be in high risk areas and 15 in moderate risk areas. For buildings in high risk zones, the building value reaches nearly $5 million. Moderate risk structures value just over $7 million, $2 million more than buildings in high risk. Low risk buildings make up the remaining $15 million in the study area which is slightly over half the total building value in the identified South Kramer Landslide area.

Map 8: South Kramer Landslide Hazard Areas



7. Tsunami Risk Assessment

Tsunami Hazard Overview

A tsunami is a series of large, powerful waves that are generated by water displacement in the ocean. This displacement occurs when large amounts of energy is shifted by events such as underwater earthquakes, landslides, and volcanic eruptions (City and Borough of Sitka Multi-hazard Mitigation Plan, 2010). Tsunami waves begin as fast, long, and low waves but as they near the coastline they become slower, shorter, and higher. The increased height creates a wall of powerful water and is the basis of much destruction.

Studies have shown that the Alaska and Aleutian Seismic Zone has an 84 percent predicted occurrence of an earthquake of 7.4M or greater. If this occurs, Alaska's coastlines would be flooded within 15 minutes (City and Borough of Sitka Multi-hazard Mitigation Plan, 2010). While earthquake generated tsunamis may only allow minutes for evacuation, the first wave is not usually the most powerful or damaging providing additional time. A landslide generated tsunami, however, has no warning time and is responsible for the most tsunami related deaths in Alaska (City and Borough of Sitka Multi-hazard Mitigation Plan, 2010).

For the City and Borough of Sitka, estimates of distant source tsunami hazard (where the earthquake that generated the tsunami was not felt due to distance but the potential risk is still prominent) indicate that Sitka could experience runup to 50-foot elevation and covering up to 1 mile inland. Sitka is also listed to have a local tsunami hazard, meaning that Sitka may experience tsunami waves before sufficient warning can be given. Sitka is designated high risk for both local and Pacific-wide tsunamis (City and Borough of Sitka Multi-hazard Mitigation Plan, 2010).

The City and Borough of Sitka is prepared with tsunami warning signals by way of outdoor warning sirens, television audio and video overrides, local broadcast system or emergence vehicles, and phone messaging (dial-down) systems (City and Borough of Sitka Multi-hazard Mitigation Plan, 2010).

Below is a table outlining the most recent tsunami generated presidentially declared disasters in the United States:

Table 12: Recent Presidentially Declared Tsunami Disaster History for the U.S. West Coast

DISASTER NUMBER	DECLARATION DATE	STATE	COUNTY	INCIDENT TYPE	TITLE	INCIDENT BEGIN/END DATE	TOTAL PUBLIC ASSISTANCE GRANTS - DOLLARS OBLIGATED*
DR-1968	4/18/2011	CA	Del Norte	Tsunami	TSUNAMI WAVES	3/11/2011	
DR-1968	4/18/2011	CA	Monterey	Tsunami	TSUNAMI WAVES	3/11/2011	$38,602,951.31
DR-1968	4/18/2011	CA	Santa Cruz	Tsunami	TSUNAMI WAVES	3/11/2011	
DR-1967	4/8/2011	HI	Hawaii	Tsunami	TSUNAMI WAVES	3/11/2011	
DR-1967	4/8/2011	HI	Honolulu	Tsunami	TSUNAMI WAVES	3/11/2011	$6,544,834.12
DR-1967	4/8/2011	HI	Maui	Tsunami	TSUNAMI WAVES	3/11/2011	
DR-1964	3/25/2011	OR	Coos	Tsunami	TSUNAMI WAVE SURGE	3/11/2011	
DR-1964	3/25/2011	OR	Curry	Tsunami	TSUNAMI WAVE SURGE	3/11/2011	$5,611,823.24
DR-1964	3/25/2011	OR	Lincoln	Tsunami	TSUNAMI WAVE SURGE	3/11/2011	

Tsunami Risk Assessment

Tsunami models are available for the Sitka Sound, via the Alaska Division of Geological and Geophysical Surveys (DGGS). Hypothetical composite lines, also referred to as "maximum credible scenarios," generate a maximum extent of tsunami inundation based on all model simulations (Map 9). The composite lines are generated by the following models:

> (DGGS) performed numerical modeling of historic events at Sitka, such as the tsunami triggered by the 1964 Great Alaska Earthquake, and the tsunami waves generated by the recent 2011 Tohoku and 2012 Haida Gwaii earthquakes. Hypothetical tsunami scenarios include variations of the extended 1964 rupture, megathrust earthquakes in the Alaska Peninsula region and in the Cascadia subduction zone, and a thrust earthquake in the region of the Queen Charlotte-Fairweather fault zone (Suleimani, E.N., Nicolsky, D.J., and Koehler, R.D, 2013).

For this risk assessment, the locations of improved parcels were compared to the geographic extent of the tsunami. The results of the risk assessment are shown in Table 13.

Table 13: Building Exposure Associated with Maximum Credible Scenario Tsunamis in Sitka Sound

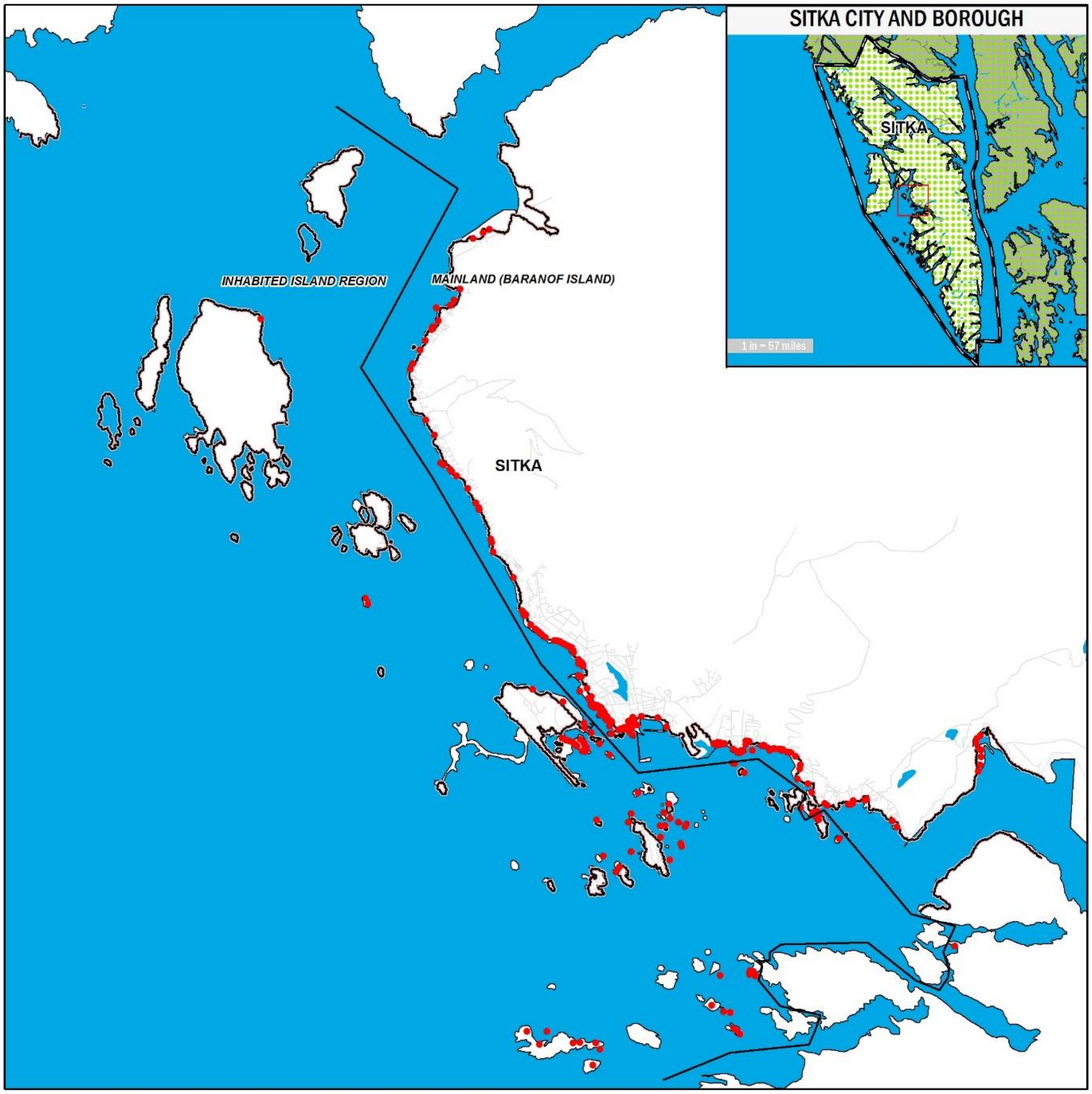
COMMUNITY NAME	TOTAL ESTIMATED VALUE OF BUILDINGS	BUILDING VALUE IN TSUNAMI ZONE	TOTAL NUMBER OF BUILDINGS	TOTAL NUMBER OF BUILDINGS IN TSUNAMI ZONE	PERCENTAGE OF BUILDINGS IN TSUNAMI ZONE
SITKA CITY AND BOROUGH	$1,073,742,841	$181,613,659	2,733	270	9.9%
MAINLAND (BARANOF ISLAND)	$1,005,390,025	$138,194,313	2,555	170	6.7%
INHABITED ISLANDS	$68,352,817	$43,419,347	178	100	56.2%

Approximately 10-percent of Sitka's building stock (270 buildings) are in an identified tsunami hazard area. The inhabited islands in Sitka Sound have a greater proportion of buildings at risk when compared to the mainland. Of the 178 buildings, 100 (56.2-percent) are determined to be located within a tsunami hazard area totaling $43.5 million. The Mainland has a greater quantity of structures at risk (170) but a smaller fraction of the overall building stock at 6.7-percent. The value of structures at risk is more than three times higher than the inhabited islands, totaling just over $138 million. Overall, Sitka closely approaches $200 million in building and content losses if a worst case scenario tsunami event were to occur.

The tsunami inventory assessment can be used to identify properties for mitigation projects as well as areas for additional outreach. Areas of greatest impact and potential mitigation actions will be shown in the community sections of this report (Section 12, Areas of Mitigation Interest). All results, databases, and maps are provided in the Risk Assessment Database included with this report.

Map 9: Maximum Inundation for a Sitka Sound Tsunami

MAXIMUM EXTENT
TSUNAMI



MAP SYMBOLOGY

TSUNAMI HAZARD
- STRUCTURE AT RISK
- ESTUNATED TSUNAMI INUNDATION EXTENT

BASEMAP LAYERS
- PROJECT AREA BOUNDARY
- FEDERAL LAND
- LOCAL ROAD

ABOUT

THIS MAP DISPLAYS THE MAXIMUM TSUNAMI EXTENT FOR ALL CREDIBLE SCENARIOS AND HISTORIC EVENTS.

1 in = 2 miles 1:101,253

SOURCE DATA FOR THIS RISK REPORT WAS COMPILED FROM FEMA'S REGION X OFFICE, FEMA'S MAP SERVICE CENTER, USGS, AND THE STATE OF ALASKA DIVISION OF GEOLOGICAL AND GEOPHYSICAL SURVEYS.
THIS IS A NON-REGULATORY PRODUCT AND IS PROVIDED TO YOUR COMMUNITY FOR INFORMATION GATHERING AND SHARING PURPOSES ONLY.

8. Avalanche Hazard Profile

Avalanche Hazard Overview

The two main types of snow avalanches are loose snow avalanches and slab avalanches. Loose snow avalanches occur when a portion of snow slips and brings with it more loose snow. These can become dangerous when the snow is wet, such as in the spring, or when loose snow avalanches trigger slab avalanches. Slab avalanches occur when a mass of snow (slab) breaks free and travels downward. Once released, the slab breaks into smaller pieces and gains speed becoming especially dangerous (City and Borough of Sitka Multi-hazard Mitigation Plan, 2010).

Factors that influence avalanche conditions include terrain details such as vegetation cover, slope angle, and elevation. In addition to terrain, weather and precipitation patterns may have effects on avalanche susceptibility. More sunlight causes snow melt which makes for a heavier, weaker slope. Inversely, shaded, icy snow may break away from layers of inconsistent snow. Typically, avalanches occur in slopes greater than 25 degrees but less than 60 degrees. Once a slope reaches 60 degrees the snow will not hold and will fall off right away (City and Borough of Sitka Multi-hazard Mitigation Plan, 2010). Aside from environmental factors, human activity increases the likelihood of an avalanche. Activities such as skiing/snowboarding in backcountry terrain increases the avalanche potential with no warning.

The City and Borough of Sitka has limited avalanche risk due to the containment of avalanches to the mountainous backcountry. However, the probability of an avalanche occurring in Sitka is high. Avalanches in this area are likely to occur annually but with little impact to the populated areas of Sitka (City and Borough of Sitka Multi-hazard Mitigation Plan, 2010). According to the Sitka City and Borough Hazard Mitigation Plan, Blue Lake Road is an avalanche danger zone. With several avalanche paths crossing here, the use of this road is dangerous. A common road for locals, there is currently no warning system in place in the event of an avalanche.

Currently there is not enough complete data to assess avalanche risk within the project area. Additional risk data and assessments may be explored as more information is available.

9. Wildfire Hazard Profile

Wildfire Hazard Overview

Wildfires are defined as fire that rages out of control in the wilderness, like a forest or countryside. Wildfires are common in wildland settings where the initiation may often begin unnoticed promoted by outside influences such as lightening or human caused disturbance. These hazard events can occur at any time throughout the year but have higher potential during period of drought or little rainfall. High winds can also contribute to the spreading of fire. Wildfires spread quickly, igniting brush, trees, and homes.

The City and Borough of Sitka is at risk for wildfires due to the forestry located throughout the City and Borough. Fuel, weather, and topography influence wildland fire behavior. Fuel determines how much energy the fire releases, how quickly the fire spreads, and how much effort is needed to contain the fire. The primary fuels in wildland fires are living and dead vegetation. Weather is the most variable and uncontrollable factor in wildland fire fighting. Weather includes temperature, relative humidity, wind, and precipitation. High temperatures and low humidity encourage fire activity, while low temperatures and high humidity help retard fire behavior. Wind dramatically effects fire behavior and is a critical factor in fire spread and control. Topography directs the movement of air, which can also affect fire behavior. When the terrain funnels air, as in a canyon, it can lead to faster spreading.

Table 14: Wildfire Hazard History within the City and Borough of Sitka

DATE	DESCRIPTION
May 1-9, 1979	Six wildfires occurred in the Sitka areas with a total of 51.5 acres destroyed
April 25, 1980	State fire crews from Big Lake and Eagle River responded to a fire on Schrock Road. Approximately 25 people, four ground tankers, and one all-terrain vehicles were involved containing the 20 acre blaze
June 1996	Miller's Reach fire destroyed 450 buildings in the Big Lake area west of Wasilla. Wasilla became the Incident Command center for the fire. Smoke and ash from the fire drifted to Wasilla.

No presidentially declared wildfire disasters have been identified to date in the City and Borough of Sitka. However, the potential exists. Wildfires in Sitka are unlikely due to the relatively low temperatures and high precipitation. While the risk is minor, the potential increases with decreased precipitation and/or drought conditions.

The City and Borough of Sitka holds one active fire department for the entire 2,900 square mile area. The Sitka Fire Department consists of four divisions: fire, emergency medical, search and rescue, and dive. These divisions are made up of ten paid positions and 85 volunteer positions (City of Sitka, 2016).

Table 15: Fire Statistics for Alaska Division of Forestry in the City and Borough of Sitka

YEAR	NUMBER OF FIRES	ACRES
1990	96	55.0
1991	116	1,267.4
1992	111	155.3
1993	121	134.7
1994	95	36.2
1995	90	163.1
1996	186	37,871.0
1997	149	155.9
1998	77	52.9
1999	106	781.1
2000	108	57.2
2001	106	398.1
2002	151	1,771.8

Currently there is not enough complete data to assess wildfire risk within the project area. Additional risk data and assessments may be explored as more information is available.

Map 10: Historic Wildfire Incidents

13. Citations

Bechtol Planning & Development, City and Borough of Sitka, WHPacific, 2010, City and Borough of Sitka Multi-Hazard Mitigation Plan.

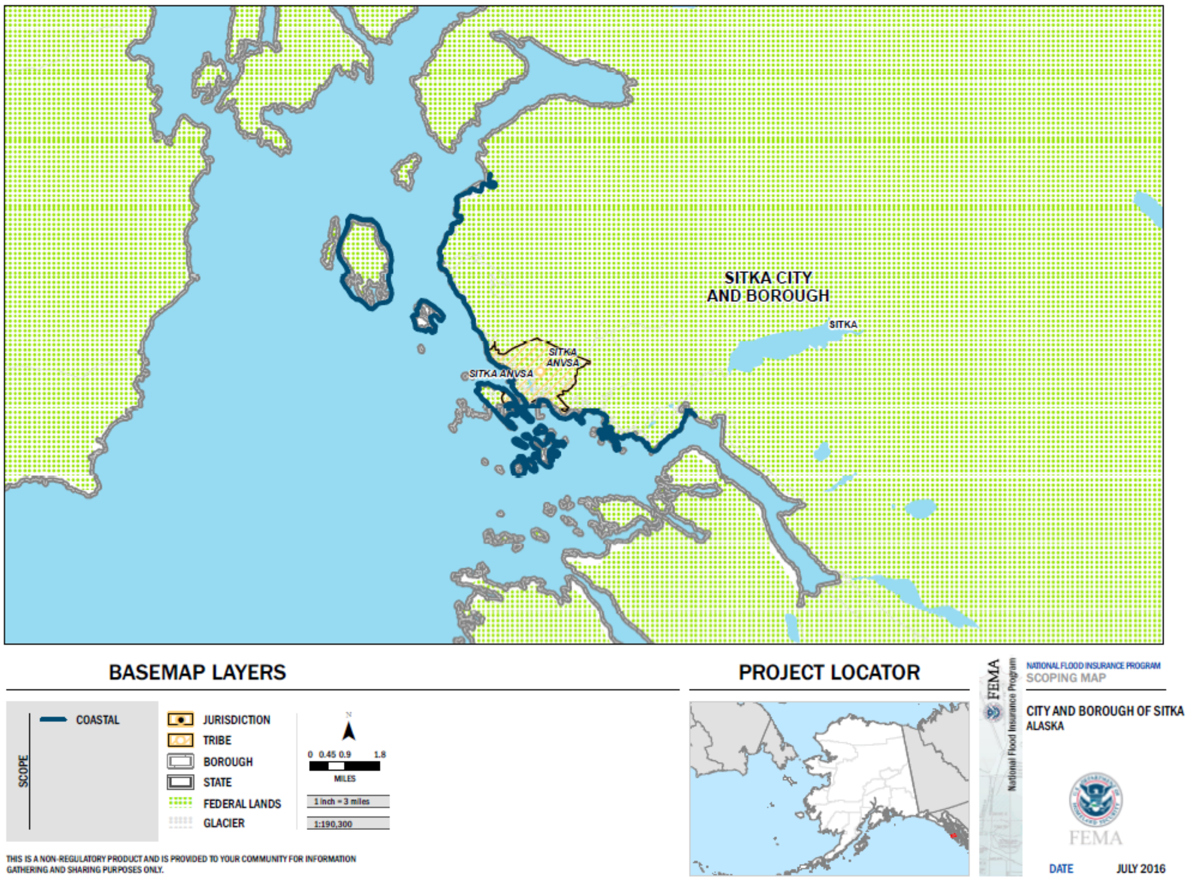
City of Sitka, 2016, The Official Web Site of the City and Borough of Sitka, http://www.cityofsitka.com/

Flood Insurance Study, FEMA, 2016, City and Borough of Sitka Alaska, Volume 1.

Shannon & Wilson, 2016, South Kramer Avenue Landslide: Jacobs Circle to Emmons Street, Sitka, Alaska.

Suleimani, E.N., Nicolsky, D.J., and Koehler, R.D., 2013. Tsunami inundation maps of Sitka, Alaska, http://www.dggs.alaska.gov/pubs/id/26671

10. Appendix



Map of project scope for the City and Borough of Sitka, Alaska.